The Mission of the Chardon Local Schools is High Achievement for All Students, Where Learning is Our Most Important Work.

Science Course of Study:

BIOLOGY

Revised January 2022

Biology

Committee Members: Rebecca Schneider, Lisa Tekavec, Rob Mizen

Description: Biology is a high school level course, which satisfies the Ohio Core science graduation requirements of Ohio Revised Code Section 3313.603. This section of Ohio law requires three units of science.. Each course should include inquiry-based laboratory experience that engages students in asking valid scientific questions and gathering and analyzing information. This course investigates the composition, diversity, complexity and interconnectedness of life on Earth. Fundamental concepts of heredity and evolution provide a framework through inquiry-based instruction to explore the living world, the physical environment and the interactions within and between them. Students engage in investigations to understand and explain the behavior of living things in a variety of scenarios that incorporate scientific reasoning, analysis, communication skills and real-world applications.
[Source]

Strand: Heredity

Learning Standards:	**How Taught?**
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) 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. 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	**Teaching activities may include, but are not limited to:** • Students closely read select passages from documents to analyze text structure, development, and consequent meanings • Teacher provides direct instruction, give feedback, and model critical thinking • Small group and class discussions • Cooperative learning groups • Students to define, use, and connect to content area and based vocabulary • Students analyze video content related to standards that provide a broader global perspective of content. • Design and conduct lab-based investigations that connect content to real-life experiences. • Provide opportunities for out of building excursions (field trips) to provide additional real world application of standards. • Using technology and mathematics to improve investigations and communications. • Utilize data to impact instruction

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. B.H.4: Mutations 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. 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.	
Materials (may include but not limited to): ● **Textbook** ● **Microscopes** ● **Gel electrophoresis apparatus** ● **Basic Biology Lab Supplies** ● **On-line Simulations i.e. Gizmos** ● **Poster paper** ● **Glue** ● **Scissors** ● **Markers** ● **Colored Pencils** ● **Tape** ● **Misc craft supplies** ● **Models** ● **Specimens** ● **Chromebook** ● **Videos related to topics** ● **Gradecam** ● **Applicable Chromebooks apps**	**How Assessed?** **Assessments may include, but are not limited to:** ● Pre-Assessments (pre-tests, observation, questioning, diagnostics) ● Formative Assessments (entry/exit slips, mini analysis assignments, group work, discussions, homework/classwork, self and peer evaluations, checklists, guided notes, observations,quizzes, conferences, rubrics, lesson review questions, lab reports) ● Summative Assessments (formal essays, using rubrics; tests/exams, project, evaluation, demonstration, lab practicals) **How Re-Taught?** **Re-teaching activities may include, but are not limited to:** ● descriptive feedback on original task/assessment ● student examples of expectations ● modeling ● student self assessments

	• manipulatives • presenting the information again in a different way • review sessions • graphic organizers • small-group instruction • practice activities • computer tutorials / programs • peer tutoring • breaking down concept into smaller components • games and hands-on activities • cooperative learning • Universal Design for Learning principles offering students opportunities to experience and engage material in new and different ways

Strand: Cells

Learning Standards:	**How Taught?** **Teaching activities may include, but are not limited to:**
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. 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	• Students closely read select passages from documents to analyze text structure, development, and consequent meanings • Teacher provides direct instruction, give feedback, and model critical thinking • Small group and class discussions • Cooperative learning groups • Students to define, use, and connect to content area and based vocabulary • Students analyze video content related to standards that provide a broader global perspective of content. • Design and conduct lab-based investigations that connect content to real-life experiences. • Provide opportunities for out of building excursions (field trips) to provide additional real world application of standards. • Using technology and mathematics to improve investigations and communications. • Utilize data to impact instruction

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. Note 1: The idea that protein molecules assembled by cells conduct the work that goes on inside and outside the cells in an organism can be learned without going into the biochemical details. It is sufficient for students to know that the molecules involved are different configurations of a few amino acids and that the different shapes of the molecules influence what they do.

Materials (may include but not limited to):

- **Textbook**
- **Microscopes**
- **Gel electrophoresis apparatus**
- **Basic Biology Lab Supplies**
- **On-line Simulations i.e. Gizmos**
- **Poster paper**
- **Glue**
- **Scissors**
- **Markers**
- **Colored Pencils**
- **Tape**
- **Misc craft supplies**
- **Models**
- **Specimens**
- **Chromebook**
- **Videos related to topics**
- **Gradecam**
- **Applicable Chromebooks apps**

How Assessed?
Assessments may include, but are not limited to:

- Pre-Assessments (pre-tests, observation, questioning, diagnostics)
- Formative Assessments (entry/exit slips, mini analysis assignments, group work, discussions, homework/classwork, self and peer evaluations, checklists, guided notes, observations,quizzes, conferences, rubrics, lesson review questions, lab reports)
- Summative Assessments (formal essays, using rubrics; tests/exams, project, evaluation, demonstration, lab practicals)

