East Penn School District
Curriculum and Instruction

Curriculum for: Genetics/Microbiology, Honors

Course(s): Honors Genetics/Microbiology

Grades: 10-12

Department: Science

Periods per cycle: 8

Type of offering: elective

Developed by: Debra Barthold

ADOPTED: 2018

Length of Period (average minutes): 42

Length of Course (yrs): 1

Credit(s) awarded: 1.4 4.5/4.0

Enduring Understandings & Essential Questions	**Knowledge**	**Skills**	**Standards**
Enduring Understandings: ● DNA sequences are the blueprints of life. ● Mutations provide the variation necessary for life to persist. ● As an organism grows and develops, carefully orchestrated chemical reactions activate and deactivate parts of the genome at strategic times and in specific locations. Essential Question: ● What controls the expression of our genes? ● How does the structure of nucleic acids, genes and chromosomes relate to their function? ● What is the relationship between the processes of replication, transcription, and translation? ● What are the ultimate causes of genetic errors?	● DNA structure and function. ● Central dogma of life. ● Processes of DNA replication, transcription, and translation ● Protein processing. ● History of the discovery of DNA and relevant experiments . ● Role of RNA. ● Types of mutations. ● Effects of atypical chromosome number and structure. ● Mechanisms of control in gene expression. ● Relevance of the epigenome.	● Relate the structure of DNA to its function. ● Explain the relationship of DNA, genes, and chromosomes. ● Demonstrate the processes of DNA replication and protein synthesis. ● Identify regulatory factors in the processes of DNA replication, transcription, translation, and protein processing. ● Investigate the role of the environment in gene expression. ● Describe how genetic mutations alter DNA and their effect on phenotype. ● Research genetic disorders resulting from mutations. ● Discuss current topics in the field of genomics.	NGSS Standards: ● HS-LS1-1.Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells. ● LS1.A : Structure and Function - All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. ● HS-LS3-1. Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring. ● LS3.A : Inheritance of Traits - Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA . The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural

			functions, and some have no as- yet known function. ● HS-LS3-2. Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors. ● LS3.B: Variation of Traits - In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. Environmental factors can also cause mutations in genes, and viable mutations are inherited. - Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors.
Enduring Understandings: ● Scientific research often leads to technological advances that can have positive and/or negative impacts upon society as a whole.	● Genetic Engineering ● Restriction enzymes. ● Gel Electrophoresis ● PCR ● Bioethics ● CRISPR technology ● DNA microchip analysis ● Genetic Testing	● Define Genetic Engineering and describe its subcategories and aims in various biological fields. ● Explain the properties of DNA that lend to its	NGSS Standards: ● HS-LS1-1.Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells. ● LS1.A : Structure and Function

● Modern biotechnologies manipulate DNA providing new ways to study, monitor, treat diseases and alter the environment. Essential Questions: ● How will genetic technologies contribute to our understanding and treatment of common human genetic diseases? ● What regulations should be enacted on these technologies? ● What legal and ethical problems have arisen from new DNA technologies? ● Just because we can should we (use these technologies)?	● DNA fingerprinting ● New Terminology- genomics, proteomics, metagenomics.	manipulation in the laboratory. ● Evaluate current research techniques in treating genetic diseases. ● Summarize the major methods of analyzing DNA and their results. ● Perform and analyze DNA gel electrophoresis patterns. ● Explain how restriction enzymes are used in mapping. ● Explain how linkage studies led to sequencing of the human genome. ● Describe the technology behind identifying, sequencing, synthesizing, and amplifying DNA. ● Discuss moral and ethical considerations of gene therapy. ● Describe several applications of DNA fingerprinting and microarray analysis.	- All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. - Crosscutting Concepts Structure and Function Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. ● LS3.A : Inheritance of Traits - Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA . The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as- yet known function.
Enduring Understandings:	● Stages of the cell cycle.	● Identify stages of mitosis in onion root	NGSS Standards:

