Understanding By Design Unit Template

Title of Unit	Earth Systems	**Grade Level**	8th
Curriculum Area	Science	**Time Frame**	20 days (september)
Developed By	Alex Gurvits		

Identify Desired Results (Stage 1)

Content Standards

MS-ESS1-4: Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history. [Clarification Statement: Emphasis is on how analyses of rock formations and the fossils they contain are used to establish relative ages of major events in Earth's history. Examples of Earth's major events could range from being very recent (such as the last Ice Age or the earliest fossils of homo sapiens) to very old (such as the formation of Earth or the earliest evidence of life). Examples can include the formation of mountain chains and ocean basins, the evolution or extinction of particular living organisms, or significant volcanic eruptions.] [Assessment Boundary: Assessment does not include recalling the names of specific periods or epochs and events within them.]

MS-ESS2-1: Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process. [Clarification Statement: Emphasis is on the processes of melting, crystallization, weathering, deformation, and sedimentation, which act together to form minerals and rocks through the cycling of Earth's materials.] [Assessment Boundary: Assessment does not include the identification and naming of minerals.]

MS-ESS2-2: Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales. [Clarification Statement: Emphasis is on how processes change Earth's surface at time and spatial scales that can be large (such as slow plate motions or the uplift of large mountain ranges) or small (such as rapid landslides or microscopic geochemical reactions), and how many geoscience processes (such as earthquakes, volcanoes, and meteor impacts) usually behave gradually but are punctuated by catastrophic events. Examples of geoscience processes include surface weathering and deposition by the movements of water, ice, and wind. Emphasis is on geoscience processes that shape local geographic features, where appropriate.]

MS-ESS2-3: Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions. [Clarification Statement: Examples of data include similarities of rock and fossil types on different continents, the shapes of the continents (including continental shelves), and the locations of ocean structures (such as ridges, fracture zones, and trenches).] [Assessment Boundary: Paleomagnetic anomalies in oceanic and continental crust are not assessed.]

MS-ESS2-4: Develop a model to describe unobservable mechanisms the cycling of water through Earth's systems driven by energy from the sun and the force of gravity. [Clarification Statement: Emphasis is on the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle. Examples of models can be conceptual or physical.] [Assessment Boundary: A quantitative understanding of the latent heats of vaporization and fusion is not assessed.]

Understandings	Essential Questions

Overarching Understanding	Overarching	Topical
The Earth's surface features The Earth's surface has changed dramatically over time, and changes continue to occur. Changes in the Earth's surface are caused by natural processes such as erosion, deposition and plate tectonics. The Earth System is composed of and part of a multitude of systems, which cycle and interact resulting in dynamic equilibrium. Compare and contrast Earth with other planets in the Solar System, and explains why technology is necessary to study other planets and the universe beyond our Solar System. Scientific inquiry involves asking scientifically–oriented questions, collecting evidence, forming explanations, connecting explanations to scientific knowledge and theory, and communicating and justifying explanations.	• If no one was there, how do we know Earth's history? • What provides the forces that drive Earth's systems? • Do all of the changes to Earth's systems occur in similar time scales? • How do stars, such as our sun, produce energy? • How can technology help us understand the history of the universe and what is yet to be discovered?	• What connections are there between the changing surface of the earth and the evolution of life? • What interactions create our climate? How are they changing? • How do I fit in with all of Earth's parts? • How can humanity change climate or other interrelated Earth systems? • Why does studying the past help scientists to predict future climate? • How can we predict what effect terrestrial systems would have on other systems like the hydrosphere, atmosphere, or biosphere?
Related Misconceptions		
Despite key evidence, people may believe the Earth is flat. Students may not properly understand the magnitude of the size/scale of objects in the universe (i.e. the belief that our sun is a large star, when it is not) Waves caused by the moon (they are caused by currents and winds...current and winds are results of temperature and salinity variation) Students need to know Earth's climate is dependent not only on the sun but the ocean. Students do not understand that elements were not produced on (or by) planet earth. Students have a hard time conceptualizing geologic and/or cosmological time Students may not understand how fossils are made or correctly dated Though they may be hearing about carbon in the news (related to climate change) it is necessary for life on earth		
Knowledge Students will know…	**Skills** Students will be able to…	

Within a natural system, the transfer of energy drives the motion and cycling of matter	Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity Develop and describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates. Create a flowchart or model to describe the cycling of matter and the flow of energy in an ecosystem Ask questions and define the parameters of a solution for one of the problems disrupting the stability of the ecosystem within a New Jersey State Park.

Assessment Evidence (Stage 2)

Performance Task Description

• **Goal** • **Role** • **Audience** • **Situation** • **Product/Performance** • **Standards**	"Change the Surface of the Earth" Students will assume the role of a geologist and create a presentation (poster, brochure, multimedia) that demonstrates an understanding of the forces involved with the deformation of the Earth's crust. They must integrate a section about a current technology that prevents damage to buildings, homes, etc. from the geologic event of their choice (i.e.: earthquakes, glacier movement, erosion, how they change the surface, and tech advancement to prevent structural damage)

Other Evidence

- Lectures and mini-lessons
- Website exploration
- Partner or small group work
- Student presentations
- Reports
- Reflections
- In-class labs
- Performance assessments
- Quick Labs
- Science Journal/Diary
- Inquiry Warm Up Activities.
- Virtual Lab activities
- Pretests
- Class Discussions
- Socrative discussion
- Phet simulations
- Kahoot
- Turn and talk
- Fist to five
- Exit tickets
- Worksheets/Homework
- Lab Reports
- Quizzes
- Tests(multiple choice and OEQ)

Learning Plan (Stage 3)

• **Where are your students headed? Where have they been? How will you make sure the students know where they are going?** • **How will you hook students at the beginning of the unit?** • **What events will help students experience and explore the big idea and questions in the unit? How will you equip them with needed skills and knowledge?** • **How will you cause students to reflect and rethink? How will you guide them in rehearsing, revising, and refining their work?** • **How will you help students to exhibit and self-evaluate their growing skills, knowledge, and understanding throughout the unit?** • **How will you tailor and otherwise personalize the learning plan to optimize the engagement and effectiveness of ALL students, without compromising the goals of the unit?** • **How will you organize and sequence the learning activities to optimize the engagement and achievement of ALL students?**	Within this unit, students will use the geologic time scale to organize Earth's 4.6-billion-year-old history. They will cite specific textual evidence from science and technical texts to support analysis of rock strata to show how the geologic time scale is used to organize Earth's 4.6-billion-year-old history. They will use analysis of rock formations and the fossils they contain to establish relative ages of major events in Earth's history. Examples of Earth's major events could include the Ice Age or the earliest fossils of Homo sapiens, or the formation of Earth and the earliest evidence of life. Emphasis should be on analyses of rock strata providing only relative dates, not an absolute scale. Students can use variables to represent numbers or quantities and write expressions when solving problems while constructing their explanations. Examples can include the formation of mountain chains and ocean basins, the evolution or extinction of particular living organisms, or significant volcanic eruptions. *[Note: Assessment does not include recalling the names of specific periods or epochs and events within them.]* Students will develop and use models to describe the cycling of Earth materials and the flow of energy that drives this process. This energy comes from the heat of the core of the Earth, which is transferred to the mantle. Convection currents within the mantle then drive the movement of tectonic plates. Emphasis is on the processes of melting, crystallization, weathering, deformation, and sedimentation, which act together to form minerals and rocks through the cycling of Earth's materials. Students can generate models to demonstrate the rock cycle, with specific focus on the processes causing change. Students can analyze pictures and rock samples that demonstrate various processes of melting, crystallization, weathering, deformation, and sedimentation. *[Note: Students are not identifying and naming minerals within this unit].* Students will construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales. Emphasis is on how processes change Earth's surface at time and spatial scales that can be large (such as slow plate motions or the uplift of large mountain ranges) or small (such as rapid landslides or microscopic geochemical reactions). Further emphasis is on how many geoscience processes (such as earthquakes, volcanoes, and meteor impacts) usually behave gradually but are punctuated by catastrophic events. Students can gather data and plot volcanoes and earthquakes in order to collect evidence to support the idea that these interactions among Earth's systems have shaped Earth's history and will determine its future. Additional examples can include changes on Earth's surface from weathering and deposition by the movements of water, ice, and wind. Emphasis is also on geoscience processes that shape local geographic features, such as New Jersey's Ridge and Valley Province, Highlands

