6th Grade Science

Pacing Guide and Unpacked Standards

GROVEPORT MADISON SCHOOLS

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Resources: School District U-46, of Chicago, IL, The Ohio Department of Education, Columbus City Schools, Common Core Institute and North Carolina Department of Public Instruction.

We would like to thank the teachers of GMLSD that provided feedback and support.

Groveport Madison Science Pacing Guide

6	Science Inquiry and Application	Earth and Space Science	Physical Science	Life Science	Standards for Literacy-Reading (Integrate Throughout Each Topic)
1st **9 wks**	**Thinking Like a 21st Century Scientist/ Engineer** Intro to Science, Technology and Engineering: Lab Safety Procedures/Equipment; Team Building; Computer Technology; Engineering Design		**Composition of Matter (6.PS.1)** Atoms, Elements, Particles, Mass, Volume, Density		**RST.6-8.1** Cite specific textual evidence to support analysis. **RST.6-8.2 (a,b)** Analyze central idea & summarize. **RST.6-8.3** Follow precisely a multistep procedure. **RST.6-8.4** Determine the meaning of symbols & key terms. **RST.6-8.5** Analyze the structure of text. **RST.6-8.6** Analyze the author's purpose. **RST.6-8.7** Integrate quantitative or technical information visually. **RST.6-8.8** Distinguish among facts & speculations in a text. **RST.6-8.9** Compare and contrast gained information on the same topic. **RST.6-8.10** Read, comprehend & respond to science/technical texts.
2nd **9 wks**	**Thinking Like a 21st Century Scientist/Engineer** (continue to integrate)	**Minerals and Rocks: (6.ESS.1, 6.ESS.2, a-b)** Properties, Identification, Formation of: Minerals Sedimentary Rock, Igneous Rock	**Changes of State (6.PS.2)** Thermal Energy, Particle Motion, Phase Change, Conservation of Mass **Energy (6.PS.3)** Kinetic and Potential **Motion and Speed (6.PS.4)** Speed, Creating/Interpreting Graphs, Circular Motion		
3rd **9 wks**	**Thinking Like a 21st Century Scientist/Engineer** (continue to integrate)	**Minerals and Rocks (6.ESS.2c, 6.ESS.3)** Metamorphic Rock, Rock Cycle **Soil (6.ESS.4)** Sampling Properties, Formation Soil, Horizons **Uses of Minerals, Rocks, and Soils (6.ESS.5)** Uses Methods of Extraction, Conservation, and Managements			**Standards for Literacy-Writing (Integrate Throughout Each Topic)** **WHST.6-8.1 (a,b,c,d,e,f)** Write arguments to support claims & thesis. **WHST.6-8.2 (a,b,c,d,e,f)** Write informative/explanatory texts. **WHST.6-8.4** Develop, organize & produce clear and coherent writing. **WHST.6-8.5** Develop & strengthen writing through revision processes. **WHST.6-8.6** Use technology to produce & publish writing. **WHST.6-8.7** Conduct short research projects. **WHST.6-8.8** Gather relevant information from credible digital & print sources. **WHST.6-8.9** Support analysis & draw evidence from informational text. **WHST.6-8.10** Write over extended time.
4th **9 wks**	**Thinking Like a 21st Century Scientist/Engineer** (continue to integrate)			**Cells (6LS.1)** Types of Cells, Cellular Organelles, Cell Structure, Cell Function **Cell Reproduction (6LS.2)** Microscope Use, Modern Cell Theory, Cell Reproduction Disease **Levels of Organizations (6.LS.3**) Tissue / Organs, Organ Systems, Plant vs. Animal Tissues, Homeostasis **Cellular - Multi-Cellular (6.LS.4)** Classification, Cladograms, Adaptations, Symmetry	

Ohio's Learning Standards- Clear Learning Targets
Science, Grade 6

6.ESS.1

ROCKS, MINERALS AND SOIL

Minerals have specific, quantifiable properties.

Vocabulary
Cleavage
Density
Fracture
Hardness
Inorganic
Luster
Mineral
Streak

Essential Understandings

- Minerals are naturally occurring, inorganic solids that have a definedchemical composition.
- Minerals have properties that can be observed and measured.
- Minerals form in specific environments.

Note: The emphasis is on learning how to identify the mineral by conducting tests (not through memorization)

Essential Skills	**The students can identify minerals by testing their properties.** **The students can use mineral properties to identify minerals.**

Misconceptions

- Rocks are the same, and it's hard to tell how they originated.

- Rocks and minerals are the same thing; distinguishing them is not important.

- Humans can fabricate rocks and minerals; artifacts are the same as rocks and minerals.

- Rocks are hard.

- Allowing student investigation in the testing of different mineral properties is a key part of really understanding minerals. The properties of the mineral define its value and uses. The USGS provides mineral resources and information that can support the teaching of minerals. Specific mineral data is available using the website's search engine.

- Understanding how to test minerals accurately is essential in identifying minerals correctly. Identification should not be based upon visuals, but rather testing and analyzing the results. Many minerals can look or feel the same, so it is important to encourage students to run tests before identifying an unknown mineral. The Mineralogical Society of America offers training, workshops, data and resources to support learning about minerals and geology.

- Connecting mineral uses with mineral identification is an important part of teaching about minerals with connections to the real world. Geology.com provides information on each major mineral type or group with details on mineral properties and uses.

