Grades 9-12 Science  
Biology

Characteristics of Life

Stage 1: Desired Results

Catholic Standards

DOC All Grades DOC: Catholic Standards

The Profession of Faith

Students will be able to

1. Recognize God in the world's order, beauty, and goodness (CCC 32).

8. Understand that the world was made for the glory of God, the Creator of all things (CCC 290; 293).

9. Know that we are created in God's image to serve Him and to rule over all creatures (CCC 380).

Life in Christ

Students will be able to

2. Know that we must assume responsibility for the acts we perform (CCC 1781).

7. Assume personal responsibility (CCC 1914).

11. Respect all human life (CCC 2318).

12. Respect the integrity of all creation, including animals, plants, and all nature (CCC 2415).

Targeted Standards

NGSS Grade 2 NGSS: Disciplinary Core Ideas

ETS1: Engineering Design

Defining and Delimiting an Engineering Problem

A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. (K-2-ETS1- 1) (secondary to KPS2-2)

NGSS Grade 9-12 NGSS: Crosscutting Concepts

Crosscutting Statements

Patterns Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

OH Grade 9-12 OH: Science (2011)

HS Biology

Science Inquiry and Application During the years of grades 9 through 12 all students must use the following scientific processes to construct their knowledge and understanding in all science content areas:

Identify questions and concepts that guide scientific investigations;

Design and conduct scientific investigations;

Use technology and mathematics to improve investigations and communications;

Formulate and revise explanations and models using logic and evidence (critical thinking);

Recognize and analyze explanations and models

Communicate and defend a scientific argument.

Course Content:Cells

Cellular processes: Characteristics of life regulated by cellular processes

OH Grades 9-10 OH: Literacy in History/Social Studies, Science, & Technical Subjects 6-12

Capacities of the Literate Individual

Students Who are College and Career Ready in Reading, Writing, Speaking, Listening, & Language

They demonstrate independence.

Reading: Science & Technical Subjects

Integration of Knowledge and Ideas 7. Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words.

RST.9-10.7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

Read and comprehend complex literary and informational texts independently and proficiently.

RST.9-10.10. By the end of grade 10, read and comprehend science/technical texts in the grades 910 text complexity band independently and proficiently.

Catholic Identity

DOC All Grades Catholic Identity

Catholic Social Justice Teachings

Care for God's Creation

The Rights of Children

5. THE RIGHT TO A LEARNING ENVIRONMENT THAT VALUES COOPERATION and challenges its members to critical and reflective thinking in their search for truth.

Summary

In biology, students learn that the cell is the basic building block of life for all living things. In addition, students learn the connection between chemistry and biology when investigating the influence of chemical bonding and elements on the structure and function of macromolecules. These foundational principles are an integral part of the student's working knowledge of cellular processes such as cell cycle, energy processing, metabolism, and reproduction which are covered in later units.

According to the Ohio Department of Education, this unit builds on content knowledge from middle school pertaining to cell theory by focusing on the cell as a living system as well as being part of an interconnected larger system (multicellularity) with an ecosystem. In addition, students are expected to understand that cells themselves are composed of elements (carbon, hydrogen, nitrogen, oxygen, phosphorus, and sulfur) which arrange themselves to form large and complex molecules (carbohydrates, lipids, proteins, and nucleic acids) which are common in all cells.

Unit Goals

**Once students have completed this unit they will be able to:**

1. Describe cell theory and its three major tenets.
2. Describe the seven characteristics of life.
3. Compare and contrast the four types of chemical bonding.
4. Evaluate the role of elements in the formation of macromolecules.
5. Describe the structure and function of the four major types of macromolecules.
6. Evaluate the influence of macromolecules on cellular functioning.

Big Ideas

Cells are the basic building blocks of life whose composition and complexity determines various characteristics of life including homeostasis, reproduction, growth/development, energy processing, metabolism, and structure and function.

Enduring Understandings

1. Cells are the basic building blocks of life and are found in all living things.
2. All cells come from pre-existing cells.
3. To be defined as a "living thing," an organism must have all of the following characteristics: organization, growth and development, maintenance of homeostasis, energy processing (metabolism), and reproduction.
4. All cells contain the following elements: carbon, hydrogen, oxygen, nitrogen, phosphorus, and sulfur.
5. The covalent and hydrogen bonding in water allows properties which make Earth a viable planet for life including high specific heat, polarity, cohesion and adhesion, universal solvent, and expansion of water as it freezes.
6. The formation of ionic compounds and ions in cells produces electrochemical potentials which drive cellular processes in organisms.
7. The ability of carbon to bond covalently with other atoms allows for the production of complex and diverse macromolecules.
8. The breaking and building of bonds between atoms are the basis for energy storage and processing in cells.
9. There are four major macromolecules found in all living things, which play a role in cellular functioning: carbohydrates, proteins, lipids, and nucleic acids.

Content

**characteristics of life**

1. metabolism
2. homeostasis
3. growth
4. development
5. reproduction
6. Cell Theory

**properties of an atom**

1. protons
2. neutrons
3. electrons
4. nucleus
5. energy levels
6. molecules
7. compounds

**four types of chemical bonding**

1. covalent bonding
2. ionic bonding
3. hydrogen bonding
4. Van der Waals interactions

**properties of water**

1. polarity
2. universal solvent
3. high specific heat
4. cohesion
5. adhesion
6. expansion

**bonding of carbon**

**macromolecules**

1. carbohydrates
2. lipids
3. nucleic acids
4. proteins

Skills

**Bloom's Taxonomy/DOK**

**Remember (Level 1)**

1. Define vocabulary pertaining to the unit.
2. Describe the various characteristics of macromolecules.
3. Select the appropriate macromolecule based on the monomer.
4. List the four types of chemical bonds.
5. Describe the seven characteristics of life.
6. Write statements explaining a specific concept using appropriate vocabulary, grammar, and punctuation.

**Understand (Level 1 and 2)**

1. Classify the four types of macromolecules based on structure, function, and examples.
2. Categorize the four types of chemical bonds.
3. Describe the importance of water in the viability of life on Earth.
4. Discuss the influence of covalent bonding on the behavior of carbon.
5. Explain how macromolecules are built and broken down.
6. Relate the structure and function of a macromolecule to its chemical properties and behaviors.
7. Distinguish between the various elements present in each macromolecule.

**Analyze (Level 3)**

1. Differentiate between the four types of macromolecules
2. Distinguish between the four types of chemical bonds based on the behavior of the electrons in each bond.
3. Explain how the four properties of water make it a unique molecule.
4. Organize information in order to prepare for upcoming assessments.
5. Outline pertinent topics in the unit to prepare for upcoming assessments.
6. Compare and contrast the four types of macromolecules.

**Evaluate (Level 3 and Level 4)**

1. Justify how you can identify various macromolecules using specific litmus tests.
2. Test a group of unknown samples to determine the type of macromolecules present.
3. Experiment to test a formulated hypothesis.
4. Verify the identification of your unknown samples by performing control tests.
5. Defend your statements using quantitative and qualitative evidence gathered during your experiment.

**Create (Level 4)**

1. Design an experiment to test a group of unknown samples in the lab to determine the type of macromolecule present.
2. Formulate a plan for how unknown and control samples will be tested.
3. Generate conclusions based on quantitative and qualitative evidence.
4. Hypothesize the outcome of a test used to identify a known and unknown sample containing a variety of macromolecules.

Essential Questions

1. What characteristics are common among all living things?
2. How do the properties of various elements influence chemical nature and types of molecules found in cells?
3. How does the chemical bonding of molecules affect their structure and function in cells and cellular processes?
4. What unique properties are found in water, which provides a viable planet for life on Earth?
5. What are macromolecules and how do they affect the cellular functioning of a cell?

Stage 2: Assessment Evidence

Macromolecule Lab

Summative: Lab Assignment

See attached file (possible to add formative assessments as students proceed through lab).

Chemical Bonding

Summative: Lab Assignment

See attached file (possible to add formative assessments as students proceed through lab).

Unit Exam

Summative: Unit Exam

Students will be able to demonstrate mastery of the following concepts: characteristics of lifechemical bondingproperties of watermacromolecules

Thinking Maps

Formative: Graphic Organizer

chemical bondingmacromolecules

Foldables

Formative: Graphic Organizer

chemical bondingmacromolecules

Chapter Quizzes

Summative: Quiz

Lab Investigations

Formative: Cooperative Group Work

Various Formative Assessments

Formative: Class Work

Think-Pair-ShareKWL ChartsFist to 5Bell WorkExit Slips3-2-1 (Students indicate 3 ideas they understand, 2 ideas they are still confused on, and 1 question they have.)ClickersJigsaws

Virtual Labs

Summative: Online Learning

Homework

Formative: Homework

These can be teacher made.

Resources

Stage 3: Learning Plan

Learning Experiences

1. Graphic Organizer: Students will create Foldables on Chemical Bonding and Macromolecules. (See Links.)
2. Graphic Organizer: Students will use Thinking Maps to learn concepts. (See Links.)
3. Cooperative Learning Groups: Students will use the Jigsaw approach to address concepts.
4. Cooperative Learning Groups: Students will participate in a Macromolecule Lab Investigation.
5. Cooperative Learning Groups: Students will participate in a Chemical Bonding Investigation.

Resources

* Foldables: Chemical Bonding (<http://www.csun.edu/~krowlands/Content/Academic_Resources/Foldables/Basic%20Foldables.pdf>)

Technology Integration

**iPad Applications (Free):**

1. Khan Biology
2. Molecules (Sunset Lake Software)
3. Science 360 (National Science Foundation)
4. Periodic Table of Elements

**YouTube:**

1. Crash Course Biology (Macromolecules: You are What You Eat)
2. Crash Course Biology (Atomic Hook-ups)
3. Bozeman Science (The Molecules of Life)
4. Bozeman Science (Chemical Bonds: Covalent vs. Ionic)
5. Bozeman Science (Essential Characteristics of Life)
6. Molecules Gone Wild (Music Video)
7. There Might Be Giants ("Meet the Elements" Song)
8. Dogs Teaching Chemistry (Chemical Bonds)
9. Neil deGrasse Tyson (The Most Astounding Fact)

**Virtual Labs:**

1. Macromolecule Virtual Lab (See Links.)
2. Chemical Bonding Virtual Lab (See Links.)

Resources

* Macromolecule Virtual Lab (<http://faculty.kirkwood.edu/apeterk/learningobjects/biologylabs.htm>)

Resources

Resources

**Books:**

1. Gray, T. (2009). *The elements: A visual exploration of every known atom in the universe*. New York: Black Dog Leventhal Publishers, Inc.
2. Bryson, B. (2004). *A short history of nearly everything. New York*: Crown Publishing Group.

**Twitter**:

1. Sally Ride Science (@SallyRideSci)
2. MIT Biology (@MITBiology)
3. Smithsonian (@smithsonian)
4. Reuters Science News (@ReutersScience)
5. AAAS News (@AAAS\_News)
6. Ted Talks (@TEDTalks)
7. NIH (@NIH)
8. The Royal Society (@royalsociety)
9. Nature (@NatureNews)
10. Science Magazine (@sciencemagazine)
11. New York Times Science (@nytimesscience)
12. National Science Foundation (@nsf)

Resources

* Nature ([www.nature.com](http://www.nature.com))

Grades 9-12 Science  
Biology

Cells & Cellular Processing

Stage 1: Desired Results

Catholic Standards

DOC All Grades DOC: Catholic Standards

The Profession of Faith

Students will be able to

1. Recognize God in the world's order, beauty, and goodness (CCC 32).

8. Understand that the world was made for the glory of God, the Creator of all things (CCC 290; 293).

9. Know that we are created in God's image to serve Him and to rule over all creatures (CCC 380).

Life in Christ

Students will be able to

7. Assume personal responsibility (CCC 1914).

11. Respect all human life (CCC 2318).

12. Respect the integrity of all creation, including animals, plants, and all nature (CCC 2415).

The Celebration of the Christian Mystery

Students will be able to

2. Understand that God blessed all living beings (CCC 1080).

Targeted Standards

NGSS Grade 2 NGSS: Disciplinary Core Ideas

ETS1: Engineering Design

Defining and Delimiting an Engineering Problem

A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. (K-2-ETS1- 1) (secondary to KPS2-2)

NGSS Grade 9-12 NGSS: Crosscutting Concepts

Crosscutting Statements

Patterns Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

NGSS Grade 9-12 NGSS: Science and Engineering Practices

Practice 8. Obtaining, evaluating, and communicating information

Obtaining, evaluating, and communicating information in 912 builds on K8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.

Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).

Practice 6. Constructing explanations (for science) and designing solutions (for engineering)

Constructing explanations and designing solutions in 912 builds on K8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.

Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.

Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

Practice 7. Engaging in argument from evidence

Engaging in argument from evidence in 912 builds on K8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.

Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge and student-generated evidence.

Practice 1. Asking questions (for science) and defining problems (for engineering)

Asking questions and defining problems in 912 builds on K8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.

Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information.

Ask questions that arise from examining models or a theory, to clarify and/or seek additional information and relationships.

Ask questions to determine relationships, including quantitative relationships, between independent and dependent variables.

Evaluate a question to determine if it is testable and relevant.

Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory.

Define a design problem that involves the development of a process or system with interacting components and criteria and constraints that may include social, technical, and/or environmental considerations.

Practice 3. Planning and carrying out investigations

Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.

Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.

Plan and conduct an investigation or test a design solution in a safe and ethical manner including considerations of environmental, social, and personal impacts.

Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated.

Manipulate variables and collect data about a complex model of a proposed process or system to identify failure points or improve performance relative to criteria for success or other variables.

Practice 4. Analyzing and interpreting data

Analyzing data in 912 builds on K8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.

Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

OH Grade 9-12 OH: Science (2011)

HS Biology

Science Inquiry and Application During the years of grades 9 through 12 all students must use the following scientific processes to construct their knowledge and understanding in all science content areas:

Identify questions and concepts that guide scientific investigations;

Design and conduct scientific investigations;

Use technology and mathematics to improve investigations and communications;

Formulate and revise explanations and models using logic and evidence (critical thinking);

Recognize and analyze explanations and models

Communicate and defend a scientific argument.

Course Content:Cells

Cell structure and function: Structure, function and interrelatedness of cell organelles

Cell structure and function: Eukaryotic cells and prokaryotic cells

Cellular processes: Characteristics of life regulated by cellular processes

Cellular processes: Photosynthesis, chemosynthesis, cellular respiration

OH Grades 9-10 OH: Literacy in History/Social Studies, Science, & Technical Subjects 6-12

Writing

Text Types and Purposes 1. Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence.

WHST.9-10.1. Write arguments focused on discipline-specific content.

WHST.9-10.1b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audiences knowledge level and concerns.

WHST.9-10.1d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

WHST.9-10.1e. Provide a concluding statement or section that follows from or supports the argument presented.

Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.

WHST.9-10.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

WHST.9-10.2e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

WHST.9-10.2f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

Production and Distribution of Writing 4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST.9-10.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.

WHST.9-10.6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

Draw evidence from literary or informational texts to support analysis, reflection, and research.

WHST.9-10.9. Draw evidence from informational texts to support analysis, reflection, and research.

Capacities of the Literate Individual

Students Who are College and Career Ready in Reading, Writing, Speaking, Listening, & Language

They demonstrate independence.

Reading: Science & Technical Subjects

Key Ideas and Details 1. Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.

RST.9-10.1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas.

RST.9-10.2. Determine the central ideas or conclusions of a text; trace the texts explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

Analyze how and why individuals, events, or ideas develop and interact over the course of a text.

RST.9-10.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks attending to special cases or exceptions defined in the text.

Analyze the structure of texts, including how specific sentences, paragraphs, and larger portions of the text (e.g., a section, chapter, scene, or stanza) relate to each other and the whole.

RST.9-10.5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).

Integration of Knowledge and Ideas 7. Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words.

RST.9-10.7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

Read and comprehend complex literary and informational texts independently and proficiently.

RST.9-10.10. By the end of grade 10, read and comprehend science/technical texts in the grades 910 text complexity band independently and proficiently.

Catholic Identity

DOC All Grades Catholic Identity

Catholic Social Justice Teachings

Rights and Responsibilities

Care for God's Creation

The Rights of Children

3. THE RIGHT TO BE RESPECTED AS INDIVIDUALS with human dignity.

4. THE RIGHT TO WORK ACTIVELY TOWARD THEIR OWN EMPOWERMENT through the development of their gifts and talents.

5. THE RIGHT TO A LEARNING ENVIRONMENT THAT VALUES COOPERATION and challenges its members to critical and reflective thinking in their search for truth.

Summary

This unit focuses on the structure and function of cell parts in prokaryotic and eukaryotic cells. Students are expected to be able to identify, distinguish, and describe the functions of cell parts. As stated by the Ohio Department of Education, focus should be on the concept of the cell as a functioning, interconnected living system rather than on memorization of cell parts. In addition, students should be able to distinguish characteristics which help students to compare and contrast eukaryotic and prokaryotic cells.

In this unit, students should be able to explain how matter and energy are conserved during the process of cellular respiration and photosynthesis. In addition, students need to be able to connect content presented in this unit with information presented in previous units, including macromolecules and chemical behavior of elements and molecules.

Students should be able to describe and evaluate how cell processes are regulated. In addition, they should be able to recognize the influence of external changes on the internal functioning of cells (e.g., change in carbon dioxide levels in a pond affects the rate of photosynthesis in phytoplankton) and homeostasis.

Unit Goals

**Once students have completed this unit, they will be able to:**

1. Identify and describe cell parts in prokaryotic and eukaryotic cells.
2. Describe the historical basis and contributions of various scientists to our current understanding of cells and cellular processes.
3. Compare and contrast prokaryotic and eukaryotic cells.
4. Describe how cell parts work together to create a complex living system which helps the cell carry out various processes.
5. Relate the laws of conservation of matter and energy to the process of cellular respiration and photosynthesis.
6. Describe how cells obtain and transform energy through cellular respiration and photosynthesis.
7. Describe the relationship of photosynthesis and cellular respiration in terms of products and reactants.
8. Explain the steps involved in cellular respiration and photosynthesis.
9. Describe alternative ways cells obtain energy including chemosynthesis and fermentation.
10. Connect concepts from previous units to current concepts presented in this unit to describe how the molecular level affects the cellular level of an organism.
11. Evaluate how changes to the external environment influence the internal environment of the cell.
12. Explain how the endosymbiotic theory explains the relationship between prokaryotes and eukaryotes.

