LAB-AIDS Correlations for OHIO'S 2018 LEARNING STANDARDS: BIOLOGY

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This document is intended to show how our curriculum products align with the *Ohio 2018 Learning Standards: Biology*[1].

ABOUT OUR PROGRAMS

Lab-Aids Core Science Programs are developed to support current knowledge on the teaching and learning of science. All materials support an inquiry-driven pedagogy, with support for literacy skill development and with assessment programs that clearly show what students know and are able to do from using the programs. All programs have extensive support for technology in the school science classrooms and feature comprehensive teacher support.

ABOUT SEPUP

Materials from the Science Education for Public Understanding Program (SEPUP) are developed at the Lawrence Hall of Science, at the University of California, Berkeley, and distributed nationally by Lab-Aids, Inc. Development of SEPUP materials is supported by grants from the National Science Foundation. SEPUP programs are available as full year courses, or separately, as units, each taking 3-9 weeks to complete. For more information about SEPUP, visit www.sepuplhs.org.

ABOUT SCIENCE AND GLOBAL ISSUES BIOLOGY

Science and Global Issues: Biology was developed by SEPUP with grant support from the National Science Foundation. It was field tested nationally in classrooms across the country. The program consists of a student book, equipment kit, print and online teacher resources, and online content for students, including additional print, video, digital simulations and more. The five units in this course look at topics such as human impact on ecosystems, world health, genetically modified organisms, and biodiversity. In each unit, students are challenged to reason scientifically while applying their understanding of the main concepts of that unit: sustainability, ecology, cell biology, genetics, and evolution. For more information on the *Science and Global Issues: Biology* program, please visit www.Lab-Aids.com/SGI.

[1] http://education.ohio.gov/getattachment/Topics/Learning-in-Ohio/Science/Ohios-Learnin[...]ndards-and-MC/SciFinalStandardsMC060719.pdf.aspx?lang=en-US

Science and Global Issues: Biology Scope and Sequence

Science and Global Issues: Biology **Unit Name**	**Activities**	**Issue Focus**
Unit A Sustainability	1-6	Aspects of sustainability from a personal, community and global perspective
Unit B Ecology: Living on Earth	1-19	Sustainability from an ecosystems perspective, with a focus on humans' impacts on ecosystems; Making decisions regarding fisheries management
Unit C Cell Biology: World Health	1-18	Disparities between developing and developed countries in terms of diseases' impacts on life; Making decisions about priorities for diseases that limit social, economic, and environmental progress
Unit D Genetics: Feeding the World	1-20	Comparison of selective breeding and genetic modification; Use of genetically modified organisms, particularly in the production of agricultural crops
Unit E Evolution: Maintaining Diversity	1-15	Conserving genetic, species and ecosystem diversity; Ecosystems services and intrinsic value models for conservation

NATURE OF SCIENCE HIGH SCHOOL*

Nature of Science One goal of science education is to help students become scientifically literate citizens able to use science as a way of knowing about the natural and material world. All students should have sufficient understanding of scientific knowledge and scientific processes to enable them to distinguish what is science from what is not science and to make informed decisions about career choices, health maintenance, quality of life, community and other decisions that impact both themselves and others.		
Categories	**High School**	
Scientific Inquiry, Practice and Applications All students must use these scientific processes with appropriate laboratory safety techniques to construct their knowledge and understanding in all science content areas.	• Identify questions and concepts that guide scientific investigations. • Design and conduct scientific investigations using a variety of methods and tools to collect empirical evidence, observing appropriate safety techniques. • Use technology and mathematics to improve investigations and communications. • Formulate and revise explanations and models using logic and scientific evidence (critical thinking). • Recognize and analyze explanations and models.	SEPUP's *Science and Sustainability* is grounded in current understandings about cognitive development, the learning process, and the pedagogical methods that support construction of science knowledge. All aspects of the instructional materials— from the overall organization of the teaching–learning cycle to the design and sequencing of the activities to the detail of the suggested teaching

