School District of Marshfield Course Syllabus

Course Name: Biology
Length of Course: Year
Credit: 1 Credit

Program Goal:

The School District of Marshfield K-12 Science Program will prepare and motivate learners to explore, problem solve and collaborate with their classmates to interpret science and explain the world around them. Learners will acquire knowledge and evidence that promotes creative solutions through the evaluation and understanding of scientific theories and evidence. Learners will collect, analyze and reason with scientific data through investigations that ultimately allow for the generation of scientific explanations. Critical thinking skills will elevate natural curiosity, make sense of scientific data and promote scientific literate citizens.

Course Description:

This course will be placing emphasis on introducing basic concepts of biology (including scientific process and the characteristics and chemistry of life), cells and cell processes, genetics, evolution (natural selection and adaptations), ecology (how organisms interact with one another) and touch on some topics in environmental science.

A variety of methods will be used, including lecture, video, small or large group discussions, laboratory-based/ group activities. These methods will be used to aide in the understanding of nature and the existence of life around us.

Wisconsin Standards for Science (SCI)	
Crosscutting Concepts (CC)	
CC1: Students use science and engineering practices, disciplinary core ideas, and ***patterns*** to make sense of phenomena and solve problems.	
Patterns	CC1.h: Students observe patterns in systems at different scales and cite patterns as empirical evidence for causality in supporting their explanations of phenomena. They recognize classifications or explanations used at one scale may not be useful or need revision using a different scale, thus requiring improved investigations and experiments. They use mathematical representations to identify and analyze patterns of performance in order to reengineer a designed system.
CC2: Students use science and engineering practices, disciplinary core ideas, and ***cause and effect*** relationships to make sense of phenomena and solve problems.	
Cause and Effect	CC2.h: Students understand empirical evidence is required to differentiate between cause and correlation and to make claims about specific causes and effects. They suggest cause and effect relationships to explain and predict behaviors in complex natural and designed systems. They also propose causal relationships by examining what is known about smaller scale mechanisms within the system. They recognize changes in systems may have various causes that may not have equal effects.
CC3: Students use science and engineering practices, disciplinary core ideas, and an understanding of ***scale, proportion and quantity*** to make sense of phenomena and solve problems.	
Scale, Proportion, and Quantity	CC3.h: Students understand the significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. They recognize patterns observable at one scale may not be observable or exist at other scales, and some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly. They use orders of magnitude to understand how a model at one scale relates to a model at another scale. They use algebraic thinking to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).
CC4: Students use science and engineering practices, disciplinary core ideas, and an understanding of ***systems and models*** to make sense of phenomena and solve problems.	

Systems and System Models	CC4.h: Students investigate or analyze a system by defining its boundaries and initial conditions, as well as its inputs and outputs. They use models (e.g., physical, mathematical, computer models) to simulate the flow of energy, matter, and interactions within and between systems at different scales. They also use models and simulations to predict the behavior of a system, and recognize that these predictions have limited precision and reliability due to the assumptions and approximations inherent in the models. They also design systems to do specific tasks.
CC5: Students use science and engineering practices, disciplinary core ideas, and an understanding of ***energy and matter*** to make sense of phenomena and solve problems.	
Energy and Matter	CC5.h: Students understand that the total amount of energy and matter in closed systems is conserved. They describe changes of energy and matter in a system in terms of energy and matter flows into, out of, and within that system. They also learn that energy cannot be created or destroyed. It only moves between one place and another place, between objects and/or fields, or between systems. Energy drives the cycling of matter within and between systems. In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.
CC6: Students use science and engineering practices, disciplinary core ideas, and an understanding of ***structure and function*** to make sense of phenomena and solve problems.	
Structure and Function	CC6.h: Students investigate systems by examining the properties of different materials, the structures of different components, and their interconnections to reveal the systems' function and solve a problem. They infer the functions and properties of natural and designed objects and systems from their overall structure, the way their components are shaped and used, and the molecular substructures of their various materials.
CC7: Students use science and engineering practices, disciplinary core ideas, and an understanding of ***stability and change*** to make sense of phenomena and solve problems.	
Stability and Change	CC7.h: Students understand much of science deals with constructing explanations of how things change and how they remain stable. They quantify and model changes in systems over very short or very long periods of time. They see some changes are irreversible, and negative feedback can stabilize a system, while positive feedback can destabilize it. They recognize systems can be designed for greater or lesser stability.
Science and Engineering Practices (SEP)	
SEP1: Students ***ask questions and define problems***, in conjunction with using crosscutting concepts and disciplinary core ideas, to make sense of phenomena and solve problems.	