Big Ideas

1. Cells contain specialized parts for the purposes of transportation, energy processing, metabolism, movement, reproduction, and feedback. Multicellular organisms perform functions which may not exist in other unicellular organisms.
2. Cell functions are regulated by complex interactions among different types of molecules relating to growth, metabolism, reproduction, response, and energy transformations.
3. The laws of conservation for matter and energy can be used to explain the steps involved in various cellular processes, such as cellular respiration and photosynthesis.
4. The relationship between prokaryotes and eukaryotes can be described and understood through the endosymbiotic theory.

Enduring Understandings

1. While the structure, function, and complexity of cells vary among living things, commonalities exist among all living things in terms of types of molecules and cell parts.
2. Regardless of the cellular process occurring, biological systems obey the laws of conservation of matter and energy.
3. Cellular processes can be understood in terms of transformation of matter and energy through cellular respiration and photosynthesis.
4. To fulfill the requirement for life, cells must be able to process energy in order to respond and adapt to their environment to maintain homeostasis.
5. Cell organelles work together to form a complex living system that helps all cells carry out the basic functions of life (growth, development, reproduction, metabolism, etc.).
6. Life originated approximately 4 billion years ago with the first prokaryotic cells. Over time, prokaryotic cells evolved through the process of endosymbiosis to form the first eukaryotic cells.

Content

**cell types**

1. prokaryotes
2. eukaryotes

**cell organelles**

1. nucleus
2. nucleolus
3. mitochondria
4. golgi apparatus
5. endoplasmic reticulum
6. cytoskeleton
7. centriole
8. lysosome
9. ribosome
10. cell membrane
11. cell wall
12. vacuole
13. chloroplast

**conservation of energy**

**conversation of matter**

* laws of thermodynamics

**cellular processes**

* cellular respiration (aerobic respiration)
* fermentation (anaerobic respiration)
* chemosynthesis
* photosynthesis
* ATP

**endosymbiotic theory**

**scientific contributions**

1. Hooke
2. van Leeuwenhoek
3. Schleiden
4. Schwann
5. Margulis
6. Virchow
7. Janssen
8. Van Helmont
9. Priestley
10. Lavoisier
11. Ingenhousz
12. Von Mayer
13. Engelmann
14. Calvin
15. Krebs

Skills

**Remember (DOK Level 1)**

Define vocabulary pertinent to the unit to increase content knowledge.

Describe the laws of conservation of energy and matter.

Draw visual diagrams to represent various concepts presented in class.

Identify the reactants and products in a chemical equation.

Locate where each stage of a cellular process is occurring.

Recognize the organelles and macromolecules involved in cellular processes.

**Understand (DOK Level 1 and Level 2)**

1. Clarify the relationship between cellular respiration and photosynthesis.
2. Distinguish between prokaryotic and eukaryotic cells using a microscope.
3. Compare the similarities between: prokaryotes and eukaryotes, cellular respiration and photosynthesis, aerobic and anaerobic respiration.
4. Contrast the differences between: prokaryotes and eukaryotes, cellular respiration and photosynthesis, aerobic and anaerobic respiration.
5. Summarize the steps involved in cellular respiration, photosynthesis, and fermentation.
6. Explain the difference between lactic acid and alcohol fermentation in cells.

**Apply (DOK Level 2)**

1. Show where in the cell various organelles are located.

**Analyze (DOK Level 3)**

1. Discriminate between prokaryotic and eukaryotic cells.
2. Deconstruct the stages of cellular respiration and photosynthesis in order to identify the various molecules involved and how they are formed/broken down.
3. Outline the major parts of each cellular process.
4. Investigate the effects of changes in the external environment on the internal environment of a cell.

**Evaluate (DOK Level 3 and Level 4)**

1. Defend the theory of endosymbiosis as a mechanism in understanding the relationship between prokaryotes and eukaryotes.
2. Assess the impact of changes in a cell's environment on its ability to function and respond to maintain homeostasis.
3. Justify statements made in class through quantitative and qualitative data collected during lab.
4. Test manipulations to an independent variable to determine how a dependent variable responds.
5. Verify results gathered in lab investigations using available quantitative and qualitative evidence.
6. Recommend suggestions for further investigation based on results from current investigations.

**Create (DOK Level 4)**

1. Generate conclusions based on analysis of quantitative and qualitative data in lab.
2. Formulate a hypothesis to test the effects of changes on the external environment on a cell.
3. Compose a thoughtful and detailed analysis to describe the relationship between cellular processes and proper functioning of the cell.
4. Design an experiment to evaluate the effect of external changes on the rate of photosynthesis and cellular respiration.

Essential Questions

1. What cell parts are common to all living organisms?
2. How do changes in the external environment influence the internal environment of an organism?
3. How do changes in a cell's environment affect its ability to maintain homeostasis?
4. How does a cell utilize cellular parts to respond and adapt to changes in the internal and external environment of the living system?
5. What similarities and differences exist among prokaryotic and eukaryotic cells?
6. How do the laws of conservation of energy and matter explain the role of energy and matter in cellular processes?
7. How are the processes of cellular respiration and photosynthesis similar? Dissimilar?
8. What are some alternative ways in which cells obtain energy from their environment?
9. How are cellular parts utilized to produce various macromolecules in the cell?
10. What role do macromolecules play in cellular processes occurring within the cell?
11. What mechanisms are involved in allowing cells to organize to create complex living systems such as tissues, organs, organ systems, and organisms?
12. What scientific contributions have influenced and shaped our current understanding of cells and cellular processes?
13. How does the endosymbiotic theory explain the origin of eukaryotic cells from prokaryotic cells?

Stage 2: Assessment Evidence

Various Formative Assessments

Formative: Class Work

KWL ChartThink-Pair-ShareFist to 53-2-1Cloze ReadingSmart Board: Pass the PenClickersBell WorkExit Slips

Foldables/Thinking Maps

Formative: Graphic Organizer

Cellular Respiration Lab Investigation

Summative: Lab Assignment

Possible to add in formative assessment pieces during lab investigationCan add in a formal lab report

Cell Lab Investigation

Summative: Lab Assignment

Possible to add in formative assessment pieces during lab investigationCan add in a formal lab report

Photosynthesis Lab Investigation

Summative: Lab Assignment

Possible to add in formative assessment pieces during lab investigationCan add in a formal lab report

Unit Exam

Summative: Unit Exam

Chapter Quizzes

Summative: Quiz

Resources

Stage 3: Learning Plan

Learning Experiences

1. Laboratory Groups: Students will participate in a Photosynthesis Lab Investigation.
2. Laboratory Groups: Students will participate in a Cellular Respiration Lab Investigation.
3. Laboratory Groups: Students will participate in a Cells Lab Investigation.
4. Creativity: Students will use the Photosynthesis Song to review concepts.
5. Technology Tools: Smart Board. Students will participate in "Pass the Pen." (Students drag and drop reactants and products of photosynthesis/cellular respiration/fermentation into the appropriate locations, and drag and drop steps of each cycle.)
6. Cooperative Learning Groups: Students will use the Jigsaw approach to explore concepts.
7. Graphic Organizer: Students will use Foldables for Photosynthesis vs. Cellular Respiration. (See Links.)
8. Graphic Organizer: Students will use Thinking Maps to review concepts. (See Links.)

Resources

Technology Integration

**iPad Apps (Free):**

1. iCell (Hudson Alpha iCell)
2. Virtual Cell Animations (VCell Productions)
3. Click and Learn (Howard Hughes Medical Institute)

**YouTube:**

1. Crash Course Biology (ATP Respiration)
2. Crash Course Biology (Photosynthesis)
3. Bozeman Science (Photosynthesis Cellular Respiration)
4. Khan Academy (Introduction to Cellular Respiration)
5. Interactive Biology (Cellular RespirationEnergy in a Cell)
6. There Might Be Giants (PhotosynthesisSong)

**TED Talks: See Links**

**Virtual Labs: See Links**

Resources

* Cellular Respiration Virtual Lab (<http://www.classzone.com/cz/books/bio_07/resources/htmls/virtual_labs/virtualLabs.html>)

Resources

Resources

**Books:**

1. Thomas, L. (1978). *Lives of a cell: Notes of a biology teacher.* New York: Penguin Group.

**Twitter**:

1. Sally Ride Science (@SallyRideSci)
2. MIT Biology (@MITBiology)
3. Smithsonian (@smithsonian)
4. Reuters Science News (@ReutersScience)
5. AAAS News (@AAAS\_News)
6. TED Talks (@TEDTalks)
7. NIH (@NIH)
8. The Royal Society (@royalsociety)
9. Nature (@NatureNews)
10. Science Magazine (@sciencemagazine)
11. New York Times Science (@nytimesscience)
12. National Science Foundation (@nsf)

Resources

* National Science Teachers' Association ([www.nsta.org](http://www.nsta.org))

Grades 9-12 Science  
Biology

Cell Division & Differentiation

Stage 1: Desired Results

Catholic Standards

DOC All Grades DOC: Catholic Standards

The Profession of Faith

Students will be able to

1. Recognize God in the world's order, beauty, and goodness (CCC 32).

8. Understand that the world was made for the glory of God, the Creator of all things (CCC 290; 293).

Life in Christ

Students will be able to

2. Know that we must assume responsibility for the acts we perform (CCC 1781).

11. Respect all human life (CCC 2318).

12. Respect the integrity of all creation, including animals, plants, and all nature (CCC 2415).

Targeted Standards

NGSS Grade 2 NGSS: Disciplinary Core Ideas

ETS1: Engineering Design

Defining and Delimiting an Engineering Problem

A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. (K-2-ETS1- 1) (secondary to KPS2-2)

NGSS Grade 9-12 NGSS: Crosscutting Concepts

Crosscutting Statements

Patterns Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

NGSS Grade 9-12 NGSS: Science and Engineering Practices

Practice 8. Obtaining, evaluating, and communicating information

Obtaining, evaluating, and communicating information in 912 builds on K8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.

Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).

Practice 6. Constructing explanations (for science) and designing solutions (for engineering)

Constructing explanations and designing solutions in 912 builds on K8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.

Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.

Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

Practice 1. Asking questions (for science) and defining problems (for engineering)

Asking questions and defining problems in 912 builds on K8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.

Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information.

Ask questions that arise from examining models or a theory, to clarify and/or seek additional information and relationships.

Ask questions to determine relationships, including quantitative relationships, between independent and dependent variables.

Ask questions to clarify and refine a model, an explanation, or an engineering problem.

Evaluate a question to determine if it is testable and relevant.

Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory.

Practice 2. Developing and using models

Modeling in 912 builds on K8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.

Practice 3. Planning and carrying out investigations

Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.

Plan an investigation or test a design individually and collaboratively to produce data to serve as the basis for evidence as part of building and revising models, supporting explanations for phenomena, or testing solutions to problems. Consider possible confounding variables or effects and evaluate the investigations design to ensure variables are controlled.

Plan and conduct an investigation or test a design solution in a safe and ethical manner including considerations of environmental, social, and personal impacts.

Select appropriate tools to collect, record, analyze, and evaluate data.

Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated.

Manipulate variables and collect data about a complex model of a proposed process or system to identify failure points or improve performance relative to criteria for success or other variables.

Practice 4. Analyzing and interpreting data

Analyzing data in 912 builds on K8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.

Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.

OH Grade 9-12 OH: Science (2011)

HS Biology

Science Inquiry and Application During the years of grades 9 through 12 all students must use the following scientific processes to construct their knowledge and understanding in all science content areas:

Identify questions and concepts that guide scientific investigations;

Design and conduct scientific investigations;

Use technology and mathematics to improve investigations and communications;

Formulate and revise explanations and models using logic and evidence (critical thinking);

Recognize and analyze explanations and models

Communicate and defend a scientific argument.

Course Content:Cells

Cellular processes: Characteristics of life regulated by cellular processes

Cellular processes: Cell division and differentiation

OH Grades 9-10 OH: Literacy in History/Social Studies, Science, & Technical Subjects 6-12

Writing

Text Types and Purposes 1. Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence.

WHST.9-10.1. Write arguments focused on discipline-specific content.

WHST.9-10.1a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.

WHST.9-10.1b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audiences knowledge level and concerns.

WHST.9-10.1d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

WHST.9-10.1e. Provide a concluding statement or section that follows from or supports the argument presented.

Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.

WHST.9-10.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

WHST.9-10.2a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

WHST.9-10.2b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

WHST.9-10.2e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

WHST.9-10.2f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

Production and Distribution of Writing 4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST.9-10.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.

WHST.9-10.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.

WHST.9-10.6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.

WHST.9-10.8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

Draw evidence from literary or informational texts to support analysis, reflection, and research.

WHST.9-10.9. Draw evidence from informational texts to support analysis, reflection, and research.

Range of Writing 10. Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

WHST.9-10.10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Capacities of the Literate Individual

Students Who are College and Career Ready in Reading, Writing, Speaking, Listening, & Language

They demonstrate independence.

Reading: Science & Technical Subjects

Key Ideas and Details 1. Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.

RST.9-10.1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

Analyze how and why individuals, events, or ideas develop and interact over the course of a text.

RST.9-10.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks attending to special cases or exceptions defined in the text.

Craft and Structure 4. Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.

RST.9-10.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 910 texts and topics.

Analyze the structure of texts, including how specific sentences, paragraphs, and larger portions of the text (e.g., a section, chapter, scene, or stanza) relate to each other and the whole.

RST.9-10.5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).

Assess how point of view or purpose shapes the content and style of a text.

RST.9-10.6. Analyze the authors purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

Integration of Knowledge and Ideas 7. Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words.

RST.9-10.7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

Analyze how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take.

RST.9-10.9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

Read and comprehend complex literary and informational texts independently and proficiently.

RST.9-10.10. By the end of grade 10, read and comprehend science/technical texts in the grades 910 text complexity band independently and proficiently.

Catholic Identity

DOC All Grades Catholic Identity

Catholic Social Justice Teachings

Life and Dignity of the Human Person

Call to Family, Community, and Participation

Option for the Poor and Vulnerable

Solidarity

Care for God's Creation

The Rights of Children

2. THE RIGHT TO A SAFE ENVIRONMENT that promotes care, protection, and security.

3. THE RIGHT TO BE RESPECTED AS INDIVIDUALS with human dignity.

4. THE RIGHT TO WORK ACTIVELY TOWARD THEIR OWN EMPOWERMENT through the development of their gifts and talents.

5. THE RIGHT TO A LEARNING ENVIRONMENT THAT VALUES COOPERATION and challenges its members to critical and reflective thinking in their search for truth.

8. THE RIGHT TO LEARN RESPONSIBILITY for themselves and their actions.

9. THE RIGHT TO MAKE RESPONSIBLE DECISIONS founded on religious conviction.

10. THE RIGHT TO GUIDANCE FROM THE CHURCH in their development as loving people.

Summary

This unit focuses on limits to cell growth which affect the ability of a cell to maintain homeostasis. In addition, this unit investigates various cellular processes an organism employs to maintain homeostasis including active transport (endocytosis, exocytosis, etc.) and passive transport (diffusion, osmosis, and facilitated diffusion).

This unit investigates the ways cells undergo growth, development, and reproduction (asexual and sexual) by investigating the cell cycle. According to the Ohio Department of Education, emphasis is on understanding that the cell is a living system which is regulated by a variety of complex processes which work together to maintain homeostasis. Details on the steps of the cell cycle, including differentiation of mitosis and meiosis is studied at this grade level. In addition, this unit continues to build on concepts presented in previous units (macromolecules, cells, cell organelles, etc.). The understanding of how the cell divides and how DNA is transmitted to offspring is critical in the building of core principles presented in later units (genetics and evolution).

Unit Goals

**Once students have completed this unit, they should be able to:**

1. Explain the limitations to cell growth.
2. Describe and analyze problems which arise in maintaining homeostasis when a cell continues to grow.
3. Compare and contrast active and passive transport.
4. Describe what happens in the cell in terms of movement, energy usage, and concentration based on the type of transport occurring (diffusion, osmosis, etc.).
5. Describe how the structure of the plasma membrane is designed to produce a selectively permeable environment.
6. Explain the stages of cell cycle and what happens in each stage.
7. Describe the stages of mitosis and meiosis in terms of the movement and structure of DNA (chromatin, sister chromatids, chromosomes, etc.).
8. Compare and contrast mitosis and meiosis.
9. Describe how the cell regulates and monitors cell cycle.
10. Evaluate possible problems which may arise in cell cycle and their results (uncontrolled cell division, nondisjunction, etc.).
11. Explain how cancer develops and disrupts homeostasis.
12. Discuss the care and treatment of patients with cancer including latest research in prevention and treatment.
13. Evaluate and discuss the connection between cell cycle and the transmission of genetic information to a cell's offspring.
14. Compare and contrast sexual and asexual reproduction.

Big Ideas

1. There are limitations to how large a cell can grow due to challenges with metabolism, information processing, and waste management which affects the homeostasis of a cell.
2. Cells will maintain homeostasis through the movement of materials into and out of the cell through active and passive transport.
3. Cells will undergo cell division (mitosis and meiosis) in order to carry out the necessary characteristics of life (growth, development, and reproduction). Problems with the cell cycle can lead to problems in the ability of a cell to maintain homeostasis including cancer, mutations, genetic disorders, etc.

Enduring Understandings

1. Cells are prevented from continuously growing due to challenges in maintaining homeostasis in regards to increased demands on energy processing, metabolism, and waste management.
2. Proteins are responsible for regulating and monitoring various checkpoints during a cell's life cycle (G1, G2, S, and M phase).
3. Due to the differentiation and specialization of some cells in multicellular organisms, some cells will not go through cell division (e.g. brain cells).
4. The chemical composition of the plasma membrane produces a selectively permeable environment that helps a cell to maintain homeostasis through the cellular processes of active and passive transport.
5. The genetic information of a cell is transmitted from parent to offspring through the process of mitosis (somatic cells) or meiosis (germ cells).
6. Depending on the type of cell (prokaryote or eukaryote) or organism (unicellular and multicellular), different mechanisms are involved to help a cell reproduce (asexual or sexual reproduction).
7. Proper control of the cell is vital in the proper functioning of the cell during its life to prevent problems which may disrupt homeostasis (e.g. cancer).
8. Problems during cell cycle may result in outcomes which impact the offspring of the cell (e.g. nondisjunction).
9. In multicellular organisms, mitosis is the mechanism for the growth and development of the organism, whereas meiosis is the mechanism for genetic variation.
10. Crossing over in meiosis results in variation resulting in genetically unique offspring, which is a component for the mechanism of how evolution operates.
11. Advances in technology and research have led to new suggestions for the prevention and treatment of various diseases.