From: Wiggins, Grant and J. Mc Tighe. (1998). Understanding by Design, Association for Supervision and Curriculum Development
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Understanding By Design Unit Template

Title of Unit	Structure and Properties of Matter	**Grade Level**	8th
Curriculum Area	Science	**Time Frame**	20 days (october)
Developed By			

Identify Desired Results (Stage 1)

Content Standards

MS-PS1-1: Develop models to describe the atomic composition of simple molecules and extended structures. *[Clarification Statement: Emphasis is on developing models of molecules that vary in complexity. Examples of simple molecules could include ammonia and methanol. Examples of extended structures could include sodium chloride or diamonds. Examples of molecular-level models could include drawings, 3D ball and stick structures, or computer representations showing different molecules with different types of atoms.] [Assessment Boundary: Assessment does not include valence electrons and bonding energy, discussing the ionic nature of subunits of complex structures, or a complete depiction of all individual atoms in a complex molecule or extended structure.]*

Understandings	Essential Questions	
Overarching Understanding	**Overarching**	**Topical**

Atoms form molecules that range in size from two to thousands of atoms Solids may be formed from molecules, or they may be extended structures with repeating subunits.	• How is it that everything is made of stardust? • What is the universe made of? • What is matter? • Does matter cycle through parts of Earth?	• Is it possible to tell if two substances are mixed or if they reacted with each other? • How can particles combine to produce a substance with different properties? • What happens at the molecular level in each state of matter and when matter changes states? • What are the physical characteristics and chemical properties of pure substances? • How do atomic and molecular interactions explain the properties of matter that we see and feel?
Related Misconceptions		
All the substances around us, like water, are made of smaller particles of matter (atoms, and atoms are made of subparticles) Size scale of “small” relative to microscopic to atomic Matter can change phases multiple times.		
Knowledge Students will know…	**Skills** Students will be able to…	

1. Substances are made from different types of atoms, which combine with one another in various ways. 2. Atoms form molecules that range in size from two to thousands of atoms. 3. Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. 4. Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. 5. In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. 6. Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). 7. The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter. 8. Density, melting point, boiling point, solubility, flammability, and odor are particular to pure substances	• Identify the main parts and particles of an atom through labeling or modeling • Identify the charges and locations of protons, neutrons, and electrons • Indicate how atoms combine with other atoms through comparison of charges, structure, etc. • Model the arrangement of atoms on a gaseous or liquid state • Compare and contrast the states of matter and properties of such (solid, liquid, gas) • Develop models to describe the atomic composition of simple molecules and extended structures. • Create (3D ball and stick method or candy and toothpicks) and use model to show various molecules and their structure (water, glucose, etc.) • Differentiate between elements using properties of matter

Assessment Evidence (Stage 2)

Performance Task Description

• **Goal** • **Role** • **Audience** • **Situation** • **Product/Performance** • **Standards**	Determine the composition of unknown compound based upon quantitative data, substantiate your findings using one or more graphic organizer and summary statement. Provide students with 2 or more substances in solution (i.e., salt water solution, sugar water solution) and a control (i.e., distilled water). Challenge them to come up with a method to determine which, if any, of these solutions are ionic, covalent, or metallic compounds by collecting quantitative data about the properties of each. Provide any materials necessary to complete this: glassware, agitators, digital balance, hot plate (boiling point), multi -meter/9v battery (conductivity - ionic compounds).

Other Evidence

- Lectures and mini-lessons
- Website exploration
- Partner or small group work
- Student presentations
- Reports
- Reflections
- In-class labs
- Performance assessments
- Quick Labs
- Science Journal/Diary
- Inquiry Warm Up Activities.
- Virtual Lab activities
- Pretests
- Class Discussions
- Socrative discussion
- Phet simulations
- Kahoot
- Turn and talk
- Fist to five
- Exit tickets
- Worksheets/Homework
- Lab Reports
- Quizzes
- Tests(multiple choice and OEQ)

Learning Plan (Stage 3)

• **Where are your students headed? Where have they been? How will you make sure the students know where they are going?** • **How will you hook students at the beginning of the unit?** • **What events will help students experience and explore the big idea and questions in the unit? How will you equip them with needed skills and knowledge?** • **How will you cause students to reflect and rethink? How will you guide them in rehearsing, revising, and refining their work?** • **How will you help students to exhibit and self-evaluate their growing skills, knowledge, and understanding throughout the unit?** • **How will you tailor and otherwise personalize the learning plan to optimize the engagement and effectiveness of ALL students, without compromising the goals of the unit?** • **How will you organize and sequence the learning activities to optimize the engagement and achievement of ALL students?**	Within this unit, students will use informational text and models (which can include student-generated drawings, 3-D ball-and-stick structures, or computer representations) to understand that matter is composed of atoms and molecules. These models should reflect that substances are made from different types of atoms. Student models can be manipulated to show that molecules can be disassembled into their various atoms and reassembled into new substances according to chemical reactions. This scientific knowledge can be used to explain the properties of substances. Students will examine and differentiate between physical and chemical properties of matter. They are limited to the analysis of the following characteristic properties: density, melting point, boiling point, solubility, flammability, and odor. This analysis of properties serves as evidence to support that chemical reactions of substances cause a rearrangement of atoms to form different molecules. Students will also recognize that they are using models to observe phenomena too small to be seen. Students who demonstrate this understanding can develop or modify a model of simple molecules to describe the molecules' atomic composition. Examples of molecules that can be modeled include water, oxygen, carbon dioxide, ammonia, and methanol. Additionally, students will develop and modify a model that describes the atomic composition of an extended structure showing a pattern of repeating subunits. Examples may include sodium chloride and diamonds. Due to the repeating subunit patterns, models can include student-generated drawings, 3-D ball-and-stick structures, and computer representations. Building upon these experiences, students will analyze and interpret data on the properties of substances in order to provide evidence that a chemical reaction has occurred. They will also analyze and interpret data to determine similarities and differences in findings. Students will recognize that macroscopic patterns are related to the nature of microscopic and atomic-level structure. They will use patterns to identify cause-and-effect relationships and graphs and charts to identify patterns in data.