Asking Questions SEP1.A	SEP1.A.h: Students ask questions to formulate, refine, and evaluate empirically testable questions. This includes the following: Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and seek additional information. Ask questions that arise from examining models or theories to clarify and seek additional information and relationships. Ask questions to determine relationships, including quantitative relationships, between independent and dependent variables. Ask questions to clarify and refine a model or an explanation. Evaluate a question to determine if it is testable and relevant. Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory. Ask and evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of the design.
SEP2: Students ***develop and use models***, in conjunction with using crosscutting concepts and disciplinary core ideas, to make sense of phenomena and solve problems.	
Developing Models SEP2.A	SEP2.A.h: Students use, synthesize, and develop models to predict and show relationships among variables and between systems and their components in the natural and designed world. This includes the following: Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism, or system in order to select or revise a model that best fits the evidence or design criteria. Design a test of a model to ascertain its reliability. Develop, revise, and use models based on evidence to illustrate and predict the relationships between systems of between components of a system.

	Develop and use multiple types of models to provide mechanistic accounts and predict phenomena. Move flexibly between these model types based on merits and limitations. Develop a complex model that allows for manipulation and testing of a proposed process or system. Develop and use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and solve problems.
SEP3: Students ***plan and carry out investigations***, in conjunction with using crosscutting concepts and disciplinary core ideas, to make sense of phenomena and solve problems.	
Planning and Conducting Investigations SEP3.A	SEP3.A.h: Students plan and carry out investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models: This includes the following: Individually and collaboratively plan an investigation or test a design to produce data that can serve as evidence to build and revise models, support explanations for phenomena, and refine solutions to problems. Consider possible variables or effects and evaluate the investigation's design to ensure variables are controlled. Individually and collaboratively plan and conduct an investigation to produce data to serve as the basis for evidence. In the design: decide on types, how much, and accuracy of data needed to produce reliable measurements. Consider limitations on the precision of the data (e.g., number of trials, cost, risk, time) and refine the design accordingly. Plan and conduct an investigation or test a design solution in a safe and ethical manner including considerations of environmental, social, and personal impacts. Select appropriate tools to collect, record, analyze, and evaluate data. Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated. Manipulate variables and collect data about a complex model of a proposed process or system to identify failure points, or to improve performance relative to criteria for success.

SEP4: Students ***analyze and interpret data***, in conjunction with using crosscutting concepts and disciplinary core ideas, to make sense of phenomena and solve problems.	
Analyze and Interpret Data SEP4.A	SEP4.A.h: Students engage in more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. This includes the following: Analyze data using tools, technologies, and models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. Apply concepts of statistics and probability to scientific and engineering questions and problems, using digital tools when feasible. Concepts should include determining the fit of functions, slope, and intercepts to data, along with correlation coefficients when the data is linear. Consider and address more sophisticated limitations of data analysis (e.g., sample selection) when analyzing and interpreting data. Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations. Evaluate the impact of new data on a working explanation or model of a proposed process or system. Analyze data to optimize design features or characteristics of system components relative to criteria for success.
SEP5: Students ***mathematics and computational thinking***, in conjunction with using crosscutting concepts and disciplinary core ideas, to make sense of phenomena and solve problems.	
Qualitative and Quantitative Data SEP5.A	SEP5.A.h: Students use algebraic thinking and analysis, a range of linear and nonlinear functions (including trigonometric functions, exponentials, and logarithms), and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. This includes the following: Decide if qualitative or quantitative data are best to determine whether a proposed object or tool meets criteria for success. Create and/or revise a computational model or simulation of a phenomenon, designed device, process, or system.