Instructional Strategies and Resources

Discovery Ed: www.unitedstreaming.com Introduction to Rocks and Minerals [3:18], Physical Properties for classifying Minerals [4:45], Mineral Types [1:52]

-Websites: Rocks for Kids: http://www.rocksforkids.com/RFK/howrocks.html
Properties of Common Minerals: http://newyorkscienceteacher.com/sci/site/files/esrt/ESRT-2010.pdf
ODNR ROCK KITS: http://www.dnr.state.oh.us/tabid/22338/Default.aspx

-Carleton College provides geology-specific assessment techniques that can identify misconceptions, lists of common Earth science misconceptions and resources to correct misconceptions at http://serc.carleton.edu/NAGTWorkshops/teaching_methods/conceptests/index.html

-NASA provides a list of overarching Earth Science questions that address many of the common misconceptions at this grade level. There are resources and information that help address questions that center on Earth Systems Science at http://science.nasa.gov/big-questions/

Career Connections

Analytical chemist, Medicinal chemist, Theoretical chemist, Chemical engineers Geologist, Machine Operator, Site Manager, Environmentalists, Engineer

Prior Knowledge	Future Knowledge
PreK-2: Objects have physical properties, properties of objects can change, and Earth's nonliving resources have specific properties. **Grades 3-5:** Rocks and soil have characteristics, soil contains pieces of rocks, and objects are composed of matter and may exhibit electrical conductivity and magnetism.	**Grades 7-8:** Biogeochemical cycles, igneous environments and the history of Earth (including the changing environments) from the interpretation of the rock record are studied. **High School:** The formation of elements, chemical bonding and crystal structure are found in the Physical Sciences. In grades 11-12 Physical Geology, mineralogy is explored at depth.

Ohio's Learning Standards- Clear Learning Targets
Science, Grade 6

6.ESS.2

ROCKS, MINERALS AND SOIL

Igneous, metamorphic and sedimentary rocks have unique characteristics that can be used for identification and/or classification.

Vocabulary

Chemical Sedimentary Rock
Clastic Sedimentary Rock
Contact metamorphism
Extrusive Igneous rock
Foliated

High Silica
Igneous
Intrusive Igneous rock
Lava
Low Silica
Magma
Metamorphic Rock
Nonfoliated
Organic Sedimentary Rock
Regional metamorphism
Sedimentary Rocks
Strata
Stratification
Texture

Essential Understandings

- Most rocks are composed of one or more minerals, but there are a few types of sedimentary rocks that contain organic material, such as coal.
- The composition of the rock, types of mineral present, mineral arrangement, and/or mineral shape and size can be used to identify the rock and to interpret its history of formation, breakdown (weathering) and transport (erosion).

Essential Skills

The students can identify the unique characteristics to classify rocks.

The students can describe the formation of igneous rocks.

The students can use the unique characteristic of sedimentary rocks to identify and classify sedimentary rocks.

The students can identify the characteristics/classify metamorphic rocks.

The students can describe how metamorphic rocks form.

Misconceptions

- Rocks are the same, and it's hard to tell how they originated.

- Rocks and minerals are the same thing; distinguishing them is not important.

- Humans can fabricate rocks and minerals; artifacts are the same as rocks and minerals.

- Rocks are hard.

- Carleton College provides geology-specific assessment techniques that can identify misconceptions, lists of common Earth science misconceptions and resources to correct misconceptions at http://serc.carleton.edu/NAGTWorkshops/teaching_methods/conceptests/index.html.

- NASA provides a list of overarching Earth Science questions that address many of the common misconceptions at this grade level. There are resources and information that help address questions that center on Earth Systems Science at http://science.nasa.gov/big- questions/.

Instructional Strategies and Resources

-Involving students in rock collecting and building a classroom set of representative rocks can be a way to connect the classroom to what students see locally. The USGS provides a list of resources and links to help in the teaching of rock identification and rock formation at the middle school level. It is important that students identify and classify rocks using specific characteristics, such as what minerals are present and texture/grain size. Appearance alone should not be relied upon for identification.

-It is important to teach how specific types of rocks form and connect this teaching to understanding Earth's history. The National Earth Science Teachers Association provides background information about the formation of each type of rock (sedimentary, metamorphic and igneous). In addition, information is provided about minerals found in the rocks.

-Introducing students to topographic and geologic maps can be used to connect the local geology to what is being taught in the classroom. ODNR's Division of Geological Survey provides a number of resources that link to Ohio specific geology, including a variety of geologic maps and information about the history of Ohio's geologic history.

-NSTA provides learning modules called SciPacks that are designed to increase teacher content knowledge through inquiry-based modules. This module addresses rock forming environments.

-The College Board provides Earth Science recommendations for grades 6-12 (beginning on page 21). Essential questions and scientific applications are included in this document to encourage investigation and scientific inquiry. In addition, connections to other topics and subjects are suggested to add relevancy and interest for students

Career Connections	
Analytical chemist, Medicinal chemist, Theoretical chemist, Chemical engineers Geologist: people who study rocks, minerals, and composition, Machine Operator: the person who operates equipment, Site Manager: oversees each role and responsibility on the job site, Environmentalists: concerned with the environmental impact of projects, Engineer: understand and design the process, which includes the types of materials used	
Prior Knowledge **PreK-2:** Objects have physical properties, properties of objects can change and Earth's nonliving resources have specific properties. **Grades 3-5:** Rocks and soil have characteristics, soil contains pieces of rocks, rocks form in different ways, and objects are composed of matter and may exhibit electrical conductivity and magnetism.	**Future Knowledge** **Grades 7-8:** Sedimentary, metamorphic and igneous environments, and the history of Earth (including the changing environments) from the interpretation of the rock record are studied. **High School:** The formation of elements, chemical bonding and crystal structure are found in the Physical Sciences. In grades 11/12 Physical Geology, depositional environments, volcanics, characteristics of rocks and mineralogy are explored in depth.

Ohio's Learning Standards- Clear Learning Targets
Science, Grade 6

6.ESS.3

ROCKS, MINERALS AND SOIL

Igneous, metamorphic and sedimentary rocks form in different ways.

Vocabulary
Igneous
Metamorphic
Rock
Rock Cycle
Sedimentary

Essential Understandings

- Magma or lava cools and crystallizes to form igneous rocks.
- Heat and pressure applied to existing rock forms metamorphic rocks.
- Sedimentary rock forms as existing rock weathers chemically and/or physically and the weathered material is compressed and then lithifies.
- Each rock type can provide information about the environment in which it was formed.

Essential Skills	**The students can use the rock cycle to describe the formation of igneous, sedimentary and metamorphic rocks.**

Misconceptions

- All rocks are the same, and it's hard to tell how they originated.

- Rocks and minerals are the same thing; distinguishing them is not important.

- Humans can fabricate rocks and minerals; artifacts are the same as rocks and minerals.

- All rocks are hard.