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Categories	**High School**	
	• Communicate and support scientific arguments.	strategies—have been tailored to support students' learning. The activities employ varied teaching strategies and learning opportunities, move from the concrete to the more abstract, target common misconceptions, emphasize guided inquiry, and balance a strong, guided-inquiry orientation with engineering design challenges, readings, and opportunities for practice. Sustained attention is applied to processing for meaning as students are often asked to apply what they have learned in the context of sustainability. During the "getting started" phase of the SEPUP learning cycle, students review their initial ideas; in the "doing the activity" phase, students collect and analyze data and talk about their experiences with other students and the teacher. In the "analysis" phase, students reflect on what they have learned and respond to analysis questions designed to think deeper.

Science is a Way of Knowing
Science assumes the universe is a vast single system in which basic laws are consistent. Natural laws operate today as they did in the past and they will continue to do so in the future. Science is both a body of knowledge that represents a current understanding of natural systems and the processes used to refine, elaborate, revise and extend this knowledge.
	• Various science disciplines use diverse methods to obtain evidence and do not always use the same set of procedures to obtain and analyze data (i.e., there is no one scientific method).
	  • Make observations and look for patterns.
	  • Determine relevant independent variables affecting observed patterns.
	  • Manipulate an independent variable to affect a dependent variable.
	  • Conduct an experiment with controlled variables based on a question or hypothesis.
	  • Analyze data graphically and mathematically.
	• Science disciplines share common rules of evidence used to evaluate explanations about natural phenomenon by using empirical standards, logical arguments and peer reviews.
	  • Empirical standards include objectivity, reproducibility, and honest and ethical reporting of findings.
	  • Logical arguments should be evaluated with open-	

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Categories	**High School**	
	mindedness, objectivity and skepticism. • Science arguments are strengthened by multiple lines of evidence supporting a single explanation. • The various scientific disciplines have practices, methods, and modes of thinking that are used in the process of developing new science knowledge and critiquing existing knowledge.	In teacher-guided discussions, students present their own ideas, listen to the ideas of other students, revise their thinking, and come to new understandings of the concepts being developed. Learning goals, assessment outcomes, and assessments are closely aligned and clearly delineated. Students are afforded multiple ways to express their understandings and level of mastery. This array of features allows students with a range of learning styles to achieve their optimal level of understanding. For all activities, the teacher edition gives detailed suggestions for teaching and assessment strategies, discusses the rationales for those strategies, and discusses possible student preconceptions. Literacy supports are embedded and use a variety of strategies to support student growth in reading comprehension,
Science is a Human Endeavor Science has been, and continues to be, advanced by individuals of various races, genders, ethnicities, languages, abilities, family backgrounds and incomes.	• Science depends on curiosity, imagination, creativity and persistence. • Individuals from different social, cultural, and ethnic backgrounds work as scientists and engineers. • Science and engineering are influenced by technological advances and society; technological advances and society are influenced by science and engineering. • Science and technology might raise ethical, social and cultural issues for which science, by itself, does not provide answers and solutions.	

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Categories	**High School**	
Scientific Knowledge is Open to Revision in Light of New Evidence Science is not static. Science is constantly changing as we acquire more knowledge.	• Science can advance through critical thinking about existing evidence. • Science includes the process of comparing patterns of evidence with current theory. • Some science knowledge pertains to probabilities or tendencies. • Science should carefully consider and evaluate anomalies (persistent outliers) in data and evidence. • Improvements in technology allow us to gather new scientific evidence.	writing, oral presentations, and media viewing. The mixture of activity types (such as laboratory experiments, readings, data analysis, video clips, historical vignettes) provides the learner with multiple avenues to gather, analyze, and compare current data and thinking with that of the past. Through these experiences, learners have the opportunity to use data from a variety of sources to understand the changes that have occurred in scientific thinking, and how and why these changes came about. They also learn about important contributions from various cultures and are provided examples of how past and present scientific thinking and discoveries are influenced by the technology and ethics of the time period.

