MIDDLE SCHOOL LIFE SCIENCE CURRICULUM MAP AND PACING GUIDE

This pacing guide is based on NGSS performance standards and gives a basic outline of the material to cover in a middle school setting.

Class periods are based on projected time requirements by major subject area using various text resources.

Class period allotments acount for 155-180 instructional days, teacher's discretion on actual instructional days per unit is expected.

Listed under assessment/resources are labs from the Argument-Driven Inquiry in Life Science lab book (will be provided to interested schools) and links to resources to help structure activities and labs to meet performance expectations.

Vocabulary shown is based on key vocab in related text sources and may be expanded/edited as needed to meet lesson goals.

Vocabulary listed is shown for the entire "unit" and may not be specifically tied to the individual standard as it appears in this pacing guide.

Class Periods	Standard	Performance Expectation	Clarification	Disciplinary Core Ideas	Key Vocabulary	Assessment/ Resources links	Catholic Identity
SCIENTIFIC METHOD							
7-10 class periods			Examine the steps used by scientists to investigate the natural world.	There is no set "formula" for conducting scientific research, but there are universally accepted steps that can help define, organize, conduct experiments, and to collect and analyze data to help researchers stay on track.	hypothesis, dependent variable, independent variable, quantitative data, qualitative data	Students will be assessed as they construct and carry out their labs and research throughout the year.	Roger Bacon (c. 1214-1294) - Francisan friar who is described as the forerunner to the modern scientific method.
STRUCTURE, FUNCTION, AND INFORMATION PROCESSING							
Cells (**MS-LS1-1** and **MS-LS2-2**); 15-20 class periods	**MS-LS1-1**	Plan and conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.	Emphasis is on developing evidence that living things are made of cells, distinguish between living and nonliving things, and understand that living things may be made of one or more cells.	**LS1.A** - All living things are made up of cells, which is the smallest unit that can be said to be alive. An organism may consist of one single cell or many different numbers and types of cells.	Unicellular vs. mutlicellular, prokaryotic vs. eukartyotic	Plant and animal cells lab; Argument-Driven Inquiry in Life Science Lab 4: What type of cell is on the unknown slides?	Genesis 1: God's creation (Gn. 1:27 "God created man in his image"; Gn. 2:7 "The Lord God formed man out of the clay of the ground..."); Catholic Catechism: "Human life is sacred because from its beginning it involves the creative action of God..." (2258)

	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.	Emphasis is on the cell functioning as a whole system and the primary role of the nucleus, choloroplast, mitochondira, cell membrane, and cell wall. Assessment of organelle structure/function relationships is limited to the cell wall and cell membrane, while the function of other organelles is limited to their relationship to the whole cell.	**LS1.A** - Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell.	Cell wall, cell membrane, nucleus, chloroplast, mitochondria, diffusion, osmosis, active vs. passive transport	Cell diffusion lab Argument-Driven Inquiry in Life Science Lab 3 - Osmosis: How Does the Concentration of Salt in Water Affect the Rate of Osmosis?	
Human biology (**MS-LS1-3** and **MS-LS1-8**); 25-30 class periods	**MS-LS1-3**	Construct an explanation supported by evidence for how the body is composed of interacting systems consisting of cells, tissues, and organs working together to maintain homeostasis.	Emphasis is on the function and interactions of the major body systems, rather than the functions of individual systems.	**LS1.A** - In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions.	The human body systems: skeletal, muscular, integumentary, circulatory, respiratory, digestive, excretory, nervous, immune, endocrine, reproductive systems	Human biology labs	**Catholic Catechism**: "The human body shares the dignity of 'the image of God'," and "Life and physical health are precious gifts entrusted to us by God. We must take care of them..." (2288) **Caritas in Veritate**: Pope Benedict on challenges to the practices of Catholic health
	MS-LS1-8	Gather and synthesize information that sensory receptors respond to stimuli, resulting in immediate behavior and/or storage as memories.	Assessment does not include mechanisms for the transfer of this information.	**LS1.D** - (1) Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. (2) Plants respond to stimuli such as gravity (geotropism) and light (phototropism).	Stimulus, response, neurons, neurotransmitters, geotropism, phototropism	Argument-Driven Inquiry in Life Science Lab 8 - Memory and Stimuli: How Does the Way Information is Presented Affect Working Memory?	The Catechism states "The use of drugs inflicts very grave damage on human health and life." (2291)