- Carleton College provides geology-specific assessment techniques that can identify misconceptions, lists of common Earth science misconceptions and resources to correct misconceptions at http://serc.carleton.edu/NAGTWorkshops/teaching_methods/conceptests/index.html

- NASA provides a list of overarching Earth Science questions that address many of the common misconceptions at this grade level. There are resources and information that help address questions that center on Earth Systems Science at http://science.nasa.gov/big- questions/.

Instructional Strategies and Resources

- ODNR's Division of Geological Survey provides interactive maps and geologic maps that can be used to show local and statewide surficial and bedrock geology. There are many other resources that help support the teaching of rocks and the rock cycle. Information from this website also can be used to help prepare students to make their own geologic maps of their local communities.

- The USGS provides a list of resources and links to help in the teaching of rock identification and rock formation at the middle school level.

- NSTA offers a number of helpful books and resources that address the rock cycle and learning about the environment in which rocks form. This is a link to Rocks SciPack, which can be a good starting point for most teachers.

Career Connections

Geologist: people who study rocks, minerals, and composition, Machine Operator: the person who operates equipment, Site Manager: oversees each role and responsibility on the job site, Environmentalists: concerned with the environmental impact of projects, Engineer: understand and design the process, which includes the types of materials used

Prior Knowledge

PreK-2: Objects have physical properties, properties of objects can change and Earth's nonliving resources have specific properties.

Grades 3-5: Rocks and soil have characteristics, soil contains pieces of rocks, rocks form in different ways, and objects are composed of matter and may exhibit electrical conductivity and magnetism.

Future Knowledge

Grades 7-8: Sedimentary, metamorphic and igneous environments, and the history of Earth (including the changing environments) from the interpretation of the rock record are studied.

High School: The formation of elements, chemical bonding and crystal structure are found in the Physical Sciences. In grades 11/12 Physical Geology, depositional environments, volcanics, characteristics of rocks and mineralogy are explored in depth.

Ohio's Learning Standards- Clear Learning Targets
Science, Grade 6

6.ESS.4

ROCKS, MINERALS AND SOIL

Soil is unconsolidated material that contains nutrient matter and weathered rock.

Vocabulary
Minerals Soil
Horizon Soil
Profile
Soil Properties
Soil Region

Essential Understandings

- Soil formation occurs at different rates and is based on environmental conditions, types of existing bedrock and rates of weathering.
- Soil forms in layers known as horizons.
- Soil horizons can be distinguished from one another based on properties that can be measured.

Note: The emphasis should be on properties of soil rather than memorization

Essential Skills

The students can investigate how soil forms at different rates and has different measurable properties through soil sampling and testing.

The students can explain how soil is formed into layers called horizons based on measurable properties.

The students can identify and describe Ohio's soil as it relates to formation and soil properties.

Misconceptions

- All soil has the same composition.

- Soil is solid.

- All soil is brown.

- Soil is only found in certain areas.

- Soil is only a few years old.

- Soil comes from plants.

- Carleton College provides geology-specific assessment techniques that can identify misconceptions, lists of common Earth science misconceptions and resources to correct misconceptions at http://serc.carleton.edu/NAGTWorkshops/teaching_methods/conceptests/index.html.

- NASA provides a list of overarching Earth Science questions that address many of the common misconceptions at this grade level. There are resources and information that help address questions that center on Earth Systems Science at http://science.nasa.gov/big- questions/.

Instructional Strategies and Resources

- Discovery Ed: How Soil is Formed [3:17], Classification of Soil [2:40], Conserving Prairie Soil: The Components of Prairie Soil [3:53]

- Investigating local and statewide soil types and comparing them to actual tests of local soil samples can be a good starting point in understanding soil. Lists of soil types by state can be used to begin this process.

- Examining student-based (classroom data) soil-sample results can be a good way to compare soil types by regions. The GLOBE program allows connections to other classrooms and can be used to analyze data beyond the local area to draw conclusions about specific criteria for soil formation.

- Specific resources related to Ohio soil, including Web-based survey tools, interactive maps and mapping programs, can be used in the identification of local and state soil.

- NSTA offers reference books and materials that help students understand the properties and uses of soil at the middle school level.

- The USGS has a resource page that provides data, information, books and maps that relate to Earth's surface, soils, soil formation, weathering and erosion.

- Allowing students to test the properties of soil leads to a deeper understanding of soil formation, local soils and the importance of soil. Soil types, testing and use, and understanding the methods required for analysis of soils can further demonstrate the importance of soil conservation.

- Local Soil and Water Conservation Districts can offer multiple environmental educational resources that pertain directly to soil uses, conservation of soil, soil testing and interpretation of soil data.

- Introducing problem-solving skills through the application of science can deepen the content knowledge for soils. Testing soils to determine which types of soil would work best in a specific situation is a good way to connect soils and soil uses to the real world. One example (provided in the Vision into Practice section) involves determining which soil is best to use to deter floodwaters. The sandbag example provides inquiry and engineering design for students of all ability levels.

Career Connections Geologist: people who study rocks, minerals, and composition, Machine Operator: the person who operates equipment, Site Manager: oversees each role and responsibility on the job site, Environmentalists: concerned with the environmental impact of projects, Engineer: understand and design the process, which includes the types of materials used	
Prior Knowledge **PreK-2:** Objects have physical properties, properties of objects can change and Earth's nonliving resources have specific properties. **Grades 3-5:** Rocks and soil have characteristics. Soil contains pieces of rocks. Soil investigations measure color, texture, ability for water to pass through soil, moisture content and soil composition. Objects are composed of matter.	**Future Knowledge** **Grades 7-8:** Biogeochemical cycles and the role of soil within them, soil erosion and runoff issues, hydrologic cycle including percolation and infiltration rates, and sedimentary environments are studied. **High School:** The formation of elements, the importance of soil in an ecosystem, and issues with soil degradation and soil loss are explored. In grades 11/12 Physical Geology, depositional environments, soil mechanics, issues with mass wasting including soil/sediment contamination issues and the classification of soil is found.

Ohio's Learning Standards- Clear Learning Targets
Science, Grade 6

6.ESS.5

ROCKS, MINERALS AND SOIL

Rocks, minerals and soils have common and practical uses.

