FREEHOLD REGIONAL HIGH SCHOOL DISTRICT

OFFICE OF CURRICULUM AND INSTRUCTION

INTERNATIONAL BACCALAUREATE PROGRAM

BIOLOGY HL, YEAR 2

Grade Level: 12

Credits: 5

BOARD OF EDUCATION ADOPTION DATE:

AUGUST 29, 2016

FREEHOLD REGIONAL HIGH SCHOOL DISTRICT

Board of Education

Mr. Heshy Moses, President
Mrs. Jennifer Sutera, Vice President
Mr. Vincent Accettola
Mr. William Bruno
Mrs. Elizabeth Canario
Mr. Samuel Carollo
Mrs. Amy Fankhauser
Mrs. Kathie Lavin
Mr. Michael Messinger

Central Administration

Mr. Charles Sampson, Superintendent
Dr. Nicole Hazel, Chief Academic Officer
Dr. Jeffrey Moore, Director of Curriculum and Instruction
Ms. Stephanie Mechmann, Administrative Supervisor of Curriculum & Instruction
Dr. Nicole Santora, Administrative Supervisor of Curriculum & Instruction

Curriculum Writing Committee

Ms. Lynn Conrad

Supervisor

Ms. Mary Hough

BIOLOGY HL, YEAR 2

COURSE PHILOSOPHY

The International Baccalaureate Organization provides the following philosophy: *"Biology is the study of life. The first organisms appeared on the planet over 3 billion years ago and, through reproduction and natural selection, have given rise to the 8 million or so different species alive today. Estimates vary, but over the course of evolution 4 billion species could have been produced. Most of these flourished for a period of time and then became extinct as new, better adapted species took their place. There have been at least five periods when very large numbers of species became extinct and biologists are concerned that another mass extinction is under way, caused this time by human activity. Nonetheless, there are more species alive on Earth today than ever before. This diversity makes biology both an endless source of fascination and a considerable challenge.*

An interest in life is natural for humans; not only are we living organisms ourselves, but we depend on many species for our survival, are threatened by some and co-exist with many more. From the earliest cave paintings to the modern wildlife documentary, this interest is as obvious as it is ubiquitous, as biology continues to fascinate young and old all over the world.

The word "biology" was coined by German naturalist Gottfried Reinhold in 1802 but our understanding of living organisms only started to grow rapidly with the advent of techniques and technologies developed in the 18th and 19th centuries, not least the invention of the microscope and the realization that natural selection is the process that has driven the evolution of life.

Biologists attempt to understand the living world at all levels using many different approaches and techniques. At one end of the scale is the cell, its molecular construction and complex metabolic reactions. At the other end of the scale biologists investigate the interactions that make whole ecosystems function.

Many areas of research in biology are extremely challenging and many discoveries remain to be made. Biology is still a young science and great progress is expected in the 21st century. This progress is sorely needed at a time when the growing human population is placing ever greater pressure on food supplies and on the habitats of other species, and is threatening the very planet we occupy."

COURSE DESCRIPTION

The International Baccalaureate Organization provides the following description: *"Group 4 students at standard level (SL) and higher level (HL) undertake a common core syllabus, a common internal assessment (IA) scheme and have some overlapping elements in the option studied. They are presented with a syllabus that encourages the development of certain skills, attributes and attitudes, as described in the "Assessment objectives" section of the guide. While the skills and activities of group 4 science subjects are common to students at both SL and HL, students at HL are required to study some topics in greater depth, in the additional higher level (AHL) material and in the common options. The distinction between SL and HL is one of breadth and depth."*

COURSE SUMMARY	
COURSE GOALS	
CG1: Students will design insightful and ethical investigations to solve biological issues by using appropriate research protocols and experimental procedures. CG2: Students will assess scientific problems and develop solutions by utilizing scientific inquiry to develop hypotheses, analyze data, and communication their conclusions.	
COURSE ENDURING UNDERSTANDINGS	COURSE ESSENTIAL QUESTIONS
CEU1: Scientific experimentation, data analysis, technology, and research are used to solve real-world problems.	CEQ1a: How do we investigate and solve problems to explain the natural world? CEQ1b: What constitutes useful scientific evidence? CEQ1c: How do scientists collaborate and communicate scientific information?
CEU2: Living systems share common characteristics and can be classified based on those characteristics.	CEQ2a: How do classification schemes remain the same or change with new ideas and technology? CEQ2b: There's a saying that the apple doesn't fall far from the tree. How does genetics both prove and disprove this? CEQ2c: If everything is truly interdependent, can anything be independent?
CEU3: Homeostatic mechanisms of biological systems are influenced by changes in the system's environment.	CEQ3a: How does environment impact stability? CEQ3b: Is a change in homeostatic balance good or bad?