From: Wiggins, Grant and J. Mc Tighe. (1998). Understanding by Design, Association for Supervision and Curriculum Development
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Understanding By Design Unit Template

Title of Unit	Interactions of Matter	**Grade Level**	8th
Curriculum Area	Science	**Time Frame**	20 days (oct-nov)
Developed By			

Identify Desired Results (Stage 1)

Content Standards

MS-PS1-1: Develop models to describe the atomic composition of simple molecules and extended structures. *[Clarification Statement: Emphasis is on developing models of molecules that vary in complexity. Examples of simple molecules could include ammonia and methanol. Examples of extended structures could include sodium chloride or diamonds. Examples of molecular-level models could include drawings, 3D ball and stick structures, or computer representations showing different molecules with different types of atoms.] [Assessment Boundary: Assessment does not include valence electrons and bonding energy, discussing the ionic nature of subunits of complex structures, or a complete depiction of all individual atoms in a complex molecule or extended structure.]*

Understandings	Essential Questions	
Overarching Understanding	**Overarching**	**Topical**

Energy cannot be created or destroyed, but only change from one form to another Most of what goes on in the universe involves transformation of energy; heat energy is almost always a byproduct. Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. In a liquid, the molecules are constantly in contact with others. In a gas, the molecules are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. The changes of state that occur with variations in temperature or pressure can be described and predicted using models of matter.	• How do changes in particle motion, temperature, and state of a pure substance occur when thermal energy is added or removed? • How can models be used to show that adding or removing thermal energy increases or decreases the kinetic energy of the particles until a change of state occurs on the molecular-level of solids, liquids, and gases?	• How can you tell what molecules are doing in a substance? • How can we trace synthetic ingredients back to natural ingredients?
Related Misconceptions		
Common misconception is that temperature is a measure of a system's thermal energy.		
Knowledge Students will know…	**Skills** Students will be able to…	

1. Patterns of the periodic table include the changes in physical and chemical properties before and after interactions. 2. Each atom has a specific mass and it is the same for all atoms of that type. 3. Gases and liquids are made of molecules or inert atoms that are moving about relative to each other, In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations 4. Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals) 5. The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter	• Compare chemical versus physical properties • Differentiate between elements using properties of matter • Identify signs of a chemical reaction • Describe how atomic mass is related to different elements • Use physical models or drawings, including digital forms, to represent atoms in a chemical process. • Use mathematical descriptions to show that the number of atoms before and after a chemical process is the same. Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred. • Develop a model that predicts and describes changes in particle motion that could include molecules or inert atoms or pure substances. • Use cause-and-effect relationships to predict changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed in natural or designed systems. • Observe a “combination” of two substances and determine (using evidence) if a chemical or physical change has occurred. Then students will model the reaction using chosen media.

Assessment Evidence (Stage 2)

Performance Task Description

• **Goal** • **Role** • **Audience** • **Situation** • **Product/Performance** • **Standards**	*Students who understand the concepts are able to:* Develop a model that predicts and describes changes in particle motion that could include molecules or inert atoms or pure substances. Use cause-and-effect relationships to predict changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed in natural or designed systems. Design and carry out experiments; then student will use evidence from the experiments to support claims for whether a chemical or physical change has occurred.

Other Evidence

- Lectures and mini-lessons
- Website exploration
- Partner or small group work
- Student presentations
- Reports
- Reflections
- In-class labs
- Performance assessments
- Quick Labs
- Science Journal/Diary
- Inquiry Warm Up Activities.
- Virtual Lab activities
- Pretests
- Class Discussions
- Socrative discussion
- Phet simulations
- Kahoot
- Turn and talk
- Fist to five
- Exit tickets
- Worksheets/Homework
- Lab Reports
- Quizzes
- Tests(multiple choice and OEQ)

Learning Plan (Stage 3)

• **Where are your students headed? Where have they been? How will you make sure the students know where they are going?** • **How will you hook students at the beginning of the unit?** • **What events will help students experience and explore the big idea and questions in the unit? How will you equip them with needed skills and knowledge?** • **How will you cause students to reflect and rethink? How will you guide them in rehearsing, revising, and refining their work?** • **How will you help students to exhibit and self-evaluate their growing skills, knowledge, and understanding throughout the unit?** • **How will you tailor and otherwise personalize the learning plan to optimize the engagement and effectiveness of ALL students, without compromising the goals of the unit?** • **How will you organize and sequence the learning activities to optimize the engagement and achievement of ALL students?**	Students will locate information that describes changes in particle motion, changes in temperature, or changes in state as thermal energy is added to or removed from a pure substance. Students will then use models to predict and describe the changes in particle motion, temperature, and state of a pure substance. An example could include the change of state of water from its solid (ice) to liquid and vapor with the addition of thermal energy. Students will come to understand that this process is reversible through the removal of thermal energy, where the pure substance can return from a vapor to a liquid and back to a solid state. Students who accurately demonstrate understanding will be able to develop qualitative molecular-level models of solids, liquids, and gases to show the cause-and- effect relationships of adding or removing thermal energy, which increases or decreases the kinetic energy of the particles until a change of state occurs. Models could include drawings and diagrams. Students will also need to use mathematics to demonstrate their understanding of the particle motion that is taking place during these changes in state. They will use positive and negative numbers to represent the changes in particle motion and temperature as thermal energy is added or removed. They will then integrate an expression of that same quantitative information in a visual format. It is important to note that students will need to be responsible for developing the models that they use. It is possible that the teacher could model the process with one type of model and provide opportunities for students to use different types of model to illustrate the same process. After students have a firm understanding of the motion of particles during a phase change, they will be able to move to the next section of this unit. In this portion of the unit of study, students will apply their understanding of particle and chemical change from Unit 1 to make sense of how natural resources react chemically to produce new substances. Students will explain that as a result of the rearrangement of atoms during a chemical process, the synthetic substance has different characteristic properties than the original pure substance. For example, pure substances like methane, carbon monoxide, and carbon dioxide can be combined chemically to form synthetic fuel. The synthetic fuel would have different characteristic properties than the original pure substances. Within this unit, students will gather, read, and synthesize qualitative information from multiple sources about the use of natural resources to form synthetic materials and how these new materials affect society. Examples of new materials could include new medicine, foods, and alternative fuels. Some sources could include journals, articles, brochures, or digital media from government publications and/or private industries. Students will cite some of these sources to support the analysis of evidence that these synthetic materials were formed from natural resources and have an impact on society. They will pay special attention to the precise details of explanations or descriptions of how these new substances affect society. Students

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Understanding By Design Unit Template

Title of Unit	Chemical Reactions	**Grade Level**	8th
Curriculum Area	Science	**Time Frame**	25 days (dec-jan)
Developed By			
Identify Desired Results (Stage 1)			
Content Standards			

MS-PS1-1: Develop models to describe the atomic composition of simple molecules and extended structures. *[Clarification Statement: Emphasis is on developing models of molecules that vary in complexity. Examples of simple molecules could include ammonia and methanol. Examples of extended structures could include sodium chloride or diamonds. Examples of molecular-level models could include drawings, 3D ball and stick structures, or computer representations showing different molecules with different types of atoms.] [Assessment Boundary: Assessment does not include valence electrons and bonding energy, discussing the ionic nature of subunits of complex structures, or a complete depiction of all individual atoms in a complex molecule or extended structure.]*

MS-PS1-2: Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred. *[Clarification Statement: Examples of reactions could include burning sugar or steel wool, fat reacting with sodium hydroxide, and mixing zinc with hydrogen chloride.] [Assessment Boundary: Assessment is limited to analysis of the following properties: density, melting point, boiling point, solubility, flammability, and odor.]*

MS-PS1-3: Gather and make sense of information to describe that synthetic materials come from natural resources and impact society. *[Clarification Statement: Emphasis is on natural resources that undergo a chemical process to form the synthetic material. Examples of new materials could include new medicine, foods, and alternative fuels.] [Assessment Boundary: Assessment is limited to qualitative information.]*

MS-PS1-4: Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed. *[Clarification Statement: Emphasis is on qualitative molecular-level models of solids, liquids, and gases to show that adding or removing thermal energy increases or decreases kinetic energy of the particles until a change of state occurs. Examples of models could include drawings and diagrams. Examples of particles could include molecules or inert atoms. Examples of pure substances could include water, carbon dioxide, and helium.]*