Content

**active transport**

1. endocytosis
2. exocytosis

**passive transport**

1. diffusion
2. osmosis: hypertonic, hypotonic, isotonic
3. facilitated diffusion

**cell cycle**

1. cyclins
2. G1, G2, S, and M Phase

**mitosis**

1. prophase
2. metaphase
3. anaphase
4. telophase

**meiosis**

1. meiosis I
2. meiosis II
3. crossing over/gene shuffling
4. nondisjunction

**cancer**

Skills

**Remember (DOK Level 1)**

1. Define vocabulary pertinent to the unit to increase content knowledge.
2. Describe the limits to cell growth.
3. Draw and label the stages of cell cycle using relevant vocabulary.
4. List the stages of mitosis and meiosis in the order in which they occur.

**Understand (DOK Level 1 and Level 2)**

1. Classify cells into groups based on the way in which they reproduce.
2. Explain how a cell regulates homeostasis through active and passive transport.
3. Compare the following concepts: active and passive transport, sexual and asexual reproduction, mitosis and meiosis.
4. Contrast the following concepts: active and passive transport, sexual and asexual reproduction, mitosis and meiosis.
5. Distinguish between the different stages of mitosis and meiosis based on specific characteristics present during a specific stage.
6. Describe how genetic information is transmitted from parent to offspring during sexual and asexual reproduction.
7. Illustrate the various stages of mitosis using information gained during a lab investigation.

**Apply (DOK Level 2)**

1. Examine cells under the microscope to connect concepts presented in class to real-life examples.
2. Use a microscope to identify the stages of cell cycle using knowledge gained from class discussions.

**Analyze (DOK Level 3)**

1. Differentiate between mitosis and meiosis in terms of how genetic information is transmitted from parent to offspring.
2. Deduce the impact of cell division on genetic continuity (mitosis) or genetic variation (meiosis) of an organism.
3. Investigate the current body of research in the treatment and prevention of cancer.

**Evaluate (DOK Level 3 and Level 4)**

1. Verify the validity of current research in medicine using primary sources of information (scientific journals, news articles, etc.).
2. Justify appropriate treatment and prevention plans for cancer based on evidence gathered from multiple sources (websites, journals, etc.).

**Create (DOK Level 4)**

1. Hypothesize the influence of a specific error in cell division on the cell's offspring.
2. Generate conclusions based on evidence gathered during lab investigations.

Essential Questions

1. What are the limitations to how large a cell can grow?
2. What challenges in the ability of a cell to maintain homeostasis arise when a cell continues to grow?
3. How does a cell regulate and monitor cell growth?
4. What mechanisms does a cell employ to move materials in and out of the cell?
5. How does the structure of the plasma membrane help a cell maintain homeostasis?
6. What are the different stages of cell cycle and what happens during each stage?
7. How is genetic information transmitted from the parent to offspring through the process of mitosis and meiosis?
8. What problems can arise during cell cycle and what are their possible outcomes?
9. What is cancer and how does it develop in a cell?
10. What role does protein play in the regulation of cell cycle?
11. What are some ways that humans can help reduce their risk of cancer?
12. How are scientists treating cancer, and what developments are currently in progress in terms of research?
13. What are the differences and similarities between the following: active and passive transport, asexual and sexual reproduction, mitosis and meiosis?

Stage 2: Assessment Evidence

Diffusion Lab Investigation

Summative: Lab Assignment

Ability to add in formative pieces during lab investigationAbility to add in formal lab report

Variety of Formative Assessments

Formative: Class Work

Bell WorkExit SlipsFist-to-53-2-1Cloze ReadingKWLThink-Pair-ShareJigsaws

Mitosis Lab Investigation

Summative: Lab Assignment

Ability to add in formative pieces during lab investigation

Unit Exam

Summative: Unit Exam

Chapter Quizzes

Summative: Quiz

Cancer Pamphlet/Brochure

Summative: Project

Foldables/Thinking Maps

Formative: Graphic Organizer

Resources

Stage 3: Learning Plan

Learning Experiences

1. Laboratory Groups: Students will participate in a lab activity on Mitosis Meiosis. (See Links.)
2. Graphic Organizer: Students will create Mitosis and Meiosis Flip Books. (See Links.)
3. Laboratory Groups: Students will participate in a lab on Mitosis: Chromosome Replication Division. (See Links.)
4. Simulation: Students will participate in an online simulation animation on Cell Cycle, Mitosis, Meiosis.
5. Simulation: Students will participate in a Phet Diffusional Simulation Activity. (See Links.)
6. Laboratory Group: Students will participate in a Diffusion Osmosis Lab. (See Links.)
7. Demonstration: Students will view a Diffusion Osmosis demonstration.
8. Writing to Inform: Students will create a Cancer Pamphlet/Brochure.
9. Graphic Organzier: Students will create Foldables to review concepts. (See Links.)
10. Graphic Organizer: Students will use Thinking Maps to review concepts. (See Links.)

Resources

* Mitosis Meiosis: Doing It on the Table (<http://www.indiana.edu/~ensiweb/lessons/gen.mm.html>)

Technology Integration

**iPad Apps (Free):**

1. iCell (HudsonAlpha iCell)
2. Virtual Cell Animations (VCell Productions)
3. American Cancer Society (Wiley Publishing)
4. Click and Learn (Howard Hughes Medical Institute)

**YouTube:**

1. Bozeman Science (Cell Cycle, Mitosis, and Meiosis)
2. Khan Academy (Mitosis and Meiosis)
3. The Penguin Professor (Cell Cycle and Mitosis)
4. Crash Course Biology (Mitosis: Splitting Up is Hard to Do)
5. Crash Course Biology (Meiosis: Where the Sex Starts)
6. Amoeba Sisters (Cell Cycle and Cancer)
7. Amoeba Sisters (Meiosis: The Great Divide)
8. Johnny Clore (Cell Cycle Checkpoints)
9. Cancer Quest (Animated Introduction to Cancer Biology)
10. VSauce (Why Don't We All Have Cancer?)

**TED Talks: See Links**

**Virtual Labs: See Links**

Resources

* McGraw-Hill Cell Cycle and Cancer Virtual Lab (<http://www.mhhe.com/biosci/genbio/virtual_labs_2K8/labs/BL_03/index.html>)

Resources

Resources

**Books:**

1. Almeida, C.A. Barry, S.A. (2010). *Cancer: Basic science and clinical aspects*. Hoboken, NJ: Wiley.
2. Ewald, P. Ewald, H.S. (2012). *Controlling cancer: A powerful plan for taking on the world's most daunting disease* (TED Books). New York: TED Books.
3. Murray, A. Hunt, T. (1993). *Cell cycle: An introduction.* New York: Oxford University Press.
4. Wilson, L., Matsudaira, P.T. (1998). *Mitosis and meiosis.* Philadelphia, PA: Elsevier Science.

**Twitter:**

1. Sally Ride Science (@SallyRideSci)
2. MIT Biology (@MITBiology)
3. Dr. Eric Lander (@eric\_lander)
4. Dr. J. Craig Venter (@jcventer)
5. HHMI Cool Science (@HHMICoolSci)
6. Molecular Biology (@molecular)
7. Smithsonian (@smithsonian)
8. Reuters Science News (@ReutersScience)
9. AAAS News (@AAAS\_News)
10. TED Talks (@TEDTalks)
11. NIH (@NIH)
12. The Royal Society (@royalsociety)
13. Nature (@NatureNews)
14. Science Magazine (@sciencemagazine)
15. New York Times Science (@nytimesscience)
16. National Science Foundation (@nsf)

Resources

* The Washington Post ([www.washingtonpost.com](http://www.washingtonpost.com))

Grades 9-12 Science  
Biology

DNA & RNA

Stage 1: Desired Results

Catholic Standards

DOC All Grades DOC: Catholic Standards

The Profession of Faith

Students will be able to

1. Recognize God in the world's order, beauty, and goodness (CCC 32).

8. Understand that the world was made for the glory of God, the Creator of all things (CCC 290; 293).

Life in Christ

Students will be able to

7. Assume personal responsibility (CCC 1914).

11. Respect all human life (CCC 2318).

12. Respect the integrity of all creation, including animals, plants, and all nature (CCC 2415).

Targeted Standards

OH Grade 9-12 OH: Science (2011)

HS Biology

Science Inquiry and Application During the years of grades 9 through 12 all students must use the following scientific processes to construct their knowledge and understanding in all science content areas:

Identify questions and concepts that guide scientific investigations;

Design and conduct scientific investigations;

Use technology and mathematics to improve investigations and communications;

Formulate and revise explanations and models using logic and evidence (critical thinking);

Recognize and analyze explanations and models

Communicate and defend a scientific argument.

Course Content: Heredity

Structure and function of DNA in cells

Mutations

Course Content:Cells

Cellular processes: Characteristics of life regulated by cellular processes

OH Grades 9-10 OH: Literacy in History/Social Studies, Science, & Technical Subjects 6-12

Writing

Text Types and Purposes 1. Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence.

WHST.9-10.1. Write arguments focused on discipline-specific content.

WHST.9-10.1a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.

WHST.9-10.1b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audiences knowledge level and concerns.

WHST.9-10.1c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.

WHST.9-10.1d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

WHST.9-10.1e. Provide a concluding statement or section that follows from or supports the argument presented.

Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.

WHST.9-10.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

WHST.9-10.2a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

WHST.9-10.2b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

WHST.9-10.2c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.

WHST.9-10.2d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.

WHST.9-10.2e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

WHST.9-10.2f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

Production and Distribution of Writing 4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST.9-10.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.

WHST.9-10.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.

WHST.9-10.6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

Research to Build and Present Knowledge 7. Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.

WHST.9-10.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.

WHST.9-10.8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

Draw evidence from literary or informational texts to support analysis, reflection, and research.

WHST.9-10.9. Draw evidence from informational texts to support analysis, reflection, and research.

Range of Writing 10. Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

WHST.9-10.10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Capacities of the Literate Individual

Students Who are College and Career Ready in Reading, Writing, Speaking, Listening, & Language

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Reading: Science & Technical Subjects

Key Ideas and Details 1. Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.

RST.9-10.1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas.

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Analyze how and why individuals, events, or ideas develop and interact over the course of a text.

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RST.9-10.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 910 texts and topics.

Analyze the structure of texts, including how specific sentences, paragraphs, and larger portions of the text (e.g., a section, chapter, scene, or stanza) relate to each other and the whole.

RST.9-10.5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).

Assess how point of view or purpose shapes the content and style of a text.

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Catholic Identity

DOC All Grades Catholic Identity

Catholic Social Justice Teachings

Life and Dignity of the Human Person

Rights and Responsibilities

The Dignity of Work and the Rights of Workers

Call to Family, Community, and Participation

Solidarity

Care for God's Creation

The Rights of Children

1. THE RIGHT TO A CATHOLIC COMMUNITY that witnesses to Christ and the Gospel by protecting them from child abuse, including sexual abuse and neglect.

2. THE RIGHT TO A SAFE ENVIRONMENT that promotes care, protection, and security.

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8. THE RIGHT TO LEARN RESPONSIBILITY for themselves and their actions.

9. THE RIGHT TO MAKE RESPONSIBLE DECISIONS founded on religious conviction.

10. THE RIGHT TO GUIDANCE FROM THE CHURCH in their development as loving people.

Summary

This unit focuses on the structure and function of DNA and RNA in the transmission of genetic information from parent to offspring. According to the Ohio Department of Education, this unit builds on core ideas learned during middle school that genes are responsible for the passing on of traits from one generation to the next. In the high school level, students are expected to be able to articulate the details and relationships between the structure of DNA, nature of proteins, and variation among organisms.

Students are expected to use concepts obtained from previous units (macromolecules, chemistry, etc.) to understand the universality of DNA in all living things. In addition, the historical implications and scientific contributions of various scientists (Chargaff, Franklin, Crick, Watson, Hershey, etc.) should be discussed to help students understand how our current body of knowledge concerning DNA and genetics has evolved over time.

In this unit, foundations are set to help students comprehend and understand concepts presented in later units (heredity) by investigating and analyzing DNA replication and protein synthesis. In addition, students are asked to evaluate and assess the results of mutations (point, frameshift, chromosomal, etc.) occurring in DNA replication and their impact on protein synthesis. To prepare students for the units on heredity and evolution, students should understand that mutations can be beneficial, neutral, or detrimental.

Unit Goals

**Once students have completed this unit they will be able to:**

1. Compare and contrast DNA and RNA.
2. Compare and contrast transcription and translation.
3. Describe the steps involved in DNA replication.
4. Describe the steps involved in protein synthesis.
5. Evaluate the central dogma of biology and its connection to gene expression.
6. Discuss the scientific contributions of various scientists to the current understanding of DNA.
7. Analyze and discuss the various scientific experiments which influenced Watson and Crick's model of DNA.
8. Understand that DNA is a universal code found in all living things.
9. Differentiate between DNA replication in prokaryotes and eukaryotes.
10. Differentiate between protein synthesis in prokaryotes and eukaryotes.
11. Analyze the effects of changes in DNA on proteins (gene expression).
12. Differentiate between beneficial, neutral, and detrimental mutations.
13. Describe the effect of point mutations, frameshift mutations, and chromosomal mutations on gene expression.
14. Evaluate how advances in technology continue to increase our understanding of DNA.

Big Ideas

1. All living things contain DNA, which is responsible for the transmission of genetic information from one generation to the next through DNA replication and protein synthesis. Genes are composed of DNA which is transcribed and translated into proteins that are expressed in living organisms.
2. Changes in the sequence of DNA can result in mutations that are beneficial, neutral, or detrimental. In addition, mutations can result in changes in the structure and function of proteins which influence gene expression.
3. The universality of DNA, including its structure and function, is found in all living organisms and is the foundation for modern genetics and the mechanism of how evolution works.
4. Our current body of knowledge of modern genetics and DNA is the result of multiple scientific contributions of many scientists over time. Advances in technology continue to increase our knowledge of various scientific concepts.

Enduring Understandings

1. All living things contain DNA, which is a nucleic acid, that stores and transmits genetic information from parent to offspring during sexual and asexual reproduction.
2. The universality of DNA provides evidence that all living things evolved from a common ancestor.
3. DNA replication occurs in a semi-conservative manner.
4. Genes are expressed through proteins in living organisms which are transcribed and translated from DNA and RNA during protein synthesis.
5. Changes in DNA, called mutations, can provide genetic variation to living things if the mutation is beneficial.
6. Mutations are often neutral or detrimental (missense, nonsense, and neutral mutations) and are caused by random changes in DNA.
7. Changes in DNA can alter the expression of genes by changing the structure of proteins which ultimately influences its functioning and behavior.
8. Our current knowledge of DNA and gene expression arose from various scientific contributions from many scientists over a long period of time.
9. Current advances in technology continue to influence our current knowledge of DNA and gene expression.
10. DNA replication and protein synthesis, resulting in gene expression, are the foundation for our understanding of modern genetics and the mechanism of how evolution works.

Content

**DNA RNA**

1. adenine
2. guanine
3. cytosine
4. thymine
5. uracil

**DNA replication**

**protein synthesis**

1. transcription
2. translation
3. RNA editing/splicing

**gene expressions**

**mutations**

1. point mutations
2. frameshift mutations
3. chromosomal mutations

**scientific contributions**

1. Griffith
2. Chargaff
3. Avery
4. Hershey
5. Chase
6. Watson
7. Crick
8. Wilkins
9. Franklin
10. Sanger
11. McClintock
12. Morgan

Skills

**Remember (DOK Level 1)**

1. Define vocabulary pertinent to the unit in order to increase content knowledge.
2. Describe the structure and function of DNA and RNA.
3. Identify the various part of a nucleotide.
4. Recognize the type of bonding involved in various cellular processes (hydrogen, covalent, peptide, etc.).
5. Select the appropriate nucleotides to pair using Chargaff's rules.

**Understand (DOK Level 1 and Level 2)**

1. Clarify the relationship between DNA and the transmission of genetic information.
2. Compare the following terms: DNA and RNA, transcription and translation, point mutation and frameshift mutation.
3. Contrast the following terms: DNA and RNA, transcription and translation, point mutation and frameshift mutation.
4. Describe the various scientific contributions responsible for our current understanding of DNA.
5. Explain how genetic information is transcribed and translated from DNA to proteins.
6. Predict the outcome of mutations on gene expression in living things.
7. Summarize the steps of DNA replication and protein synthesis.

**Apply (DOK Level 2)**

1. Examine the relationship between DNA and proteins in gene expression.
2. Use Chargaff's rules to demonstrate the semi-conservative nature of DNA.
3. Use the genetic code to transcribe and translate a sequence of DNA to protein.

**Analyze (DOK Level 3)**

1. Differentiate between protein synthesis in prokaryotes and eukaryotes.
2. Investigate influence of scientific experiments on our modern understanding of DNA and gene expression.
3. Organize the various scientists and scientific contributions in chronological order.
4. Outline the development of the model for DNA using evidence from various scientific experiments.

**Evaluate (DOK Level 3 and Level 4)**

1. Assess the influence of the work of other scientists on Watson and Crick's model of DNA.
2. Justify the importance of protein synthesis on gene expression.
3. Critique the methodology of scientific experiments (past and present) relating to the behavior, structure, and function of DNA.

**Create (DOK Level 4)**

1. Generate discussion on the importance of collaboration in building scientific models of understanding in science.
2. Produce a model of DNA which illustrates current understanding.

Essential Questions

1. How is the structure of DNA similar to RNA? How is it different?
2. Why is DNA considered universal and what information does it provide about the interconnectedness of living things?
3. Why is the model for DNA replication semi-conservative?
4. What is the central dogma of biology, and how does it increase our understanding of gene expression?
5. What role do proteins play in the expression of genes in living organisms?
6. What role does the environment play in the expression of genes?
7. How is DNA replication similar in prokaryotes and eukaryotes? How is it different?
8. How is protein synthesis similar in prokaryotes and eukaryotes? How is it different?
9. What are mutations and how do they arise?
10. Why are mutations more often neutral or detrimental rather than beneficial?
11. What is the relationship between mutations and genetic variation in living organisms?
12. What is the effect of different types of mutations (point, frameshift, etc.) on the expression of genes in offspring?
13. How is the structure of DNA related to our understanding of DNA replication?
14. How have current and past scientists contributed to our current understanding of DNA and gene expression?
15. What scientific experiments or research influenced Watson and Crick's model of DNA?

Stage 2: Assessment Evidence

Various Formative Assessments

Formative: Class Work

Think-Pair-ShareCloze Reading3-2-1Fist-to-FiveJigsawBell WorkExit SlipsClickers

Say It With DNA

Summative: Cooperative Group Work

Contains formative pieces.