Vocabulary
Nonrenewable
Open-Pit
Ore Quarries
Reclamation
Strip Mining
Subsurface Mining
Surface Mining

Essential Understandings

- Nearly all manufactured material requires some kind of geologic resource.
- Most geologic resources are considered nonrenewable.
- Rocks, minerals and soil are examples of geologic resources that are nonrenewable.

Essential Skills

The students can identify examples of different ways the soil, rock and minerals can be used.

The students can recognize the characteristics of soil, rock and minerals to determine how they can be used.

Misconceptions

- Soil is sterile. (Remind students that life exists in soil. If it were sterile, there would be no life inside of it.)

- All soil is brown. (Most have bits of red, yellow and orange, and then you get black from organic matter. The more unusual colors—blue, green, purple—you'll find in wetlands or from some unusual minerals. They also have a lot of texture. Run your hand over soils, and you'll find some are smooth, some are bumpy, and some have huge rocks in them.)

- Soil is only found in certain areas. (Soil is found everywhere.)

- NASA lists common misconceptions for all ages about the sun and the Earth at http://www- istp.gsfc.nasa.gov/istp/outreach/sunearthmiscons.html.

- Carleton College provides geology-specific assessment techniques that can identify misconceptions, lists of common Earth science misconceptions and resources to correct misconceptions at http://serc.carleton.edu/NAGTWorkshops/teaching_methods/conceptests/index.html

- NASA provides a list of overarching Earth Science questions that address many of the common misconceptions at this grade level. There are resources and information that help address questions that center on Earth Systems Science at http://science.nasa.gov/big-questions/

Instructional Strategies and Resources

- It is important to relate the properties of minerals and the characteristics of rocks and soil to their value and use as resources. The USGS provides mineral resources and information that can support the teaching of minerals at the middle school level. Specific mineral data is available using the search engine on this USGS mineral resource Webpage.

- ODNR's Mineral Resource Division provides Ohio-specific mineral resources, mineral uses and data regarding these resources. Students should be encouraged to investigate the different uses for geologic resources in Ohio. Ask: What properties allow this rock, mineral or soil to be used for this purpose? There must be a connection between the physical and chemical properties and the use.

- Connecting mineral, soil or rock resource use with the historical information about geologic resource use in Ohio can engage students and deepen the knowledge of resources in Ohio. A brief history of Ohio's geologic resources allows students to research changes that have occurred in resource use. Mining techniques can be a good connection to the real world and the environment.

- NSTA provides learning modules called SciPacks that are designed to increase teacher content knowledge through inquiry-based modules. This module addresses the Earth's Resources, including the uses of resources.

- Introducing problem-solving skills through the application of science can deepen the content knowledge for soils. Testing soilsto determine which types of soil would work best in a specific situation is a good way to connect soils and soil uses to the real world. One example (provided in the Vision into Practice section) involves determining which soil (from four or five unknown samples) is best to use to deter floodwaters. The sandbag example provides inquiry and engineering design for students of all ability levels.

Career Connections Geologist, Sculptor, Environmentalist, Engineer	
Prior Knowledge **PreK-2**: Objects have physical properties, properties of objects can change and Earth's nonliving resources have specific properties. **Grades 3-5**: Rocks and soil have characteristics, Earth's resources can be used for energy, renewable and nonrenewable resources, some of Earth's resources are limited.	**Future Knowledge** **Grades 7-8**: Biogeochemical cycles (including the hydrologic cycle) are related to erosion and weathering of rock, minerals and soil. The history of Earth (including the formation of nonrenewable resources) from the interpretation of the rock record are studied. **High School:** The formation of elements, chemical bonding and nuclear energy are found in the Physical Sciences. In grades 11/12 Physical Geology, Earth's resources and specific laws pertaining to the resources are explored at a greater depth.

Ohio's Learning Standards- Clear Learning Targets
Science, Grade 6

6.LS.1

CELLULAR TO MULTICELLULAR

Cells are the fundamental unit of life.

Vocabulary

Cell membrane	Cell wall
Cells	Chloroplast
Eubacteria	Fungi
Lysosome	Microbes
Mitochondria	Multicellular
Nucleus	Organisms
Organs	Plantae cells
Plasma membrane	Protists
Ribosome	Single-celled
Tissue	Vacuole

Essential Understandings

- All living things are composed of cells.
- Different body tissues and organs are made of different kinds of cells.
- The ways cells function are similar in all living organisms.

Note: Emphasis should be placed on the function and coordination of cell organelles as well as their roles in overall cell function. Specific information about the organelles that need to be addressed at this grade level will be found in the model curriculum.

Essential Skills

The students can identify single-celled organisms. The students can identify multicellular organisms.

The students can distinguish between the different tissues and organs in plants and animals. The students can use microscopes to observe cells, tissues, and organs from different organisms. The students can use micrographs to observe cells, tissues, and organs from different organisms.

The students can use models and illustrations to observe cells, tissues, and organs from different organisms.

Misconceptions

-San Diego State University provides a list of naïve ideas that children hold about cells along with the scientific idea that needs to be established to correct misconceptions.

Instructional Strategies and Resources

- The University of Utah's Genetic Learning Center has an interactive (move the scroll bar from left to right) site to explore cell size and scale. This helps make the connection between cell size and how many cells are required to make tissues, organs and organ systems of entire organisms.

- Prepare slides with a variety of cell samples for viewing under the microscope to examine a variety of cells. The cells should be from different parts of the organism and from different organisms. Make comparisons between the cells based on their location and origin. Explain why they have the structure and function that they do. Oklahoma City Community College's website has detailed information on how to use a microscope. Click on the Biology button, and then click Introduction to the Microscope. Using information from observations and cell research, build a model of a cell. This organizational tool can be used to document findings.

- Cells Alive and the University of Utah offer an interactive animated view of the interior of a cell. The organelles and their functions are the focus.

- Vision Learning provides teacher background information about the cell and its discovery.

Career Connections

Pathologist, Cytology screener, Work in a histocompatibility and immunogenetics laboratory

Prior Knowledge

PreK-2: Living things have specific traits and are made up of a variety of structures.