MS-PS1-5: Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved. *[Clarification Statement: Emphasis is on law of conservation of matter and on physical models or drawings, including digital forms, that represent atoms.] [Assessment Boundary: Assessment does not include the use of atomic masses, balancing symbolic equations, or intermolecular forces.]*

MS-PS1-6: Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.* *[Clarification Statement: Emphasis is on the design, controlling the transfer of energy to the environment, and modification of a device using factors such as type and concentration of a substance. Examples of designs could involve chemical reactions such as dissolving ammonium chloride or calcium chloride.] [Assessment Boundary: Assessment is limited to the criteria of amount, time, and temperature of substance in testing the device.]*

MS-PS3-4: Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample. *[Clarification Statement: Examples of experiments could include comparing final water temperatures after different masses of ice melted in the same volume of water with the same initial temperature, the temperature change of samples of different materials with the same mass as they cool or heat in the environment, or the same material with different masses when a specific amount of energy is added.] [Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.]*

MS-PS3-5: Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object. *[Clarification Statement: Examples of empirical evidence used in arguments could include an inventory or other representation of the energy before.]*

Understandings	Essential Questions

<table>
<tr><th>Overarching Understanding</th><th>Overarching</th><th>Topical</th></tr>
<tr><td>There are many branches of chemistry, and each extends to many aspects of our daily lives
Materials are composed of atoms, which have given arrangement and properties within them.
In a chemical process, the atoms that make up the original substances (reactants) are regrouped into different molecules.
These new substances have different properties than those of the reactants.
The law of conservation of mass is a mathematical description of natural phenomena.
Chemical equations can be recognized by looking for common signs (arrow, reactants, products, etc.)</td><td rowspan="3">How do chemists solve problems?
How do substances combine or change (react) to form new substances?
Why do some substances have chemically predictable reactions?
How does understanding energy help us to understand chemical reactions?
How is the Law of Conservation of Mass useful and important in science?</td><td rowspan="3">What happens to atoms when you bake a cake?

How can a device be designed, constructed, tested, and modified that either releases or absorbs thermal energy by chemical processes?</td></tr>
<tr><th>Related Misconceptions</th></tr>
<tr><td>Students often believe that the amount of matter or atoms change during a chemical reaction. (i.e. common misconception: when your burn a piece of paper the ash will weigh less than the initial piece of paper)

Chemistry and math are unrelated is a misconception</td></tr>
<tr><td>Knowledge
Students will know…</td><td colspan="2">Skills
Students will be able to…</td></tr>
</table>

1. Substances react chemically in characteristic ways. 2. In a chemical process, the atoms that make up the original substances are regrouped into different molecules. 3. New substances created in a chemical process have different properties from those of the reactants. 4. The total number of each type of atom in a chemical process is conserved, and thus the mass does not change (the law of conservation of matter). 5. Matter is conserved because atoms are conserved in physical and chemical processes. 6. The law of conservation of mass is a mathematical description of natural phenomena. 7. Some chemical reactions release energy, others store energy. 8. The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. 9. A solution needs to be tested, and then modified on the basis of the test results, in order to improve it.	• Create a model or flow chart that identifies relevant components for a given chemical reaction • Describe the numbers and types of molecules that make up the reactants • Describe the numbers and types of molecules that make up the products. • Analyze properties of substances and use them to predict how the chemical reaction will occur • Utilize math to formulate an explanation for the conservation of mass • Compare and contrast reactants and products for a given chemical reaction

Assessment Evidence (Stage 2)

Performance Task Description

• **Goal** • **Role** • **Audience** • **Situation** • **Product/Performance** • **Standards**	Build a model or apparatus using flasks (or water bottles) with alka seltzer, balloon, and water to show that mass is conserved during a chemical reaction. (Place alka-seltzer in balloon and water in flask, take mass before and after reaction.) Exothermic/Endothermic Design Challenge: Students will design an instant ice pack and hand warmers after testing reactions of substances to gather data of energy transfer to drive their design.
Other Evidence	

Lectures and mini-lessons

- Website exploration
- Partner or small group work
- Student presentations
- Reports
- Reflections
- In-class labs
- Performance assessments
- Quick Labs
- Science Journal/Diary
- Inquiry Warm Up Activities.
- Virtual Lab activities
- Pretests
- Class Discussions
- Socrative discussion
- Phet simulations
- Kahoot
- Turn and talk
- Fist to five
- Exit tickets
- Worksheets/Homework
- Lab Reports
- Quizzes
- Tests (multiple choice and OEQ)

Learning Plan (Stage 3)

• **Where are your students headed? Where have they been? How will you make sure the students know where they are going?** • **How will you hook students at the beginning of the unit?** • **What events will help students experience and explore the big idea and questions in the unit? How will you equip them with needed skills and knowledge?** • **How will you cause students to reflect and rethink? How will you guide them in rehearsing, revising, and refining their work?** • **How will you help students to exhibit and self-evaluate their growing skills, knowledge, and understanding throughout the unit?** • **How will you tailor and otherwise personalize the learning plan to optimize the engagement and effectiveness of ALL students, without compromising the goals of the unit?** • **How will you organize and sequence the learning activities to optimize the engagement and achievement of ALL students?**	Students begin by gaining understanding that substances react chemically in very characteristic ways. To develop this understanding, students will follow precisely a multistep procedure when carrying out experiments that involve chemical reactions that release energy and chemical reactions that absorb energy. As part of their data analysis, students will integrate quantitative information about atoms before and after the chemical reaction. The analysis will include translating written information into information that is expressed in a physical model or drawing or in digital forms. Reasoning both quantitatively and abstractly to communicate their understanding of these reactions, students will model the law of conservation of matter. They will use ratio and rate to demonstrate that the total number of atoms involved in the chemical reactions does not change and therefore mass is conserved. Within this unit, students will develop a model of the reactions they observe to describe how the total number of atoms does not change in a chemical reaction. Examples of models could include physical models, drawings, or digital forms that represent atoms. Student models ideally should have the ability to be manipulated to represent the rearrangement of reactants to products as a way to demonstrate that matter is conserved during chemical processes. Students will show how their model provides evidence that the law of conservation of matter is a mathematical description of what happens in nature. In prior units of study, students have learned about the behavior of particles of matter during a change of state and about characteristic chemical and physical properties of matter. This unit will leverage that prior learning by having students undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes. For example, students could design a device that releases heat in a way similar to how heat is released when powdered laundry detergent is mixed with water to form a paste. Students will need to be able to track energy transfer as heat energy is either released to the environment or absorbed from the environment. Students could also design a device that absorbs and stores heat from the environment. The design problem has already been identified; therefore, the emphasis is on designing the device, controlling the transfer of energy to the environment, and modifying the device according to factors such as type and concentration of substance. The criteria for a successful design have not been determined; therefore, teachers will need to work with students to determine criteria for a successful design. Before attempting to determine criteria, students will conduct a short research project to familiarize themselves with scientific information they can use

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Understanding By Design Unit Template

Title of Unit	Structure and Function: Cells	**Grade Level**	8th
Curriculum Area	Science	**Time Frame**	15 days (jan-feb)
Developed By			
Identify Desired Results (Stage 1)			
Content Standards			

MS-LS1-1: Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells. [Clarification Statement: Emphasis is on developing evidence that living things are made of cells, distinguishing between living and nonliving things, and understanding that living things may be made of one cell or many and varied cells.]