*Adapted from Appendix H – Understanding the Scientific Enterprise: The Nature of Science in the Next Generation Science Standards

Biology

CONTENT ELABORATION: HEREDITY

Building on knowledge from elementary school (plants and animals have life cycles and offspring resemble their parents) and knowledge from middle school (reproduction, Mendelian genetics, inherited traits and diversity of species), Heredity focuses on the explanation of genetic patterns of inheritance. In middle school, students learn that living things are a result of one or two parents, and traits are passed to the next generation through either asexual or sexual reproduction. Foundational concepts of mitosis and meiosis are introduced in grades 6 and 8. In addition, they learned that trasits are defined by instructions encoded in many discrete genes and that a gene may come in more than one form called alleles.

CONTENT STATEMENT *(Content may be found in both the Student Edition and the Teacher Edition)*	**Relevant Unit: Activity** *(Content in parentheses may not be taught to mastery)*
B.H.1 Cellular Genetics	
Life is specified by genomes. Each organism has a genome that contains all the biological information needed to develop and maintain that organism. The biological information contained in a genome is encoded in its deoxyribonucleic acid (DNA) and is divided into discrete units called genes. Genes code for proteins. Different parts of the genetic instructions are used in different types of cells, influenced by the cell's environment and history. The many body cells in an individual can be very different from one another, even though they are all descended from a single cell and thus have essentially identical genetic instructions. (AAAS)	**Cell Biology: C5, C6, C10, C14** **Genetics: D11, D16, D17**
B.H.2: Structure and function of DNA in cells	
Mendel's laws of inheritance (introduced in grade 8) are interwoven with current knowledge of DNA and chromosome structure and function to build toward basic knowledge of modern genetics. Genes are segments of DNA molecules. The sequence of DNA bases in a chromosome determines the sequence of amino acids in a protein. Inserting, deleting or substituting segments of DNA molecules can alter genes. Sorting and recombination of genes in sexual reproduction and meiosis specifically result in a variance in traits of the offspring of any two parents. This content can be explicitly connected to evolution.	**Cell Biology: C5, C6, C13, C14,** **Genetics: D2, D3, D9, D10, D12, D13, D14, D16, D17** **(Evolution: E8, E10, E11, E12)**
B.H.3: Genetic mechanisms and inheritance	
Genetic variation in traits among offspring is a result of the movement of chromosomes crossing over, independent assortment, and recombination during gamete formation. Gene interactions described in middle school were limited primarily to dominant and codominant traits. In high school, genetic mechanisms, both classical and modern, including incomplete dominance, sex-linked traits, and dihybrid crosses, are investigated through real-world examples. Statistics and probability allow us to compare observations made in the real world with predicted outcomes. Dihybrid crosses can be used to explore linkage groups, gene interactions and phenotypic variations. Chromosome maps reveal linkage groups.	**Genetics: D2, D3, D4, D5, D6, D7, D8, D12, D13, D14, D16, D17**
B.H.4: Mutations	

CONTENT STATEMENT *(Content may be found in both the Student Edition and the Teacher Edition)*	**Relevant Unit: Activity** *(Content in parentheses may not be taught to mastery)*
Genes can be altered by insertion, deletion, or substitution of a segment of DNA molecules. An altered gene is a mutation and will be passed on to every cell that develops from it. The resulting features may help, harm or have little or no effect on the offspring's success in its environments. Gene mutations in gametes are passed on to offspring.	**Cell Biology: (C13)** **Genetics: D4, D5, D13, D14, D16**
B.H.5: Modern genetics	
Technological developments that lead to the current knowledge of heredity are introduced for study. The development of the model for DNA structure was the result of experimentation, hypothesis, testing, statistical analysis and technology as well as the studies and ideas of many scientists. James Watson and Francis Crick developed the current model based on the work of Rosalind Franklin and others. Scientists continue to extend the model and use it to devise technologies to further our understanding and application of genetics. The emphasis is not on the memorization of specific steps of gene technologies, but rather on the interpretation and application of the results.	**Genetics: D1, D2, D7, D15, D18, D19, D20**