	Use mathematical, computational, and algorithmic representations of phenomena or design solutions to describe and support claims and explanations. Apply techniques of algebra and functions to represent and solve scientific and engineering problems. Use simple limit cases to test mathematical expressions, computer programs, algorithms, or simulations of a process or system to see if a model "makes sense" by comparing the outcomes with what is known about the real world. Apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m^3, acre-feet, and others).
SEP6: Students ***construct explanations and design solutions***, in conjunction with using crosscutting concepts and disciplinary core ideas, to make sense of phenomena and solve problems.	
Construct an Explanation SEP6.A	SEP6.A.h: Students create explanations that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. This includes the following: Make quantitative and qualitative claims regarding the relationship between dependent and independent variables. Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources, including students' own investigations, models, theories, simulations, and peer review. Explanations should reflect the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. Apply scientific ideas, principles, and evidence to provide an explanation of phenomena taking into account possible, unanticipated effects.
SEP7: Students ***engage in argument from evidence***, in conjunction with using crosscutting concepts and disciplinary core ideas, to make sense of phenomena and solve problems.	

<table>
<tr><td>Argue from Evidence
SEP7.A</td><td>SEP7.A.h:
Students use appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world. Arguments may also come from current scientific or historical episodes in science. This includes the following:

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

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

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

Construct, use, and present oral and written arguments or counterarguments based on data and evidence.

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

Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments. Consider relevant factors (e.g. economic, societal, environmental, and ethical considerations).</td></tr>
<tr><td colspan="2">SEP8: Students will obtain, evaluate and communicate information, in conjunction with using crosscutting concepts and disciplinary core ideas, to make sense of phenomena and solve problems.</td></tr>
<tr><td>Obtain, Evaluate, and Communicate Information
SEP8.A</td><td>SEP8.A.h:
Students evaluate the validity and reliability of claims, methods, and designs. This includes the following:

Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions, and to obtain scientific and technical information. Summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.</td></tr>
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	Compare, integrate, and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively, or text-based) in order to address a scientific question or solve a problem. Gather, read, and evaluate scientific and technical information from multiple authoritative sources, assessing the evidence and usefulness of each source. Synthesize and evaluate the validity and reliability of multiple claims, methods, or designs that appear in scientific and technical texts or media reports. Verify the data when possible. Communicate scientific and technical information in multiple formats, including orally, graphically, textually, and mathematically. Examples of information could include ideas about phenomena or the design and performance of a proposed process or system.
Life Science (LS)	
LS1: Students use science and engineering practices, crosscutting concepts, and an understanding of ***structures and processes*** **(on a scale from molecules to organisms)** to make sense of phenomena and solve problems.	
Growth and Development for Organisms LS1.B	LS1.B.h: Growth and division of cells in organisms occurs by mitosis and differentiation for specific cell types.
LS2: Students use science and engineering practices, crosscutting concepts, and an understanding of ***interactions, energy, and dynamics within ecosystems*** to make sense of phenomena and solve problems.	
Interdependent Relationships in Ecosystems LS2.A	LS2.A.h: Ecosystems have carrying capacities resulting from biotic and abiotic factors. The fundamental tension between resource availability and organism populations affects the abundance of species in any given ecosystem. The combination of the factors that affect an organism's success can be measured as a multidimensional niche.
Cycles of Matter and Energy Transfer in Ecosystems LS2.B	LS2.B.h: Photosynthesis and cellular respiration provide most of the energy for life processes. Only a fraction of matter consumed at the lower level of a food web is transferred up, resulting in fewer organisms at higher levels. At each link in an ecosystem, elements are combined in different ways, and matter and energy are conserved. Photosynthesis and cellular respiration are key components of the global carbon cycle.
Ecosystem Dynamics, Functioning, and Resilience LS2.C	LS2.C.h: If a biological or physical disturbance to an ecosystem occurs, including one induced by human activity, the ecosystem may return to its more or less original state or become a very different ecosystem, depending on the complex set of interactions within the ecosystem.

