East Penn School District
Curriculum and Instruction

Curriculum for: Global Science Inquiry (GSI)

Course(s): Global Science Inquiry

Grades: 9

Department: Science **Length of Period (average minutes): 42**

Periods per cycle: 6 **Length of Course (yrs): 1**

Type of offering: elective **Credit(s) awarded: 1.0 4.0/4.0**

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ADOPTED: 2018

Enduring Understandings	Essential Questions	Knowledge	Skills	Standards
• Chemical compounds make up all living things. • Life (as we know it) is carbon-based. • Death results from the inability of one or more body systems to maintain vital processes. • Environmental factors impact body systems differently and can have fatal outcomes.	• What does it mean to be alive? • How is human health affected by exposure to different substances? • How do the body systems interact to maintain life? • Why is carbon a key component of all life on earth?	• How organisms are able to sustain life. • How a body system functions. • How different environmental stressors impact body systems. • Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. • Systems of specialized cells within organisms help them perform the essential functions of life. • Feedback mechanisms maintain a living system's internal conditions within certain limits. • Atoms form compounds based on their structure. • Due to its structure, carbon forms numerous compounds.	• Create an analogy for how living things are based on a system of increasing complexity starting with same types of organic molecules and ending with an organism. • Investigate how external factors can influence internal homeostatic controls (like exercise on heart rate, body temperature, perspiration) through feedback loops. • Analyze the impact of an environmental stressor on various body systems and homeostasis • Suggest ways to mitigate environmental stressors so as to improve human health. • Using humans, trees, other common organisms, etc., write an	NGSS Standards: • HS-LS1-2 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. • HS-LS1-3 Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis. • HS-LS1-6 Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules. • HS-PS1-1 Use the periodic table as a model to predict the relative properties of elements based on the

		• Sugar molecules contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells. (HS-LS1-6)	explanation/create a model that demonstrates the chemical commonality between several organisms, as well as how these chemicals interconvert to form compounds with vastly different properties and functions. • Diagram how the atomic structure of carbon is responsible for its bonding ability to form the various compounds present in living things.	patterns of electrons in the outermost energy level of atoms.
• Overpopulation can lead to unsustainable resource use and environmental damage. • Matter is not created nor destroyed, it just changes form. • Human population and resource use is increasing exponentially • Resources determine the development of urban areas.	• What factors affect carrying capacity of human populations? • What does sustainability look like in urban areas? • How do we design sustainable methods of supporting human populations?	• Resource availability has guided the development of human society. Area Resources have social, economic, social and geopolitical impacts. New technologies and social regulations can change the balance of these factors. • The sustainability of human societies and the biodiversity that supports them requires responsible	• Evaluate trade-offs of placement of essential urban infrastructure like landfills, wastewater treatment, drinking water treatment. • Using chemical equations, show how bacteria in landfills can decompose garbage, to create harvestable natural gas. • Create a model of a city for 1,000 people,	NGSS Standards: • HS-LS2-1 Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales • HS-LS2-2 Use mathematical representations to support and revise explanations based on

		management of natural resources. ● Reactants form products in chemical reactions and atoms are conserved during this process. ● Finite resources control the ability of organisms to produce populations of great size. ● Interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time . Changes in the systems and their results are proportional. ● Carrying capacities result from factors such as the availability of living and nonliving resources and from challenges such as predation, competition, and disease.	considering what resources would be required to sustainably host that population. Then, evaluate the impact of overpopulating that same model tenfold. ● Calculating an ecological footprint of resource use and evaluating sustainability ● Evaluate a local sustainability issue and refine a technological solution that reduces the impact of human activity. ● Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.	evidence about factors affecting biodiversity and populations in ecosystems of different scales. (focus on population growth) ● HS-PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. ● HS-ESS2-2 Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. ● HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems. ● HS-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including

				cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
● The Earth is made of interconnected systems that all living things interact with (Carbon) ● Rainforests are one of the most biologically diverse areas on Earth, and provide humans with many tangible and intangible benefits. ● Energy enters a rainforest ecosystem as sunlight, and is transferred through each step in a food web. ● The energy transfer within an ecosystem is not 100% efficient. ● Matter is also transferred through ecosystems and must be conserved.	● Where does my food come from? ● What is the current impact of agriculture? ● How is agriculture affected by technology? ● What does the future of agriculture look like?	● Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. ● As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. ● The process of photosynthesis converts light energy to stored chemical	● Apply knowledge of plant classification, plant anatomy and physiology to the production and management of plants ● Prepare and implement a plant management plan that addresses the influence of environmental factors, nutrients, and media on plant growth. ● Given exposure to a list of major global, agricultural issues, students must collaborate in groups, to propose a solution to one of these issues, emphasizing understanding of environmental sustainability, societal impacts, and realistic implementation.	NGSS Standards: ● HS-ETS1-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants." ● HS-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. ● HS-LS1-5 Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy. ● HS-LS2-6 Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of