MS-LS1-2: Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function. [Clarification Statement: Emphasis is on the cell functioning as a whole system and the primary role of identified parts of the cell, specifically the nucleus, chloroplasts, mitochondria, cell membrane, and cell wall.] [*Assessment Boundary: Assessment of organelle structure/function relationships is limited to the cell wall and cell membrane. Assessment of the function of the other organelles is limited to their relationship to the whole cell. Assessment does not include the biochemical function of cells or cell parts.*]

MS-LS1-3: Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells. [Clarification Statement: Emphasis is on the conceptual understanding that cells form tissues and tissues form organs specialized for particular body functions. Examples could include the interaction of subsystems within a system and the normal functioning of those systems.] [*Assessment Boundary: Assessment does not include the mechanism of one body system independent of others. Assessment is limited to the circulatory, excretory, digestive, respiratory, muscular, and nervous systems.*]

MS-LS1-4: Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively. [Clarification Statement: Examples of behaviors that affect the probability of animal reproduction could include nest building to protect young from cold, herding of animals to protect young from predators, and vocalization of animals and colorful plumage to attract mates for breeding. Examples of animal behaviors that affect the probability of plant reproduction could include transferring pollen or seeds, and creating conditions for seed germination and growth. Examples of plant structures could include bright flowers attracting butterflies that transfer pollen, flower nectar and odors that attract insects that transfer pollen, and hard shells on nuts that squirrels bury.]

MS-LS1-5: Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. [Clarification Statement: Examples of local environmental conditions could include availability of food, light, space, and water. Examples of genetic factors could include large breed cattle and species of grass affecting growth of organisms. Examples of evidence could include drought decreasing plant growth, fertilizer increasing plant growth, different varieties of plant seeds growing at different rates in different conditions, and fish growing larger in large ponds than they do in small ponds.] [*Assessment Boundary: Assessment does not include genetic mechanisms, gene regulation, or biochemical processes.*]

MS-LS1-6: Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms. [Clarification Statement: Emphasis is on tracing movement of matter and flow of energy.] [*Assessment Boundary: Assessment does not include the biochemical mechanisms of photosynthesis.*]

MS-LS1-7: Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism. [Clarification Statement: Emphasis is on describing that molecules are broken apart and put back together and that in this process, energy is released.] [*Assessment Boundary: Assessment does not include details of the chemical reactions for photosynthesis or respiration.*]

MS-LS1-8: Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories. [*Assessment Boundary: Assessment does not include mechanisms for the transmission of this information.*]

<table>
<tr><th colspan="2">Understandings</th><th colspan="2">Essential Questions</th></tr>
<tr><th>Overarching Understanding</th><th></th><th>Overarching</th><th>Topical</th></tr>
<tr><td colspan="2">All living things are made of cells and we use this, and other characteristics to distinguish living from nonliving.
The shape of an object or organism impact its function.
Cell organelles are special structures and are responsible for particular functions.
Cell membranes are chemically different than cell walls.
Cell membranes regulate what enters and leaves a cell.
The body is a system of multiple and interacting subsystems.
Cells work together to form tissues, and tissues form organs with specialized functions.</td><td rowspan="3">• How do organisms live, grow, and respond to their environments?
• What is the basis of life?
• How are organisms of same kind (species) different from each other?
• How can we prove cells make up living things?
• How do living things obtain energy?</td><td rowspan="3">• How is carbon important to life on Earth?
• Why is carbon capable of making macromolecules?
• What are the 4 main macromolecules and their function?
• How do unicellular and multicellular life differ?
• How do organelles allow for eukaryotic cells to function more efficiently?
• How does the chemical structure of the cell membrane help maintain homeostasis?</td></tr>
<tr><th colspan="2">Related Misconceptions</th></tr>
<tr><td colspan="2">The difference between abiotic and biotic versus living and dead may be an issue for some students.
Some students believe breathing and moving are characteristics of life. they are not
Students may not realize plants are alive and/or made of cells</td></tr>
<tr><td colspan="2">Knowledge
Students will know…</td><td colspan="2">Skills
Students will be able to…</td></tr>
</table>

1. The elements that comprise the majority of living matter 2. How atoms, elements, and compounds differ 3. Cells are made of complex molecules that consist mostly of carbon 4. All living things are made of cells 5. Microscopes are scientific tools that aid in seeing microscopic life and cells 6. The importance of the cell theory in establishing the field of biology 7. All cells have similar structures, such as cell membranes, that function similarly in different organisms 8. All cells come from other cells through growth and division, therefore producing more cells 9. Living things get energy from the sun through the process of photosynthesis, performed inside the chloroplasts of producers 10. Cellular respiration is a process that releases stored energy from photosynthesis and occurs mainly in the mitochondria 11. The cell membrane is a boundary between the cell and its environment and regulates what enters and leaves the cell through passive and active transport	• Describe the three parts of the Cell Theory and analyze how the changed the field of biology • Evaluate evidence supporting the cell theory • Examine the importance of the microscope as a scientific tool, and in the discovery of cells • Conduct an investigation to collect evidence that living things are comprised of cells, either one celled or multicelled • Compare and contrast (the pros and cons of) unicellular and multicellular organisms • Identify and describe the structures that most cells have in common • Describe and diagram the structure and function of each organelle • Explain how plant and animal cells differ • Use a model to describe the function of a cell as a whole • Examine how the structure of organelles contribute to the overall function of the cell • Identify the reactants and products of photosynthesis • Illustrate plant and animals cells and where cellular respiration and photosynthesis occur in each • Differentiate respiration (breathing) from cellular respiration (release of energy) • Create a model to describe how food is rearranged through chemical reactions forming new molecules that provide usable energy for the cell • Analyze how the structure of the cell membrane regulates the transport of materials based on size of molecules • Compare and contrast passive and active transport using diagrams and give examples of each • Examine passive transport in a lab setting using a model of a cell membrane
Assessment Evidence (Stage 2)	

Performance Task Description	
• **Goal** • **Role** • **Audience** • **Situation** • **Product/Performance** • **Standards**	• Conduct an investigation to support the idea that living things are made of cells and differ in number and types of cells • Develop a model to describe the function of a cell and the ways in which the structure of organelles contribute to function • Develop an argument based on evidence and applied reasoning to explain the ways in which animal behaviors and plant structures affect successful reproduction • Construct an explanation based on evidence for how environmental and genetic factors affect growth in organisms • Propose a scientific explanation based on evidence for the role photosynthesis plays in the cycling of matter between organisms (energy in energy out) • 3D model of cell • Flower dissection • Diffusion lab with baggies and iodine/starch • Microscope labs or online simulations • Chart of organelles and function and associated biomolecules
Other Evidence	

Lectures and mini-lessons

- Website exploration
- Partner or small group work
- Student presentations
- Reports
- Reflections
- In-class labs
- Performance assessments
- Quick Labs
- Science Journal/Diary
- Inquiry Warm Up Activities.
- Virtual Lab activities
- Pretests
- Class Discussions
- Socrative discussion
- Phet simulations
- Kahoot
- Turn and talk
- Fist to five
- Exit tickets
- Worksheets/Homework
- Lab Reports
- Quizzes
- Tests (multiple choice and OEQ)

Learning Plan (Stage 3)