CONTENT ELABORATION: EVOLUTION

The basic concept of biological evolution is that Earth's present-day species descended from earlier, common ancestral species. At the elementary school level, evolution concepts include the relationship between organisms and the environment, interactions among parents and offspring and an introduction to the fossil record and extinction. At the middle school level, concepts include biodiversity (as part of biomes) and speciation, further exploration of the fossil record and Earth's history, changing environmental conditions (abiotic factors), natural selection and biological evolution. At the high school level, the study of evolution includes Modern Synthesis, the unification of genetics and evolution, historical perspectives of evolutionary theory, gene flow, mutation, speciation, natural selection, genetic drift and sexual selection.

CONTENT STATEMENT *(Content may be found in both the Student Edition and the Teacher Edition)*	**Relevant Unit: Activity** *(Content in parentheses may not be taught to mastery)*
B.E.1: Mechanisms	
Natural selection is used to describe the process by which traits become more or less common in a population due to consistent environmental pressures upon the survival and reproduction of individuals with the trait. Mathematical reasoning is applied to solve problems (e.g., use Hardy-Weinberg principle to explain deviations in observed gene frequency patterns in a population compared to expected patterns based on the assumptions of the principle). Populations evolve over time. Evolution through natural selection is the consequence of the interactions of: 1. The potential for a population to increase its numbers; 2. The genetic variability of offspring due to mutation and recombination of genes; 3. A finite supply of the resources required for life; and 4. The differential survival and reproduction of individuals based on phenotype(s). Mutations are described in the content elaboration for Heredity. Apply the knowledge of mutation and genetic drift to real-world examples. Biological evolution explains the natural origins for the diversity of life.	

CONTENT STATEMENT *(Content may be found in both the Student Edition and the Teacher Edition)*	**Relevant Unit: Activity** *(Content in parentheses may not be taught to mastery)*
Emphasis shifts from thinking in terms of selection of individuals with a particular trait to changing proportions of a trait in populations as a result of the mechanisms of natural selection, genetic drift, movement of genes into and out of populations and sexual selection.	
• Natural selection	**Evolution: E4, E11**
• Mutation	**Evolution: E4, E8, E10, E11, E12**
• Genetic drift	**Evolution: E10**
• Gene flow (immigration, emigration)	**Evolution: E10, E13**
• Sexual selection	**Evolution: E4**
B.E.2: Speciation	
Biological classification expanded to molecular evidence Classification systems are frameworks, developed by scientists, for describing the diversity of organisms; indicating the degree of relatedness among organisms. Recent molecular sequence data generally support earlier hypotheses regarding lineages of organisms based upon morphological comparisons. Both morphological and molecular comparisons can be used to describe patterns of biodiversity (cladograms present hypotheses to explain descent from a common ancestor with modification). The concept of descent from a common ancestor with modification provides a natural explanation for the diversity of life on Earth as partially represented in the fossil record and in the similarities of existing species.	**Evolution: E4, E5, E6, E7, E8, E10, E12, E13**
Variation of organisms within a species due to population genetics and gene frequency Different phenotypes result from new combinations of existing genes or from mutations of genes in reproductive cells. At the high school level, the expectation is to combine grade 8 knowledge with an explanation of genes and the function of chromosomes. Natural selection works on the phenotype. Heritable characteristics influence how likely an organism is to survive and reproduce in a particular environment. When an environment changes, the survival value of inherited characteristics may change. This may or may not cause a change in species that inhabit the environment. Use real-world examples to illustrate natural selection, gene flow, sexual selection, and genetic drift.	**Evolution: E4, E8, E10, E11, E12, E13**