MATTER AND ENERGY IN ORGANISMS AND ECOSYSTEMS							
Photosynthesis and cellular respiration (**MS-LS1-6** and **MS-LS1-7**); 10-15 class periods	**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.	Empahsis is on tracing movement of matter and flow of energy. This does not include the biochemical mechanisms of photosynthesis.	**LS1.C -** Plants, algae, and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use.	Photosynthesis, chloroplasts, chlorophyll		
	MS-LS1-7	Develop a model to describe how food moleclues are rearranged through chemical reactions to release energy during cellular respiration and/or form new molecules that support growth as this matter moves through an organism.	Emphasis is on describing that molecules are broken apart and put back together and in this process, energy is released. This does not include details of the chemical reactions for respiration.	**LS1.C** - Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules, to support growth, or to release energy.	Cellular respiration		
Ecology (**MS-LS2-1, MS-LS2-3, MS-LS2-4, MS-LS2-2, MS-LS2-5**); 25-30 class periods	**MS-LS2-1**	Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.	Emphasis is on cause and effect relationships between resources and growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant and scarce resources.	**LS2.A** - (1) Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (2) In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (3) Growth of organisms and population increases are limited by access to resources.	Biotic vs. abiotic factors, organism, ecosystem, limiting factor, carrying capacity	Argument-Driven Inquiry in Life Science Lab 10 - Predator-Prey Relationships: How Is the Size of a Predator Population Related to the Size of a Prey Population? (also aligns to MS-LS2-4)	**U.S Conference for Catholic Bishops**: Caring for God's Creation. **Pope John Paull II:** "Peace With All Creation." **Pope Benedict XVI:** "If You Want to Cultivate Peace, Protect Creation" (2010). **U. S. Conferences of Catholic Bishops:** Renewing the Earth.

	MS-LS2-3	Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.	Emphasis is on describing the conservation of matter and flow of energy associated with ecosystems, and on defining the boundaires of the ecosystem. This does not include the use of chemical reactions to describe the processes.	**LS2.B** - Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil (terrestrial) or water (aquatic). The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem.	Food webs, producers, consumers, decomposers, terrestrial ecosystem, aquatic ecosystem	Argument-Driven Inquiry in Life Science Lab 13 - Carbon Cycling: Which Carbon Cycle Process Affects Atmospheric Carbon the Most?	
	MS-LS2-4	Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.	Emphasis is on recognizing patterns in data and making warranted inferences about shifts in populations due to changes in the ecosystem.	**LS2.C -** Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations.	Primary vs. secondary succession	Argument-Driven Inquiry in Life Science Lab 10 - Predator-Prey Relationships: How Is the Size of a Predator Population Related to the Size of a Prey Population? (also aligns to MS-LS2-1)	
INTERDEPENDENT RELATIONSHIPS IN ECOSYSTEMS							
	MS-LS2-2	Construct an explanation that predicts patterns of interactions among organisms in a variety of ecosystems.	Emphasis is on predicting patterns of interactions such as competition, predation, mutualism, and parasitism in different ecosystems in terms of the relationships among and between organisms.	**LS2.A** - Predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions may become so interdependent that each organism requires the other for survival. Although the species involved in these competitve, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments (living and nonliving) are shared.	Symbiosis, mutualism, competition, predation, predator, prey, parasitism		**Laudato Si**: Encyclical Letter of Pope Francis. **Pope John Paul II:** "God Made Man The Steward of Creation" (2001). **U.S. Bishops:** "Global Climate Change: A Plea for Dialogue, Prudence, and the Common Good." (2001)