UNIT GOALS & PACING		
UNIT TITLE	**UNIT GOALS**	**RECOMMENDED DURATION**
Unit 5: Evolution and Biodiversity	Students will analyze the biodiversity on Earth and analyze the evolutionary history of organisms.	4 weeks
Unit 6: Human Physiology	Students will analyze the inter-relatedness of the major systems in the human body and evaluate and communicate the effects of this inter-relatedness on the health of an individual.	6 weeks
Unit 7: Nucleic Acids	Students will draw conclusions about the functions of nucleic acids.	3 weeks
Unit 8: Metabolism, Cell Respiration, and Photosynthesis	Students will analyze the interdependency of photosynthesis and metabolism and hypothesize about the effect of any changes.	4 weeks
Unit 9: Plant Biology	Students will analyze major plant structures, and relate the structure to the function of plant parts with regard to transport in xylem and phloem of plants, as well as to growth and reproduction of plants.	4 weeks
Unit 10: Genetics and Evolution	Students will analyze and connect change at the genetic level with biodiversity and evolution.	3 weeks
Unit 11: Animal Physiology	Students will compare organ systems of different phyla and analyze the similarities and differences.	4 weeks
Unit 12: Ecology and Conservation	Students will connect human activities with ecosystems to make predictions about future disruptions and draw conclusions about how to prevent further disruptions.	6 weeks

BIOLOGY HL, YEAR 2 **SUGGESTED DURATION:**
UNIT 5: Evolution and Biodiversity **12 WEEKS**

UNIT OVERVIEW	
UNIT LEARNING GOALS	
Students will analyze the biodiversity on Earth and analyze the evolutionary history of organisms.	
UNIT LEARNING SCALE	
4	In addition to score 3 performances, the student can: • evaluate the validity and application of data generated; • propose solutions to topic problems; and • identify and explain improvements to topic investigations.
3	The student can: • prove that evolution occurs when heritable characteristics of a species change; • develop a logical argument citing examples that adaptive radiation occurs; • analyze the properties of divergence and convergence and how they affect evolution; • investigate the process of natural selection and how adaptations affect it; • correlate natural selection to mutation, meiosis, and sexual reproduction; • apply the concept of binomial nomenclature universality and explain the advantages of this; • draw conclusions about the taxonomic process and explain why changes have occurred since its inception; and • relate the science of cladistics to evolutionary change.
2	The student sometimes needs assistance from a teacher, makes minor mistakes, and/or can do the majority of level 3 performances.
1	The student needs assistance to avoid major errors in attempting to reach score 3 performances.
0	Even with assistance, the student does not exhibit understanding of the performances listed in score 3.

ENDURING UNDERSTANDINGS	ESSENTIAL QUESTIONS
EU1: Biological evolution is supported by multiple lines of empirical evidence.	EQ1a: How can patterns, trends, and discrepancies provide evidence of evolution? EQ1b: How much evidence is required to support the theory of evolution by natural selection? What kind of counter evidence would be used to refute the theory of evolution by natural selection?
EU2: The diversity of life has evolved and continues to evolve by natural selection.	EQ2a: What current changes in the environment could affect our future evolution? EQ2b: Is human natural selection still occurring?
EU3: Species are named and classified using an internationally agreed upon system.	EQ3: Why should classification systems in science be standard throughout the world?
EU4: The ancestry of groups of species can be deduced by comparing their base of amino acid sequences.	EQ4: How can cladistics change theories of common ancestry in various species?