Grades 3-5: Organisms are made of parts.

Future Knowledge

High School: Details of cellular processes such as photosynthesis, chemosynthesis, cellular respiration, cell division and differentiation are studied. Cellular organelles studied are cytoskeleton, Golgi complex and endoplasmic reticulum.

Ohio's Learning Standards- Clear Learning Targets
Science, Grade 6

6.LS.2

CELLULAR TO MULTICELLULAR

All cells come from pre-existing cells.

Vocabulary
Binary Fission Cells
Chromosomes
Genetic material
Mitosis Multicellular
Organisms
Reproduction
Species

Essential Understandings

- Cells repeatedly divide resulting in more cells and growth and repair in multicellular organisms.

Note: This is not a detailed discussion of the phases of mitosis or meiosis. The focus should be on reproduction as a means of transmitting genetic information from one generation to the next, cellular growth and repair.

Essential Skills

The students can explain how cells reproduce for the continuation of every species.

The students can identify the binary fission process for producing a new single cell organism.

The students can explain how cells multiply for growth and repair in multicellular organisms.

The students can describe how chromosomes are the structures in cells that contain the genetic material.

Students can observe cells dividing by using microscopes, micrographs, models and illustrations.

Misconceptions

-San Diego State University provides a list of naïve ideas that children hold about cells along with the scientific idea that needs to be established to correct misconceptions.

- The Annenberg Media series Essential Science for Teachers: Life Science: Session 1: Children's Ideas provides greater insight to misconceptions children hold about the origin of living things. The students are elementary in this session but the content is relevant for middle school students. Classroom video and lessons are provided to help students avoid these misconceptions.

- The article Slow Death of Spontaneous Generation provides a historical overview of the timeline and scientific experiments performed to dispel the misconception of spontaneous generation.

Instructional Strategies and Resources

- Prepare slides with a variety of cell samples for viewing under the microscope to examine a variety of cells. The cells should be from different parts of the organism and from different organisms. Make comparisons between the cells based on their locations and origins. Explain why they have the structure and function that they do. Oklahoma City Community College's website has detailed information on how to use a microscope. Click on the Biology button, and then click Introduction to the Microscope. Using information from observations and cell research, build a model of a cell. This organizational tool can be used to document findings.

- Cells Alive and the University of Utah offer an interactive animated view of the interior of the cell. The organelles and their functions are the focus.

- The University of Utah's Genetic Learning Center has an interactive (move the scroll bar from left to right) site to explore cell size and scale. This helps make the connection between cell size and how many cells are required to make tissues, organs and organ systems of entire organisms.

- Vision Learning provides teacher background information about the cell and its discovery.

Career Connections

Histopathologist, Microbiologist, Doctor specializing in genetics

Prior Knowledge

PreK-2: Living things are made up of a variety of structures.

Grades 3-5: Individual organisms inherit many traits from their parents indicating a reliable way to transfer information from one generation to the next.

Future Knowledge

Grade 8: More details about asexual and sexual reproduction will be studied.

Ohio's Learning Standards- Clear Learning Targets
Science, Grade 6

6.LS.3

CELLULAR TO MULTICELLULAR

Cells carry on specific functions that sustain life.

Vocabulary
Cells
Membrane
Molecules
Nutrients
Organisms

Essential Understandings

- Many basic functions of organisms occur in cells.
- Cells take in nutrients and energy to perform work, like making various molecules required by that cell oran organism.
- Every cell is covered by a membrane that controls what can enter and leave the cell.
- Within the cell are specialized parts for the transport of materials, energycapture and release, protein building, waste disposal, information feedback and movement.

Note: Emphasis should be placed on the function and coordination of cell components, as well as on their roles in overall cell function.

Essential Skills

The students can identify how cells take in nutrients and energy to perform work. The students can explain how a membrane works in cells.

The students can explain the role of cells that carry out life functions for organisms. The students can explain the role of tissues that carry out life functions for organisms. The students can explain the role of organs that carry out life functions for organisms.

The students can explain the role of organ systems that carry out life functions for organisms.

The students can recognize specialized parts within cells for transporting materials, energy capture and release, protein building, water disposal, information feedback and movement.

Misconceptions

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Instructional Strategies and Resources

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- Vision Learning provides teacher background information about the cell and its discovery.

Career Connections

Histopathologist, Microbiologist, Doctor specializing in genetics, Pathologist, Cytology screener, Work in a histocompatibility and immunogenetics laboratory

Prior Knowledge

PreK-2: Living things have specific traits. Living things require energy, water and a particular temperature range.

Grades 3-5: Organisms are made of parts.

Future Knowledge

Grades 7-8: Photosynthesis and respiration are compared.

High School: Details of cellular processes are studied. Molecules enter and leave the cell by the mechanisms of diffusion, osmosis and active transport.

Ohio's Learning Standards- Clear Learning Targets
Science, Grade 6

6.LS.4

CELLULAR TO MULTICELLULAR

Living systems at all levels of organization demonstrate the complementary nature of structure and function.

Vocabulary
Body plans
Cells
Classification Internal structures
Multicellular Muscles
Organisms
Organs
Single-cell
Symmetry
Tissues

Essential Understandings

- The level of organization within organisms includes cells, tissues, organs, organ systems and whole organisms.
- Whether the organism is single-celled or multicellular, all of its parts function asa whole to perform the tasks necessary for the survival of the organism.
- Organisms have diverse body plans, symmetry and internal structures that contribute to their being able to survive in their environments.

Essential Skills

The students can compare and contrast muscles and organs within multicellular organisms.

The students can classify organisms based on body plans, symmetry, and internal structures.

The students can investigate the commonality of life for plants and animals.

The students can compare cells, types of tissues, organs, and organ systems between organisms.

The students can inquire and show mathematical relationships between cell size and a cell's ability to transport necessary materials into its interior.

Misconceptions

- San Diego State University provides a list of naïve ideas that children hold about cells along with the scientific idea that needs to be established to correct misconceptions.