CONTENT ELABORATION: DIVERSITY AND INTERDEPENDENCE OF LIFE

Building on knowledge from elementary school (interactions of organisms within their environment and the law of conservation of matter and energy, food webs) and from middle school (flow of energy through organisms, biomes and biogeochemical cycles), this topic at the high school level focuses on the study of diversity and similarity at the molecular level of organisms. Additionally, the effects of physical/chemical constraints on all biological relationships and systems are investigated. The unidirectional flow of energy and the cycling of matter as organisms grow, reproduce and die occurs at all levels of biological organization. Previous knowledge focused on biological systems at equilibrium; at the high school level, biological systems not at equilibrium and their responses are considered. Diagrams and models are used to explain the effects of real-world interactions and events within an ecosystem.

CONTENT STATEMENT *(Content may be found in both the Student Edition and the Teacher Edition)*	**Relevant Unit: Activity** *(Content in parentheses may not be taught to mastery)*
B.DI.1: Biodiversity	
The great diversity of organisms and ecological niches they occupy result from more than 3.8 billion years of evolution. Populations of individual species and groups of species comprise a vast reserve of genetic diversity. Loss of diversity alters energy flow, cycles of matter and persistence within biological communities. Loss of genetic diversity in a population increases its probability of extinction.	
• Genetic diversity	**Evolution: E1, E2, E10, E12**
• Species diversity	**Evolution: E1, E2, E5, E6, E7, E8, E9, E11, E13**
B.DI.2: Ecosystems	
Ecosystems change as geological and biological conditions vary due to natural and anthropogenic factors. Like many complex systems, ecosystems have cyclical fluctuations around a state of equilibrium. The rate of these fluctuations in ecosystems can increase due to anthropogenic factors. Changes in ecosystems may lead to disequilibrium, which can be seen in variations in carrying capacities for many species. Authentic data are used to study the rate of change in matter and energy relationships, population dynamics, carbon and nitrogen cycling, population changes and growth within an ecosystem. Graphs, charts, histograms and algebraic thinking are used to explain concepts of carrying capacity of populations and homeostasis within ecosystems by investigating changes in populations that occur locally or regionally. Mathematical models can include the exponential growth model and the logistic growth model. The simplest version of the logistic growth model is Population Growth Rate = rN(K-N)/K, which incorporates the biological concept of limited (non-infinite) carrying capacity, based upon intra- and interspecies competition for resources such as food, as represented	
• Equilibrium and disequilibrium	**Ecology: B1, B3, B5, B14**
• Carrying capacity	**Ecology: (B5), (B6), (B12), B14, (B15)**
B.DI.3: Loss of Diversity	
An ecosystem will maintain equilibrium with small fluctuations in its abiotic and biotic components, but significant fluctuations can result in long-term alterations of the ecosystem and ultimately a loss of biodiversity. This can be caused by natural and anthropogenic events. Humans are a biotic factor in ecosystems and can impact critical variables within these systems. Climate is dependent on a number of feedback loops between sunlight, the ocean, the atmosphere and the biosphere. Increasing mean global	

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temperatures cause increased variance in weather that impacts both biotic and abiotic factors. Multiple changes happening simultaneously can stress ecosystems. Extreme events such as prolonged drought, floods, or the introduction or removal of species can result in long-term alterations to ecosystems and their functions. The current rate of extinction is at least 100-1000 times the average background rate observed in the fossil record. The observed rates of biodiversity loss are indicative of a severe and pervasive disequilibrium in ecosystems. At the high school level, students should examine the factors that contribute to the accelerated extinction rates observed today and the implications of declining biodiversity carrying capacity. Misconceptions about population growth capacity, interspecies and intraspecies competition for resources, and what occurs when members of a species immigrate to or emigrate from ecosystems are included in this topic. Technology can be used to access real-time/authentic data to study population changes and growth in specific locations.	
• Climate change	**Ecology: B1, B8** **Cell Biology: (C2)**
• Anthropocene effects	**Ecology: B1, B4, B5, B8, B15, B16, B17, B18, B19** **Evolution: E2**
• Extinction	**Evolution: E2, E3, E13**
• Invasive species	**Ecology: (B1), (B2), B4, (B16)** **Evolution: (E2)**