COMMON ASSESSMENT	
ALIGNMENT	DESCRIPTION
LG1 EU1, EQ1a, b EU2, EQ2a, b EU3, EQ3 EU4, EQ4 HS-LS4-1, 4 HS-LS2-8 RST.11-12.3, 4 WHST.11-12.1 DOK 4	Students will design/conduct investigations, generate hypotheses, analyze collected data, and generate conclusions through the following laboratory activities: • compare limbs of different animal phyla to investigate homologous structures; • design an experiment to test for antibiotic resistance in bacteria; • construct dichotomous keys to identify species; and • interpret cladograms to compare different species.

TARGETED STANDARDS		
DECLARATIVE KNOWLEDGE	PROCEDURAL KNOWLEDGE	STANDARDS TO INTRODUCE
adaptation adaptive radiation analogous structures cladogram comparative morphology dichotomous key evolution fitness homologous structures natural selection pendactyl limb phylogenetic tree selective breeding vestigial structures	Compare the pendactyl limb of mammals, birds, amphibians and reptiles with different methods of locomotion (DOK 3) Compare and contrast groups of organisms in phylogenetic trees, cladograms and dichotomous keys, including but not limited to characteristics, evolutionary history, and data that could extend the tree (DOK 3) Construct dichotomous keys for use in identifying specimens (DOK 3)	HS-LS4-1 Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.
Galapagos Islands macroevolution melanistic insects	Illustrate the development of melanistic insects in polluted areas (DOK 1) Analyze the adaptions of various species, such as the beaks of finches in the Galapagos, based on contributing factors (DOK 2)	HS-LS4-4 Construct an explanation based on evidence for how natural selection leads to adaptation of populations.
antibiotic resistance microevolution	Analyze the evolution of antibiotic resistance in bacteria (DOK 4)	HS-LS2-8 Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.

DECLARATIVE KNOWLEDGE	PROCEDURAL KNOWLEDGE	STANDARDS TO FURTHER DEVELOP
	Follow precisely a complex multistep procedure when carrying out experiments (DOK 1)	RST.11-12.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
	Attend to precise meaning of terms as they are used in particular scientific or technical contexts (DOK 2)	RST.11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.
	Write arguments that logically sequences claims, reasons, and evidence (DOK 4)	WHST.11-12.1 Write arguments focused on discipline-specific content.

BIOLOGY HL, YEAR 2 **SUGGESTED DURATION:**
UNIT 6: Human Physiology **12 WEEKS**

UNIT OVERVIEW

UNIT LEARNING GOALS

Students will connect the inter-relatedness of the major systems in the human body and evaluate and communicate the effect this inter-relatedness on the health of an individual.

UNIT LEARNING SCALE

4	In addition to score 3 performances, the student can: • evaluate the validity and application of data generated; • propose solutions to topic problems; and • identify and explain improvements to topic investigations.
3	The student can: • analyze the correlation between structure and function of the digestive system; • explain the different methods of membrane transport; • analyze the correlation between structure and function of the circulatory system; • compare the circulatory system to other body systems; • analyze the correlation between structure and function of the immune system; • analyze the correlation between structure and function of the excretory system; • correlate the excretory system with other body systems; • analyze the correlation between structure and function of the nervous system; • correlate the nervous system with other body systems; • analyze the correlation between structure and function of the endocrine system; and • correlate the endocrine system with other body systems.
2	The student sometimes needs assistance from a teacher, makes minor mistakes, and/or can do the majority of level 3 performances.
1	The student needs assistance to avoid major errors in attempting to reach score 3 performances.
0	Even with assistance, the student does not exhibit understanding of the performances listed in score 3.

ENDURING UNDERSTANDINGS	ESSENTIAL QUESTIONS
EU1: Models can help to explain the structures that exist in the human body.	EQ1: How can models be used as representations of real world processes?
EU2: The continued understanding of the structure of the cardiovascular system has allowed for the development of research addressing disease and illness.	EQ2a: Why would theories having to do with the movement of blood in the body be regarded as uncertain? EQ2b: How can the history of discoveries in blood and blood product be used today?
EU3: The human body has structures and processes that resist the continuous threat of invasion by pathogens.	EQ3: Why is it important for the body to have cell processes that change and adapt to invasions by pathogens?
EU4: The lungs are actively ventilated to ensure that gas exchange can occur passively.	EQ4: Could there be alternate mechanisms in the human body to allow for ventilation?
EU5: Neurons transmit the message, synapses modulate the message.	EQ5: Why is an understanding of neurotransmitters and synapses important in the development of pharmaceuticals for the treatment of mental disorders?
EU6: Hormones are utilized in a variety of therapies related to homeostasis and reproduction, such as replacement therapies.	EQ6: Should particular hormone treatments be utilized even if they could lead to health risks?