-The Annenberg Media series Essential Science for Teachers: Life Science: Session 1: Children's Ideas provides greater insight to misconceptions children hold about the origin of living things. The students are elementary in this session but the content is relevant for middle school students. Classroom video and lessons are provided to help students avoid these misconceptions.

Instructional Strategies and Resources

- Use compare and contrast strategies (e.g., Venn diagrams) to help clarify similarities and differences in types of cells.

- Prepare slides with a variety of cell samples for viewing under the microscope to examine a variety of cells. The cells should be from different parts of the organism and from different organisms. Make comparisons between the cells based on their locations and origins. Explain why they have the structure and function that they do. Oklahoma City Community College's website has detailed information on how to use a microscope. Click on the Biology button, and then click Introduction to the Microscope. Using information from observations and cell research, build a model of a cell. This organizational tool can be used to document findings.

- Wisc-Online offers an interactive opportunity to examine an animal cell and learn about the functions of its organelles.

- The University of Utah's Genetic Learning Center has an interactive (move the scroll bar from left to right) site to explore cell size and scale. This helps make the connection between cell size and how many cells are required to make tissues, organs and organ systems of entire organisms.

- Vision Learning provides teacher background information about the cell and its discovery**.**

Career Connections

Histopathologist, Microbiologist, Doctor specializing in genetics, Pathologist, Cytology screener, Work in a histocompatibility and immunogenetics laboratory

Prior Knowledge

PreK-2: Living things have specific traits. Living things require energy, water and a particular temperature range.

Grades 3-5: Organisms are made of parts.

Future Knowledge

Grade 8: Cellular reproduction is studied.

High School: The unity and diversity of life and the evolutionary mechanisms that contribute to the organization of living things are studied.

Ohio's Learning Standards- Clear Learning Targets
Science, Grade 6

6.PS.1

MATTER AND MOTION

Matter is made up of small particles called atoms.

Vocabulary
Atom
Atomic composition
Compounds Density
Element
Mass
Matter
Molecules
Volume

Essential Understandings

- Matter has mass, volume and density and is made up of particles called atoms.
- Elements are a class of substances composed of a single kind of atom.
- Molecules are the combination of two or more atoms that are joined together chemically.

Essential Skills

The students can recognize that all matter is made up of atoms.

The students can explain that atoms take up space, have mass, and are in constant motion.

The students can create models of elements and molecules to show atomic differences. The students can describe the composition of substances in terms of elements.

The students can measure the mass and volume of a substance, and calculate density by dividing mass by the volume.

The students can compare substances by the amount of mass a substance has in a given amount of volume (density).

The students can construct and interpret mass vs. volume graphs.

Misconceptions

- Gases do not have mass.

- Mass and volume, which both describe an amount of matter, are the same property.

- Air and oxygen are the same gas.

- Particles of solids have no motion. Particles possess the same properties as the materials they compose. For example, atoms of copper are "orange and shiny," gas molecules are "transparent," and solid molecules are "hard."

- Particles are misrepresented in sketches with no differentiation between atoms and molecules.

- Molecules of a gas just float rather than being kept in the gaseous state by their motion.

- There is not empty space between molecules; rather students believe there is dust, germs or air between the particles of air.

- Although some students may think that substances can be divided up into small particles, they do not recognize the particles as building blocks, but as formed of basically continuous substances under certain conditions. Students of all ages show a wide range of beliefs about the nature and behavior of particles, including a lack of appreciation of very small size of particles. (AAAS 1993).

- Students often reason that because atoms are so small they have no mass. Several studies of students' initial conception of an atom show they perceive it as either "a small piece of material" or the "ultimate bit of material obtained when a portion of material is progressively subdivided." Such bits are thought to vary in size and shape and possess properties similar to the properties of the parent material. For example, some students consider atoms of a solid to have all or most of the macro properties that they associate with the solid, such as hardness, hotness/coldness, color and state of matter (Driver, Squire, Rushworth & Wood-Robinson, 1994, p. 74).

- Essential Science for Teachers: Physical Science: Session 2: The Particle Nature of Matter highlights different ideas that students have about matter, illustrated through interviews with students. The first half of the program shows how students can progress from a continuous model of matter to a model of matter that is made of discrete particles with nothing between them. It demonstrates activities to help students move from a continuous model to a particle model of matter. Notice that the real learning does not necessarily come from doing the activities, but from the discussions and questioning that occur after the experiences.

Instructional Strategies and Resources

- The Annenberg Media series Essential Science for Teachers: Physical Science: Session 2: The Particle Nature of Matter is a video on demand produced by Annenberg. It guides teachers through the essential concepts, includes student interviews that highlight common misconceptions and shows experiments and classroom instructional strategies that can be used to address these misconceptions.

Career Connections

Nuclear physicist, Career in nuclear medicine, Rheologist, Solid state physicist

Prior Knowledge

PreK-2: Properties are descriptions that can be observed using the senses. Materials can be sorted according to their properties. Changes in materials are investigated.

Grades 3-5: Objects are composed of matter, which has mass* and takes up space. Matter includes solids, liquids and gases (air). Volume is the amount of space an object takes up. The total amount of matter and mass* remains the same when it undergoes a change.

**While mass is the scientifically correct term to use in this context, the NAEP 2009 Science Framework (page 27) recommends usingthe more familiar term "weight" in the elementary grades with the distinction between mass and weight being introduced at the middle school level. In Ohio, students will not be assessed on the differences between mass and weight until Grade 6.*

Future Knowledge

Grades 7-8: Differences between pure substances and mixtures and acids and bases are explored. Elements in the periodic table can be classified as a metal, nonmetal or nonreactive gas based on their properties and position on the periodic table. Atoms can be joined together to form separate molecules or large three-dimensional networks. Changes are classified into two groups, chemical or physical, depending upon whether the atomic composition of the materials changes.

High School: Protons, neutrons and electrons make up atoms. The relationship between atomic structure and the periodic table is explored. The nature of ionic, covalent and metallic bonding is also studied.

