Escondido Union High School District

Medical Biology

EUHSD Board Approval Date: 4/17/18
The EUHSD Medical Biology curriculum document is aligned to the new California Next Generation Science Standards. It identifies what students should be able to know and do by grade level in a comprehensive standards-based course of study. The curriculum document is updated annually based on student academic achievement data, research and best practices, and input from stakeholders. The EUHSD curriculum document contains the following documents and/or information:

A. Course Description  
B. Course Guidelines/Requirements - graduation credit information, transcript information, adopted materials, adopted technology, assessment outline  
C. Instructional Materials References  
D. Scope and Sequence Map with Essential Standards outlined by Unit  
E. References to key essential design and implementation documents

A comprehensive course of study and/or program is designed so that all students have access to the rigorous curriculum necessary to graduate high school demonstrating college and career readiness skills. Student-Centered learning provides opportunity for collaboration, communication, and a robust learning environment and provides opportunities for all students to meet the goals of the district’s Instructional Focus at the time of this writing: “All students communicate their thinking, ideas and understanding by effectively using oral, written and/or non-verbal expression.”

Key design considerations in the transition to the new California Next Generation Science Standards is a focus on changes in pedagogy. The NGSS instructional shifts guide classroom teaching and learning and form the foundation of curriculum and instructional design. Specific references to the key NGSS Instructional shifts are outlined within the 2015/2016 California Science framework document.

The curriculum document is aligned to the California Next Generation Science Standards: [http://www.cde.ca.gov/pd/ca/sc/ngssstandards.asp](http://www.cde.ca.gov/pd/ca/sc/ngssstandards.asp)
Medical Biology Course Description

Medical Biology is a college preparatory laboratory science course aligned to the Next Generation Science Standards. This course is designed to provide students with an understanding of foundational biological concepts through the lens of human biology, public health, and medicine. Students will engage in hands-on inquiry experiments, conduct research, complete simulations, and apply knowledge of biology to explain medical phenomena. Topics include the relationship between science and medicine, cell physiology, genetics, evolution, and ecology with an emphasis on public health.

<table>
<thead>
<tr>
<th>Course Requirements</th>
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<tbody>
<tr>
<td><strong>Course Length:</strong> Year Long</td>
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<tr>
<td><strong>UC/CSU Requirement:</strong> Meets UC/CSU “d” requirements</td>
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<tr>
<td><strong>Course Number (Semester A):</strong> 3659</td>
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<td><strong>Course Number (Semester B):</strong> 3660</td>
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<tr>
<td><strong>Credits (Semester A):</strong> 5 Biological Science</td>
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<tr>
<td><strong>Required Prerequisite/s:</strong> Completion or Concurrent Enrollment in Algebra 1 or Math 1 (Integrated)</td>
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<tr>
<td><strong>Board Approval Date (Curriculum):</strong> 4/17/18</td>
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<tr>
<td><strong>Core Instructional Material/s:</strong> None</td>
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<tr>
<td><strong>Technology and Resource/s:</strong></td>
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<tr>
<td><em>Individual student computer</em></td>
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<tr>
<td><em>Probeware</em></td>
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<tr>
<td><em>Variety of classroom laboratory equipment</em></td>
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<tr>
<td><em>Interactive Curriculum document with rubrics and detailed performance tasks plans</em></td>
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<td><strong>Assessment/s:</strong></td>
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Meeting the Needs of ELs:

- Utilize the student information system to acquire the language levels of EUHSD English Learners.
- In 2012, the CA Department of Education adopted new language level proficiency descriptors and new EL state standards. Visit the following website to learn more about those new descriptors and corresponding standards: [http://www.cde.ca.gov/sp/el/er/documents/eldstdspublication14.pdf](http://www.cde.ca.gov/sp/el/er/documents/eldstdspublication14.pdf)
- In 2014, the CA Department of Education adopted new ELA-ELD Framework, with specific strategies designed to meet the needs of EL students. Visit the following URL to learn more about the new frameworks: [http://www.cde.ca.gov/ci/rl/cf/documents/elaelfwchapter11.pdf](http://www.cde.ca.gov/ci/rl/cf/documents/elaelfwchapter11.pdf)
The Scope and Sequence Guide is a California standards based document that delineates the standards based skills students are expected to know and do in order to meet College and Career Readiness expectations. Each unit of study in the Scope and Sequence document is designed to build upon the previous unit and/or prerequisite coursework in support of student mastery of specific standards based skills. The Scope and Sequence document provides the framework of understanding for key assignments, key assessments, and instructional resources and strategies that serve to assist students in meeting unit learning objectives. The document will be updated annually with input from all stakeholders.