• **Where are your students headed? Where have they been? How will you make sure the students know where they are going?** • **How will you hook students at the beginning of the unit?** • **What events will help students experience and explore the big idea and questions in the unit? How will you equip them with needed skills and knowledge?** • **How will you cause students to reflect and rethink? How will you guide them in rehearsing, revising, and refining their work?** • **How will you help students to exhibit and self-evaluate their growing skills, knowledge, and understanding throughout the unit?** • **How will you tailor and otherwise personalize the learning plan to optimize the engagement and effectiveness of ALL students, without compromising the goals of the unit?** • **How will you organize and sequence the learning activities to optimize the engagement and achievement of ALL students?**	This unit of study begins with students distinguishing between living and nonliving things. Students will conduct investigations examining both living and nonliving things and using the data they collect as evidence for making this distinction. During this investigation, students will study living things that are made of cells, either one cell or many different numbers and types of cells. Students will also study nonliving things, some of which are made up of cells. Students will understand that life is a quality that distinguishes living things—composed of living cells—from once-living things that have died or things that never lived. Emphasis is on students beginning to understand the cell theory by developing evidence that living things are made of cells, distinguishing between living and nonliving things, and understanding that living things may be made of one cell or many and varied cells. Students will pose a question drawn from their investigations and draw on several sources to generate additional related, focused questions that allow for multiple avenues of exploration. They will conduct a short research project to collect evidence to develop and support their answers to the questions they generate. The report created from their research will integrate multimedia and visual displays of cells and specific cell parts into a presentation that will clarify the answers to their questions. Students will include in their reports variables representing two quantities, such as the number of cells that makes up an organism and units representing the size or type of the organism, and their conclusion about the relationship between these two variables. They will write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Students will analyze the relationship between the dependent and independent variables using graphs and tables and relate the graphs and tables to the equation. As a continuation of their study of the cell, students will study the structure of the cell. This study begins with thinking of the cell as a system that is made up of parts, each of which has a function that contributes to the overall function of the cell. Students will learn that within cells, special structures—such as the nucleus, chloroplasts, mitochondria, cell membrane, and cell wall—are responsible for particular functions. It is important to remember that students are required only to study the functions of these organelles in terms of how they contribute to the overall function of the cell, not in terms of their biochemical functions. As part of their learning about the structure of the cell, students use models as a way of visualizing and representing structures that are microscopic. Students will develop and use a model to describe the function of the cell as a whole and the ways parts of the cell contribute to the cell's function. Models can be made of a variety of materials, including student-generated drawings, digital representations, or 3-D structures. Students will examine the structure and function relationship of the cell membrane and the cell wall. They will learn that the structure of the cell membrane makes it

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Understanding By Design Unit Template

Title of Unit	Inheritance and variation of Traits	**Grade Level**	8th
Curriculum Area	Science	**Time Frame**	15 days (mar)
Developed By			

Identify Desired Results (Stage 1)

Content Standards

MS-LS1-4: Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.[Clarification Statement: Examples of behaviors that affect the probability of animal reproduction could include nest building to protect young from cold, herding of animals to protect young from predators, and vocalization of animals and colorful plumage to attract mates for breeding. Examples of animal behaviors that affect the probability of plant reproduction could include transferring pollen or seeds, and creating conditions for seed germination and growth. Examples of plant structures could include bright flowers attracting butterflies that transfer pollen, flower nectar and odors that attract insects that transfer pollen, and hard shells on nuts that squirrels bury.]

MS-LS1-3: Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.[Clarification Statement: Emphasis is on conceptual understanding that changes in genetic material may result in making different proteins.] [Assessment Boundary: Assessment does not include specific changes at the molecular level, mechanisms for protein synthesis, or specific types of mutations.]

MS-LS3-2:Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation. [Clarification Statement: Emphasis is on using models such as Punnett squares, diagrams, and simulations to describe the cause and effect relationship of gene transmission from parent(s) to offspring and resulting genetic variation.]

MS-LS4-4: Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment. [Clarification Statement: Emphasis is on using simple probability statements and proportional reasoning to construct explanations]

MS-LS4-5: Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms. [Clarification Statement: Emphasis is on synthesizing information from reliable sources about the influence of humans on genetic outcomes in artificial selection (such as genetic modification, animal husbandry, gene therapy); and, on the impacts these technologies have on society as well as the technologies leading to these scientific discoveries.]

MS-LS4-6: Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time. [Clarification Statement: Emphasis is on using mathematical models, probability statements, and proportional reasoning to support explanations of trends in changes to populations over time.] [Assessment Boundary: Assessment does not include Hardy Weinberg calculations.]

Understandings	Essential Questions	
Overarching Understanding	**Overarching**	**Topical**

• Genetic variation among offspring results from the independent assortment and segregation of alleles within parent genotypes. • Genetic information within offspring is inherited in pairs of alleles; one from each parent organism. • Genotype determines phenotype in organisms, though the reverse is not always true. • Traits and behaviors are naturally selected over time to increase the fitness of a population of organisms. • Genes control singular traits through genetic coding for sequences of proteins. • Modification in the genome of an organism can result in desired traits. • Allele expression follows a predictable pattern.	• Why do different organisms of the same species feature different traits? • Why does sexual reproduction between parent organisms increase the potential survivability of a given population of offspring? • How do internal genetic factors influence the observable traits of an organism? • How does base pairing work? • What monomer is involved in DNA structure?	• What effects can mutations have on organisms? • What are the genetic implications for sexual and asexual reproduction? • How do structures and behaviors increase the likelihood of successful reproduction by organisms? • How do the environment and genetic factors determine the growth of plants and animals?
Related Misconceptions		
Students may think an organism can choose to change a physical trait through use or to suit the environment Students may think organisms can pass on acquired traits to their offspring (“Lamarkian” thinking)		
Knowledge Students will know…	**Skills** Students will be able to…	

1. DNA in cells stores the instructions for making proteins 2. Most characteristics (phenotypes) are determined by the proteins produced in cells 3. Mendel's role in the history of genetics 4. Mendel used techniques that established the discovery of patterns that arise in inheritance, showing that certain traits are dominant or recessive 5. Traits are dependent on gene expression (expressed vs masked) 6. Dominant and recessive alleles work to express traits 7. Punnett squares are used to predict the probability of a genotype/ phenotype of an offspring from two parents 8. Mutations occur in DNA and chromosomes 9. Changes in DNA cause changes in the formation of proteins 10. Changes in proteins may cause changes in the expressed trait or phenotype 11. Mutations can be advantageous, harmful, or silent (neutral) 12. (Selective breeding)	• Construct an explanation for how mutations such as inversion, deletion, etc. impact the production of proteins by using base-pair alterations as compared to normal protein production as evidence. • Solve Punnett Squares to predict the pattern of inheritance of given traits for offspring between two parents of known genotype. • Utilize a model to show the inheritance of genes through production of unique sperm and eggs. • Interpret data on crop yields and reduction of negative traits and diseases to form an argument for or against the proliferation of GMOs and potential human genetic engineering.

Assessment Evidence (Stage 2)

Performance Task Description

• **Goal** • **Role** • **Audience** • **Situation** • **Product/Performance** • **Standards**	Model how each gene controls proteins and specific traits of an organism Cite evidence on how protein structure influences function Predict the outcomes of a given trait due to sexual reproduction Identify a mutation or deficiency within a human body system on the tissue, organ, or organ system level and predict how that alteration would impact the system by using a normal, functioning system to justify their prediction.