Ohio's Learning Standards- Clear Learning Targets
Science, Grade 6

6.PS.2

MATTER AND MOTION

Changes of state are explained by a model of matter composed of particles that are in motion

Vocabulary
Attraction
Gases
Liquids
Solids
Substance
Atoms
Collide
Mass
Molecules
Particles
Phase change
Thermal energy

Essential Understandings

- Temperature is a measure of the average motion of the particles in a substance.
- Heat is a process of energy transfer rather than a type of energy. Energy transfer can result in a change in temperature or a phase change.
- When substances undergo changes of state, atoms change their motion and position.

Note: It is not the intent of this standard to encourage vocabulary identification (matching definitions with heat, temperature, and thermal energy). Instead, these are provided as conceptual tools for understanding the role of energy in physical, biotic, atmospheric, oceanic, and geologic systems covered in grade 6 and subsequent grades and courses.

Essential Skills

The students can explain that thermal energy is a measure of the motion of particles (kinetic energy) in a substance.

The students can describe the factors that affect thermal energy.

The students can investigate temperature change in order to infer changes in thermal energy.

The students can describe solids, liquids, and gases in terms of motion of and spacing and attractions between particles.

The students can model and explain how mass is conserved when substances undergo a change of state.

Misconceptions

- Gases are not matter because most are invisible.
- Gases do not have mass.
- A thick liquid has a higher density than water.
- Mass and volume, which both describe an amount of matter, are the same property.
- Air and oxygen are the same gas.
- Helium and hot air are the same gas.
- Expansion of matter is due to the expansion of particles, rather than the increased particle spacing.
- Particles of solids have no motion.
- Relative particle spacing among solids, liquids and gasses is incorrectly perceived and not generally related to the densities of the states.
- Materials can only exhibit properties of one state of matter.
- Melting/freezing and boiling/condensation are often understood only in terms of water.
- The smoke seen with dry ice is carbon dioxide vapor.
- The temperature of an object drops when it freezes.
- Steam is visible water gas molecules.
- Melting and dissolving are confused.
- Dew formed on the outside of glass comes from the inside of the glass.
- Molecules of a gas just float rather than being kept in the gaseous state by their motion.
- From a time of about 27:50 to 49:00 this video on demand produced by Annenberg, shows student interviews and classroom discussions that illustrate common misconceptions about evaporating, boiling and condensing. Strategies to address these misconceptions also are illustrated, including a series of experiments guiding students to construct an accurate particle model of matter that can explain the properties of gases and liquids and changes between them.
- Students regard powders as liquids and any non-rigid material, such as a sponge or a cloth as being somewhere in between a solid and a liquid.
- Students have difficulty recognizing the vibration of particles. (Driver, Squire, Rushworth & Wood-Robinson, 1994).
- Particles disappear during burning, boiling and evaporation.
- Science in Focus: Energy produced by Annenberg is a series of videos on demand dealing with energy. This segment deals with heat. The video series is designed to make teachers aware of common student misconceptions. While not all concepts addressed are appropriate to be taught at this grade level, being aware of them can help avoid perpetuating common misconceptions.

Instructional Strategies and Resources

- The Phenomena and Representations for Instruction of Science in Middle Schools (PRISMS) website has a collection of representationsto help students visualize atoms in a crystalline array. This website is part of the National Science Digital Library and also can be accessed through http://nsdl.org.

- Changing State, an interactive simulation from BBC Schools, allows students to heat and cool water and observe phase changes. The final section dealing with heating the gas further can be explained by the motion of the gas particles.

- From the series of videos on demand Essential Science for Teachers: Physical Science produced by Annenberg, the second part of The Particle Nature of Matter, starting at about 28:00, deals with differences in gases, liquids and solids and the idea that all particles are in motion. Notice the discussions and questioning strategies used to get students thinking at higher levels.

- The beginning of this segment of Essential Science for Teachers: Physical Science, produced by Annenberg, shows how the properties and changes of phases of matter can be explained with a particle model. Student interviews identify common misconceptions. Experiments and questioning strategies are shown that can guide students to a more accurate understanding of these concepts.

- HMH School Publishers sponsors this animation that shows the spacing and movement of particles in a solid, liquid and gas. This can be used with a student who needs more visualization than what static pictures in a book or on a chalkboard can provide.

Career Connections

Design geothermal plants, Geologist, Molecular physicist

Prior Knowledge

PreK-2: Properties can be observed and used to sort materials. Changes in materials are investigated, including solid-liquid phase changes.

Grades 3-5: Matter has mass* and volume. Properties of solids, liquids and gases, and phase changes are reversible and do not change the identity of the material. The total amount of matter remains the same when it undergoes a change. Mass* stays constant during phase changes.

Future Knowledge

Grades 7-8: Acids, bases, mixtures and pure substances are investigated. Elements are classified as metals, nonmetals or nonreactive gases based on their properties and position on the periodic table. Atoms can be joined together into separate molecules or large three-dimensional networks. Changes are classified as chemical or physical, depending upon whether the atomic composition of the materials changes.

Ohio's Learning Standards- Clear Learning Targets
Science, Grade 6

6.PS.3

MATTER AND MOTION

There are two categories of energy: kinetic and potential.

Vocabulary
Electrical energy
Gravitational potential energy
Kinetic energy
Medium
Potential energy
Sound energy

Essential Understandings

- Objects and substances in motion have kinetic energy.
- Objects and substances can have energy as a result of their position (potential energy).

Note: Chemical and elastic potential energy should not be included at this grade; this is found in PS grade 7.

Essential Skills

The students can explain that objects and substances in motion have kinetic energy.

The students can explain that objects and substances can have energy as a result of their position.

The students can explore, investigate, and explain various types of potential and kinetic energy.

Misconceptions

- Things use up energy.
- Energy is confined to some particular origin, such as what we get from food or what the electric company sells.
- An object at rest has no energy.
- The only type of potential energy is gravitational.
- Energy is a thing.
- The terms “energy” and “force” are interchangeable.

Instructional Strategies and Resources

- The simulation at the bottom of this site from the University of Oregon Department of Physics allows students to change the mass and height of different spheres and see the changes in gravitational potential energy.

Career Connections

Career in kinesiology, Engineer that designs roller coasters

Prior Knowledge

PreK-2: A variety of sounds and motions are experienced. The sun is the principal source of energy (ESS). Plants get energy from sunlight (LS).