COMMON ASSESSMENT	
ALIGNMENT	DESCRIPTION
LG1 EU1, EQ1 EU2 EQ2a, b EU3 EQ3 EU4 EQ4 EU5 EQ5 EU6 EQ6 HS-LS1-2, 3, 4 RST.11-12.3, 4 WHST.11-12.1 DOK 4	Students will design/conduct investigations, generate hypotheses, analyze collected data, and generate conclusions through the following laboratory activities: • use of dialysis tubing to model absorption of digested food in the intestine; • design a model to illustrate pressure changes in the heart during the cardiac cycle; • monitor ventilation in humans at rest and after mild and vigorous exercise; • analysis of oscilloscope traces showing resting potentials and action potentials; and • research causes of jet lag and how melatonin can alleviate it.

TARGETED STANDARDS		
DECLARATIVE KNOWLEDGE	PROCEDURAL KNOWLEDGE	STANDARDS TO FURTHER DEVELOP
amylase bile digestive system emulsification gastric fluid nutrition peptidase villi	Produce an annotated diagram of the digestive system (DOK 2) Identify the tissue layers in transverse sections of the small intestine (DOK 2)	HS-LS1-2 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
circulatory system erythrocyte interstitial fluid leukocyte lymphatics plasma serum thrombocyte	Identify blood vessels as arteries, capillaries, or veins from the structure of their walls (DOK 2) Recognize the chambers and valves of the heart and blood vessels (DOK 1)	HS-LS1-3 Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
alveoli carbonic anhydrase respiratory system tidal volume vital capacity	Monitor ventilation in humans at rest and after mild and vigorous exercise, and assess the changes (DOK 4)	HS-LS1-3 Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

DECLARATIVE KNOWLEDGE	PROCEDURAL KNOWLEDGE	STANDARDS TO FURTHER DEVELOP
antibody antigen autoimmune response basophil B-cell eosinophil immune system immunoglobulins macrophage mast cell neutrophil T-cell	Assess the effects of viruses on the immune system (DOK 3)	HS-LS1-3 Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
action potential axons dendrites ganglia membrane potential nervous system neuroglia neurons	Analyze data of resting potentials and action potentials of neurons (DOK 4)	HS-LS1-3 Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
endocrine system glands (adrenal, pituitary) hormone hypothalamus neurotransmitter target cells	Compare similarities and differences between male and female hormones and their effects (DOK 2)	HS-LS1-3 Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
	Follow precisely a complex multistep procedure when carrying out experiments (DOK 1)	RST.11-12.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
	Attend to precise meaning of terms as they are used in particular scientific or technical contexts (DOK 2)	RST.11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.
	Write arguments that logically sequences claims, reasons, and evidence (DOK 4)	WHST.11-12.1 Write arguments focused on discipline-specific content.

BIOLOGY HL, YEAR 2 **UNIT 7: Nucleic Acids**	**SUGGESTED DURATION:** **3 WEEKS**

UNIT OVERVIEW	
UNIT LEARNING GOALS	
Students will draw conclusions about the functions of nucleic acids.	
UNIT LEARNING SCALE	
4	In addition to score 3 performances, the student can: • evaluate the validity and application of data generated; • propose solutions to topic problems; and • identify and explain improvements to topic investigations.
3	The student can: • investigate the idea that DNA structure suggests the mechanism for DNA replication; • compare the various enzymes that are essential for DNA replication; • differentiate between introns and exons; • investigate the process of gene expression and how it is regulated; • differentiate between DNA and RNA; and • compare and contrast the different assemblies of proteins.
2	The student sometimes needs assistance from a teacher, makes minor mistakes, and/or can do the majority of level 3 performances.
1	The student needs assistance to avoid major errors in attempting to reach score 3 performances.
0	Even with assistance, the student does not exhibit understanding of the performances listed in score 3.