● Cells maintain a balance between cell division and cell death. ● Cancer is uncontrolled cell growth. ● Scientific research often leads to technological advances that can have positive and negative impacts on society. ● Sexual reproduction results in genetic variation of species. Essential Questions: ● Why is regulation of the cell cycle important? ● How are cancer cells different from other cells? ● What is the importance of stem cells? ● How does sexual reproduction result in genetic variation? ● What causes birth defects?	● Events that occur in the stages of mitosis. ● Control/ regulatory factors of the cell cycle. ● Events that occur in the stages of meiosis. ● The differences between mitosis and meiosis. ● Role of Apoptosis. ● Role of stem cells in cell proliferation. ● Process for cell differentiation. ● Crossing over and independent assortment in meiosis. ● Occurrence of identical and fraternal twins. ● Role of genes in aging process. ● Genetics of cancer.- - Relationship of genes to cancer. - Characteristics of cancer cells. - Detection. - Current treatments.	tips utilizing the microscope. ● Discuss various regulatory factors in the control of the cell cycle. ● Prepare a comparison chart between mitosis and meiosis. ● Prepare a concept map describing cell differentiation/ cell lineages. ● Provide examples of apoptosis in human health. ● Research current applications for stem cell technology. ● Research new technologies in cancer treatment and detection.	● HS-LS1-4. Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. ● LS1.B: Growth and Development of Organisms - In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism ● HS-LS3-2. Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors. ● LS3.B: Variation of Traits - In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. Environmental

			factors can also cause mutations in genes, and viable mutations are inherited.
Enduring Understandings: ● Mendel's Laws of Genetics can be used to study and predict inheritance patterns. ● Patterns of inheritance can be obscured when genes have many variants, interact with each other and the environment, are in mitochondria, or are linked on the same chromosome. ● Most human traits are multifactorial. ● Our sex chromosomes at conception set the developmental program for maleness or femaleness, but gene expression before and after birth greatly influences what unfolds. Essential Questions: ● What are common patterns of inheritance? ● What are the exceptions to Mendel's Laws? ● How can we predict the transmission of traits to future generations? ● What models are used to study inheritance patterns?	● Mendel's Laws of Genetics ● Single gene inheritance ● Multiple alleles ● Polygenic Inheritance ● Punnett Squares ● Inheritance patterns and pedigree analysis ● Mitochondrial Genes ● Linkage ● Probability ● Sex chromosomes ● Traits inherited on sex chromosomes. ● Sex-limited and sex influenced traits ● X inactivation ● Genomic imprinting ● Multifactorial traits ● Identical twin studies ● Influence of genes on behavior	● Explain how Mendel's Law of Segregation reflects the events of meiosis. ● Explain how Mendel's Law of Independent Assortment follows the transmission of two or more genes on different chromosomes. ● Analyze case studies that appear to alter expected mendelian ratios. ● Solve probability problems utilizing binomial expansion equations and factorial equation method. ● Perform monohybrid, dihybrid and sex-linked crosses utilizing Drosophila melanogaster and analyze outcome via Chi Square. ● Analyze pedigrees to determine inheritance patterns. ● Explain how linked traits are inherited	NGSS Standards: ● HS-LS3-3. Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population. ● LS3.B: Variation of Traits - Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors. ● HS-LS3-1. Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring. ● LS3.A : Inheritance of Traits - Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA . The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as- yet known function.

● What determines our sexual identity? ● How does the environment influence genetic traits in populations?		differently from Mendelian traits. ● Solve linkage problems and correlate how linkage is utilized in determining gene location and genetic mapping. ● Produce a concept map on the scope of genomic imprinting. ● Discuss issues and experiments in sexual identity. ● Research behavioral disorders analyzing the role of genes and environmental influences.	
Enduring Understandings: ● Microbiology includes many disciplines and career opportunities. ● Microbes have many beneficial applications for humans. ● Microbes are essential to our survival. Essential Questions: ● How do the different fields of Microbiology impact society?	● Fields of study included in Microbiology. ● Career opportunities applicable to Microbiology. ● General characteristics of microorganisms. ● Classification of microorganisms. ● Current research and technological advances in areas of Microbiology.	● Research current technological advances in the field of Microbiology. ● Present identifying specialist and microorganisms. ● Identify microorganisms and structures utilizing the microscope. ● Evaluate the impact microorganisms have on humans.	NGSS Standards: ● LS2.A: Interdependent Relationships in Ecosystems - Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the

● What is the role of microbes in infections and disease? ● What role do microorganisms have in earth's ecosystems? ● How are microorganisms used to create solutions for human problems?	● Essential role of microorganisms.		abundance (number of individuals) of species in any given ecosystem. ● HS-LS1-1. Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells. - Structure and Function Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.
Enduring Understandings: ● Structural components are used to classify bacteria. ● The single celled bacteria cell carries out all functions necessary for life. ● Bacteria have different habitats based on their nutritional adaptations for carbon and energy sources. ● Environmental factors influence growth patterns of microbes. ● Bacteria utilize various metabolic pathways. ● Bacteria are identified by their ability to utilize various substrates based on their biochemical enzymatic activity.	● Structures and functions of bacterial cells. ● Gram Stain Procedure ● Growth Factors ● Nutritional categories ● Reproduction by binary fission ● Population Growth Curves-phases and limiting factors. ● Enzymes and regulation of pathways ● Metabolic pathways utilized by different types of bacteria. ● Physical and chemical microbial control methods.	● Evaluate Gram Stains to classify bacteria based on cell wall structures and bacterial shapes. ● Demonstrate asceptic technique for isolation of bacteria. ● Analyze bacterial growth curves for population limiting factors. ● Analyze the effectiveness of different categories of antibiotics with different types of bacteria utilizing the Kirby Bauer Susceptibility Test Method.	NGSS Standards: ● HS-LS1-7. Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy. ● HS-LS2-3. Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions. ● LS1.C: Organization for Matter and Energy Flow in Organisms - As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another.