CONTENT ELABORATION: CELLS

Building on knowledge from middle school (cell theory, cell division and differentiation), this topic focuses on the cell as a system itself (single-celled organism) and as part of larger systems (multicellular organism), sometimes as part of a multicellular organism, always as part of an ecosystem. The cell is a system that conducts a variety of functions associated with life. Details of cellular processes such as photosynthesis, chemosynthesis, cellular respiration and biosynthesis of macromolecules are addressed at this grade level. The concept of the cell and its parts as a functioning biochemical system is more important than just memorizing the parts of the cell.

CONTENT STATEMENT *(Content may be found in both the Student Edition and the Teacher Edition)*	**Relevant Unit: Activity** *(Content in parentheses may not be taught to mastery)*
B.C.1: Cell Structure and Function	
Every cell produces a membrane through which substances pass differentially, maintaining homeostasis. Molecular properties and concentration of the substances determine which molecules pass freely and which molecules require the input of energy. In all but quite primitive cells, a complex network of proteins provides organization and shape. Within the cell are specialized parts that transport materials, transform energy, build proteins, dispose of waste and provide information feedback and movement. Many chemical reactions that occur in some cells of multicellular organisms do not occur in most of the other cells of the organism. Prokaryotes, simple single-celled organisms, are first found in the fossil record about 3.8 billion years ago. Cells with nuclei, eukaryotes, developed one billion years ago and from these increasingly complex multicellular organisms descended.	

CONTENT STATEMENT *(Content may be found in both the Student Edition and the Teacher Edition)*	**Relevant Unit: Activity** *(Content in parentheses may not be taught to mastery)*
• Structure, function, and interrelatedness of cell organelles	**Cell Biology: C3, C4, C5, C6, C7, C8, C9, C10, C12** **Genetics: D***
• Eukaryotic cells and prokaryotic cells	**Cell Biology: (C3), C4**
B.C.2: Cellular Processes	
Living cells interact with, and can have an impact on, their environment. Carbon is a necessary element that cells acquire from their environment. Cells use carbon, along with hydrogen, oxygen, nitrogen, phosphorous and sulfur, during essential processes like respiration, photosynthesis, chemosynthesis and biosynthesis of macromolecules (e.g., proteins, lipids, carbohydrates). Chemical reactions that occur within a cell can cause the storage or release of energy by forming or breaking chemical bonds. Specialized proteins called enzymes lower the activation energy required for chemical reactions, increasing the reaction rate. Positive and negative feedback mechanisms regulate internal cell functions as external conditions vary. Most cells function within a narrow range of temperature and pH. Variations in external conditions that exceed the optimal range for a cell can affect the rate at which essential chemical reactions occur in that cell. At very low temperatures, reaction rates are slow. High temperatures can irreversibly change the structure of most protein molecules. Changes in pH beyond the optimal range of the cell can alter the structure of most protein molecules and change how molecules within the cell interact. The sequence of DNA bases on a chromosome determines the sequence of amino acids in a protein. Enzymatic proteins catalyze most chemical reactions in cells. Protein molecules are long, folded chains made from combinations of 20 common amino-acids. The activity of each protein molecule results from its sequence of amino acids and the shape the chain takes as a result of that sequence.	
Characteristics of life regulated by cellular processes	**Cell Biology: C6, C7, C8, C9, C10, C11, C12, C13, C14** **Genetics D* D16, D17**
Photosynthesis, chemosynthesis, cellular respiration, biosynthesis of macromolecules	**Cell Biology: C2, C14** **Genetics: D16**

* Many activities in Unit D: Genetics apply to the first bullet in each sub-standard because the nucleus is an organelle and DNA regulates many characteristics of life. Unit D activities relating specifically to DNA's structure and role in hereditary characteristics were not listed because this content is accounted for in the B.H: HEREDITY standard.