Foldables/Thinking Maps

Formative: Graphic Organizer

DNA Virtual Lab

Summative: Lab Assignment

Ability to add formative pieces

Journal Writing

Summative: Reflective Writing

Can use with suggested readings for this unitCan use in conjunction with science journals

Science Journals

Summative: Writing Assignment

Have students read 2-3 journal articles and critique the writing and research based on a specific topic.

Resources

Stage 3: Learning Plan

Learning Experiences

1. Graphic Organizer: Students will create DNA Origami. (See Links.)
2. Technology: Students will participate in DNA Virtual Lab (Glencoe/McGraw Hill). (See Links.)
3. Graphic Organizer: Students will complete Protein Synthesis Coloring. (See Links.)
4. Graphic Organizer: Students will complete DNA Coloring. (See Links.)
5. Laboratory Groups: Students will participate in Say It With DNA Activity. (See Links.)

Resources

* DNA Coloring: The Double Helix (<http://www.biologycorner.com/worksheets/DNAcoloring.html>)

Technology Integration

**iPad Apps (Free):**

1. Click and Learn (Howard Hughes Medical Institute)
2. Genetic Code (iVanya)
3. iProtein (Eidogen-Sertanty)
4. GenomeCache (HudsonAlpha Institute)

**YouTube:**

1. Blame it on the DNA (Music Video)
2. Bozeman Science (What is DNA?)
3. Bozeman Science (Transcription and Translation)
4. Crash Course Biology (DNA Structure and Replication)
5. Crash Course Biology (DNA, Hot Pockets, The Longest Word Ever)
6. Amoeba Sisters (Protein Synthesis and the Lean, Mean Ribosomes Machine)
7. PBS Documentary: DNA (See Links.)

**TED Talks: See Links**

**Virtual Labs/Simulations: See Links**

**Misc:**

1. Building Modern Science Internet Sites (See Link.)
2. PBS NOVA: *DNA: Secret of Photo 51* DVD

Resources

* TED: How We Discovered DNA (<http://www.ted.com/talks/james_watson_on_how_he_discovered_dna>)

Resources

Resources

**Books:**

1. Watson, J.D. Berry, A. (2009). *DNA: The secret of life.* New York: Knopf Doubleday Publishing Group.
2. Watson, J.D. (2011). *The double helix: A personal account of the discovery of the structure of DNA.* New York: Scribners.
3. Torsten, K. (2003). *DNA: Changing science and society.* New York: Cambridge University Press.
4. Glynn, J. (2012). *My sister Rosalind Franklin: A family memoir*. New York: Oxford University Press.
5. Bryson, B. (2004). *A short history of nearly everything*. New York: Crown Publishing Group.

**Twitter:**

1. Sally Ride Science (@SallyRideSci)
2. MIT Biology (@MITBiology)
3. Dr. Eric Lander (@eric\_lander)
4. Dr. J. Craig Venter (@jcventer)
5. HHMI Cool Science (@HHMICoolSci)
6. Molecular Biology (@molecular)
7. Smithsonian (@smithsonian)
8. Reuters Science News (@ReutersScience)
9. AAAS News (@AAAS\_News)
10. TED Talks (@TEDTalks)
11. NIH (@NIH)
12. The Royal Society (@royalsociety)
13. Nature (@NatureNews)
14. Science Magazine (@sciencemagazine)
15. New York Times Science (@nytimesscience)
16. National Science Foundation (@nsf)
17. DNA Learning Center (@DNALC)
18. Edutopia (@edutopia)

Resources

* Cells Alive! ([www.cellsalive.com](http://www.cellsalive.com))

Grades 9-12 Science  
Biology

Cellular Genetics & Biotechnology

Stage 1: Desired Results

Catholic Standards

DOC All Grades DOC: Catholic Standards

The Profession of Faith

Students will be able to

1. Recognize God in the world's order, beauty, and goodness (CCC 32).

8. Understand that the world was made for the glory of God, the Creator of all things (CCC 290; 293).

9. Know that we are created in God's image to serve Him and to rule over all creatures (CCC 380).

Life in Christ

Students will be able to

2. Know that we must assume responsibility for the acts we perform (CCC 1781).

11. Respect all human life (CCC 2318).

12. Respect the integrity of all creation, including animals, plants, and all nature (CCC 2415).

Targeted Standards

NGSS Grade 9-12 NGSS: Crosscutting Concepts

Crosscutting Statements

Patterns Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

NGSS Grade 9-12 NGSS: Science and Engineering Practices

Practice 8. Obtaining, evaluating, and communicating information

Obtaining, evaluating, and communicating information in 912 builds on K8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.

Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).

Practice 6. Constructing explanations (for science) and designing solutions (for engineering)

Constructing explanations and designing solutions in 912 builds on K8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.

Practice 1. Asking questions (for science) and defining problems (for engineering)

Asking questions and defining problems in 912 builds on K8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.

Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information.

Ask questions that arise from examining models or a theory, to clarify and/or seek additional information and relationships.

Ask questions to determine relationships, including quantitative relationships, between independent and dependent variables.

Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory.

Practice 2. Developing and using models

Modeling in 912 builds on K8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.

Practice 4. Analyzing and interpreting data

Analyzing data in 912 builds on K8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.

Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.

OH Grade 9-12 OH: Science (2011)

HS Biology

Science Inquiry and Application During the years of grades 9 through 12 all students must use the following scientific processes to construct their knowledge and understanding in all science content areas:

Identify questions and concepts that guide scientific investigations;

Design and conduct scientific investigations;

Use technology and mathematics to improve investigations and communications;

Formulate and revise explanations and models using logic and evidence (critical thinking);

Recognize and analyze explanations and models

Communicate and defend a scientific argument.

Course Content: Heredity

Cellular genetics

Structure and function of DNA in cells

Genetic mechanisms and inheritance

Mutations

Modern genetics

OH Grades 9-10 OH: Literacy in History/Social Studies, Science, & Technical Subjects 6-12

Writing

Text Types and Purposes 1. Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence.

WHST.9-10.1. Write arguments focused on discipline-specific content.

WHST.9-10.1a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.

WHST.9-10.1b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audiences knowledge level and concerns.

WHST.9-10.1c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.

WHST.9-10.1d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

WHST.9-10.1e. Provide a concluding statement or section that follows from or supports the argument presented.

Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.

WHST.9-10.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

WHST.9-10.2a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

WHST.9-10.2b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

WHST.9-10.2c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.

WHST.9-10.2d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.

WHST.9-10.2e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

WHST.9-10.2f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

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WHST.9-10.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

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Analyze the structure of texts, including how specific sentences, paragraphs, and larger portions of the text (e.g., a section, chapter, scene, or stanza) relate to each other and the whole.

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Catholic Identity

DOC All Grades Catholic Identity

Catholic Social Justice Teachings

Life and Dignity of the Human Person

Rights and Responsibilities

The Dignity of Work and the Rights of Workers

Call to Family, Community, and Participation

Option for the Poor and Vulnerable

Solidarity

Care for God's Creation

The Rights of Children

1. THE RIGHT TO A CATHOLIC COMMUNITY that witnesses to Christ and the Gospel by protecting them from child abuse, including sexual abuse and neglect.

2. THE RIGHT TO A SAFE ENVIRONMENT that promotes care, protection, and security.

3. THE RIGHT TO BE RESPECTED AS INDIVIDUALS with human dignity.

4. THE RIGHT TO WORK ACTIVELY TOWARD THEIR OWN EMPOWERMENT through the development of their gifts and talents.

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7. THE RIGHT TO LEARN THE SKILL OF SELF PROTECTION by identifying safe and unsafe situations.

8. THE RIGHT TO LEARN RESPONSIBILITY for themselves and their actions.

9. THE RIGHT TO MAKE RESPONSIBLE DECISIONS founded on religious conviction.

10. THE RIGHT TO GUIDANCE FROM THE CHURCH in their development as loving people.

Summary

This unit focuses on the explanation and understanding of genetic patterns of inheritance. According to the Ohio Department of Education, this unit builds on concepts introduced in elementary and middle school levels (life cycles, inheritance, reproduction, Mendelian genetics, and diversity of species). Students should arrive having a basic understanding of the following concepts: asexual and sexual reproduction, traits determined by genes, and genes coming in one or more forms (alleles).

Building on this foundation, this unit focuses on the following concepts pertaining to genetics (Ohio Department of Education, 2011):

* Life is defined by genomes, or an entire sequence of DNA that determines the structure, function, and behaviors of living organisms.
* The sequence of DNA in a gene determines the sequence of amino acids which builds a protein.
* Changes in DNA can alter genes and ultimately the structure and function of proteins.
* Mutations can be passed on to offspring which may result in beneficial, neutral, or detrimental changes to the offspring.
* Different genes are active in different types of cells whose activity and functionality is determined by environment and evolutionary history.

This unit interweaves the concept of Mendelian and non-Mendelian genetics with our current body of knowledge pertaining to DNA to provide a foundation for the basis of modern genetics. In addition, the historical contributions of scientists who have contributed to our current understanding of genetics is also investigated (Mendel, Morgan, Human Genome Project, etc.). This unit also investigates the influence of gene shuffling and mutation on variation, which connects to future units in order to understand the mechanism of evolution.

According to the Ohio Department of Education, students are expected to understand and use various genetic tests (monohybrid and dihybrid crosses, test crosses, pedigrees, karyotypes, etc.) to determine probable genotypic and phenotypic outcomes through mathematics using both Mendelian (simple dominance) and non-Mendelian genetics (co-dominance, incomplete dominance, sex-linked, multiple allele, epistasis, polygenic, etc.). It is suggested that current advances in technology are examined and analyzed using real-world examples (DNA fingerprinting, gene therapy, etc.).

Unit Goals

**Once students have completed this unit, they should be able to:**

1. Describe the scientific contributions of various scientists to our current body of knowledge pertaining to genetics.
2. Explain the importance of Gregor Mendel's work for providing a foundation for understanding genetics.
3. Discuss the laws of inheritance and apply them to real life examples (law of dominance, law of independent assortment).
4. Predict possible genotypic and phenotypic outcomes using test crosses, monohybrid crosses, dihybrid crosses, pedigrees, and karyotypes.
5. Describe how mutations influence gene expression by investigating various genetic diseases (sickle cell anemia, cystic fibrosis, Huntington's, Tay Sachs, etc.).
6. Differentiate between Mendelian and non-Mendelian genetics.
7. Examine and analyze the role of the Human Genome Project on changing the face of modern genetics.
8. Investigate and critique recent advances in technology on our understanding of modern genetics and its benefits/risks (DNA hacking, cloning, genetic engineering, gene therapy, etc.).
9. Describe how the transmission of traits from parents to offspring results in variations among species through mutations and gene shuffling.
10. Use mathematics (probability and statistics) to investigate and solve real-life problems pertaining to genetics.

Big Ideas

1. The genetic information present in all living things is contained in a nucleic acid, DNA, which contains the instructions for making proteins.
2. Changes in DNA will affect genes and ultimately the expression of genes by possibly altering the structure and function of proteins.
3. Our current body of knowledge pertaining to genetics is a result of numerous scientific contributions from scientists over many years.
4. Current advances in technology continue to increase our body of knowledge pertaining to modern genetics, which requires us to examine, analyze, and critique possible benefits and risks in biomedical research.
5. Mathematics can be used to help create predictions for determining the possible genotype and/or phenotype of a group of organisms and their offspring.
6. Understanding genetics is the basis for recognizing the mechanism of how evolution occurs in nature.

Enduring Understandings

1. Variations among individuals in a population arise in two ways: gene shuffling (meiosis) and mutations.
2. Variations among individuals as a result of genetics is the basis for how evolution works in nature.
3. Changes in DNA, mutations, affect genes which ultimately affects the expression of genes by the alteration of proteins through beneficial or detrimental mutations.
4. Various tools can be utilized by geneticists to diagnose and treat a variety of genetic diseases (Punnett Squares, pedigrees, karyotypes, etc.).
5. Mathematics can be utilized to make predictions pertaining to the possible phenotypic and genotypic outcomes for a group of individuals and their offspring.
6. Our modern understanding of genetics is a result of various scientific contributions from scientists over time, in conjunction with recent advances in technology and the completion of the Human Genome Project.
7. Recent advances in technology continue to raise questions about the potential benefits and risks to society through genetic engineering, cloning, gene therapy, DNA hacking, etc.

Content

**DNA**

1. chromosomes
2. genes
3. alleles
4. traits

**genotype**

1. homozygous dominant
2. heterozygous dominant
3. recessive

**gene expression**

**phenotype**

**Mendelian genetics**

1. simple dominance
2. law of dominance
3. law of segregation
4. law of independent assortment

**gene/linkage maps**

**non-Mendelian genetics**

1. codominance
2. incomplete dominance
3. multiple alleles
4. polygenic
5. epistasis

**genetic disorders**

1. cystic fibrosis
2. color-blindness
3. hemophilia
4. sickle cell anemia
5. Tay Sachs
6. PKU
7. muscular dystrophy
8. Huntington's disease
9. Down Syndrome
10. Klinefelter's Syndrome
11. Turner's Syndrome

**scientific contributions**

1. Mendel
2. Miescher
3. Sutton
4. Bateson
5. Punnett
6. Johanssen
7. Nilsson-Ehle
8. Morgan
9. Sturtevant
10. Creighton
11. McClintock
12. Sanger
13. Collins
14. Mullis
15. Brown

**human genome project**

**modern genetics**

1. DNA fingerprinting
2. genetic engineering
3. gene therapy
4. DNA hacking
5. personalized medicine
6. genetic counseling
7. PCR
8. microarrays

**genetic tools**

1. Punnett Squares (monohybrid and dihybrid)
2. test crosses
3. pedigrees
4. karyotypes
5. genomic mapping

Skills

**Remember (DOK Level 1)**

1. Define vocabulary pertinent to the unit to help increase content knowledge.
2. Describe the laws of genetics (law of dominance, law of segregation, law of independent assortment).
3. Draw a Punnett square to determine the possible genotype or phenotype outcome for a genetic cross.

**Understand (DOK Level 1 and Level 2)**

1. Classify the offspring based on their genotype or phenotype.
2. Explain the influence of mutations on gene expression.
3. Compare the following terms: genotype and phenotype, dominant and recessive, Mendelian and non-Mendelian genetics.
4. Contrast the following terms: genotype and phenotype, dominant and recessive, Mendelian and non-Mendelian genetics.
5. Distinguish between affected and non-affected individuals using a pedigree for a specific trait.
6. Describe the genotype of an individual using a karyotype.
7. Illustrate the probability of an organism having a specific condition using pedigrees and/or Punnett Squares.

**Apply (DOK Level 2)**

1. Examine the effect of mutations on genetic disorders using real-life examples.
2. Use research from multiple sources to examine, analyze, and critique advances in modern medicine using a specific genetic disorder.

**Analyze (DOK Level 3)**

1. Differentiate between autosomal dominant, autosomal recessive, and sex-linked conditions using information provided through a pedigree.
2. Deduce the effect of environmental factors on the expression of genes.
3. Investigate the role of gene therapy and genetic counseling using real-life examples.

**Evaluate (DOK Level 3 and Level 4)**

1. Verify the role of scientific contributions in modern genetics by using multiple sources to gain information about particular advances in genetics (cloning, gene therapy, etc.).
2. Justify the validity of specific tools or treatments in terms of benefits and risks for society using real-life examples in modern genetics.

**Create (DOK Level 4)**

1. Hypothesize the effect of mutations on a specific group of individuals using evidence from a variety of sources.
2. Generate conclusions pertaining to the use of genetics to solve real-life examples using multiple sources of evidence.

Essential Questions

1. What was the importance of Mendel's experiments, and what did they teach us about genetics?
2. How have other scientists helped to increase our current understanding of genetics?
3. What tools can be utilized to help make predictions about the possible genotypic or phenotypic outcomes of a group of individuals and their offspring?
4. What advances are currently happening with technology in terms of modern genetics, and what are their possible benefits/risks to society?
5. What was the purpose of the Human Genome Project and what lessons have we learned since its completion?
6. How can we use mathematics to investigate and solve real-life problems pertaining to genetics?
7. How do mutations influence gene expression in offspring, and what are some possible diseases which can result from these mutations?
8. How can the laws of genetics be applied to Mendelian and non-Mendelian genetics?
9. What is the relationship between environmental factors and DNA in the expression of genes (proteins)?

Stage 2: Assessment Evidence

Various Formative Assessments

Formative: Class Work

Bell WorkExit SlipsKWL ChartsThink-Pair-Share3-2-1Fist-to-FiveCloze ReadingClickers

Foldables/Thinking Maps

Formative: Graphic Organizer

Unit Exam

Summative: Unit Exam

Genetics Labs

Summative: Lab Assignment

Coin Toss Baby LabDNA Fingerprinting LabWho Ate the Cheese?Pedigree ActivityKaryotype ActivityDNA Virtual LabsGenetics Problems Ability to add formative pieces and/or formal lab report

Genetics Poster/Presentation

Summative: Research Project

Assign or have students select a specific genetic disorder to research.Have students include historical information, current treatments, critique current research, describe how the disease is diagnosed, illustrate gene map for the condition, etc.

Resources

Stage 3: Learning Plan

Learning Experiences

1. Technology: Students will perform the DNA Virtual Labs/Simulations. (See Links in Technology Integration.)
2. Video: Students will view and discuss the movie *Cracking the Code of Life.* (See Links in Technology Integration.)
3. Video: Students will view and discuss the movie *Cracking Your Genetic Code.* (See Links in Technology Integration.)
4. Technology Integration: Students will view the movie *GATTACA* and discuss. (See Links in Technology Integration.)
5. Cooperative Learning: Students will participate in Coin Toss Genetics Lab. (See Links.)
6. Problem Solving: Students will participate in the Who Ate the Cheese Activity. (See Links.)
7. Problem-Solving: Students will participate in the DNA Fingerprinting Lab. (See Links.)
8. Lecture: Students will view and discuss a variety of TED Talks. (See Links in Technology Integration.)
9. Cooperative Learning Groups: Students will create genetics posters and give presentations.
10. Problem-Solving: Students will complete genetics problems.
11. Research: Students will participate in the Karyotype Activity. (See Links.)
12. Problem-Solving: Students will participate in the Pedigree Activity. (See Links.)
13. Graphic Organizers: Students will create Foldables to learn concepts.
14. Graphic Organizers: Students will use Thinking Maps to learn concepts.