Other Evidence

Lectures and mini-lessons

- Website exploration
- Partner or small group work
- Student presentations
- Reports
- Reflections
- In-class labs
- Performance assessments
- Quick Labs
- Science Journal/Diary
- Inquiry Warm Up Activities.
- Virtual Lab activities
- Pretests
- Class Discussions
- Socrative discussion
- Phet simulations
- Kahoot
- Turn and talk
- Fist to five
- Exit tickets
- Worksheets/Homework
- Lab Reports
- Quizzes
- Tests (multiple choice and OEQ)

Learning Plan (Stage 3)

• **Where are your students headed? Where have they been? How will you make sure the students know where they are going?** • **How will you hook students at the beginning of the unit?** • **What events will help students experience and explore the big idea and questions in the unit? How will you equip them with needed skills and knowledge?** • **How will you cause students to reflect and rethink? How will you guide them in rehearsing, revising, and refining their work?** • **How will you help students to exhibit and self-evaluate their growing skills, knowledge, and understanding throughout the unit?** • **How will you tailor and otherwise personalize the learning plan to optimize the engagement and effectiveness of ALL students, without compromising the goals of the unit?** • **How will you organize and sequence the learning activities to optimize the engagement and achievement of ALL students?**	Using models, such as electronic simulations, physical models, or drawings, students will learn that genes are located in the chromosomes of cells and each chromosome pair contains two variants of each gene. Students will need to make distinctions between chromosomes and genes and understand the connections between them. DNA will be introduced in high school. Students will learn that chromosomes are the genetic material that is found in the nucleus of the cell and that chromosomes are made up of genes. They will also learn that each gene chiefly controls the production of specific proteins, which in turn affect the traits of the individual. Students should be given opportunities to use student-developed conceptual models to visualize how a mutation of genetic material could have positive, negative, or neutral impact on the expression of traits in organisms. Emphasis in this unit is on conceptual understanding that mutations of the genetic material may result in making different proteins; therefore, models and activities that focus on the expression of genetic traits, rather than on the molecular-level mechanisms for protein synthesis or specific types of mutations, are important for this unit of study. For example, models that assign genetic information to specific segments of model chromosomes could be used. Students could add, remove, or exchange genes located on the chromosomes and see that changing or altering a gene can result in a change in gene expression (proteins and therefore traits). Students will continue this unit of study by describing two of the most common sources of genetic variation, sexual and asexual reproduction. Students will be able to show that in sexual reproduction, each parent contributes half of the genes acquired by offspring, whereas in asexual reproduction, a single parent contributes the genetic makeup of offspring. Using models such as Punnett squares, diagrams, and simulations, students will describe the cause-and-effect relationship between gene transmission from parents(s) to offspring and the resulting genetic variation. Using symbols to represent the two alleles of a gene, one acquired from each parent, students can use Punnett squares to model how sexual reproduction results in offspring that may or may not have a genetic makeup that is different from either parent. Students can observe the same mixing of genetic information using colored counters or electronic simulations. Using other models, students can show that asexual reproduction results in offspring with the same combination of genetic information as the parents. Students can summarize the numerical data they collect during these activities as part of their description of why asexual reproduction results in offspring with identical genetic combinations and sexual reproduction results in offspring with genetic variations. As a culmination of this unit of study, students could make multimedia presentations to demonstrate their understanding of the key concepts. Students could participate in a short research project and cite the specific textual evidence used to support the analysis of any scientific information they gather. They could integrate quantitative or technical information as part of their presentation. For example, students can take data collected during investigations of genetic mutations and provide a narrative description of their results. They could use data

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Understanding By Design Unit Template

Title of Unit	Selection and Adaptation	**Grade Level**	8th
Curriculum Area	Science	**Time Frame**	15 (mar)
Developed By			
Identify Desired Results (Stage 1)			
Content Standards			

MS-LS4-1:
MS-LS4-2: Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships. [Clarification Statement: Emphasis is on explanations of the evolutionary relationships among organisms in terms of similarity or differences of the gross appearance of anatomical structures.]

MS-LS4-3: Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy. [Clarification Statement: Emphasis is on inferring general patterns of relatedness among embryos of different organisms by comparing the macroscopic appearance of diagrams or pictures.] [Assessment Boundary: Assessment of comparisons is limited to gross appearance of anatomical structures in embryological development.]

MS-LS4-4: Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment. [Clarification Statement: Emphasis is on using simple probability statements and proportional reasoning to construct explanations]

MS-LS4-5: Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms. [Clarification Statement: Emphasis is on synthesizing information from reliable sources about the influence of humans on genetic outcomes in artificial selection (such as genetic modification, animal husbandry, gene therapy); and, on the impacts these technologies have on society as well as the technologies leading to these scientific discoveries.]

MS-LS4-6: Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time. [Clarification Statement: Emphasis is on using mathematical models, probability statements, and proportional reasoning to support explanations of trends in changes to populations over time.] [Assessment Boundary: Assessment does not include Hardy Weinberg calculations.]

Understandings	Essential Questions	
Overarching Understanding	**Overarching**	**Topical**
Charles Darwin hypothesized that organisms change over time (evolution) and become better adapted to their environment and/or new conditions. Natural selection leads to the predominance of certain traits in a population, and the suppression of others. Adaptation by natural selection acting over generations is one important process by which species change over time in environmental conditions.	• How can changes to the genetic code increase or decrease an individual's chances of survival? • How can the environment affect natural selection? • Are genetically modified organisms (GMOs) safe to eat?	• How does the fossil record contribute to the Theory of Evolution? • Who is Charles Darwin and how did he contribute to the field of biology? • What does evolution have to do with natural selection?
Related Misconceptions		

Hypothesis vs. theory Theory vs. Scientific Theory Natural vs. artificial selection Homologous (and its meaning) structures Adaptation vs. evolution Methods by which adaptation takes place How genes (chemical information/instructions for protein) are selected for/ against by the environment Students may think an organism can change at will to survive in the environment and pass acquired traits on to offspring Students do not realize the connection between successful adaptation and genetic information		selection? ● How do factors lead to natural selection? ● What is artificial selection? ● How is artificial selection contribute to the success of humans?
Knowledge Students will know…	**Skills** Students will be able to…	

1. Darwin observed and compared many fossils from extinct organisms with those from living organisms 2. Fossils are mineral replacements, preserved remains, or traces of organisms that lived in the past. 3. Patterns can be observed when observing the chronological order of fossil appearance in rock layers 4. Anatomical similarities exist between organisms living today and those that are contained within the fossil record 5. Sometimes the differences in characteristics between individuals of the same species provide advantages in surviving, finding mates, and reproducing 6. Several factors can cause natural selection to take place (genes, variation, environmental pressures) 7. In artificial selection, humans have the capacity to influence certain characteristics of organisms by selective breeding. One can choose desired traits determined by genes, which are then passed onto offspring. 8. Artificial selection is driven by humans and entails using genetic and chemical information	• Describe the process of evolution through natural selection by outlining evidence from the perspective of Charles Darwin (in chart, advertisement, video, or graphic form) • Critique how animal and plant structures are the results of natural selection • Identify ways plants use or interact with other organisms to increase the success of their reproduction • Investigate and visualize the likelihood (probability) of successful reproductive rates in various situations • Analyze how genes, environmental change, competition, and mutation can drive natural selection by comparing populations in a given environment (mice against different backgrounds, peppered moth case study) • Construct an explanation using evidence and graphics that shows how traits in a population increase some individuals' probability of surviving and reproducing in a specific environment • Compare and contrast time lapse photos of embryological development of various species and develop an explanation that shows how this is evidence for common traits/ancestors • Describe how mutations affect the variability of traits by performing a simulation • Identify that offspring obtain their chromosomes and genetic instructions (for proteins) from their parents

Assessment Evidence (Stage 2)

Performance Task Description

• **Goal** • **Role** • **Audience** • **Situation** • **Product/Performance** • **Standards**	Model the impact of morphological differences in bird breaks amongst changing environmental conditions to collect evidence and argue for the benefits of variation among a species driven by natural selection. Predict the response of organisms to environmental changes Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time

Other Evidence

- Lectures and mini-lessons
- Website exploration
- Partner or small group work
- Student presentations
- Reports
- Reflections
- In-class labs
- Performance assessments
- Quick Labs
- Science Journal/Diary
- Inquiry Warm Up Activities.
- Virtual Lab activities
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- Turn and talk
- Fist to five
- Exit tickets
- Worksheets/Homework
- Lab Reports
- Quizzes
- Tests (multiple choice and OEQ)