		energy by converting carbon dioxide plus water into sugars plus released oxygen. ● Reactions In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present. ● The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. ● Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.	● Design a garden that maximizes efficiency while minimizing resource use, to demonstrate sustainable agricultural practices without the need for reduction of biodiversity (i.e. deforestation in rainforests). ● Construct an explanation/model of transfer of energy and matter in their designed garden. ● Students will evaluate their gardens, expressing how they could be usefully implemented, to increase the sustainability of agriculture and address the needs of our current and growing population.	organisms in stable conditions, but changing conditions may result in a new ecosystem. ● HS-ESS3-1 Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. ● HS-ESS3-3 Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity. ● HS-ESS2-6 Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth. ● HS-PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved

				during a chemical reaction.
● The Earth is made of interconnected systems that all living things interact with (Carbon) ● Rainforests are one of the most biologically diverse areas on Earth, and provide humans with many tangible and intangible benefits. ● Energy enters a rainforest ecosystem as sunlight, and is transferred through each step in a food web. ● The energy transfer within an ecosystem is not 100% efficient. ● Matter is also transferred through ecosystems and must be conserved.	● How does resource use impact Earth? ● What is the value of biodiversity? ● How does matter and energy cycle through ecosystems? ● How can new organisms grow and new things be made, yet the amount of matter on earth will never change?	● Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. (HS-LS2-3) ● Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. At each link in an ecosystem, matter and energy are conserved. (HS-LS2-4) ● Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged	● Follow the path of a carbon atom from the atmosphere through a rainforest ecosystem ● Create a food web showing feeding relationships and transfer of matter and energy ● Examining threats to rainforest ecosystems and biodiversity and identifying the ripple effects on matter cycling and energy transfer ● Propose solutions to the threats to biodiversity due to human activities. ● Students will quantitatively evaluate how the carbon cycle obeys the law of conservation of mass.	NGSS Standards: ● HS-ESS2-6. Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. ● HS-LS2-4. Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem. ● HS-LS2-6. Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. ● HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human

		among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes. (HS-LS2-5) ● Anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. (HS-LS2-7) ● Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). ● Humans depend on the living world for the resources and other benefits provided by biodiversity. ● Sustaining biodiversity so that ecosystem functioning and		activities on the environment and biodiversity.* ● HS-PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

		productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. (HS-LS2-7) ● In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present. (HS-PS1-6)		
● Not all greenhouse gases are the same. ● Increasing greenhouse gases contribute to global climate change. ● Global climate change affects all of Earth's systems. ● Scientists studying ice cores use direct measurements and elemental isotopes to determine historical climate data.	● Why does climate change matter? ● How do we know about past climates when nobody was around to keep track? ● What role do greenhouse gases play in habitability of Earth? ● How do glaciers	● The earth has undergone periods of cyclical cooling and warming due to a variety of factors (ex. cyclical changes to earth's orbit, eccentricity, solar output, tectonic events, ocean circulation, volcanic activity, etc.)(ESS1.B) ● Earth's systems, being dynamic and	● Students will model ice core samples to evidence how climate has changed through time. ● Students will illustrate differences between isotopes and how those differences affect the properties of the substances containing those isotopes.	NGSS Standards: ● HS-ESS1-6 Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history." ● HS-PS1-1 Use the periodic table as a model to predict the

● Anthropogenic changes to the carbon cycle have had an effect on the climate system of Earth. ● Atmospheric composition affects Earth's energy budget.	serve as an indicator of the dangers of climate change?	interacting, cause feedback effects that can increase or decrease the original changes. (ESS2.A) ● The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's reradiation into space. (ESS2.D) ● Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS-ESS2-4) ● Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts (ESS3.D)	● Students will simulate the greenhouse effect with different amounts & types of greenhouse gases. ● Students will analyze direct measurements of temperature and atmospheric composition to evaluate scientific claims about global climate change. ● Students will use evidenced based data to predict the impact of global climate change on a location on Earth.	relative properties of elements based on the patterns of electrons in the outermost energy level of atoms. ● HS-ESS2-4 Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. ● HS-ESS3-5 Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.

		• Current climate models predict that average global temperatures will continue to rise, the rate of which will be dependent on the amounts of human-generated greenhouse gases added to the atmosphere each year • Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation, but when engineering these technologies need to consider constraints and impacts. (HS-ESS3-4) (ETS1.B) • The amount and type of a specific isotope can provide evidence of changes to Earth's systems. (HS-PS1-1)		
• Activities that humans perform on land have far-reaching consequences that	• Why are coral reefs important to humans? • How does global	• Ocean water chemistry can naturally change and	• Evaluate the issue of ocean acidification and propose a solution that will	NGSS Standards: • HS-ESS3-4. Evaluate or refine a technological