Grades 3-5: Objects with energy have the ability to cause change. Heat, electrical energy, light, sound and magnetic energy are forms of energy. Earth’s renewable and nonrenewable resources can be used for energy (ESS). All processes that take place within organisms require energy (LS).

Future Knowledge

Grades 7-8: Conservation of Energy and methods of energy transfer, including waves, are introduced. Chemical and elastic potential energy are explored.

High School: Standard formulas are used to calculate energy for different objects and systems.

Ohio's Learning Standards- Clear Learning Targets

Science, Grade 6

6.PS.4

MATTER AND MOTION

An object's motion can be described by its speed and the direction in which it is moving.

Vocabulary
Distance
Hypothesis
Motion
Position vs. Time Graph
Reference Point
Speed
Speed vs. Time Graph
Time

Essential Understandings

- An object's position and speed can be measured and graphed as a function of time.

Note: Velocity and acceleration rates should not be included at this grade level; these terms are introduced in high school.

Essential Skills

The students can describe an objects motion in relation to a reference point.

The students can calculate an object's speed based on the amount of time it takes to travel a certain distance.

The students can analyze and interpret position vs. time and speed vs. time graphs in order to describe an object's motion.

Misconceptions

- Some students think that an object traveling at constant speed requires a force.

- Some students think that time can be measured without establishing the beginning of the interval. The location of an object can be described by stating its distance from a given point, ignoring direction.

-Students believe that a line with a negative slope represents a falling object.

Instructional Strategies and Resources

-Websites: YouTube or Bing videos, Physics Tutorial: How to solve physics problems, 6:06 minutes, www.youtube.com/watch?v=calsn76D9gA

- www.BrainPop.com video, Distance, Rate, Time

- The Moving Man is an interactive simulation from PhET shows graphs for different types of motion.

Career Connections

Race car driver, Work as a part of a racing crew, Engineer

Prior Knowledge

PreK-2: Sound is produced from vibrating motions. Motion is a change in an object's position with respect to another object.
Forces are pushes and pulls that are necessary to change the motion of an object. Greater changes of motion for an object require larger forces.

Grades 3-5: The amount of change in movement of an object is based on the mass* of the object and the amount of force exerted. The speed of an object can be calculated from the distance traveled in a period of time.

**While mass is the scientifically correct term to use in this context, the NAEP 2009 Science Framework (page 27) recommends using the more familiar term "weight" in the elementary grades with the distinction between mass and weight being introduced at the middle school level. In Ohio, students will not be assessed on the differences between mass and weight until Grade 6.*

Future Knowledge

Grades 7-8: The concept of fields is introduced to describe forces at a distance. The concept of force is expanded to include magnitude and direction.

High School: Acceleration is introduced. Complex problems involving motion in two-dimensions and free fall will be solved. Complex position vs. time graphs, velocity vs. time graphs, and acceleration vs. time graphs will be analyzed conceptually and mathematically with connections made to the laws of motion.

Common Core Standards for Literacy in Science – Reading Standards 6-8

Key Ideas and Details:
CCSS.ELA-LITERACY.RST.6-8.1
Cite specific textual evidence to support analysis of science and technical texts.

CCSS.ELA-LITERACY.RST.6-8.2
Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.

CCSS.ELA-LITERACY.RST.6-8.3
Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

Craft and Structure:
CCSS.ELA-LITERACY.RST.6-8.4
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 6-8 texts and topics*.

CCSS.ELA-LITERACY.RST.6-8.5
Analyze the structure an author uses to organize a text, including how the major sections contribute to the whole and to an understanding of the topic.

CCSS.ELA-LITERACY.RST.6-8.6
Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text.

Integration of Knowledge and Ideas:
CCSS.ELA-LITERACY.RST.6-8.7
Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

CCSS.ELA-LITERACY.RST.6-8.8
Distinguish among facts, reasoned judgment based on research findings, and speculation in a text.

CCSS.ELA-LITERACY.RST.6-8.9
Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

Range of Reading and Level of Text Complexity:
CCSS.ELA-LITERACY.RST.6-8.10
By the end of grade 8, read and comprehend science/technical texts in the grades 6-8 text complexity band independently and proficiently.

Common Core Standards for Literacy in Science – Writing Standards 6-8

CCSS.ELA-LITERACY.WHST.6-8.1
Write arguments focused on *discipline-specific content*.

CCSS.ELA-LITERACY.WHST.6-8.1.A, B, C, D, E
Introduce claim(s) about a topic or issue, acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically; support claim(s) with logical reasoning and relevant, accurate data and evidence that demonstrate an understanding of the topic or text, using credible sources; use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), counterclaims, reasons, and evidence; establish and maintain a formal style; provide a concluding statement or section that follows from and supports the argument presented.

CCSS.ELA-LITERACY.WHST.6-8.2
Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

CCSS.ELA-LITERACY.WHST.6-8.2.A, B, C, D, E, F
Introduce a topic clearly, previewing what is to follow; organize ideas, concepts, and information into broader categories as appropriate to achieving purpose; include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension; develop the topic with relevant, well-chosen facts, definitions, concrete details, quotations, or other information and examples; use appropriate and varied transitions to create cohesion and clarify the relationships among ideas and concepts; use precise language and domain-specific vocabulary to inform about or explain the topic,; establish and maintain a formal style and objective tone; provide a concluding statement or section that follows from and supports the information or explanation presented.

Production and Distribution of Writing:
CCSS.ELA-LITERACY.WHST.6-8.4
Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

CCSS.ELA-LITERACY.WHST.6-8.5
With some guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on how well purpose and audience have been addressed.

CCSS.ELA-LITERACY.WHST.6-8.6
Use technology, including the Internet, to produce and publish writing and present the relationships between information and ideas clearly and efficiently.

Research to Build and Present Knowledge:
CCSS.ELA-LITERACY.WHST.6-8.7
Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

CCSS.ELA-LITERACY.WHST.6-8.8
Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.

CCSS.ELA-LITERACY.WHST.6-8.9
Draw evidence from informational texts to support analysis, reflection, and research.

Range of Writing:
CCSS.ELA-LITERACY.WHST.6-8.10
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.