In coursework requiring reading and writing, the following standards are not specifically stated in any one unit of study, but are the result of implementation throughout the curriculum as students participate in reading, writing, and speaking/listening standards based activities.

- By the end of grade 11, students will read and comprehend literary nonfiction in the grades 11-CCR text completely and proficiently, with scaffolding as needed at the high range. (Reading Informational Text Standard 10)
- Students will write routinely over extending time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks and purposes. (Writing Standard 10)
- “To be college and career ready, students must have ample opportunities to take part in a variety of rich and structured conversations – as part of a whole class, in small groups, and with a partner – build around important content in various domains. They must be able to contribute appropriately to conversations, make comparisons and contrasts, and analyze and synthesize a multitude of ideas according to the standards of evidence appropriate to a particular discipline.” (Standards for ELA Anchor Standards for Speaking/Listening)

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<th>Unit</th>
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<td>2: Cell Physiology</td>
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<td>3: Central Dogma</td>
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<td>4: Heredity</td>
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<td>5: Evolution</td>
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<td>6: Ecology</td>
<td>2</td>
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<td>7: Project</td>
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# Medical Biology Scope and Sequence

## Unit 1 – Science and Medicine

**Length:** 3 Weeks

### Unit Description:
This introductory unit exposes students to key terms of the scientific process and how the process applies to medical diagnosis. They will learn the importance of laboratory safety. Through hands-on, inquiry experiences students will learn how to use various equipment used in medical biology laboratories to make measurements.

### Focus Unit Standards:

<table>
<thead>
<tr>
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<td>DCI</td>
<td>Disciplinary Core Ideas</td>
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**HS-ETS1-2** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

**Optimizing the Design Solution:** Criteria may need to be broken down into simpler ones that can be approaches systematically, and decisions about the priority of certain criteria over others (tradeoffs) may be needed. (HS-ETS1-2)

**HS-ETS1-3.** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural and environmental impacts.

**Developing Possible Solutions:** 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. (HS-ETS1-3)

### Crosscutting Concepts:
- Systems and system models

### Science and Engineering Practices:
- Constructing explanations and designing solutions
- Using mathematics and computational thinking

### Key Learning Objectives:

Students will...
- Explain and use the scientific process/method to answer a medical or scientific question.
- Conduct a simple experiment to demonstrate their understanding of the scientific process.
- Demonstrate proper use of a variety of laboratory equipment to make accurate measurements.
- Describe and demonstrate proper laboratory safety protocols.
- Properly use terminology associated with experimentation (variables, hypothesis, purpose, data) and medicine.

**Essential Questions:**
- How is the scientific process used in medical diagnosis?
- Why are laboratory skills necessary for proper diagnosis?

### Unit Assignments & Assessments:

1-1 The Scientific Process in Diagnosis:
- Students will learn about the scientific process as it applies to medical diagnoses. The activity is set up as patient rooms (stations) with several patients that require a diagnosis. Students will use inquiry and the scientific method to analyze patient symptoms and perform tests to determine a diagnosis for each patient.

1-2 Scientific Measurements & Equipment:
- Students will become more familiar with common measurements and equipment used in the medical biology labs for this course. They will do a variety of tasks for medical applications that has them creating ratios & percentages, measuring mass & volume, graphing, measuring length, making observations, measuring time, research and references, and measuring temperature.

1-3 Portfolio/Interactive Notebook:
- Students will create a portfolio that will serve as storage of their lab reports, research projects (short and long term), and other key documents and learning experiences. Teachers may choose to utilize a print or digital notebook.

1-4 Lab Safety:
- Students will participate in lab safety training. Students will participate in a written lab safety test. Students must complete the test with at least 80% accuracy.