Learning Plan (Stage 3)

• **Where are your students headed? Where have they been? How will you make sure the students know where they are going?** • **How will you hook students at the beginning of the unit?** • **What events will help students experience and explore the big idea and questions in the unit? How will you equip them with needed skills and knowledge?** • **How will you cause students to reflect and rethink? How will you guide them in rehearsing, revising, and refining their work?** • **How will you help students to exhibit and self-evaluate their growing skills, knowledge, and understanding throughout the unit?** • **How will you tailor and otherwise personalize the learning plan to optimize the engagement and effectiveness of ALL students, without compromising the goals of the unit?** • **How will you organize and sequence the learning activities to optimize the engagement and achievement of ALL students?**	In this unit of study, students will build on their prior knowledge by constructing explanations that describe how genetic variations increase some individuals' probability of surviving and reproducing. Mathematical representations will be used to support explanations of how natural selection leads to increases and decreases of specific traits in populations over time. Students will analyze numerical data sets that represent a proportional relationship between some change in the environment and corresponding changes in genetic variation over time. Students will summarize these numerical data sets and construct explanations for how the proportional relationship could impact the probability of some individuals surviving and reproducing in a specific environment. Students will construct explanations based on evidence that describes how genetic variations can provide a survival and reproductive advantage over other traits. This evidence could be provided through activities that model these phenomena or by examining and analyzing data from informative texts. Based on their findings, students can write claims about how natural selection leads to a predominance of some traits in a population and the suppression of other traits. Students will pay attention to precise details in explanations from specific textual evidence and will cite this evidence to support their analysis and reflection on research that explains how genetic variation of traits in a population increases some individuals' probability of surviving and reproducing in a specific environment. Students will compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading these texts and write informative/explanatory texts on how natural selection leads to the predominance of some traits and the suppression of others in a population. Students will engage effectively in a range of collaborative discussions where they will present their claims and findings. These discussions may be one-on-one between students, in small groups, or teacher-led large group discussions. In these discussions, students will build on others' ideas while expressing their own clearly. Claims must emphasize salient points in a focused, coherent manner, supported with relevant evidence, sound valid reasoning, and well-chosen details. Students must use appropriate eye contact, adequate volume, and clear pronunciation. There are multiple activities available that show students how one trait can provide a survival advantage over another in a specific environment. As part of these activities, students can analyze data and determine ratio relationships to provide evidence of cause-and-effect relationships. These ratios can be used to explain why some inherited traits result in individuals that have a survival advantage in a specific environment over time or why other traits in a population are suppressed. When an environment changes as a result of human influence and/or natural processes on Earth, traits that were present in populations of organisms and that led to a survival advantage in that environment before the change may no longer offer an advantage. Changes in environmental conditions can be the driving cause of the suppression of traits in populations.

Understanding By Design Unit Template

Title of Unit	Body Systems	**Grade Level**	8th
Curriculum Area	Science	**Time Frame**	15 days (apr-may)
Developed By			

Identify Desired Results (Stage 1)

Content Standards

MS-LS1-3: Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells. *[Clarification Statement: Emphasis is on the conceptual understanding that cells form tissues and tissues form organs specialized for particular body functions. Examples could include the interaction of subsystems within a system and the normal functioning of those systems.] [Assessment Boundary: Assessment does not include the mechanism of one body system independent of others. Assessment is limited to the circulatory, excretory, digestive, respiratory, muscular, and nervous systems.]*

MS-LS1-8: Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories. *[Assessment Boundary: Assessment does not include mechanisms for the transmission of this information.]*

Understandings	Essential Questions	
Overarching Understanding	**Overarching**	**Topical**

Students develop a basic understanding of the role of cells in body systems and how those systems work to support the life functions of the organism. Students will construct explanations for the interactions of systems in cells and organisms. Students understand that special structures are responsible for particular functions in organisms, and that for many organisms, the body is a system of multiple-interaction subsystems that form a hierarchy, from cells to the body. Students construct explanations for the interactions of systems in cells and organisms and for how organisms gather and use information from the environment. • The brain is the control center of the human body and is composed of many specialized cells. • The structure of a biological feature is directly related to the function.	• What are humans made of? • How do organ systems give an advantage in processing information? • Which process is more vital - sensory or motor impulses?	• What is the evidence that a body is actually a system of interacting subsystems composed of groups of interacting cells? • How do organisms receive and respond to information from their environment? • Is the brain the most important human organ? • How do the differences in structure relate to the function of the biological features of the nervous system?
Related Misconceptions		
An important student misconception to understand is the view that body systems exist and function independently from each other. Most students are unaware of the relationships between systems and the function of the entire organism. A new focus in standards is information processing and feedback. Students should work on understanding the function of the nervous system, but also its importance in sending and retrieving information. A large misconception is that humans only use 10% of their brain (and that the rest in relatively misunderstood or not functional). Students have also been told deoxygenated blood is blue in their veins, and misunderstand the chemistry behind blood and oxygen transfer. Some students may also think digestive processes are done by other organisms like worms, because they have misconceptions about symbiotic bacteria in our guts.		

Knowledge Students will know…	**Skills** Students will be able to…
1. In multicellular organisms, the body is a system of multiple, interacting subsystems. 2. Subsystems are groups of cells that work together to form tissues. 3. Organs are groups of tissues that work together to perform a particular body function. 4. Tissues and organs are specialized for particular body functions 5. Systems may interact with other systems. 6. Systems may have subsystems and be part of larger complex systems. 7. Interactions are limited to the circulatory, excretory, digestive, respiratory, muscular, and nervous systems. 8. Scientists and engineers are guided by habits of mind such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas. 9. Sense receptors respond to different inputs (electromagnetic, mechanical, chemical). 10. Sense receptors transmit responses as signals that travel along nerve cells to the brain. 11. Signals are then processed in the brain. 12. Brain processing results in immediate behaviors or memories. 13. Cause-and-effect relationships may be used to predict response to stimuli in natural systems.	• Use an oral and written argument supported by evidence to support or refute an explanation or a model of how the body is a system of interacting subsystems composed of groups of cells. • Gather, read, and synthesize information from multiple appropriate sources about sensory receptors' response to stimuli. • Assess the credibility, accuracy, and possible bias of each publication and methods used. • Describe how publications and methods used are supported or not supported by evidence.

Assessment Evidence (Stage 2)

Performance Task Description

• **Goal** • **Role** • **Audience** • **Situation** • **Product/Performance** • **Standards**	*Students who understand the concepts are able to:* Students will investigate neurological disorders, evaluate existing solutions, and design or improve tools to assist humans with neurological disorders. They will investigate how the structure of cells and organs in the nervous system affect their functions and how problems can arise in this system. Students will model information processing either from sense organ to brain or brain to sense organ to show how messages are sent and received and how the structure of neurons and organs relate to their functions. Students will plan investigations on a chosen or assigned topic related to the brain and/or senses to test a phenomenon they have observed or experienced or past studies they have researched. (Example: How does the age of a person relate to their ability to identify tones? Example 2: How does the color of font affect one's short term memory?)

Other Evidence

- Lectures and mini-lessons
- Website exploration
- Partner or small group work
- Student presentations
- Reports
- Reflections
- In-class labs
- Performance assessments
- Quick Labs
- Science Journal/Diary
- Inquiry Warm Up Activities.
- Virtual Lab activities
- Pretests
- Class Discussions
- Socrative discussion
- Phet simulations
- Kahoot
- Turn and talk
- Fist to five
- Exit tickets
- Worksheets/Homework
- Lab Reports
- Quizzes
- Tests (multiple choice and OEQ)

Learning Plan (Stage 3)

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