Social Interactions and Group Behavior LS2.D	LS2.D.h: Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives.
LS3: Students use science and engineering practices, crosscutting concepts, and an understanding of ***heredity*** to make sense of phenomena and solve problems.	
Inheritance of Traits LS3.A	LS3.A.h: DNA carries instructions for forming species' characteristics. Each cell in an organism has the same genetic content, but genes expressed by cells can differ.
Variation of Traits LS3.B	LS3.B.h: The variation and distribution of traits in a population depend on genetic and environmental factors. Genetic variation can result from mutations caused by environmental factors or errors in DNA replication, or from chromosomes swapping sections during meiosis.
LS4: Students use science and engineering practices, crosscutting concepts, and an understanding of ***biological evolution*** to make sense of phenomena and solve problems.	
Evidence of Common Ancestry and Diversity LS4.A	LS4.A.h: The ongoing branching that produces multiple lines of descent can be inferred by comparing DNA sequences, amino acid sequences, and anatomical and embryological evidence of different organisms.
Natural Selection LS4.B	LS4.B.h: Natural selection occurs only if there is variation in the genes and traits between organisms in a population. Traits that positively affect survival can become more common in a population.
Adaptation LS4.C	LS4.C.h: Evolution results primarily from genetic variation of individuals in a species, competition from resources, and proliferation of organisms better able to survive and reproduce. Adaptation means that the distribution of traits in a population, as well as species expansion, emergence, or extinction, can change when conditions change.
Biodiversity and Humans LS4.D	LS4.D.h: Biodiversity is increased by formation of new species and reduced by extinction. Humans depend on biodiversity but also have adverse impacts on it. Sustaining biodiversity is essential to supporting life on Earth.
Engineering, Technology, and the Application of Science (ETS)	
ETS1: Students use science and engineering practices, crosscutting concepts, and an understanding of ***engineering design*** to make sense of phenomena and solve problems.	
Defining and Delimiting Engineering Problems ETS1.A	ETS1.A.h: Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed

	through engineering. These global challenges also may have manifestations in local communities.
Developing Possible Solutions ETS1.B	ETS1.B.h: 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. Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical. They are also useful in making a persuasive presentation to a client about how a given design will meet his or her needs.
ETS2: Students use science and engineering practices, crosscutting concepts, and an understanding of the ***links among Engineering, Technology, Science and Society*** to make sense of phenomena and solve problems.	
Interdependence of Science, Engineering, and Technology ETS2.A	ETS2.A.h: Science and engineering complement each other in the cycle known as research and development (R&D). Many research and development projects may involve scientists, engineers, and others with wide ranges of expertise.
Influence of Engineering, Technology, and Science on Society and the Natural World ETS2.B	ETS2.B.h: Modern civilization depends on major technological systems, such as agriculture, health, water, energy, transportation, manufacturing, construction, and communications. Engineers continuously modify these systems to increase benefits while decreasing costs and risks. New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.

Key Vocabulary:			
Biology	Cells	Metabolism	Homeostasis
Evolution	Heredity	Observation	Hypothesis
DNA	RNA	Organic molecules	Organelles
Passive transport	Active transport	Energy	ATP
Kreb’s cycle	Mitosis	Meiosis	Centromere
Chromatid	Natural selection	Adaptations	Ecology

Population	Ecosystem	Biome	Exponential growth
Logistic growth	Carrying capacity	Limiting factor	Competition
Niche	Resource partitioning	Food web	Producer
Invasive species	Greenhouse effect	Nutrient cycling	Global warming

Topics/Content Outline- Units and Themes:

Intro to Biology:

- Part 1: Scientific Process
- Part 2: Characteristics of Life
- Part 3: Chemistry of Life & Biochemistry

Cells and Cells Processes:

- Part 1: Microscopy
- Part 2: Cells & Cell Processes
- Part 3: Cell Transport
- Part 4: Energy & Enzymes
- Part 5: Cellular Respiration
- Part 6: Photosynthesis
- Part 7: Mitosis
- Part 8: Meiosis

Genetics:

- Part 1: Mendelian Genetics
- Part 2: DNA & DNA Replication
- Part 3: Gene Expression
- Part 4: Genetic Disorders & Pedigrees

Evolution:

- Part 1: Famous Beaks
- Part 2: Darwin & Evolution
- Part 3: Evidence for Evolution
- Part 4: Microevolution
- Part 5: Macroevolution

Ecology:

- Part 1: Introduction to Ecology

- Part 2: Population Ecology
- Part 3: Community Ecology
- Part 4: Ecosystem Ecology
- Part 5: Environmental Issues
- Part 6: Behavior Ecology

Primary Resource(s):
Biology Now, 2nd Edition W.W. Norton & Company ISBN: 978-0-393-66400-3 ©2018
The Story of Life W.W. Norton & Company ISBN: 978-0-393-63156-2 ©2019