### Assessments:
- 1-1: CER
- 1-2: Lab Practical
- 1-3: Notebook Rubric
- 1-4: Safety Quiz
Medical Biology Scope and Sequence
Unit 2 – Cell Physiology
Length: 9 Weeks

Unit Description: Students identify and explain the characteristics of living things. They analyze the structural organization in the human body and the role of homeostasis in keeping people alive. Students study and perform experiments using the various macromolecules that comprise an organism. Through inquiry investigations, students learn the cell on an anatomical and physiological level, including the bioenergetic processes. Students create models of cell division to better understand cancer and investigate how different doses of chemotherapy drugs affect cell function.

Focus Unit Standards:
PE = Performance Expectations (White)
DCI = Disciplinary Core Ideas

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. [Assessment Boundary: Assessment does not include identification of specific cell or tissue types, whole body systems, specific protein structures and functions, or the biochemistry of protein synthesis.]

Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1)

HS-LS1-2 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. [Clarification Statement: Emphasis is on functions at the organism system level such as nutrient uptake, water delivery, and organism movement in response to neutral stimuli. An example of an interacting system could be an artery depending on the proper function of elastic tissue and smooth muscle to regulate and deliver the proper amount of blood within the circulatory system.] [Assessment Boundary: Assessment does not include interactions and functions at the molecular or chemical reaction level.]

Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. (HS-LS1-2)

HS-LS1-3 Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis. [Clarification Statement: Examples of investigations could include heart rate response to exercise, stomate response to moisture and temperature, and root development in response to water levels.] [Assessment

Key Learning Objectives:

Students will…
- Identify and explain the basic characteristics of a living thing (e.g., cells, homeostasis, evolve, energy, reproduce, respond to the environment, genetics, growth).
- Explain and describe the basic structure (organelles and cell membrane) and function of cells in single (prokaryote) and multicellular organisms (eukaryote).
- Use a model to explain that multicellular organisms have a structural organization that has a critical function for the organism (e.g., cells, tissues, organs, organ systems).
- Design and perform an experiment to look at the role of homeostasis in multicellular organisms with a focus on basic feedback mechanisms.
- Make use a model to show how people use cellular respiration to break down food molecules to transfer energy and matter. (not steps of cellular respiration)

Unit Assignments & Assessments:

2-1 Cell Specialization and Systems:
- Students will study and observe the function of organ systems and the specialized cells that form those systems while diagnosing a medical condition affecting those systems. The lab is separated into several patients/stations, each including symptom comparison, cellular image comparison, and a diagnostic test. The body systems covered include digestive, immune, skeletal, nervous, and respiratory. Students observe how a disease localized to a single body system can affect and create symptoms in multiple body systems.

2-2 Macromolecules:
- Students will make and use models to perform dehydration synthesis and hydrolysis on carbohydrates, proteins, lipids, and nucleic acids. Students will experimentally observe how digestive enzymes work to break down macromolecules during digestion. Lab groups also have the opportunity to test common food items for macromolecules. The activities focus on the presence of carbon, hydrogen, oxygen, and nitrogen in the structure of monosaccharides, amino acids, fatty acids, and nucleotides.

2-3 Homeostasis and Feedback:
- In this lab, students will be performing an experiment to look at homeostatic mechanisms within a human system. Students will interpret the results and report the findings.

2-4 Cellular Respiration:
- Students will have the opportunity to perform experiments to observe aerobic and anaerobic respiration in the human body.
Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and function even as external conditions change within the range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. (HS-LS1-3)

**HS-LS1-4 Use a model to illustrate the role of cellular division (mitosis) and the differentiation in producing and maintaining complex organisms.** [Assessment Boundary: Assessment does not include specific gene control mechanisms or rote memorization of the steps of mitosis.]

In multicellular organisms, individual cells grow and then divide in 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 the differentiation produce and maintain a complex organism, composed of system so tissues and organs that work together to meet the needs of the whole organism.

**HS-LS1-5 Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.** [Clarification statement: Emphasis is on illustrating inputs and outputs of matter and the transfer and transformation of energy in photosynthesis by plants and other photosynthesizing organisms. Examples of models could include diagrams, chemical equations, and conceptual models.] [Assessment boundary: Assessment does not include specific biochemical steps.]

The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen.

**HS-LS1-6. Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.** [Clarification Statement: Emphasis is on using evidence from models and simulations to support explanations.] [Assessment Boundary: Assessment does not include the details of the specific chemical reactions or identification of macromolecules.]