ENDURING UNDERSTANDINGS	ESSENTIAL QUESTIONS
EU1: The structure of DNA is ideally suited to its function.	EQ1:Why is knowledge of form important in understanding function?
EU2: Information stored as a code in DNA is copied onto mRNA and there is research evidence that the environment can trigger heritable changes in epigenetic factors.	EQ2: How can the environment trigger heritable changes from DNA to gene expression?
EU3: Information transferred from DNA to mRNA is translated into an amino acid sequence, and research into biogenetics is changing the way we research and understand innate and learned behavior.	EQ3: Why would the nature vs. nurture argument have an effect on the survival of an organism?

COMMON ASSESSMENT	
ALIGNMENT	DESCRIPTION
LG1 EU2, EQ 2 HS-LS1-1 HS-LS3-1, 2 RST.11-12.3, 4 WHST.11-12.1 DOK 4	Students will design/conduct investigations, generate hypotheses, analyze collected data, and generate conclusions through the following laboratory activities: • utilization of molecular visualization software to analyze the association between protein and DNA; and • analysis of DNA fingerprinting and electrolysis.

TARGETED STANDARDS		
DECLARATIVE KNOWLEDGE	PROCEDURAL KNOWLEDGE	STANDARDS TO FURTHER DEVELOP
bacteriophage exon intron Miescher polysomes purine pyrimidine	Analyze the results of various experiments that provided evidence that DNA is the hereditary material (DOK 4) Differentiate between introns and exons, and their purposes (DOK 2) Identify polysomes in electron micrographs of prokaryotes and eukaryotes (DOK 1)	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.
transcription translation	Utilize methods to analyze the association between protein and DNA (DOK 4)	HS-LS3-1 As questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.
		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.
	Follow precisely a complex multistep procedure when carrying out experiments (DOK 1)	RST.11-12.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
	Attend to precise meaning of terms as they are used in particular scientific or technical contexts (DOK 2)	RST.11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.
	Write arguments that logically sequences claims, reasons, and evidence (DOK 4)	WHST.11-12.1 Write arguments focused on discipline-specific content.

BIOLOGY HL, YEAR 2 UNIT 8: Metabolism, Cell Respiration, and Photosynthesis	SUGGESTED DURATION: 4 WEEKS

UNIT OVERVIEW	
UNIT LEARNING GOALS	
Students will analyze the interdependency of photosynthesis and metabolism and hypothesize about the effect of any changes.	
UNIT LEARNING SCALE	
4	In addition to score 3 performances, the student can: • evaluate the validity and application of data generated; • propose solutions to topic problems; and • identify and explain improvements to topic investigations.
3	The student can: • synthesize the idea that metabolic pathways consist of chains and cycles of enzyme catalyzed reactions; • understand that metabolic pathways can be controlled by end product inhibition; • connect the major steps of cell respiration, with their components and products; • formulate why there are many steps to cell respiration; • know the major steps of photosynthesis, and the major components and products; and • formulate why there are many steps to photosynthesis.
2	The student sometimes needs assistance from a teacher, makes minor mistakes, and/or can do the majority of level 3 performances.
1	The student needs assistance to avoid major errors in attempting to reach score 3 performances.
0	Even with assistance, the student does not exhibit understanding of the performances listed in score 3.

ENDURING UNDERSTANDINGS	ESSENTIAL QUESTIONS
EU1: Metabolic reactions are regulated in response to the cell's needs.	EQ1a: Why would metabolic pathways be advantageous for allowing for optimal chemical reactions?
EU2: Energy is converted to a usable form in cell respiration and photosynthesis.	EQ2a: Why does energy need to be converted from one form to another?

COMMON ASSESSMENT	
ALIGNMENT	DESCRIPTION
LG1 EU1, EQ1 EU2, EQ2 HS-LS1-5,6,7 RST.11-12.3, 4 WHST.11-12.1 DOK 4	Students will design/conduct investigations, generate hypotheses, analyze collected data, and generate conclusions through the following laboratory activities: • use of databases from global research studies to identify potential new anti-malarial drugs; • design and conduct an enzyme inhibition experiment; • design and conduct a cellular respiration experiment that tests different environmental factors – collection of data from multiple sources; and • conduct a photosynthesis experiment that demonstrates the cyclic relationship with cellular respiration.