	MS-LS2-5	Evaluate competing design solutions for maintaining biodiversity and protecting ecoystem stability.	Examples of ecsoystem protections could include water purification, waste management, nutrient recycling, prevention of soil erosion, and eradication of invasive species. Examples of desing solution constraints could include scientific, economic, and social considerations.	**LS2.C** - Biodiversity describes the variety of species found in Earth's ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health. **LS4.D** -(1) Changes in biodiversity can influence humans' resources, as well as ecosystem services that humans rely on. (2) Humans impact biodiversity both positvely and negatively. **ETS1.B** - There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem.	Biodiversity, ecosystem stability		
GROWTH, DEVELOPMENT, AND REPRODUCTION OF ORGANISMS							
Plants and animals (**MS-LS1-4**); 5-10 periods	**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.	Examples of animal behaviors could include herding of animals to protect young from predators or animals transferring pollen or seeds. Examples of plant structures could include bright flowers attracting butterflies that transfer pollen or flower nectar and odors that attract insects to spread pollen.	**LS1.B** - (1) Animals engage in characteristic behaviors that increase the odds of reproduction. (2) Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction.	Plant reproductive structures, pollination, germination		**St. Francis of Assisi** - patron saint of all animals. **Catholic Catechism**: "Animals are entrusted to man's stewardship; he must show them kindness." (2457) **Genesis 1:11-12** "Let the earth bring forth vegetation; every kind of plant that bears seeds and every kind of fruit tree on earth." **Pope Francis**: Laudato Si. **Pope Boccone** - Cistercian botanist. **Antonio Jose Cavanilles** - botanist priest.

Genetics and cell division (**MS-LS1-5, MS-LS3-1, MS-LS3-2, MS-LS4-5**); 25-30 class periods	**MS-LS1-5**	Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.	Examples of local environmental factors include food, light, space, and water. Examples of genetic factors could include the genes responsible for size differences in different breeds. Examples of evidence could include drought decreasing plant growth or fertilizer increasing plant growth.	**LS1.B** - Genetic factors as well as local conditions affect the growth of the adult plant.	Environmental vs. genetic factors		Brother Gregor Mendel: Austrian monk who discovered the basic principles of heredity through experiments in his garden, who is known as the "Father of Modern Genetics."
	MS-LS3-1	Develop and use a model to explain 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.	Mutations in body cells are not inherited. Emphasis is on conceptual understanding that changes in genetic material may result in making different proteins.	**LS3.A** - Genes are located in the chromsomes of cells, with each chromosome pair containing two variants of each of many distinct genes, with each gene controlling the production of specific proteins, which in turns affects the traits of the individual. Mutations to genes can result in changes to proteins, which can affect the structures and functions of the organism. **LS3.B** - (1) In addition to variations that arise from sexual reproduction, genetic information can be altered due to mutations, which can be beneficial, harmful, or neutral. (2) Mutations may result in changes to the structure and function of proteins.	Genes, chromosomes, alleles, mutation	Argument-Driven Inquiry in Life Science Lab 15 - Mutations in Genes: How Do Different Types of Mutations in Genes Affect the Function of an Organism?	

	MS-LS3-2	Develop and use a model to desribe how asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.	Emphasis is on using models such as diagrams and simulations to describe the cause and effect of gene transmission from parent(s) to offspring.	**LS3.A** - Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes inherited. **LS3.B**- In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other.	Asexual reproduction vs. sexual reproduction, chromosomes, alleles	Argument-Driven Inquiry in Life Science Lab 16 - Mechanisms of inheritance: How do fruit flies inherit the sepia eye color trait? (lab for sexual reproduction)	**Catholic Catechism**: "Every human life from the moment of conception until death is sacred..." (2319) "From its conception, the child has a right to life" (2322) **Genesis 1:28** "God blessed them and said 'be fertile and multiply'." **U.S. Conference of Cathloic Bishops:** Love and Sexuality. **Pope John Paul II** - Theology of the Body. **Pope Paul VI** "Humanae Vitae" on contraception use. Catholic teaching on abstinence.
	MS-LS4-5	Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms.	Emphasis is on synthesizing information from reliable sources about the influence of humans on genetic outcomes in artifical selection (such as genetic modification, selective breeding, gene therapy); and on the impacts these technologies have on society.	**LS4.B** - In artifical selection, humans have the capacity to influence certain characteristics of organisms by selective breeding. One can choose desired parental traits determined by genes, which are then passed on to offspring.	Artificial selection, selective breeding, genetic modification, gene therapy, genetic engineering		**Donum Vitae**: "Instruction on Respect for Human Life in Its Origin and on the Dignity of Procreation" **National Directory for Catechesis:** Interest in Science and Technology **Catholic Church on Stem cells:** http://stemcell.nd.edu/ethics **Catholic Catechism:** "One must hold as licit procedures carried out on human embryos..." (2275)
NATURAL SELECTION AND ADAPATIONS							
Evolution (**MS-LS4-1, MS-LS4-2, MS-LS4-3, MS-LS4-4, MS-LS4-6**); 25-30 class periods	**MS-LS4-1**	Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.	Emphasis is on finding patterns of change in the level of complexity of anatomical structures in organisms and the chronological order of fossil appearance in the rock layers.	**LS4.A** - The collection of fossils and their placement in chronological order is known as the fossil record. It documents the existence, diversity, extinction, and change of many life forms throughout the history of life on Earth.	Natural selection, fossils, fossil record, extinction	Argument-Driven Inquiry in Life Science Lab 19: Phylogenetic trees and classification of fossils: How should biologists classify the Seymouria?	**United States Catholic Catechism for Adults** (283) - God created each human soul to share immortal life with him. **Genesis 1:21** **Catholic Catechism**: "Scripture presents the work of the Creator symbolically as a succession of six days of divine 'work,' concluded by the 'rest' of the 7th day." (337)