Resources

* Create a DNA Fingerprint (<http://www.pbs.org/wgbh/nova/education/body/create-dna-fingerprint.html>)

Technology Integration

**iPad Apps (Free):**

1. Gene Screen (Cold Spring Harbor Laboratory)
2. Click and Learn (Howard Hughes Medical Institute)
3. GenomeCache (HudsonAlpha Institute for Biotechnology)
4. GeneWall Genome Browser (Wobblebase Inc.)
5. Genome Wowser (The Children's Hospital of Philadelphia)
6. Human Genome (Florence Haseltine)
7. Nature Human Genome Special Edition (Nature Publishing Group)

**YouTube:**

1. Franklin vs. Watson CrickScience History Rap Battle (Tom McFadden)
2. It's Too Late to Apoptize (Tom McFadden)
3. Crash Course Biology (Heredity)
4. Greatest DiscoveriesGenetics (Bill Nye)
5. Bozeman Science (Genetics)
6. 18 Things You Should Know About Genetics (Genome BC)
7. Genetics 101 (23andMe)
8. TED-Ed (How Mendel's Pea Plants Helped Us Understand Genetics)

**TED Talks: See Links**

**Virtual Labs/Simulations: See Links**

**Streaming Video:**

1. PBS NOVA: *Cracking the Code of Life*
2. PBS NOVA: *Cracking Your Genetic Code*
3. Movie: *GATTACA*

Resources

* TED: Could Tissue Engineering Mean Personalized Medicine? (<http://www.ted.com/talks/nina_tandon_could_tissue_engineering_mean_personalized_medicine>)

Resources

Resources

**Books:**

1. Jones, S. Van Loon, B. (2011). *Introducing genetics.* London, England: Icon Books, Ltd.
2. Willett, E. (2005). *Genetics demystified.* New York: McGraw-Hill Publishing.
3. Gonick, L., Wheelis, M. (1991). *Cartoon guide to genetics.* Harper Collins: HarperCollins Publishers.
4. Collins, F. (2010). *The language of life: DNA and the Revolution in Personalized Medicine.* New York: HarperCollins Publishers.

**Twitter:**

1. Sally Ride Science (@SallyRideSci)
2. MIT Biology (@MITBiology)
3. Dr. Eric Lander (@eric\_lander)
4. Dr. J. Craig Venter (@jcventer)
5. HHMI Cool Science (@HHMICoolSci)
6. Molecular Biology (@molecular)
7. Smithsonian (@smithsonian)
8. Reuters Science News (@ReutersScience)
9. AAAS News (@AAAS\_News)
10. TED Talks (@TEDTalks)
11. NIH (@NIH)
12. The Royal Society (@royalsociety)
13. Nature (@NatureNews)
14. Science Magazine (@sciencemagazine)
15. New York Times Science (@nytimesscience)
16. National Science Foundation (@nsf)
17. DNA Learning Center (@DNALC)
18. Edutopia (@edutopia)

Resources

* The Washington Post ([www.washingtonpost.com](http://www.washingtonpost.com))

Grades 9-12 Science  
Biology

Evolution

Stage 1: Desired Results

Catholic Standards

DOC All Grades DOC: Catholic Standards

The Profession of Faith

Students will be able to

1. Recognize God in the world's order, beauty, and goodness (CCC 32).

8. Understand that the world was made for the glory of God, the Creator of all things (CCC 290; 293).

9. Know that we are created in God's image to serve Him and to rule over all creatures (CCC 380).

Life in Christ

Students will be able to

1. Understand that we shape our own life as a result of free will (CCC 1731).

11. Respect all human life (CCC 2318).

12. Respect the integrity of all creation, including animals, plants, and all nature (CCC 2415).

The Celebration of the Christian Mystery

Students will be able to

2. Understand that God blessed all living beings (CCC 1080).

Targeted Standards

NGSS Grade 9-12 NGSS: Crosscutting Concepts

Crosscutting Statements

Patterns Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

NGSS Grade 9-12 NGSS: Science and Engineering Practices

Practice 8. Obtaining, evaluating, and communicating information

Obtaining, evaluating, and communicating information in 912 builds on K8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.

Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem.

Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source.

Evaluate the validity and reliability of and/or synthesize multiple claims, methods, and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible.

Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).

Practice 6. Constructing explanations (for science) and designing solutions (for engineering)

Constructing explanations and designing solutions in 912 builds on K8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.

Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.

Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.

Practice 7. Engaging in argument from evidence

Engaging in argument from evidence in 912 builds on K8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.

Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues.

Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments.

Respectfully provide and/or receive critiques on scientific arguments by probing reasoning and evidence, challenging ideas and conclusions, responding thoughtfully to diverse perspectives, and determining additional information required to resolve contradictions.

Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.

Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge and student-generated evidence.

Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and/or logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations).

Practice 3. Planning and carrying out investigations

Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.

Plan an investigation or test a design individually and collaboratively to produce data to serve as the basis for evidence as part of building and revising models, supporting explanations for phenomena, or testing solutions to problems. Consider possible confounding variables or effects and evaluate the investigations design to ensure variables are controlled.

Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.

Plan and conduct an investigation or test a design solution in a safe and ethical manner including considerations of environmental, social, and personal impacts.

Select appropriate tools to collect, record, analyze, and evaluate data.

Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated.

Manipulate variables and collect data about a complex model of a proposed process or system to identify failure points or improve performance relative to criteria for success or other variables.

Practice 4. Analyzing and interpreting data

Analyzing data in 912 builds on K8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.

Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.

Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations.

Evaluate the impact of new data on a working explanation and/or model of a proposed process or system.

Analyze data to identify design features or characteristics of the components of a proposed process or system to optimize it relative to criteria for success.

Practice 5. Using mathematics and computational thinking

Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

Apply techniques of algebra and functions to represent and solve scientific and engineering problems.

Use simple limit cases to test mathematical expressions, computer programs, algorithms, or simulations of a process or system to see if a model makes sense by comparing the outcomes with what is known about the real world.

Apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m3, acre-feet, etc.).

NGSS Grades K-2 NGSS: Science and Engineering Practices

Practice 1. Asking questions (for science) and defining problems (for engineering)

Asking questions and defining problems in K2 builds on prior experiences and progresses to simple descriptive questions that can be tested.

Ask questions based on observations to find more information about the natural and/or designed world(s).

Ask and/or identify questions that can be answered by an investigation.

OH Grade 9-12 OH: Science (2011)

HS Biology

Science Inquiry and Application During the years of grades 9 through 12 all students must use the following scientific processes to construct their knowledge and understanding in all science content areas:

Identify questions and concepts that guide scientific investigations;

Design and conduct scientific investigations;

Use technology and mathematics to improve investigations and communications;

Formulate and revise explanations and models using logic and evidence (critical thinking);

Recognize and analyze explanations and models

Communicate and defend a scientific argument.

Course Content: Evolution

Mechanisms: Natural selection

Mechanisms: Mutation

Mechanisms: Genetic drift

Mechanisms: Gene flow (immigration, emigration)

Mechanisms: Sexual selection

Mechanisms: History of life on Earth

Diversity of Life: Speciation and biological classification based on molecular evidence

Diversity of Life: Variation of organisms within a species due to population genetics and gene frequency

OH Grades 9-10 OH: Literacy in History/Social Studies, Science, & Technical Subjects 6-12

Writing

Text Types and Purposes 1. Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence.

WHST.9-10.1. Write arguments focused on discipline-specific content.

WHST.9-10.1a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.

WHST.9-10.1b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audiences knowledge level and concerns.

WHST.9-10.1c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.

WHST.9-10.1d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

WHST.9-10.1e. Provide a concluding statement or section that follows from or supports the argument presented.

Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.

WHST.9-10.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

WHST.9-10.2a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

WHST.9-10.2b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

WHST.9-10.2c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.

WHST.9-10.2d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.

WHST.9-10.2e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

WHST.9-10.2f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

Production and Distribution of Writing 4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST.9-10.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.

WHST.9-10.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.

WHST.9-10.6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

Research to Build and Present Knowledge 7. Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.

WHST.9-10.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.

WHST.9-10.8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

Draw evidence from literary or informational texts to support analysis, reflection, and research.

WHST.9-10.9. Draw evidence from informational texts to support analysis, reflection, and research.

Range of Writing 10. Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

WHST.9-10.10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Capacities of the Literate Individual

Students Who are College and Career Ready in Reading, Writing, Speaking, Listening, & Language

They demonstrate independence.

Reading: Science & Technical Subjects

Key Ideas and Details 1. Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.

RST.9-10.1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas.

RST.9-10.2. Determine the central ideas or conclusions of a text; trace the texts explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

Analyze how and why individuals, events, or ideas develop and interact over the course of a text.

RST.9-10.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks attending to special cases or exceptions defined in the text.

Craft and Structure 4. Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.

RST.9-10.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 910 texts and topics.

Analyze the structure of texts, including how specific sentences, paragraphs, and larger portions of the text (e.g., a section, chapter, scene, or stanza) relate to each other and the whole.

RST.9-10.5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).

Assess how point of view or purpose shapes the content and style of a text.

RST.9-10.6. Analyze the authors purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

Integration of Knowledge and Ideas 7. Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words.

RST.9-10.7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence.

RST.9-10.8. Assess the extent to which the reasoning and evidence in a text support the authors claim or a recommendation for solving a scientific or technical problem.

Analyze how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take.

RST.9-10.9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

Read and comprehend complex literary and informational texts independently and proficiently.

RST.9-10.10. By the end of grade 10, read and comprehend science/technical texts in the grades 910 text complexity band independently and proficiently.

Catholic Identity

DOC All Grades Catholic Identity

Catholic Social Justice Teachings

Life and Dignity of the Human Person

Rights and Responsibilities

The Dignity of Work and the Rights of Workers

Call to Family, Community, and Participation

Option for the Poor and Vulnerable

Solidarity

Care for God's Creation

The Rights of Children

1. THE RIGHT TO A CATHOLIC COMMUNITY that witnesses to Christ and the Gospel by protecting them from child abuse, including sexual abuse and neglect.

2. THE RIGHT TO A SAFE ENVIRONMENT that promotes care, protection, and security.

3. THE RIGHT TO BE RESPECTED AS INDIVIDUALS with human dignity.

4. THE RIGHT TO WORK ACTIVELY TOWARD THEIR OWN EMPOWERMENT through the development of their gifts and talents.

5. THE RIGHT TO A LEARNING ENVIRONMENT THAT VALUES COOPERATION and challenges its members to critical and reflective thinking in their search for truth.

6. THE RIGHT TO DEVELOP POSITIVE, RESPONSIBLE AND CARING ATTITUDES AND BEHAVIORS TOWARD OTHERS and to recognize the rights of others to be safe and free from harassment and abuse.

7. THE RIGHT TO LEARN THE SKILL OF SELF PROTECTION by identifying safe and unsafe situations.

8. THE RIGHT TO LEARN RESPONSIBILITY for themselves and their actions.

9. THE RIGHT TO MAKE RESPONSIBLE DECISIONS founded on religious conviction.

10. THE RIGHT TO GUIDANCE FROM THE CHURCH in their development as loving people.

Summary

This unit focuses on evolution, a scientific theory based on a large and well-supported body of evidence from various scientists in a variety of fields over many years. The process of evolution is driven through genetic variations which arise as a result of mutations and gene shuffling. The process of evolution can be divided into two categories: microevolution (gene frequency, genetic drift, speciation, etc.) and macroevolution (adaptive radiation, coevolution, mass extinctions, etc.). In addition, modern synthesis has continued to bridge the relationship between evolution and genetics.

According to the Ohio Department of Education, students were introduced to the idea that relationships exist between organisms and their environment as well as parents and their offspring in elementary school. In addition, students were introduced to the fossil record and the concept of extinction during the elementary grades. In middle school, concepts are expanded to include discussions of biodiversity, speciation, further exploration of the fossil record and Earth history, and the influence of the environment on organisms. In addition, biological evolution and natural selection are introduced and discussed in the middle school grades.

In high school, focus should shift from thinking in terms of selection of individuals for a specific trait to changing frequencies of traits within populations. According to the Ohio Department of Education, emphasis should be placed on the following concepts: modern synthesis, historical perspectives of evolutionary theory, current research in evolutionary biology (including bioinformatics), unification of genetics and evolution, gene flow, mutation, speciation, natural selection, genetic drift, sexual selection, and Hardy-Weinberg's principle (use the law to explain gene frequency patterns).

The State of Ohio expects educators to combine content knowledge gained in 8th grade science with explanations of the internal structure and function of chromosomes. In addition, educators are expected to use real-world examples and mathematical principles to help students grasp the relationship between mutations and evolution including genetic drift.

Unit Goals

**Once students have completed this unit they will be able to:**

1. Describe the scientific contributions of various scientists which have contributed to our current understanding of evolution.
2. Discuss the relationship between genetics and evolution.
3. Evaluate the impact of variations (mutations or gene shuffling) on the fitness of a species.
4. Analyze the effect of mutations and sexual selection on the evolution of a species using virtual simulations.
5. Use mathematical principles pertaining to Hardy-Weinberg to describe genetic drift.
6. Evaluate and analyze evidence supporting evolution including anatomy, embryology, molecular evidence, fossil evidence, biogeography, bioinformatics, and geological evidence.
7. Assess the influence of environmental factors on the expression of genes in nature.
8. Differentiate between the three types of selection (directional, stabilizing, and disruptive) using real-world examples.
9. Evaluate the importance of Charles Darwin's work on our understanding of evolution through natural selection.
10. Identify the five principles of natural selection.
11. Describe how modern research is changing our understanding of evolutionary biology through modern synthesis
12. Differentiate between allopatric and sympatric speciation.
13. Apply Hardy-Weinberg's principle to describe the changes in frequencies of a gene pool.

Big Ideas

1. Evolution is a result of interactions of populations with the environment through the process of natural selection.
2. The mechanism for how evolution works is rooted in genetic variations which arise as a result of mutations and gene shuffling.
3. Evolution is a scientific theory based on a large and well-supported body of evidence from various scientists in a variety of fields over many years.
4. Current research continues to add to and strengthen our current understanding of evolutionary biology.
5. Evolutionary biology and genetics help to explain how all living things arose from a common ancestor over a long period of time.

Enduring Understandings

1. Evolution works on a micro-level through genetics (speciation, Hardy-Weinberg, genetic drift, etc.) and on a macro-level through large scale changes in populations over time (adaptive radiation, coevolution, etc.).
2. Evolution acts on populations, rather than individuals, through complex interactions with the environment and genes. The mechanism for how evolution occurs, genetics, is a result of variations which arise through mutations or gene shuffling.
3. Evolution is not an intentional process, rather species gain advantages through random changes in DNA which may increase species fitness, which ultimately results in adaptations through heritable traits.
4. The theory of evolution is well-supported through a large body of scientific evidence spanning a variety of fields (biology, chemistry, mathematics, etc.) from various scientists over time.
5. Current advances in science and technology continue to add to and strengthen our understanding of biological evolution.
6. The relationship between evolution and genetics is the basis for understanding how all living things arose from a common ancestor.
7. God is the Creator of all life.

Content

**evolution**

**comparative anatomy**

1. vestigial structures
2. homologous structures
3. analogous structures

**embryology**

**molecular evidence**

1. Hox genes
2. horizontal gene transfer

**natural selection**

1. fitness
2. artificial selection
3. sexual selection
4. disruptive selection
5. directional selection
6. stabilizing selection

**speciation**

1. sympatric speciation
2. allopatric speciation

**microevolution**

1. gene pool
2. gene frequency
3. genetic drift
4. Founder Effect
5. Hardy-Weinberg

**macroevolution**

1. adaptive radiation (divergent evolution)
2. convergent evolution
3. coevolution
4. mass extinctions
5. fossil record
6. punctuated equilibrium
7. gradualism

**scientific contributions**

1. Hutton
2. Lyell
3. Lamarck
4. Wegener
5. Darwin
6. Wallace
7. Malthus
8. Margulis
9. Cuvier
10. Sutton
11. Morgan
12. Dobzhansky
13. Mayr
14. Dawkins

Skills

**Remember (DOK Level 1)**

1. Define vocabulary pertinent to the unit to increase content knowledge.
2. Describe how mutations influence the fitness of a species.
3. Explain how the structure of the chromosome relates to genes.
4. Identify the effect of mutations on gene expression.

**Understand (DOK Level 1 and Level 2)**

1. Classify the type of selection occurring based on evidence provided in a real-world example.
2. Explain the relationship between genetics and evolution.
3. Compare the following terms: allopatric speciation and sympatric speciation, convergent evolution and divergent evolution, analogous structures and homologous structures, artificial selection and natural selection.
4. Contrast the following terms: allopatric speciation and sympatric speciation, convergent evolution and divergent evolution, analogous structures and homologous structures, artificial selection and natural selection.
5. Distinguish between beneficial, neutral, and detrimental mutations and their effects on fitness.
6. Describe the structure of the chromosome.

**Apply (DOK Level 2)**

1. Examine anatomical evidence to determine how a specific species has evolved over time.
2. Use the Hardy-Weinberg equation to describe changes in gene frequency for a particular species.

**Analyze (DOK Level 3)**

1. Differentiate between Darwin's theory of natural selection and modern synthesis.
2. Investigate the effect of sexual selection and mutation on a theoretical population of organisms using a virtual lab.

**Evaluate (DOK Level 3 and Level 4)**

1. Evaluate current and past evidence which supports and adds to our understanding of biological evolution.
2. Justify the acceptance of evolution as a valid scientific theory using evidence from a variety of scientific fields.

**Create (DOK Level 4)**

1. Hypothesize the effect of sexual selection and mutation on the fitness of a specific population under investigation.

Essential Questions

1. How did Charles Darwin's research provide the foundation for our understanding of evolution through natural selection?
2. What is the mechanism for how microevolution works on populations?
3. What is the mechanism for how macroevolution works on populations?
4. What is the difference between sympatric and allopatric speciation?
5. What is the relationship between genetics and evolution?
6. How can we apply Hardy-Weinberg's principle to describe how allele frequencies in a gene pool change over time?
7. How can we utilize mathematics to describe genetic drift using real-world problems?
8. What evidence is present that helps to support biological evolution?
9. How do mutations contribute to the fitness of a species?
10. What influence does the environment have on the gene pool of a population?
11. How have current advances in science and technology increased our understanding of biological evolution?
12. What is the connection between sexual selection and evolution?
13. What basic principles or ideas have been gained through our understanding of evolution through natural selection?
14. What evidence have we gained today that past scientists, including Darwin, did not understand or were lacking when discussing biological evolution?
15. How can we use evolution and genetics to better understand how all living things are connected, including humans?
16. How was Lamarck's theory of evolution through acquired characteristics flawed?
17. What is modern synthesis and how does it relate to Darwin's theory of evolution through natural selection?