<table>
<thead>
<tr>
<th>Essential Questions:</th>
<th>Plan and conduct experiments involving bioenergetics.</th>
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<tbody>
<tr>
<td></td>
<td>Compare and contrast aerobic vs anaerobic respiration.</td>
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<td>Use a model to illustrate what can affect the rates of photosynthesis.</td>
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<td>Use a model to describe the cell cycle with a focus on mitosis and the relationship between parent and daughter cells.</td>
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<td></td>
<td>Properly use a microscope to make slides and identify general cell types.</td>
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<td></td>
<td>Perform an experiment to study the effects of chemotherapy and the effect on “cancerous” cells.</td>
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</tbody>
</table>

**Assessments:**

- 2-1 Lab Practical
- 2-2 Models, CER
- 2-3 CER
- 2-4 Model
- 2-5 Lab Report
- 2-6 Model, Lab Report
- 2-7 Presentation

**2-5 Photosynthesis & Medicine:**

- Students will analyze photosynthesis. Students will do some research on plants that are bioengineered for medical purposes. They will be given the scenario that a plant will be used to create a new medication but this plant must do photosynthesis quickly. They must design and conduct an experiment to determine which factors or plant has the fastest rate of photosynthesis.

**2-6 Mitosis & Cancer:**

- Students will model the cell cycle with a focus on mitosis. Students will perform an experiment to study the effects of chemotherapy and the effect on “cancerous” cells in order to determine the highest concentration that can be used without adversely affecting cell function. Students communicate their findings in a lab report.

**2-7 When Cells Get Sick:**

- Students will choose an infectious disease and will research how the causative agent affects the body on a cellular level. How does it invade the cell? Obtain energy? Disrupt homeostasis? How does the body fight back? Students will research symptoms and specific cells that counteract with the pathogen. Students will communicate their findings.
The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells.

As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. (HS-LS1-6),(HS-LS1-7)

**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.** [Clarification Statement: Emphasis is on the conceptual understanding of the inputs and outputs of the process of cellular respiration.] [Assessment Boundary: Assessment should not include identification of the steps or specific processes involved in cellular respiration.]

As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment. (HS-LS1-7)

**LS2-3** Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions. [Clarification Statement: Emphasis is on conceptual understanding of the role of aerobic and anaerobic respiration in different environments.] [Assessment Boundary: Assessment does not include the specific chemical processes of either aerobic or anaerobic respiration.]

Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. (HS-LS2-3)

**LS2-5** Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere,
and geosphere. [Clarification Statement: Examples of models could include simulations and mathematical models.] [Assessment Boundary: Assessment does not include the specific chemical steps of photosynthesis and respiration.]

Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes. (HS-LS2-5)

The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis. (secondary to HS-LS2-5)

Crosscutting Concepts:
- Systems and system models
- Energy and Matter
- Structure and function
- Stability and Change

Science and Engineering Practices:
- Engaging in argument from evidence
- Developing and using models
- Planning and carrying out investigations
- Constructing explanations and designing solutions
- Analyzing and Interpreting Data
- Obtaining, evaluating and communicating information
**Medical Biology Scope and Sequence**

**Unit 3 – Central Dogma**

**Length: 5 Weeks**

**Unit Description:** Within this unit, students learn how the structure of DNA determines the structure of proteins. This begins with developing a model for the Central Dogma and how it impacts traits for living organisms. Next, students investigate and use technologies to identify how proteins and DNA are used to diagnose medical phenomena. Last, students research technologies used for medical applications to inform public policy.

**Focus Unit Standards:**

<table>
<thead>
<tr>
<th>PE = Performance Expectations (White)</th>
<th>DCI = Disciplinary Core Ideas</th>
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<tbody>
<tr>
<td><strong>HS-LS1-1</strong> 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. [Assessment Boundary: Assessment does not include identification of specific cell or tissue types, whole body systems, specific protein structures and functions, or the biochemistry of protein synthesis.]</td>
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<tr>
<td><strong>HS-LS3-1</strong> Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring. [Assessment Boundary: Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.]</td>
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<tr>
<td><strong>ETS1-1</strong> Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal wants and needs.</td>
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**Key Learning Objectives:**

Students will...