	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.	Emphasis is on explanations of the evolutionary relationships among organisms in terms of similarity or differences of the gross appearance of anatomical structures as evidence of common ancestry.	**LS4.A** - Anatomical similarities and differences between various organisms living today and between them and organisms in the fossil record, enable the reconstruction of evolutionary history and the inference of lines of evolutionary descent.	Evolution, fossil record, anatomy, common ancestry	"The Mysteries of Cleveland-Lloyd Dinosaur Quarry" - register for a free account to get instructional materials and student access code at researchquest.org	Genesis 7:1-4 Classification of animals on Noah's ark Letter from Pope John Paul II to the Pontifical Academy of Science on evolution in 1996
	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.	Emphasis is on inferring general patterns of relatedness among embryos of different organisms by comparing the macroscopic appearance of diagrams or pictures.	**LS4.A** - Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully-formed anatomy.	Embryos, embryological development	Argument-Driven Inquiry in Life Science Lab 20 - Descent With Modification: Does Animal Embryonic Development Support or Refute the Theory of Descent With Modification?	
	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.	Emphasis is on using simple probaility statements and proportional reasoning to construct explanations.	**LS4.B** - Natural selection can lead to an increase in the frequency of some traits and the decrease of other traits.	Natual selection, genetic variation	Argument-Driven Inquiry in Life Science Lab 17 - Mechanisms of Evolution: Why Does a Specific Version of a Trait Become More Common in a Population Over Time? (also aligns to MS-LS4-6)	
	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.	Emphasis is on using mathematical models, probability statements, and proportional reasoning to support explanations of trends in changes to populations over time.	**LS4.C** - Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that suport successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes.	Adaptation, natural selection	Argument-Driven Inquiry in Life Science Lab 17 - Mechanisms of Evolution: Why Does a Specific Version of a Trait Become More Common in a Population Over Time? (also aligns to MS-LS4-4)	
ENGINEERING DESIGN (TO INCLUDE IN ALL MIDDLE SCHOOL SCIENCE CLASSES) - Incorporate engineering design throughout the school year. One example lab is provided below ("Bird Beak Design Challenge Lab"). Flinn Scientific also sells many STEM design challenge labs, inlcuding kits for Life Science.							

	MS-ETS1-1	Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.	No clarification statement provided with performance expectation.	**ETS1.A** - The more precisely a design task's critera and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions.		Bird Beak Design Challenge Lab: https://www.sciencefriday.com/educational-resources/a-new-beak-evolution-lab/	
	MS-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.	No clarification statement provided with performance expectation.	**ETS1.B** - There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem.		Bird Beak Design Challenge Lab: https://www.sciencefriday.com/educational-resources/a-new-beak-evolution-lab/	
	MS-ETS1-3	Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.	No clarification statement provided with performance expectation.	**ETS1.B** - Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. **ETS1.C** - Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process.		Bird Beak Design Challenge Lab (modify the lab to include a redesign of a new beak after testing out original designs, in order to make a better beak): https://www.sciencefriday.com/educational-resources/a-new-beak-evolution-lab/	
	MS-ETS1-4	Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.	No clarification statement provided with performance expectation.	**ETS1.B** - (1) A solution needs to be tested, and then modified on the basis of the test reults, in order to improve it. (2) Models of all kinds are important for testing solutions. **ETS1.C** - 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.		Bird Beak Design Challenge Lab (modify the lab to include testing the tools to determine the optimal design): https://www.sciencefriday.com/educational-resources/a-new-beak-evolution-lab/	