Stage 2: Assessment Evidence

Various Formative Assessments

Formative: Class Work

Bell WorkExit SlipsKWL ChartsCloze ReadingThink-Pair-ShareFist-to-53-2-1Clickers

Foldables/Thinking Maps

Formative: Homework

Unit Exam

Summative: Unit Exam

Evolution Virtual Labs

Summative: Lab Assignment

Ability to add formative pieces.Ability to add formal lab report.

Whale Evolution/Peppered Moths Lab

Summative: Lab Assignment

Journal Responses

Summative: Reflective Writing

Can be used in conjunction with streaming movies, TED Talks, resource websites, and/or science publications.Can also be combined with a formal research report (summative) as a formative assessment (journal response).

Resources

Stage 3: Learning Plan

Learning Experiences

1. Graphic Organizers: Students will use Foldables to review concepts.
2. Graphic Organizers: Students will use Thinking Maps to review concepts.
3. Laboratory Groups: Students will participate in DNA Virtual Labs. (See Links in Technology Integration.)
4. Peer Partner Learning: Students will participate in Peppered Moths Lab. (See Links.)
5. Laboratory Groups: Students will participate in Whale Evolution Lab. (See Links.)
6. Explicit Teaching: Students will watch and discuss PBS NOVA: *Darwin's Darkest Hour.*
7. Explicit Teaching: Students will watch and discuss PBS NOVA: *What Darwin Never Knew.*
8. Explicit Teaching: Students will watch and discuss Evolution Webquest. (See websites in Resources.)
9. Reflective Writing: Students will engage in journal writing.
10. Reflective Writing: Students will write movie reflections. (See streaming videos in Technology Integration.)
11. Problem Solving: Students will solve Hardy-Weinberg problems.

Resources

Technology Integration

**iPad Apps (Free):**

1. Click and Learn (Howard Hughes Medical Institute)
2. EvoLife (You Can Sleep When You're Dead Studios)
3. Khan Biology (Skillmo)

**YouTube:**

1. What is Evolution? (Stated Clearly)
2. Bozeman Science (Evidence for Evolution)
3. Bozeman Science (Natural Selection)
4. Crash Course Biology (Natural Selection)
5. Crash Course Biology (Evolution: It's a Thing)
6. Crash Course Biology (Speciation: Of Ligers and Men)
7. Crash Course Biology (Population Genetics: When Darwin Met Mendel)
8. Khan Academy (Introduction to Evolution and Natural Selection)

**TED Talks: See Links**

**Virtual Labs: See Links**

**Streaming Video:**

1. PBS NOVA: *Darwin's Darkest Hour* (See Links.)
2. *What Darwin Never Knew* (See Links.)
3. *Cosmos* (See Links.)
4. PBS: *Great Transformations* (Evolution)

Resources

* Virtual Lab: Biology in Motion: Evolution (<http://biologyinmotion.com/evol/>)

Resources

**Books:**

1. Johnson, P. (2013). *Darwin: Portrait of a genius*. New York: Penguin Group.
2. Darwin, C. (1993). *On the origin of species.* New York: Random House Publishing Group.
3. Kardong, K. (2007). *Introduction to biological evolution*. New York: McGraw-Hill Higher Education.
4. Bryson, B. (2004). *A short history of nearly everything.* New Yor*k*: Crown Publishing Group.

**Twitter:**

1. Sally Ride Science (@SallyRideSci)
2. MIT Biology (@MITBiology)
3. Dr. Eric Lander (@eric\_lander)
4. Dr. J. Craig Venter (@jcventer)
5. HHMI Cool Science (@HHMICoolSci)
6. Molecular Biology (@molecular)
7. Smithsonian (@smithsonian)
8. Reuters Science News (@ReutersScience)
9. AAAS News (@AAAS\_News)
10. TED Talks (@TEDTalks)
11. NIH (@NIH)
12. The Royal Society (@royalsociety)
13. Nature (@NatureNews)
14. Science Magazine (@sciencemagazine)
15. New York Times Science (@nytimesscience)
16. National Science Foundation (@nsf)

Resources

* Nature ([www.nature.com](http://www.nature.com))

Grades 9-12 Science  
Biology

History of Life

Stage 1: Desired Results

Catholic Standards

DOC All Grades DOC: Catholic Standards

The Profession of Faith

Students will be able to

1. Recognize God in the world's order, beauty, and goodness (CCC 32).

8. Understand that the world was made for the glory of God, the Creator of all things (CCC 290; 293).

9. Know that we are created in God's image to serve Him and to rule over all creatures (CCC 380).

Life in Christ

Students will be able to

1. Understand that we shape our own life as a result of free will (CCC 1731).

11. Respect all human life (CCC 2318).

12. Respect the integrity of all creation, including animals, plants, and all nature (CCC 2415).

Targeted Standards

NGSS Grade 2 NGSS: Disciplinary Core Ideas

ETS1: Engineering Design

Defining and Delimiting an Engineering Problem

A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. (K-2-ETS1- 1) (secondary to KPS2-2)

NGSS Grade 9-12 NGSS: Crosscutting Concepts

Crosscutting Statements

Patterns Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

NGSS Grade 9-12 NGSS: Science and Engineering Practices

Practice 8. Obtaining, evaluating, and communicating information

Obtaining, evaluating, and communicating information in 912 builds on K8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.

Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem.

Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source.

Evaluate the validity and reliability of and/or synthesize multiple claims, methods, and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible.

Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).

Practice 6. Constructing explanations (for science) and designing solutions (for engineering)

Constructing explanations and designing solutions in 912 builds on K8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.

Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.

Practice 7. Engaging in argument from evidence

Engaging in argument from evidence in 912 builds on K8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.

Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments.

Respectfully provide and/or receive critiques on scientific arguments by probing reasoning and evidence, challenging ideas and conclusions, responding thoughtfully to diverse perspectives, and determining additional information required to resolve contradictions.

Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.

Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge and student-generated evidence.

Practice 1. Asking questions (for science) and defining problems (for engineering)

Asking questions and defining problems in 912 builds on K8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.

Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information.

Ask questions that arise from examining models or a theory, to clarify and/or seek additional information and relationships.

Ask questions to determine relationships, including quantitative relationships, between independent and dependent variables.

Ask questions to clarify and refine a model, an explanation, or an engineering problem.

Evaluate a question to determine if it is testable and relevant.

Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory.

Ask and/or evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design.

Practice 4. Analyzing and interpreting data

Analyzing data in 912 builds on K8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.

Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data.

Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations.

Evaluate the impact of new data on a working explanation and/or model of a proposed process or system.

Analyze data to identify design features or characteristics of the components of a proposed process or system to optimize it relative to criteria for success.

OH Grade 9-12 OH: Science (2011)

HS Biology

Science Inquiry and Application During the years of grades 9 through 12 all students must use the following scientific processes to construct their knowledge and understanding in all science content areas:

Identify questions and concepts that guide scientific investigations;

Design and conduct scientific investigations;

Use technology and mathematics to improve investigations and communications;

Formulate and revise explanations and models using logic and evidence (critical thinking);

Recognize and analyze explanations and models

Communicate and defend a scientific argument.

Course Content: Evolution

Mechanisms: Natural selection

Mechanisms: Mutation

Mechanisms: Genetic drift

Mechanisms: Gene flow (immigration, emigration)

Mechanisms: Sexual selection

Mechanisms: History of life on Earth

Diversity of Life: Speciation and biological classification based on molecular evidence

Diversity of Life: Variation of organisms within a species due to population genetics and gene frequency

OH Grades 9-10 OH: Literacy in History/Social Studies, Science, & Technical Subjects 6-12

Writing

Text Types and Purposes 1. Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence.

WHST.9-10.1. Write arguments focused on discipline-specific content.

WHST.9-10.1a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.

WHST.9-10.1b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audiences knowledge level and concerns.

WHST.9-10.1c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.

WHST.9-10.1d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

WHST.9-10.1e. Provide a concluding statement or section that follows from or supports the argument presented.

Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.

WHST.9-10.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

WHST.9-10.2a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

WHST.9-10.2b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

WHST.9-10.2c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.

WHST.9-10.2d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.

WHST.9-10.2e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

WHST.9-10.2f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

Production and Distribution of Writing 4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST.9-10.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.

WHST.9-10.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.

WHST.9-10.6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

Research to Build and Present Knowledge 7. Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.

WHST.9-10.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.

WHST.9-10.8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

Draw evidence from literary or informational texts to support analysis, reflection, and research.

WHST.9-10.9. Draw evidence from informational texts to support analysis, reflection, and research.

Range of Writing 10. Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

WHST.9-10.10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Capacities of the Literate Individual

Students Who are College and Career Ready in Reading, Writing, Speaking, Listening, & Language

They demonstrate independence.

Reading: Science & Technical Subjects

Key Ideas and Details 1. Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.

RST.9-10.1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas.

RST.9-10.2. Determine the central ideas or conclusions of a text; trace the texts explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

Analyze how and why individuals, events, or ideas develop and interact over the course of a text.

RST.9-10.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks attending to special cases or exceptions defined in the text.

Craft and Structure 4. Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.

RST.9-10.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 910 texts and topics.

Analyze the structure of texts, including how specific sentences, paragraphs, and larger portions of the text (e.g., a section, chapter, scene, or stanza) relate to each other and the whole.

RST.9-10.5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).

Assess how point of view or purpose shapes the content and style of a text.

RST.9-10.6. Analyze the authors purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

Integration of Knowledge and Ideas 7. Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words.

RST.9-10.7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence.

RST.9-10.8. Assess the extent to which the reasoning and evidence in a text support the authors claim or a recommendation for solving a scientific or technical problem.

Analyze how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take.

RST.9-10.9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

Read and comprehend complex literary and informational texts independently and proficiently.

RST.9-10.10. By the end of grade 10, read and comprehend science/technical texts in the grades 910 text complexity band independently and proficiently.

Catholic Identity

DOC All Grades Catholic Identity

Catholic Social Justice Teachings

Life and Dignity of the Human Person

Rights and Responsibilities

The Dignity of Work and the Rights of Workers

Call to Family, Community, and Participation

Option for the Poor and Vulnerable

Solidarity

Care for God's Creation

The Rights of Children

1. THE RIGHT TO A CATHOLIC COMMUNITY that witnesses to Christ and the Gospel by protecting them from child abuse, including sexual abuse and neglect.

2. THE RIGHT TO A SAFE ENVIRONMENT that promotes care, protection, and security.

3. THE RIGHT TO BE RESPECTED AS INDIVIDUALS with human dignity.

4. THE RIGHT TO WORK ACTIVELY TOWARD THEIR OWN EMPOWERMENT through the development of their gifts and talents.

5. THE RIGHT TO A LEARNING ENVIRONMENT THAT VALUES COOPERATION and challenges its members to critical and reflective thinking in their search for truth.

6. THE RIGHT TO DEVELOP POSITIVE, RESPONSIBLE AND CARING ATTITUDES AND BEHAVIORS TOWARD OTHERS and to recognize the rights of others to be safe and free from harassment and abuse.

7. THE RIGHT TO LEARN THE SKILL OF SELF PROTECTION by identifying safe and unsafe situations.

8. THE RIGHT TO LEARN RESPONSIBILITY for themselves and their actions.

9. THE RIGHT TO MAKE RESPONSIBLE DECISIONS founded on religious conviction.

10. THE RIGHT TO GUIDANCE FROM THE CHURCH in their development as loving people.

Summary

This unit focuses on the origin of life on Earth and its 4.6 billion year history. Through analysis of the geological time record, including information from the fossil record, molecular evidence, biogeography, and comparative anatomy, students should understand that Earth's modern-day species descended from common ancestral species.

Students should understand that the interconnectedness between living organisms and Earth's biodiversity is a result of more than 3.5 billion years of biological evolution. Ohio Department of Education expects students to understand that changes occurring today are similar to changes which happened long ago. Therefore, students should be presented with evidence and discussion on how data from various scientists and scientific fields (geology, bioinformatics, astrobiology, etc.) are used to understand how life evolved on our planet.

In addition, this unit sets the foundation for understanding classification and taxonomy. Discussion should include molecular evidence that connects eukaryotes with prokaryotes including endosymbiotic theory, horizontal gene transfer, and molecular clocks.

Focus should not be on the memorization of dates, rather on the understanding that life has evolved over long periods of time from a common ancestral species. Students should understand the relationship between mass extinctions and adaptive radiation events, which connects to previous units (macroevolution). However, they should also understand that God is the Creator of all things.

Unit Goals

**Once students have completed this unit, they will be able to:**

1. Discuss major biological and geological events occurring throughout Earth's history.
2. Evaluate the effect of mass extinctions on Earth's biodiversity.
3. Relate adaptive radiation events with Earth's five major mass extinctions.
4. Describe how endosymbiotic theory connects prokaryotic and eukaryotic organisms.
5. Analyze how conditions on ancient Earth provided materials for the synthesis of the first organic molecules.
6. Outline the major eras and time periods on Earth's geological time scale.
7. Defend the concept of modern-day species evolving from a common ancestral species.
8. Critique historical and modern research which has contributed to our understanding of how life evolved.

Big Ideas

1. Planet Earth originated approximately 4.6 billion years ago when the solar system formed. Geological events, including meteor strikes, volcanic activity, and a reducing atmosphere, contributed to early conditions on ancient Earth. In addition, biological events including the synthesis of organic molecules from inorganic molecules led to emergence of the first prokaryotic cells and the development of an oxidizing atmosphere through photosynthesis.
2. Life has continued to evolve in the past 3.5 billion years, and evidence from various scientific fields can be used to understand how events which have occurred long ago are still happening today. In addition, molecular evidence continues to demonstrate how all living organisms evolved from a common ancestral species.

Enduring Understandings

1. Planet Earth originated approximately 4.6 billion years ago when the solar system formed after the Big Bang.
2. Earth's early atmosphere was reducing and not conducive to life, resulting in approximately 1 billion years of geological events leading up to the synthesis of the first cells.
3. Conditions such as a reducing atmosphere, lightning, and volcanic eruptions provided the necessary ingredients for organic molecules to form from inorganic molecules as proposed by Oparin, Haldane, Urey, Miller, and Fox.
4. The first living organisms were anaerobic chemosynthetic prokaryotes which evolved mechanisms leading to photosynthesis.
5. Photosynthetic bacteria, similar to cyanobacteria, helped change Earth's atmosphere from reducing to oxidizing, ultimately setting up the events leading to the evolution of eukaryotic organisms and multicellularity.
6. According to endosymbiotic theory, eukaryotic organisms arose from prokaryotes. Modern evidence supports this idea, demonstrating a molecular relationship between eukaryotes and archaeabacteria.
7. Through the principle of uniformatarianism, we can understand how events which happened in the past have led to the evolution of modern-day species.
8. Mass extinctions profoundly affect Earth's biodiversity, leading to adaptive radiation events due to increased open niches in the environment.
9. By studying how life originated on Earth, scientists can better understand how all living things are connected using evidence from various scientific fields.
10. God is the Creator of all life.

Content

**uniformatarianism**

**punctuated equilibrium**

**gradualism**

**relative dating**

**radiometric/absolute dating**

**endosymbiotic theory**

**archaebacteria**

**eubacteria**

**eukaryote**

**scientific contributions**

**geological time scale**

1. Precambrian Time

Hadean Era

Archean Era

Proterozoic Era

1. Paleozoic Era

Cambrian Period

Ordovician Era

Silurian Era

Devonian Era

Carboniferous Era

Permian Era

1. Mesozoic Era

Triassic Period

Jurassic Period

Cretaceous Period

1. Cenozoic Era

Tertiary Period

Quaternary Period

**adaptive radiation**

**mass extinction**

**biodiversity**

**protocell**

**reducing atmosphere**

**oxidizing atmosphere**

**chemosynthesis**

**scientific contributions**

1. Oparin
2. Haldane
3. Lyell
4. Hutton
5. Wegener
6. Hess
7. Steno
8. Smith
9. Urey
10. Miller
11. Fox
12. Margulis

Skills

**Remember (DOK Level 1)**

Define vocabulary pertinent to the unit to increase content knowledge.

Describe the conditions present on primitive Earth.

Draw a picture illustrating what Earth looked like during a specific time period.

Identify the major eras and periods of the geological time scale.

Locate where major extinctions occurred on the geological time scale.

Recognize major adaptive radiation events on the geological time scale.

**Understand (DOK Level 1 and Level 2)**

1. Distinguish between conditions in a reducing atmosphere and an oxidizing atmosphere.
2. Compare the following terms: gradualism and punctuated equilibrium, reducing atmosphere and oxidizing atmosphere, relative dating and radiometric dating.
3. Contrast the following terms: gradualism and punctuated equilibrium, reducing atmosphere and oxidizing atmosphere, relative dating and radiometric dating.
4. Summarize the major biological and geological events occurring throughout Earth's history.
5. Explain how modern molecular evidence is used to demonstrate how modern-day species evolved from a common ancestral species.

**Apply (DOK Level 2)**

1. Explain how mass extinctions affect Earth's biodiversity.
2. Describe the relationship between mass extinctions and adaptive radiation.

**Analyze (DOK Level 3)**

1. Discriminate between punctuated equilibrium and gradualism.
2. Outline the major steps describing the synthesis of organic molecules from inorganic molecules.
3. Investigate the evidence from modern experiments to understand how organic molecules evolved on primitive Earth.
4. Analyze evidence from a variety of sources to determine the connection between living things and Earth's history.

**Evaluate (DOK Level 3 and Level 4)**

1. Defend the theory of endosymbiosis as a mechanism in understanding the relationship between prokaryotes and eukaryotes.
2. Assess the validity of Oparin and Haladane's hypothesis using Miller and Urey's experiments.
3. Justify the need for society to understand the impact of environmental changes on Earth's biodiversity.
4. Verify the relationship between eukaryotes and prokaryotes using molecular evidence from current research.

**Create (DOK Level 4)**

1. Generate a model of the geological time scale using various anaologies (football field, 24-hour clock, calendar, etc.

Essential Questions

1. How did Earth form approximately 4.6 billion years ago?
2. What evidence can be used to describe primitive conditions on Earth?
3. How did the first organic molecules form on a planet devoid of life?
4. What mechanisms can be used to describe how the first prokaryotic cells evolved approximately 3.5 billion years ago?
5. How can endosymbiotic theory be used to describe the relationship between prokaryotes and eukaryotes?
6. What information can the experiments of Urey, Miller, Stanley, and Fox provide to help scientists understand how life originated on Earth?
7. What processes led to the five major mass extinctions which have occurred over Earth's history?
8. Why do major adaptive radiation events follow closely behind a mass extinction when examining the geological time scale?
9. How have modern advances in science and technology increased or improved our understanding of how life evolved?
10. What evidence can be used to demonstrate that all living organisms evolved from a common ancestor?
11. Why are eukaryotes considered to be more closely related to archaebacteria than eubacteria?
12. How can the principle of uniformatarianism be employed to understand how Earth has changed over its 4.6 billion year history?
13. What is the difference between gradualism and punctuated equilibrium?
14. What techniques are utilized to determine the age of a specimen?
15. How can the theory of evolution be reconciled with God as the Creator of all things?