- Use/make a model of the central dogma to describe how the structure of DNA determines the structure of proteins.
- Explain the purpose of DNA and proteins for living organisms and medical applications.
- Perform an experiment (such as an ELISA) to diagnose the presence of a protein for medical purposes.
- Extract a sample of DNA from cells.
- Research various laboratory technologies such as CRISPR or gene therapy to identify how they are used for medical applications.
- Construct an explanation on the idea that regions of DNA called genes can be regulated in multiple ways, which carry out the essential functions of life through systems of specialized cells.
- Evaluate solutions to complex real-world medical problems that use proteins.

**Unit Assignments & Assessments:**

3-1 Central Dogma:
- Students will model transcription and translation. They will use their model to explain the function of DNA and proteins and how the structure of the protein can determine its function.

3-2 Medical Technologies:
- Students will do a variety of experiments to better understand how diseases or medical conditions can be diagnosed. They will extract DNA from cells then do an activity that allows them to identify the presence of a protein.

3-3 Informing Public Policy:
- Students will research various laboratory technologies such as CRISPR, gene therapy, stem cell, vaccinations, etc. to identify how they are used for medical applications. They will engage in a discussion in which students will argue the pros and cons to these technologies. They will write a position paper to inform public policy.

**Assessments:**

- 3-1: Model, CER
- 3-2: Lab Report, Model
- 3-3: Presentation
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. (HS-ETS1-1)

ETS1-3 Evaluate a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

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. (HS-ETS1-3)

Crosscutting Concepts:
- Systems and system models
- Patterns

Science and Engineering Practices:
- Constructing explanations and designing solutions
- Developing and using models
- Planning and carrying out investigations
- Analyzing and Interpreting Data
- Using mathematics and computational thinking
- Engaging in argument from evidence

Essential Questions:
- Why is DNA important to living organisms?
- What roles do proteins play in the human body?
- How has technology advanced medical diagnostics?
Medical Biology Scope and Sequence
Unit 4 – Heredity
Length: 7 Weeks

Unit Description: Within this unit, students investigate the mechanisms for inheritance of genetic traits. Students begin by modeling meiosis. After running a simulation to test if an offspring inherited a trait from a parent, students run an actual gel electrophoresis to look for evidence of familial relation. Next, students engage in a simulated blood typing experience to investigate codominance and heredity. Finally, students demonstrate their understanding of inheritance by playing the role of a geneticist counseling patients.

Focus Unit Standards:
PE = Performance Expectations (White)
DCI = Disciplinary Core Ideas

PE 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. [Assessment Boundary: Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.]

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-LS3-1)

PE 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. [Clarification Statement: Emphasis is on using data to support arguments for the way variation occurs.] [Assessment Boundary: Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.]

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. (HS-LS3-2)

Key Learning Objectives:

Students will...
- Model and explain how meiosis generates haploid cells.
- Properly use the terms associated with genetics: genotype, phenotype, chromosome, chromatid, gene, allele, homozygous, heterozygous, codominant, incomplete dominance, law of segregation, law of independent assortment, monohybrid crosses, pedigree, dihybrid crosses, polygenic traits, gene interactions.
- Use Punnett Squares as a computational model to make a prediction about the phenotypic and genotypic ratios of offspring.
- Use reasoning and valid evidence to describe that new combinations of DNA can arise from several sources, including meiosis, errors during replication, and mutations.
- Analyze karyotypes to identify major chromosomal abnormalities.
- Use or make a model of a pedigree based off of genetic information.
- Research and communication information about genetic disorders associated with humans.

Unit Assignments & Assessments:

4-1 Modeling Meiosis:
- Students model the basic stages of meiosis to show the relationship between parent and daughter cells. Students will be able to explain how sex cells are derived from oocytes and spermatocytes.

4-2 Electrophoresis:
- Students run a simulation of electrophoresis and analyze the results to determine if an offspring has inherited a gene from their parent. Students then run an actual gel electrophoresis to test for the presence of a heritable genetic disease.

4-3 Blood Types and Transfusions:
- Students perform an experiment to test “blood” samples to identify blood type. These findings are used to make recommendations for the type of blood that the patient can receive.