● Microorganisms react differently to physical and chemical control methods. ● Antimicrobial therapy is constantly evolving as microorganisms evolve. Essential Questions: ● What structures provide specific functions in the bacterial cell? ● Why are bacteria the most numerous organisms on Earth? ● How are bacteria biochemically classified? ● What techniques are utilized to grow and and identify bacteria in the clinical laboratory? ● What safety precautions are necessary when working with bacteria? ● What are the best methods for controlling bacteria? ● How can we determine the effectiveness of an antibiotic?	● Bacterial identification and classification systems. ● Antimicrobial drugs-mechanisms of action. ● Narrow vs Broad spectrum of drug activity. ● Laboratory safety protocols.	● Design and explain a flow chart of the main metabolic pathways utilized by bacterial groups including substrates, products and ATP generated. ● Compare growth patterns and colony morphologies of different bacteria in broth, tube and plate media. ● Perform and evaluate key biochemical tests to identify bacterial isolates. ● Demonstrate appropriate laboratory safety procedures. ● Evaluate an ideal antimicrobial drug.	● HS-LS1-1. Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells. ● LS1.A: Structure and Function - Systems of specialized cells within organisms help them perform the essential functions of life. ● HS-LS1-3. Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis ● HS-LS2-1. Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales. ● LS2.A: Interdependent Relationships in Ecosystems - Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. ● HS-LS4-2. Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in

			number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment. ● LS4.B: Natural Selection - Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals.
Enduring Understandings: ● Humans have a complex symbiotic relationship with bacteria. ● Our normal resident microbes (microbiota) provide protection and aid our immune system. ● Infectious diseases are caused by specific microbial pathogens that invade, multiply and damage specific host sites. ● Epidemiologists study the incidence and distribution of disease in populations with the goal of preventing disease.	● Normal resident microbiota by body site. ● Sterile body sites. ● Biofilms and quorum sensing. ● Pathogenic relationships ● Virulence factors of specific infectious bacteria. ● Infectious diseases by specific bacteria at specific body sites. ● Koch's postulates for causative agent of disease. ● Scope of Epidemiology ● Nosocomial Infections	● Investigate the role of microbiota in current medical applications. ● Explain how biofilms participate in quorum sensing. ● Explain how Koch's postulates are used to identify the causative agent of disease. ● Research an infectious disease and prepare a case study correlating mode of transmission, symptoms, diagnostic tests and treatment. ● Design a concept map comparing Humoral	NGSS Standards: ● LS2.A: Interdependent Relationships in Ecosystems - Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. ● HS-LS1-1. Construct an explanation based on evidence for how the structure of DNA

● Humans have nonspecific and specific defenses. ● Bacteria have numerous virulence factors to invade human hosts. Essential Questions: ● What role do bacteria play in our normal microbiota? ● What role do bacteria play in infectious processes? ● What mechanisms help humans to resist bacterial infections? ● What is the scope of epidemiology?	● Cells, tissues and organs of the immune system. ● Physical, mechanical and chemical barriers to infection. ● Nonspecific and Specific Immunity ● Vaccines	and cell-mediated immunity. ● Discuss methods for preventing nosocomial infections. ● Analyze the efficacy of vaccines in disease prevention.	determines the structure of proteins which carry out the essential functions of life through systems of specialized cells. - Structure and Function Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.

Materials and Resources:
Textbooks

Lewis, Ricki. Human Genetics: Concepts and Applications 11th ed. McGraw-Hill 2015.

Talaro, Kathleen Park and Arthur. Foundations in Microbiology 9th ed. McGraw-Hill 2015.

Teacher Selected Resources

"Human Genetics-Concepts & Applications 11th edition"
ISBN-13: 978-0073525365 (McGraw Hill) 2015 with online

"Foundations in Microbiology 9th edition"
ISBN-13: 978-0077731052 (McGraw Hill) 2015 with online