Stage 2: Assessment Evidence

Various Formative Assessments

Formative: Class Work

Bell WorkExit SlipsKWL ChartsJigsawsFist to Five3-2-1

Unit Exams

Summative: Unit Exam

Foldables/Thinking Maps

Formative: Graphic Organizer

Geological Time Presentations

Summative: Technology Project

Assign students a geological time period and have them research and present information to their classmates about their time period. Technology can be added by having them create presentations in Power Point, Prezi, Google Docs, etc.

Geological Time Cartoons/Comic

Summative: Visual Arts Project

History of Life Virtual Labs/Webquests

Summative: Lab Assignment

Resources

Stage 3: Learning Plan

Learning Experiences

1. Graphic Organizers: Students create Foldables to review concepts.
2. Graphic Organizers: Students use Thinking Maps to review content.
3. Problem Solving: Students will participate in the Geological Time Scale Activity. (See Links.)
4. Simulation: Students will participate in the History of Life Virtual Labs/Simulations. (See Links in Technology Integration.)
5. Research: Students will research and present Geological Time Scales.
6. Creative Project: . Students will receive a geological time period and illustrate the major events occurring during that time period in a Geological Time Scale Comic or Cartoon.
7. Explicit Teaching: Students will watch PBS NOVA videos and discuss content. (See links in Technology Integration.)
8. Technology Tools: Students will participate in Understanding Evolution WebQuests. (See Links.)
9. Technology Tools: Students will participate in Exploring Life's Origins WebQuest. (See Links.)
10. Lecture: Students will view appropriate TED Talks, take notes, and discuss content. (See Links in Technology Integration.)

Resources

* Exploring Life's Origins WebQuest (<http://exploringorigins.org/timeline.html>)

Technology Integration

**iPad Apps (Free):**

1. Khan Biology (Skillmo)
2. Click and Learn (Howard Hughes Medical Institute)
3. TimeTree (Arizona and Penn State Universities)
4. GTS (Raymond F. Gildner)
5. EarthViewer (Howard Hughes Medical Institute)

**YouTube:**

1. Bozeman (Origin of Life - Scientific Evidence)
2. Crash Course Biology (History of Life on Earth)
3. National Geographic: The Story of Earth (documentary)
4. ASAPScience (The Evolution of Life on Earth)
5. Ted-Ed (Four Ways To Understand Earth's Age)

**TED Talks: See Links**

**Virtual Labs/Simulations: See Links**

**Streaming Video:**

1. PBS NOVA: Decoding Neanderthals
2. Cosmos: A Spacetime Odyssey
3. PBS NOVA: Where Did We Come From?
4. PBS NOVA: Becoming Human
5. PBS NOVA: Arctic Dinosaurs
6. PBS NOVA: Origins: Earth is Born

Resources

* TED: Discovering Ancient Climates in Oceans and Ice (<http://www.ted.com/talks/rob_dunbar>)

Resources

**Books:**

1. Bryson, B. (2004). *A short history of nearly everything.* New York: Crown Publishing Group.

**Twitter**

1. Sally Ride Science (@SallyRideSci)
2. MIT Biology (@MITBiology)
3. Dr. Eric Lander (@eric\_lander)
4. Dr. J. Craig Venter (@jcventer)
5. HHMI Cool Science (@HHMICoolSci)
6. Molecular Biology (@molecular)
7. Smithsonian (@smithsonian)
8. Reuters Science News (@ReutersScience)
9. AAAS News (@AAAS\_News)
10. TED Talks (@TEDTalks)
11. NIH (@NIH)
12. The Royal Society (@royalsociety)
13. Nature (@NatureNews)
14. Science Magazine (@sciencemagazine)
15. New York Times Science (@nytimesscience)
16. National Science Foundation (@nsf)

Resources

* Exploring Life's Origins (<http://exploringorigins.org/timeline.html>)

Grades 9-12 Science  
Biology

Classification & Taxonomy

Stage 1: Desired Results

Catholic Standards

DOC All Grades DOC: Catholic Standards

The Profession of Faith

Students will be able to

1. Recognize God in the world's order, beauty, and goodness (CCC 32).

8. Understand that the world was made for the glory of God, the Creator of all things (CCC 290; 293).

9. Know that we are created in God's image to serve Him and to rule over all creatures (CCC 380).

Life in Christ

Students will be able to

2. Know that we must assume responsibility for the acts we perform (CCC 1781).

11. Respect all human life (CCC 2318).

12. Respect the integrity of all creation, including animals, plants, and all nature (CCC 2415).

Targeted Standards

NGSS Grade 2 NGSS: Disciplinary Core Ideas

ETS1: Engineering Design

Defining and Delimiting an Engineering Problem

A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. (K-2-ETS1- 1) (secondary to KPS2-2)

NGSS Grade 9-12 NGSS: Crosscutting Concepts

Crosscutting Statements

Patterns Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

NGSS Grade 9-12 NGSS: Science and Engineering Practices

Practice 8. Obtaining, evaluating, and communicating information

Obtaining, evaluating, and communicating information in 912 builds on K8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.

Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source.

Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).

Practice 3. Planning and carrying out investigations

Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.

Select appropriate tools to collect, record, analyze, and evaluate data.

OH Grade 9-12 OH: Science (2011)

HS Biology

Science Inquiry and Application During the years of grades 9 through 12 all students must use the following scientific processes to construct their knowledge and understanding in all science content areas:

Identify questions and concepts that guide scientific investigations;

Formulate and revise explanations and models using logic and evidence (critical thinking);

Recognize and analyze explanations and models

Communicate and defend a scientific argument.

Course Content: Heredity

Modern genetics

Course Content: Evolution

Mechanisms: History of life on Earth

Diversity of Life: Speciation and biological classification based on molecular evidence

Diversity of Life: Variation of organisms within a species due to population genetics and gene frequency

Course Content: Diversity and Interdependence of Life

Classification systems are frameworks created by scientists for describing the vast diversity of organisms indicating the degree of relatedness between organisms.

OH Grades 9-10 OH: Literacy in History/Social Studies, Science, & Technical Subjects 6-12

Writing

Text Types and Purposes 1. Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence.

WHST.9-10.1. Write arguments focused on discipline-specific content.

WHST.9-10.1a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.

WHST.9-10.1b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audiences knowledge level and concerns.

WHST.9-10.1c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.

WHST.9-10.1d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

WHST.9-10.1e. Provide a concluding statement or section that follows from or supports the argument presented.

Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.

WHST.9-10.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

WHST.9-10.2d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.

WHST.9-10.2e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

WHST.9-10.2f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

Production and Distribution of Writing 4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST.9-10.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.

WHST.9-10.6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

Research to Build and Present Knowledge 7. Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.

WHST.9-10.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.

WHST.9-10.8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

Draw evidence from literary or informational texts to support analysis, reflection, and research.

WHST.9-10.9. Draw evidence from informational texts to support analysis, reflection, and research.

Capacities of the Literate Individual

Students Who are College and Career Ready in Reading, Writing, Speaking, Listening, & Language

They demonstrate independence.

Reading: Science & Technical Subjects

Key Ideas and Details 1. Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.

RST.9-10.1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas.

RST.9-10.2. Determine the central ideas or conclusions of a text; trace the texts explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

Craft and Structure 4. Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.

RST.9-10.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 910 texts and topics.

Analyze the structure of texts, including how specific sentences, paragraphs, and larger portions of the text (e.g., a section, chapter, scene, or stanza) relate to each other and the whole.

RST.9-10.5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).

Assess how point of view or purpose shapes the content and style of a text.

RST.9-10.6. Analyze the authors purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

Integration of Knowledge and Ideas 7. Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words.

RST.9-10.7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

Analyze how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take.

RST.9-10.9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

Read and comprehend complex literary and informational texts independently and proficiently.

RST.9-10.10. By the end of grade 10, read and comprehend science/technical texts in the grades 910 text complexity band independently and proficiently.

Catholic Identity

DOC All Grades Catholic Identity

Catholic Social Justice Teachings

Life and Dignity of the Human Person

Rights and Responsibilities

The Dignity of Work and the Rights of Workers

Call to Family, Community, and Participation

Option for the Poor and Vulnerable

Solidarity

Care for God's Creation

The Rights of Children

1. THE RIGHT TO A CATHOLIC COMMUNITY that witnesses to Christ and the Gospel by protecting them from child abuse, including sexual abuse and neglect.

2. THE RIGHT TO A SAFE ENVIRONMENT that promotes care, protection, and security.

3. THE RIGHT TO BE RESPECTED AS INDIVIDUALS with human dignity.

4. THE RIGHT TO WORK ACTIVELY TOWARD THEIR OWN EMPOWERMENT through the development of their gifts and talents.

5. THE RIGHT TO A LEARNING ENVIRONMENT THAT VALUES COOPERATION and challenges its members to critical and reflective thinking in their search for truth.

6. THE RIGHT TO DEVELOP POSITIVE, RESPONSIBLE AND CARING ATTITUDES AND BEHAVIORS TOWARD OTHERS and to recognize the rights of others to be safe and free from harassment and abuse.

7. THE RIGHT TO LEARN THE SKILL OF SELF PROTECTION by identifying safe and unsafe situations.

8. THE RIGHT TO LEARN RESPONSIBILITY for themselves and their actions.

9. THE RIGHT TO MAKE RESPONSIBLE DECISIONS founded on religious conviction.

10. THE RIGHT TO GUIDANCE FROM THE CHURCH in their development as loving people.

Summary

This unit builds on concepts introduced in previous units (modern genetics, geological time scale, and evolution) by demonstrating how organisms are classified and grouped based on similarities. Students should be introduced to past classification systems (Aristotle, Linnean, etc.) while providing explanation on how organisms are classified today (phylogeny rather than morphology).

Students should also be introduced to the tools utilized by scientists to classify organisms based on shared derived characteristics including cladograms. In addition, students should be able to utilize a dichotomous key to identify and group organisms through laboratory investigations.

According to the Ohio Department of Education, students should understand common characteristics used to group organisms into the three major domains or six kingdoms of life. In addition, evidence should be used to demonstrate and discuss the interconnectedness of the three domains based on biological evolution and molecular evidence.

Recent changes in state standards have reduced the amount of content pertaining to the six kingdoms. Discretion and time constraints may contribute to the depth and detail students are asked to explore each of the three domains or six kingdoms. In addition, students can also be introduced to viruses in order to emphasize the connectivity of living organisms based on the seven characteristics of life. Emphasis should be placed on understanding the connectivity and relationships among living organisms while recognizing unique characteristics that help to classify and organize living organisms.

Unit Goals

**Once students have completed this unit, they should be able to:**

1. Discuss how past classification systems helped to group and classify organisms based on morphology.
2. Describe the importance of Linnaean's classification system on binomial nomenclature and modern taxonomy.
3. Evaluate the use of phylogeny to determine shared derived characteristics among living things.
4. Classify organisms based on shared derived characteristics.
5. Use a cladogram to analyze and evaluate the evolutionary relationship between two or more organisms.
6. Use a dichotomous key to identify an unknown organism.
7. Differentiate between the three major domains of life.
8. Compare and contrast the six kingdoms of classification.
9. List the taxonomic levels of classification.
10. Describe evidence supporting the evolutionary relationships between eukaryotes and prokaryotes.
11. Evaluate the reasons why viruses are not classified as living things.

Big Ideas

1. Organisms are grouped and classified based on phylogeny through shared derived characteristics. Living organisms are grouped into three major domains based on molecular evidence: Eukarya, Bacteria, and Archaea.
2. Organisms are further divided and grouped into six major kingdoms based on characteristics unique in that kingdom: archaebacteria, eubacteria, protist, fungi, plant, and animal.

Enduring Understandings

1. In the past, classification systems grouped organisms based on morphological relationships.
2. Recent advances in science and technology have resulted in a modern classification system which organizes and groups organisms based on phylogenetic relationships.
3. Molecular evidence indicates that organisms can be grouped into three major domains: eukarya, bacteria, and archaea.
4. Organisms are continually regrouped and reclassified as new information and evidence arises.
5. Relationships among organisms are illustrated using phylogenetic trees which display shared derived characteristics.
6. Binomial nomenclature is a naming system developed by Linnaeus which helps scientists to communicate to one another using a common system.
7. Organisms in the three domains can be further divided into six kingdoms of classification: archaeabacteria, eubacteria, fungi, protist, plant, and animal.
8. While viruses share some of the characteristics of life, their inability to reproduce and metabolize on their own prevents them from being classified as a living organism.

Content

**domains**

1. eukarya
2. archaea
3. bacteria

**kingdoms**

1. archaeobacteria
2. eubacteria
3. fungi
4. protists
5. plant
6. animal

**phylogeny**

**cladograms**

**taxonomy**

**classification**

**viruses**

**dichotomous keys**

**Aristotle**

**Linnaeus**

Skills

**Remember (DOK Level 1)**

1. Define vocabulary pertinent to the unit to increase content knowledge.
2. Describe evidence supporting the evolutionary relationships between eukaryotes and prokaryotes.
3. Draw evidence from informational texts to support analysis, reflection, and research.
4. List the taxonomic levels of classification.

**Understand (DOK Level 1 and Level 2)**

1. Classify organisms based on shared derived characteristics.
2. Explain questions and concepts that guide scientific investigations.
3. Compare and contrast the six kingdoms of classification.
4. Distinguish evidence supporting the evolutionary relationships between eukaryotes and prokaryotes.
5. Describe how scientists classify and organize living things.
6. Illustrate.

**Apply (DOK Level 2)**

1. Examine a dichotomous key to identify an unknown organism.
2. Use a cladogram to analyze and evaluate the evolutionary relationship between two or more organisms.

**Analyze (DOK Level 3)**

1. Differentiate the three major domains of life and their characteristics.
2. Deduce how our modern classification system is different from past classification systems.
3. Analyze the structure of the relationships among concepts in a text, including relationships among key terms.

**Evaluate (DOK Level 3 and Level 4)**

1. Verify how past classification systems helped to group and classify organisms based on morphology.
2. Justify the importance of Linnaean's classification system on binomial nomenclature and modern taxonomy.

**Create (DOK Level 4)**

1. Hypothesize the reasons why viruses are not classified as living things.
2. Generate conclusions based on evidence gathered during lab investigation.

Essential Questions

1. How do scientists classify and organize living things?
2. What evidence is present that supports the relationship between prokaryotes and eukaryotes?
3. How can a cladogram be utilized to demonstrate phylogenetic relationships among organisms?
4. What are the three major domains of life and their characteristics?
5. What are the six kingdoms of classification and their characteristics?
6. What past classification systems have influenced our modern classification system?
7. How is our modern classification system different from past classification systems?
8. How can a dichotomous key be employed to identify unknown organisms?
9. Why are viruses not classified as a living thing even though they share many characteristics of living things?
10. How are shared derived characteristics used to demonstrate evolutionary relationships among organisms?

Stage 2: Assessment Evidence

Various Formative Assessments

Formative: Class Work

Bell WorkExit SlipsKWL Charts3-2-1Fist to FiveCloze ReadingJigsaws

Foldables/Thinking Maps

Formative: Graphic Organizer

Unit Exam

Summative: Unit Exam

Constructing A Cladogram Lab

Summative: Lab Assignment

Ability to add formative piecesCan include a formal lab report

Dichotomous Key Activity

Summative: Lab Assignment

Kingdom Posters

Summative: Posters

Assign students a kingdom or a group of organisms in a kingdom and have them make posters illustrating that group.

Resources

Stage 3: Learning Plan

Learning Experiences

1. Graphic Organizer: Students work on Constructing A Cladogram. (See Links.)
2. Concept Attainment: Students complete Shark Dichotomous Key Activity. (See Links.)
3. Structured Overview: Students complete Cladogram Worksheet. (See Links.)
4. Graphic Organizer: Students create Foldable to review concepts. (See Links.)
5. Graphic Organizer: Students complete Thinking Maps. (See Links.)
6. Graphic Organzier: Students create Venn Diagrams to show similarities and differences in concepts.
7. Creative Project: Students create Kingdom Posters illustrating the group they have been assigned.

Resources

Technology Integration

**iPAD Apps (Free):**

1. TimeTree (Arizona and Penn State Universities)
2. Click and Learn (Howard Hughes Medical Institute)
3. Taxonomy (Miller Designs)
4. Tree of Life (PappCorn SAS)

**YouTube:**

1. Bozeman Science (Classification of Life)
2. Bozeman Science (Three Domains of Life)
3. Crash Course Biology (Taxonomy: Life's Filing System)
4. Crash Course Biology (Old Odd: Archae, Bacteria, Protists)
5. Crash Course Biology (Simple Animals)
6. Crash Course Biology (Chordates)
7. Crash Course Biology (Complex Animals)

**Virtual Labs/Simulations: See Links**

Resources

* McGraw-Hill Virtual Lab (<http://www.glencoe.com/sites/common_assets/science/virtual_labs/E07/E07.swf>)

Resources

Resources

**Twitter**

1. Sally Ride Science (@SallyRideSci)
2. MIT Biology (@MITBiology)
3. Dr. Eric Lander (@eric\_lander)
4. Dr. J. Craig Venter (@jcventer)
5. HHMI Cool Science (@HHMICoolSci)
6. Molecular Biology (@molecular)
7. Smithsonian (@smithsonian)
8. Reuters Science News (@ReutersScience)
9. AAAS News (@AAAS\_News)
10. TED Talks (@TEDTalks)
11. NIH (@NIH)
12. The Royal Society (@royalsociety)
13. Nature (@NatureNews)
14. Science Magazine (@sciencemagazine)
15. New York Times Science (@nytimesscience)
16. National Science Foundation (@nsf)

Resources

* PBS Nova ([www.pbs.org](http://www.pbs.org))

Grades 9-12 Science  
Biology

Ecology

Stage 1: Desired Results

Catholic Standards

DOC All Grades DOC: Catholic Standards

The Profession of Faith

Students will be able to

1. Recognize God in the world's order, beauty, and goodness (CCC 32).

8. Understand that the world was made for the glory of God, the Creator of all things (CCC 290; 293).

9. Know that we are created in God's image to serve Him and to rule over all creatures (CCC 380).

Life in Christ

Students will be able to

2. Know that we must assume responsibility for the acts we perform (CCC 1781).

6. Seek the common good together (CCC 1905).

11. Respect all human life (CCC 2318).

12. Respect the integrity of all creation, including animals, plants, and all nature (CCC 2415).

Targeted Standards

NGSS Grade 9-12 NGSS: Crosscutting Concepts

Crosscutting Statements

Patterns Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

NGSS Grade 9-12 NGSS: Science and Engineering Practices

Practice 8. Obtaining, evaluating, and communicating information

Obtaining, evaluating, and communicating information in 912 builds on K8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.

Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem.

Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source.

Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).

Practice 6. Constructing explanations (for science) and designing solutions (for engineering)

Constructing explanations and designing solutions in 912 builds on K8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.

Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.

Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.

Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

Practice 7. Engaging in argument from evidence

Engaging in argument from evidence in 912 builds on K8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.

Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments.

Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge and student-generated evidence.

Practice 1. Asking questions (for science) and defining problems (for engineering)

Asking questions and defining problems in 912 builds on K8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.

Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information.

Ask questions to determine relationships, including quantitative relationships, between independent and dependent variables.

Evaluate a question to determine if it is testable and relevant.

Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory.

Practice 3. Planning and carrying out investigations

Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.

Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.

Select appropriate tools to collect, record, analyze, and evaluate data.

Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated.

Manipulate variables and collect data about a complex model of a proposed process or system to identify failure points or improve performance relative to criteria for success or other variables.

Practice 4. Analyzing and interpreting data

Analyzing data in 912 builds on K8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.

Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations.

Evaluate the impact of new data on a working explanation and/or model of a proposed process or system.

Practice 5. Using mathematics and computational thinking

Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.

Apply techniques of algebra and functions to represent and solve scientific and engineering problems.

OH Grade 9-12 OH: Science (2011)

HS Biology

Science Inquiry and Application During the years of grades 9 through 12 all students must use the following scientific processes to construct their knowledge and understanding in all science content areas:

Identify questions and concepts that guide scientific investigations;

Design and conduct scientific investigations;

Use technology and mathematics to improve investigations and communications;

Formulate and revise explanations and models using logic and evidence (critical thinking);

Recognize and analyze explanations and models

Communicate and defend a scientific argument.

Course Content: Diversity and Interdependence of Life

Classification systems are frameworks created by scientists for describing the vast diversity of organisms indicating the degree of relatedness between organisms.

Ecosystems: Homeostasis: Carrying capacity

Ecosystems: Homeostasis: Equilibrium and disequilibrium

OH Grades 9-10 OH: Literacy in History/Social Studies, Science, & Technical Subjects 6-12

Writing

Text Types and Purposes 1. Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence.

WHST.9-10.1. Write arguments focused on discipline-specific content.

WHST.9-10.1a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.

WHST.9-10.1b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audiences knowledge level and concerns.

WHST.9-10.1c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.

WHST.9-10.1d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

WHST.9-10.1e. Provide a concluding statement or section that follows from or supports the argument presented.

Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.

WHST.9-10.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

WHST.9-10.2a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

WHST.9-10.2c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.

WHST.9-10.2d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.

WHST.9-10.2e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

WHST.9-10.2f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

Production and Distribution of Writing 4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST.9-10.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.

WHST.9-10.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.

WHST.9-10.6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

Research to Build and Present Knowledge 7. Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.

WHST.9-10.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.

WHST.9-10.8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

Draw evidence from literary or informational texts to support analysis, reflection, and research.

WHST.9-10.9. Draw evidence from informational texts to support analysis, reflection, and research.

Range of Writing 10. Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

WHST.9-10.10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Capacities of the Literate Individual

Students Who are College and Career Ready in Reading, Writing, Speaking, Listening, & Language

They demonstrate independence.

Reading: Science & Technical Subjects

Key Ideas and Details 1. Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.

RST.9-10.1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas.

RST.9-10.2. Determine the central ideas or conclusions of a text; trace the texts explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

Analyze how and why individuals, events, or ideas develop and interact over the course of a text.

RST.9-10.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks attending to special cases or exceptions defined in the text.

Craft and Structure 4. Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.

RST.9-10.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 910 texts and topics.

Analyze the structure of texts, including how specific sentences, paragraphs, and larger portions of the text (e.g., a section, chapter, scene, or stanza) relate to each other and the whole.

RST.9-10.5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).

Assess how point of view or purpose shapes the content and style of a text.

RST.9-10.6. Analyze the authors purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

Integration of Knowledge and Ideas 7. Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words.

RST.9-10.7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence.

RST.9-10.8. Assess the extent to which the reasoning and evidence in a text support the authors claim or a recommendation for solving a scientific or technical problem.

Analyze how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take.

RST.9-10.9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

Read and comprehend complex literary and informational texts independently and proficiently.

RST.9-10.10. By the end of grade 10, read and comprehend science/technical texts in the grades 910 text complexity band independently and proficiently.

Catholic Identity

DOC All Grades Catholic Identity

Catholic Social Justice Teachings

Life and Dignity of the Human Person

Rights and Responsibilities

The Dignity of Work and the Rights of Workers

Call to Family, Community, and Participation

Option for the Poor and Vulnerable

Solidarity

Care for God's Creation

The Rights of Children

1. THE RIGHT TO A CATHOLIC COMMUNITY that witnesses to Christ and the Gospel by protecting them from child abuse, including sexual abuse and neglect.

2. THE RIGHT TO A SAFE ENVIRONMENT that promotes care, protection, and security.

3. THE RIGHT TO BE RESPECTED AS INDIVIDUALS with human dignity.

4. THE RIGHT TO WORK ACTIVELY TOWARD THEIR OWN EMPOWERMENT through the development of their gifts and talents.

5. THE RIGHT TO A LEARNING ENVIRONMENT THAT VALUES COOPERATION and challenges its members to critical and reflective thinking in their search for truth.

6. THE RIGHT TO DEVELOP POSITIVE, RESPONSIBLE AND CARING ATTITUDES AND BEHAVIORS TOWARD OTHERS and to recognize the rights of others to be safe and free from harassment and abuse.

7. THE RIGHT TO LEARN THE SKILL OF SELF PROTECTION by identifying safe and unsafe situations.

8. THE RIGHT TO LEARN RESPONSIBILITY for themselves and their actions.

9. THE RIGHT TO MAKE RESPONSIBLE DECISIONS founded on religious conviction.

10. THE RIGHT TO GUIDANCE FROM THE CHURCH in their development as loving people.

Summary

This unit focuses on the diversity and interdependence of life through ecology. According to the Ohio Department of Education, students were introduced to the interactions among organisms, food webs, and conservation of matter in elementary school as well as flow of energy, biomes, and geochemical cycles in middle school. Emphasis is placed on the study of diversity and similarity of organisms on all biological levels (molecular through biosphere) while investigating the influence of chemical/physical limitations on biological interactions and systems.

This unit connects concepts from previous units (evolution, genetics, cells, etc.) to understand the diversity and complex connections among various ecosystems in our biosphere. Study should include how organisms transform energy and matter as they interact with their environment. Students are expected to understand how the flow of energy in the biosphere is unidirectional.

In addition, students are expected to investigate and understand concepts relating to population ecology (limiting factors, carrying capacity, exponential growth, etc.). According to the Ohio Department of Education, mathematical graphing and algebraic knowledge should be incorporated into classroom discussions and activities using real-world examples.

Students should be able to describe and elaborate on the various interactions among organisms in an ecosystem (symbiosis, succession, etc.). In addition, exploration of animal behavior can be added into this unit to better understand the complexity of interactions in ecosystems as well as their connection to evolution and genetics (innate behavior, altruism, social behavior, etc.).

Unit Goals

**Once students have completed this unit, they will be able to:**

1. Describe how energy flows unidirectionally through the biosphere.
2. Explain how ecosystems obey the law of conservation of mass and energy.
3. Evaluate the effect of changes in abiotic factors on the biotic factors within an ecosystem.
4. Analyze mathematical and graphic data to determine how populations change in response to changes in ecosystems.
5. Construct food webs to illustrate the flow of energy throughout an ecosystem.
6. Analyze a food web/ecological pyramid to describe the flow of energy within an ecosystem.
7. Differentiate between the three types of symbiotic relationships: mutualism, commensalism, and parasitism.
8. Compare and contrast primary succession and secondary succession.
9. Describe the role of various organisms (producers, decomposers, consumers, etc.) in the geochemical cycles.
10. Evaluate and critique the effect of human interactions on the stability of the biosphere.
11. Provide suggestions for how humans can support and maintain the stability of the biosphere.
12. Describe and evaluate the causes of global warming and climate change.
13. Explain how ecological principles are connected to ideas pertaining to evolution and genetics.
14. Differentiate between logistic and exponential growth.
15. Describe the influence of limiting factors on the growth of populations.
16. Use real-life examples to discuss concepts pertaining to population ecology.
17. Evaluate the influence of the environment and genetics on animal behavior.
18. Describe the importance of Malthus's work on ecology.

Big Ideas

1. The biodiversity found on Earth is a result of more than 3.5 billion years of biological evolution.
2. Ecology is a field of biology which helps to explore the interactions among living organisms and their environments. In addition, the effect of abiotic factors on living things can also provide information to understand how species adapt and evolve over time.

Enduring Understandings

1. The biodiversity of planet Earth is a result of complex changes and interactions occurring throughout 3.5 billion years of biological evolution.
2. Ecosystems can be persistent over hundreds of years through interactions within the biosphere.
3. Ecosystems will have cyclic fluctuations around a state of dynamic equilibrium that can be measured and understood to explain current changes in the biosphere.
4. Organisms transform matter and energy throughout all levels of biological organization as they interact with their environment.
5. Energy flow in the biosphere is unidirectional and obeys the laws of conservation of mass and energy.
6. Mathematical models can be used to describe and understand exponential and logistic growth in populations.
7. Food webs and ecological pyramids can be used to illustrate interactions among organisms within their ecosystem in terms of energy flow.
8. Ecosystems will change as they move towards dynamic equilibrium through primary succession and secondary succession.
9. Complex interactions between the environment and an organism result in the expression of genes which influence and control behaviors.

Content

**biosphere**

**geochemical cycles**

1. hydrologic cycle
2. carbon cycle
3. nitrogen cycle
4. phosphorus cycle

**energy processing**

1. autotroph
2. heterotroph

**greenhouse effect**

**global warming**

**climate change**

**law of conservation of mass**

**law of conservation of energy**

**primary succession**

**secondary succession**

**scientific contributions**

1. Linnaeus
2. Von Humboldt
3. Darwin
4. Elton
5. Cowles
6. Malthus
7. Verndasky
8. Hutchinson
9. Odum

**food webs**

**ecological pyramids**

**biological levels of organization**

1. organism
2. population
3. community
4. ecosystem
5. biosphere

**dynamic equilibrium**

**population ecology**

1. limiting factors
2. carrying capacity
3. birth rate/death rate
4. emigration/immigration
5. logistic growth
6. exponential growth

**innate behavior**

**social behavior**

**learned behavior**

Skills

**Remember (DOK Level 1)**

Define vocabulary pertinent to the unit to increase content knowledge.

Describe the flow of energy in an ecosystem.

Draw a food web to illustrate how organisms interact within a specific ecosystem.

Identify a specific organism (omnivore, carnivore, etc.) in a food web.

Recognize the impact of changes in abiotic factors on biotic factors in an ecosystem.

**Understand (DOK Level 1 and Level 2)**

1. Distinguish between primary succession and secondary succession.
2. Compare the following terms: primary succession and secondary succession, logistic growth and exponential growth, innate behavior and learned behavior, density-dependent factors and density-independent factors, autotroph and heterotroph.
3. Contrast the following terms: primary succession and secondary succession, logistic growth and exponential growth, innate behavior and learned behavior, density-dependent factors and density-independent factors, autotroph and heterotroph.
4. Summarize the work of Malthus and its importance to the field of ecology.
5. Explain the influence of limiting factors on the carrying capacity of a population.

**Apply (DOK Level 2)**

1. Explain the logistic growth model using algebraic equations.
2. Describe the role of various organisms (producers, consumers, etc.) on the geochemical cycles.

**Analyze (DOK Level 3)**

1. Discriminate among the three types of symbiotic relationships.
2. Outline the major causes for global warming and climate change.
3. Investigate the impact of climate change on Earth's biodiversity.
4. Analyze real-world data to evaluate the impact of global warming on climate change.
5. Analyze the complex interactions among organisms through behavioral observations or studies.

**Evaluate (DOK Level 3 and Level 4)**

1. Defend the need to educate the public on the impact of human interactions on the stability of the biosphere.
2. Assess the impact of changes in the ecosystem on various populations in the environment.
3. Evaluate the influence of the environment on gene expression that controls animal behavior.
4. Justify suggestions for improving the stability of the biosphere using evidence from multiple sources.
5. Verify recommendations made by government agencies pertaining to the global climate crisis using research and evidence from multiple sources and perspectives.

**Create (DOK Level 4)**

1. Create a food web to illustrate the unidirectional flow of energy in an ecosystem.
2. Create a graph illustrating the logistical growth of a population using real-word examples and data.
3. Generate recommendations for improving the biosphere using evidence from multiple sources.

Essential Questions

1. How has the biodiversity of Earth changed over 3.5 billion years of biological evolution?
2. How can scientists utilize real-time data (carbon dioxide levels, temperature, etc.) to analyze how the biosphere is changed?
3. What contributions did Malthus provide to the field of ecology?
4. How do organisms transform energy and matter as they interact with their ecosystems?
5. How does energy flow within the biosphere and how does this demonstrate the law of conservation of mass and energy?
6. How can mathematical models be used to describe growth in populations?
7. What is the difference between primary succession and secondary succession?
8. Why do ecosystems approach dynamic rather than static equilibrium?
9. How do interactions with the environment influence the expression of genes which control animal behaviors?
10. How do behaviors illustrate the ability of organisms to adapt and survive in their environment?
11. What is the evolutionary basis for certain behaviors observed in nature (social behavior, altruism, etc.)?
12. How does global warming contribute to climate change?
13. How is climate change occurring today different from climate change in the past?

Stage 2: Assessment Evidence

Various Formative Assessments

Formative: Class Work

Bell WorkExit SlipsKWL Charts3-2-1Fist to FiveCloze ReadingJigsawsClickers

Foldables/Thinking Maps

Formative: Graphic Organizer

Unit Exams

Summative: Unit Exam

Ecology Labs/Field Studies

Summative: Lab Assignment

Ability to add formative piecesCan add in a formal lab report

Water Crisis Project

Summative: Research Project

Can add in a technology component, debate, reflective writing, etc.Can create a collaborative or individual group project.Can have students create or design a product to help a specific area with their water crisis (e.g., filtration system).Can have students present their ideas in a summit form (e.g., Model UN) to other groups if you are assigning countries.

Journal Writing

Summative: Reflective Writing

Can use in conjunction with TED Talks, Streaming Video, science journals, etc.

Resources

Stage 3: Learning Plan

Learning Experiences

1. Graphic Organizers: Students create Thinking Maps to review concepts. (See Links.)
2. Graphic Organizers: Students create Foldables to review concepts. (See Links.)
3. Laboratory Groups: Students engage in Ecology Virtual Labs. (See Links in Technology Integration.)
4. Direct Instruction: Students take Cornell Notes on lecture.
5. Technology Project: Students will engage in the Water Crisis Project. (See Links.)
6. Problem Solving: Students participate in Deer of the Kaibab Activity. (See Links.)
7. Graphic Organizer: Students participate in the Food Webs Activity. (See Links.)
8. Direct Instruction: Students view movies (such as *11th Hour, An Inconvenient Truth*, etc.) and discuss ecological implications.
9. Writing to Reflect: Students engage in Journal Writing.
10. Field Observations: Students participate in Field Studies on Animal Behavior/Ecology.

Resources

* Water Crisis Project (<http://thewaterproject.org/resources/lesson-plans/>)

Technology Integration

**iPad Apps (Free):**

1. Project NOAH (Networked Organisms And Habitats)
2. Click and Learn (Howard Hughes Medical Institute)
3. The Green Machine (ISIS Design Systems)
4. Ecocritique (Eccologico)
5. Khan Academy (Skillmo)

**YouTube:**

1. Bozeman (Abiotic and Biotic Factors)
2. Bozeman (Communities)
3. Bozeman (Ecosystems)
4. Crash Course Biology (Ecology -- Rules for Living on Earth)
5. Crash Course Biology (Ecological Succession -- Change is Good)
6. Crash Course Biology (Community Ecology -- Feel the Love)
7. Crash Course Biology (Animal Behavior)

**TED Talks: See Links**

**Virtual Labs/Simulations: See Links**

**Streaming Video:**

1. PBS NOVA: Earth From Space
2. PBS Nature: Love in the Animal Kingdom
3. PBS Nature: Cold Warriors: Wolves and Buffalo
4. PBS Nature: Cracking the Koala Code
5. PBS Nature: Survivors of the Firestorm
6. Cosmos: A Spacetime Odyssey

Resources

* TED: Ecology from the Air (<http://www.ted.com/talks/greg_asner_ecology_from_the_air>)

Resources

**Books:**

1. Callenbach, E. (2008). *Ecology: A pocket guide, revised and expanded.* Oakland, CA: University of California Press.
2. Stiling, P. (2014). *Ecology: Global insights and investigations.* New York: McGraw-Hill Higher Education.
3. Weisman, A. (2008). *The world without us.* New York: Picador.

**Videos:**

1. *An Inconvenient Truth*
2. *The 11th Hour*
3. *Planet Earth*
4. *Life*
5. *North America*

**Twitter**

1. Sally Ride Science (@SallyRideSci)
2. MIT Biology (@MITBiology)
3. Dr. Eric Lander (@eric\_lander)
4. Dr. J. Craig Venter (@jcventer)
5. HHMI Cool Science (@HHMICoolSci)
6. Molecular Biology (@molecular)
7. Smithsonian (@smithsonian)
8. Reuters Science News (@ReutersScience)
9. AAAS News (@AAAS\_News)
10. TED Talks (@TEDTalks)
11. NIH (@NIH)
12. The Royal Society (@royalsociety)
13. Nature (@NatureNews)
14. Science Magazine (@sciencemagazine)
15. New York Times Science (@nytimesscience)
16. National Science Foundation (@nsf)

Resources

* National Oceanic and Atmospheric Administration ([www.noaa.gov](http://www.noaa.gov))