4-4 (End of Unit) Karyotypes: Diagnosing Chromosome Disorders:
- Students use genetic information to synthesize a pedigree and calculate the risk that an individual will or will not be affected by the disease. Using provided patient chromosomes, they will assemble a human karyotype and determine whether the patient has a chromosomal mutation. Then, they research the diagnosed disease and prepare an informational packet of their findings.
**PE LS3-3**: Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population. [Clarification Statement: Emphasis is on the use of mathematics to describe the probability of traits as it relates to genetic and environmental factors in the expression of traits.] [Assessment Boundary: Assessment does not include Hardy-Weinberg calculations.]

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-LS3-2),(HS-LS3-3)

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<td>• Asking questions and defining problems</td>
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- Perform simulations and experiments to analyze genetic relationships (such as electrophoresis).

**Essential Questions:**
- How do offspring inherit traits from their parents?
- Why does identification of blood type matter?
- What are different ways in which genetic diseases are identified?

**Assessments:**
- 4-1: Model, CER
- 4-2: CER
- 4-3: Lab Practical
- 4-4: Presentation
# Medical Biology Scope and Sequence

## Unit 5 – Evolution

### Length: 4 Weeks

**Unit Description:** In this unit, students analyze evolution through the lens of public health. They perform hands-on activities to identify the evidence and mechanisms of evolution. Students perform experiments and analyze the data in order to explain how a population can evolve over time and how this has led to antibiotic resistance. They generate a public safety announcement based on their findings.

### Focus Unit Standards:

- **PE = Performance Expectations (White)**
- **DCI = Disciplinary Core Ideas**

#### HS-LS4-1 Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence. [Clarification Statement: Emphasis is on a conceptual understanding of the role each line of evidence has relating to common ancestry and biological evolution. Examples of evidence could include similarities in DNA sequences, anatomical structures, and order of appearance of structures in embryological development.]

Genetic information provides evidence of evolution. DNA sequences vary among species, but there are many overlaps; in fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence. (HS-LS4-1)

#### 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. [Clarification Statement: Emphasis is on using evidence to explain the influence each of the four factors has on number of organisms, behaviors, morphology, or physiology in terms of ability to compete for limited resources and subsequent survival of individuals and adaptation of species. Examples of evidence could include mathematical models such as simple distribution graphs and proportional reasoning. [Assessment Boundary: Assessment does not include other mechanisms of evolution, such as genetic drift, gene flow through migration, and co-evolution.]

Evolution is a consequence of the interaction of four factors: (1) the potential for a species to increase in number, (2) the genetic variation of individuals in a species due to mutation

### Key Learning Objectives:

**Students will…**

- Obtain, evaluate, and communicate the importance of the historical background of evolution and the development of evolutionary theory and coevolution.
- Explain the role of evolution on the survival of a species.
- Plan and carry out investigations involving natural, artificial, and/or sexual selection and its impact on evolution.
- Develop and use graphical models that demonstrate human impact on evolution.
- Construct a model/explanation based on evidence that the process of evolution primarily results from four factors. (e.g., natural selection, mutation, gene flow/migration, genetic drift).

### Essential Questions:

- What is the evidence for and causes of evolution?
- How have humans impacted the evolution of microbes?
- Why is evolution important to the medical field?

### Unit Assignments & Assessments:

#### 5-1 Evidences of Evolution:

- Through a hands-on activity, students acquire evidence for evolutionary theory and discover how these evidences can be related to humans, health and how they may contribute to medical research. Students will communicate the findings.

#### 5-2 Natural Selection Experiment:

- Students will perform an experiment to test for the presence of an enzyme (ex. lactase) within two related, yet isolated populations. Students will then generate an explanation for how natural selection could have led to the adaptation of their population.

#### 5-3 Adapting to the Environment:

- Students simulate the increase or decrease of a mutation in a population over several generations. The data will be evaluated to determine how the change in the environmental conditions result in an increase in the number of individuals with a variation. Students will hypothesize and provide an explanation and model for how these populations could results over time in the emergence of a new species.