don't obey geographic boundaries. ● The increased carbon dioxide and thermal energy in the atmosphere is absorbed by the oceans, resulting in a decreasing pH and increasing temperatures in the oceans.. ● Coral reefs are an example of a sensitive ecosystem. ● The loss of an ecosystem can have effects on all of Earth's systems.	climate change affect the temperature and pH of the oceans? ● How do coral reefs show a changing ocean? ● What can humans do to reverse the impact of ocean warming and acidification in coral reef ecosystems?	can also be influenced by human activities. ● The oceans pH is decreasing worldwide, but is most obviously observed in coral reef environments. ● The symbiotic relationship between coral and algae is the foundation of the coral reef ecosystem. ● Coral reef ecosystems exist in locations with very specific temperature and latitude constraints. ● Coral reef ecosystems play host to organisms from top-to-bottom in the ocean food web are are critical to support healthy fisheries. ● The rates of chemical processes can be affected by temperature and concentration.	reverse the trend in coral reef environments. ● Evaluate solutions to a potentially destabilized seafood food web based on various constraints, as well as social, cultural, and environmental impacts. ● Use mathematical representations to support claims for the cycling of matter and flow of energy among marine organisms in coral reefs. ● Use statistical data in terms of water chemistry to support the declining biodiversity and populations in coral reefs. ● Design an experiment to show how temperature or dissolved gases can affect the overall chemical properties of water.	solution that reduces impacts of human activities on natural systems. ● HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. ● HS-LS2-4. Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem. ● HS-LS2-2 Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. ● HS-PS1-5. Apply scientific principles and evidence to provide an

				explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.
● Buried rocks can provide evidence of changing Earth systems and forms of energy. ● Fossil evidence provides valuable information about evolution and common ancestry. ● Fossil fuels are formed from the remains of living organisms. ● Once combusted as a source of energy, the carbon stored in fossil fuels enters the atmosphere	● How has Earth and its inhabitants changed throughout time? ● What is there to learn from buried rocks/fossils? ● How do mining and the use of fossil fuels impact humans?	● Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth's formation and early history. ● Spontaneous radioactive decays follow a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials. (secondary)	● Fossilized evidence of previous life forms when analyzed provide evidence for evolution and common ancestry. ● Earth's layers and fossils can be analyzed scientifically to teach us about Earth's formation and major events at times humans were not around. ● Construct an argument based on anthropological data about changing Earth systems and the response of humans. ● Using cost-benefit ratios, evaluate the different political, recreational, cultural, and energy-driven plans for land use. ● Use radiometric	NGSS Standards: ● HS-LS4-1. Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence. ● HS-LS4-5. Evaluate the evidence supporting claims that changes in environmental conditions may result in (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species. ● HS-ESS1-6. Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and

		● All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. ● The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it. ● When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (secondary) ● Changes in the physical environment, whether naturally occurring or human	dating to determine the age of a rock layer.	early history." ● HS-ESS2-7. Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth ● HS-ESS3-2 Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios. ● HS-PS1-8. Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.

		induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline–and sometimes the extinction–of some species. ● Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost.		
● Different landforms and biodiversity can be linked to plate tectonics. ● Cycling of matter inside the Earth has resulted in shaping the surface of the Earth. ● Earth's surface is diverse - there is new and old, high and low,	● What would the Earth be like without plate tectonics? ● What have earthquakes taught us about Earth's structure? ● How will the observable Earth and its inhabitants	● Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (ESS2.A) ● Evidence from deep probes and seismic waves, reconstructions of historical changes in	● Develop a model to show what's happening inside the Earth and how that has created some of Earth's most beautiful destinations and biggest catastrophes. ● Develop a model based on earthquake waves that show us	NGSS Standards: ● HS-ESS2-1. Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features." ● HS-ESS2-3. Develop a

and active and passive. ● Dynamic geological processes have far-reaching consequences on humans.	change?	Earth's surface and its magnetic field, and an understanding of physical and chemical processes lead to a model of Earth with a hot but solid inner core, a liquid outer core, a solid mantle and crust. Motions of the mantle and its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from Earth's interior and gravitational movement of denser materials toward the interior. (ESS2.A) ● Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geologic history. Plate movements are responsible for most continental and ocean-floor features and for the	the interior of the Earth. ● Analyze the challenge and constraints that humans face trying to deal with the threat of volcanoes and earthquakes. ● Apply concepts of natural selection to support explanations that organisms with an advantageous heritable trait tend to increase in areas created by plate tectonics in proportion to organisms lacking this trait (ex., bighorn sheep with splayed hooves). ● The Earth's surface is a conveyor belt with new land being created and old land being destroyed. Both of these areas with much different ages are areas of intense volcanic activity.	model based on evidence of Earth's interior to describe the cycling of matter by thermal convection." ● HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. ● HS-LS4-3. Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait." ● HS-ESS1-5. Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks."

		distribution of most rocks and minerals within Earth's crust. (ESS2.B) ● The radioactive decay of unstable isotopes continually generates new energy within Earth's crust and mantle, providing the primary source of the heat that drives mantle convection. Plate tectonics can be viewed as the surface expression of mantle convection. (ESS2.B) ● Continental rocks, which can be older than 4 billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old. (ESS1.C)		

Materials and Resources: Internet based