How Re-Taught?
Re-teaching activities may include, but are not limited to:

- descriptive feedback on original task/assessment
- student examples of expectations
- modeling
- student self assessments
- manipulatives

	• presenting the information again in a different way • review sessions • graphic organizers • small-group instruction • practice activities • computer tutorials / programs • peer tutoring • breaking down concept into smaller components • games and hands-on activities • cooperative learning • Universal Design for Learning principles offering students opportunities to experience and engage material in new and different ways

Strand: Evolution

Learning Standard:	**How Taught?** **Teaching activities may include, but are not limited to:**
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. 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. 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. 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	• Students closely read select passages from documents to analyze text structure, development, and consequent meanings • Teacher provides direct instruction, give feedback, and model critical thinking • Small group and class discussions • Cooperative learning groups • Students to define, use, and connect to content area and based vocabulary • Students analyze video content related to standards that provide a broader global perspective of content. • Design and conduct lab-based investigations that connect content to real-life experiences. • Provide opportunities for out of building excursions (field trips) to provide additional real world application of standards. • Using technology and mathematics to improve investigations and communications. • Utilize data to impact instruction

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.	
Materials (may include but not limited to): ● **Textbook** ● **Microscopes** ● **Gel electrophoresis apparatus** ● **Basic Biology Lab Supplies** ● **On-line Simulations i.e. Gizmos** ● **Poster paper** ● **Glue** ● **Scissors** ● **Markers** ● **Colored Pencils** ● **Tape** ● **Misc craft supplies** ● **Models** ● **Specimens** ● **Chromebook** ● **Videos related to topics** ● **Gradecam** ● **Applicable Chromebooks apps**	**How Assessed?** **Assessments may include, but are not limited to:** ● Pre-Assessments (pre-tests, observation, questioning, diagnostics) ● Formative Assessments (entry/exit slips, mini analysis assignments, group work, discussions, homework/classwork, self and peer evaluations, checklists, guided notes, observations,quizzes, conferences, rubrics, lesson review questions, lab reports) ● Summative Assessments (formal essays, using rubrics; tests/exams, project, evaluation, demonstration, lab practicals) **How Re-Taught?** **Re-teaching activities may include, but are not limited to:** ● descriptive feedback on original task/assessment ● student examples of expectations ● modeling ● student self assessments ● manipulatives ● presenting the information again in a different way ● review sessions ● graphic organizers ● small-group instruction ● practice activities ● computer tutorials / programs ● peer tutoring ● breaking down concept into smaller components ● games and hands-on activities ● cooperative learning ● Universal Design for Learning principles offering students opportunities to experience and engage material in new and different ways

Strand: Diversity and interdependence of life

Learning Standard:	**How Taught?**
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. 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 by the variable K. Carrying capacity is defined as the population equilibrium size when births and deaths are equal; hence Population Growth Rate = zero. 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	**Teaching activities may include, but are not limited to:** • Students closely read select passages from documents to analyze text structure, development, and consequent meanings • Teacher provides direct instruction, give feedback, and model critical thinking • Small group and class discussions • Cooperative learning groups • Students to define, use, and connect to content area and based vocabulary • Students analyze video content related to standards that provide a broader global perspective of content. • Design and conduct lab-based investigations that connect content to real-life experiences. • Provide opportunities for out of building excursions (field trips) to provide additional real world application of standards. • Using technology and mathematics to improve investigations and communications. • Utilize data to impact instruction

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	
Materials (may include but not limited to): • **Textbook** • **Microscopes** • **Gel electrophoresis apparatus** • **Basic Biology Lab Supplies** • **On-line Simulations i.e. Gizmos** • **Poster paper** • **Glue** • **Scissors** • **Markers** • **Colored Pencils** • **Tape** • **Misc craft supplies** • **Models** • **Specimens** • **Chromebook** • **Videos related to topics** • **Gradecam** • **Applicable Chromebooks apps**	**How Assessed?** **Assessments may include, but are not limited to:** • Pre-Assessments (pre-tests, observation, questioning, diagnostics) • Formative Assessments (entry/exit slips, mini analysis assignments, group work, discussions, homework/classwork, self and peer evaluations, checklists, guided notes, observations,quizzes, conferences, rubrics, lesson review questions, lab reports) • Summative Assessments (formal essays, using rubrics; tests/exams, project, evaluation, demonstration, lab practicals) **How Re-Taught?** **Re-teaching activities may include, but are not limited to:** • descriptive feedback on original task/assessment • student examples of expectations • modeling • student self assessments • manipulatives • presenting the information again in a different way • review sessions • graphic organizers • small-group instruction • practice activities • computer tutorials / programs

	- peer tutoring - breaking down concept into smaller components - games and hands-on activities - cooperative learning - Universal Design for Learning principles offering students opportunities to experience and engage material in new and different ways