#### 5-4 Evolution in Action:

- Students investigate the use of antibiotics, hygiene practices and the population growth to determine the effects of evolution on microorganisms. They perform an experiment and research data to identify the evolutionary path of diseases. Students will make a public health recommendation about their findings.
and sexual reproduction, (3) competition for an environment’s limited supply of the resources that individuals need in order to survive and reproduce, and (4) the ensuing proliferation of those organisms that are better able to survive and reproduce in that environment. (HS-LS4-2)

**HS-LS4-3** Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait. [Clarification Statement: Emphasis is on analyzing shifts in numerical distribution of traits and using these shifts as evidence to support explanations.] [Assessment Boundary: Assessment is limited to basic statistical and graphical analysis. Assessment does not include allele frequency calculations.]

Adaptation also means that the distribution of traits in a population can change when conditions change. (HS-LS4-3)

The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. (HS-LS4-3)

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. (HS-LS4-2),(HS-LS4-3)

**HS-LS4-4** Construct an explanation based on evidence for how natural selection leads to adaptation of populations. [Clarification Statement: Emphasis is on using data to provide evidence for how specific biotic and abiotic differences in ecosystems (such as ranges of seasonal temperature, long-term climate change, acidity, light, geographic barriers, or evolution of other organisms) contribute to a change in gene frequency over time, leading to adaptation of populations.]

Natural selection leads to adaptation that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not. (HS-LS4-3),(HS-LS4-4)

**HS-LS4-5** Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

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**5-5 Survival of the Fittest Through Immunity:**
- Students do a simulated “test” to show the immunity of certain individuals within a population to a disease. Students investigate real world scenarios to understand how human immunity to disease has had an impact on the survival of certain individuals within a population and how this affects the evolution of the disease and the population of people (such as small pox, HIV, Spanish Flu, malaria, Ebola, etc.).

**Assessments:**
- 5-1: Presentation
- 5-2: CER
- 5-3: Model
- 5-4: Lab Report, Presentation
- 5-5: Report
Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species’ evolution is lost. (HS-LS4-5)

**HS-LS4-6 Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.** [Clarification Statement: Emphasis is on designing solutions for a proposed problem related to threatened or endangered species, or to genetic variation of organisms for multiple species.]

Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline—and sometimes the extinction—of some species. (HS-LS4-5),(HS-LS4-6)

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; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (HS-ETS1-4)

Humans depend on the living world for the resources and other benefits provided by biodiversity. However, human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. (HS-LS4-6, secondary to HS-LS2-7)

**Crosscutting Concepts:**
- Systems and system models
- Cause and effect: mechanism and explanation
- Patterns
- Scale/Proportion and Quantity
<table>
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<th>Science and Engineering Practices:</th>
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<td>• Engaging in argument from evidence</td>
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<td>• Developing and using models</td>
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<tr>
<td>• Planning and carrying out investigations</td>
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<td>• Analyzing and Interpreting Data</td>
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<td>• Using mathematics and computational thinking</td>
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<td>• Constructing explanations and designing solutions</td>
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<td>• Obtaining, evaluating and communicating information</td>
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Medical Biology Scope and Sequence

Unit 6 – Ecology
Length: 6 Weeks

Unit Description: In this unit, students investigate the role of organisms within their ecosystems, with a specific emphasis on human ecosystems and public health. Organism interactions and how this can affect a population and/or individual species will be analyzed. Students explain how energy and matter cycles within the environment. Students take an investigative approach to better understand how human interactions can affect the overall health of macro and micro ecosystems.

Focus Unit Standards:

PF = Performance Expectations (White)
DCI = Disciplinary Core Ideas

**HS-LS1-2 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.**

[Clarification Statement: Emphasis is on functions at the organism system level such as nutrient uptake, water delivery, and organism movement in response to neural stimuli. An example of an interacting system could be an artery depending on the proper function of elastic tissue and smooth muscle to regulate and deliver the proper amount of blood within the circulatory system.] [Assessment Boundary: Assessment does not include interactions and functions at the molecular or chemical reaction level.]

Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. (HS-LS1-2)

**HS-LS1-3 Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.**

[Clarification Statement: Examples of investigations could include heart rate response to exercise, stomate response to moisture and temperature, and root development in response to water levels.] [Assessment Boundary: Assessment does not include the cellular processes involved in the feedback mechanism.]

Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and function even as external conditions change within the range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system (HS-LS1-3)

<table>
<thead>
<tr>
<th>Crosscutting Concepts:</th>
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<tr>
<td>• Structure and function</td>
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<td>• Systems and system models</td>
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<td>• Patterns</td>
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Key Learning Objectives:

Students will...

- Make and use graphical models to explain how different factors affect biodiversity and populations.
- Use graphs to identify the carrying capacity and what these limits result from.
- Compare and contrast species, populations and ecosystems.
- Plan and carry out investigations that relate to matter and energy transfer within a system.
- Use mathematical representation of the food web to identify the transfer of energy and matter between trophic levels (ecological pyramids).
- Identify and explain an autotroph (producers) and heterotroph (consumers) and their roles in ecosystems.
- Use or make a model to explain the relationships of organisms within ecosystems (food webs and food chains).
- Make a correlation between environmental ecosystems and ecosystems within the human body.
- Plan and conduct an experiment to examine biodiversity.

Unit Assignments and Assessments:

6-1 Carrying Capacity:

- Students use mathematical and computational models to represent and or support carrying capacity of ecosystems at different scales. The models include logistic and exponential growth and focus on population dynamics that impact or influence human health.

6-2 Cycling of Matter and Energy:

- Students participate in a hands-on activity to simulate how energy flows through a food chain. They will calculate the amount of energy lost at each step. Students construct a model to show how energy and matter flow through the environment to humans. Then they construct a biomass and energy pyramid for an ecosystem that involves humans.

6-3 The Human Ecosystems:

- Students research the various ecosystems within the human body. They make a correlation between how the body ecosystems behaves like an environmental ecosystem, identifying major microorganisms involved in keeping a person healthy as well as how energy and matter flow within this system. They present their findings to their peers.

6-4 Biodiversity and Health:

- Students conduct an experiment to examine the biodiversity within the ecosystems. Students analyze how changing the ecosystem can impact biodiversity and populations. Students share their findings in a lab
<table>
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<th>Essential Questions:</th>
<th>6-5 Bioaccumulation:</th>
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<tr>
<td>- What role do humans in ecosystems?</td>
<td>- Students model bioaccumulation of a chemical within a population (Example: mercury in aquatic food chains and the bioaccumulation of tetra-ethyl lead within fat cells). Modeling is used to demonstrate how bioaccumulation can occur at the environmental and organismal levels. Students then research and design a solution to mitigate the bioaccumulation of the substance of their choice at the environmental and/or organismal levels.</td>
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<td>- How does energy and matter flow through an ecosystem?</td>
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<td>- How do epidemics and global health crises affect human populations?</td>
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**Science and Engineering Practices:**

- Engaging in argument from evidence
- Obtaining, evaluating and communicating information
- Developing and using models
- Asking and defining problems
- Planning and carrying out investigations
- Analyzing and interpreting data
- Using mathematics and computational thinking

**Assessments:**

- 6-1: Model
- 6-2: Lab Practical, Model
- 6-3: Model
- 6-4: Lab Report, CER
- 6-5: Model, Presentation
- 6-6: Presentation
## Medical Biology Scope and Sequence
### Unit 7 – Project
#### Length: 2 Weeks

**Unit Description:** In this culminating unit, students will participate in a project that involves the skills they have acquired throughout the school year such as research, analysis, interpretation, engaging in argument from evidence and constructing explanations.

### Focus Unit Standards:
- **PE = Performance Expectations (White)**
- **DCI = Disciplinary Core Ideas**

**ETS1-2** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (HS-ETS1-2)

### Crosscutting Concepts:
- Systems and system models
- Cause and effect: mechanism and explanation

### Science and Engineering Practices:
- Engaging in argument from evidence
- Analyzing and Interpreting Data
- Constructing explanations and designing solutions
- Obtaining, evaluating and communicating information
- Asking questions and defining problems

### Key Learning Objectives:
- **Students will...**
  - Analyze and interpret the case study of an individual to create a diagnosis.
  - Research diseases using the internet.
  - Obtain, evaluate, and communicate the possible solutions for a patient diagnosed with a disease.

### Essential Questions:
- What information is needed to diagnose a patient?

### Unit Assignments and Assessments:

**7-1 When People Get Sick:**
- Students will analyze the case study of a person who is sick. The case studies will involve diseases that provide symptoms that would permit students to use the skills they have acquired over the year to create a diagnosis using evidence from the patient’s file. Students will have to provide a prognosis and communicate possible treatment solutions for the patient.

**Assessments:**
- 7-1: Presentation