TARGETED STANDARDS		
DECLARATIVE KNOWLEDGE	PROCEDURAL KNOWLEDGE	STANDARDS TO FURTHER DEVELOP
stroma thylakoid	Annotate a diagram to indicate the adaptations of a chloroplast to its function (DOK 3)	HS-LS1-5 Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.
feedback inhibition functional groups	Calculate and plot rates of chemical reactions from raw experimental results (DOK 4) Distinguish different types of inhibition from graphs at specified substrate concentrations (DOK 2)	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.
cristae electron transfer phosphorylation	Analyze diagrams of the pathways of aerobic respiration to deduce where decarboxylation and oxidation reactions take place (DOK 3) Annotate a diagram of a mitochondrion to indicate the adaptations to its function (DOK 3)	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.
	Follow precisely a complex multistep procedure when carrying out experiments (DOK 1)	RST.11-12.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
	Attend to precise meaning of terms as they are used in particular scientific or technical contexts (DOK 2)	RST.11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.
	Write arguments that logically sequences claims, reasons, and evidence (DOK 4)	WHST.11-12.1 Write arguments focused on discipline-specific content.

BIOLOGY HL, YEAR 2 UNIT 9: Plant Biology	SUGGESTED DURATION: 4 WEEKS

UNIT OVERVIEW	
UNIT LEARNING GOALS	
Students will analyze major plant structures, and relate the structure to the function of plant parts with regard to transport in xylem and phloem of plants, as well as to growth and reproduction of plants.	
UNIT LEARNING SCALE	
4	In addition to score 3 performances, the student can: • evaluate the validity and application of data generated; • propose solutions to topic problems; and • identify and explain improvements to topic investigations.
3	The student can: • construct comparisons between transport of water, minerals and gases into and out of plants; • connect the functions of plant hormones and how they aid in plant growth and movement; • hypothesize that success in plant reproduction depends on pollination, fertilization and seed dispersal; and • relate the process of coevolution that has evolved between plants and their pollinators.
2	The student sometimes needs assistance from a teacher, makes minor mistakes, and/or can do the majority of level 3 performances.
1	The student needs assistance to avoid major errors in attempting to reach score 3 performances.
0	Even with assistance, the student does not exhibit understanding of the performances listed in score 3.

ENDURING UNDERSTANDINGS	ESSENTIAL QUESTIONS
EU1: Structure and function are correlated in plants.	EQ1: Why does the structure and function have to be correlated?
EU2: Plants adapt their growth to environmental conditions.	EQ2: How does a nonmotile organism adapt to changes in the environment?
EU3: Reproduction in flowering plants is influenced by the biotic and abiotic environment.	EQ3a: Why would environmental conditions influence reproduction? EQ3b: Why is reproduction in flowering plants influenced by biotic and abiotic factors?

COMMON ASSESSMENT	
ALIGNMENT	DESCRIPTION
LG1 EU1, EQ1 EU2, EQ2 EU3, EQ3 HS-LS1-2,3, RST.11-12.3, 4 WHST.11-12.1 DOK 4	Students will design/conduct investigations, generate hypotheses, analyze collected data, and generate conclusions through the following laboratory activities: • research and comparison experiment of desert plants versus temperate plants; • design and conduct an experiment that analyzes the measurement of transpiration rates using photometers; • design and conduct an experiment that analyzes the effect of temperature or humidity on transpiration rates; • examine xylem and phloem in microscopic images; • analyze the micro propagation of plants; and • design an experiment looking at factors affecting germination in plants.

TARGETED STANDARDS		
DECLARATIVE KNOWLEDGE	PROCEDURAL KNOWLEDGE	STANDARDS TO FURTHER DEVELOP
meristem phloem xylem	Identify xylem and phloem in microscope images of stem and root (DOK 1) Draw the structure of primary xylem vessels in sections of stems based on microscopic images (DOK 1)	HS-LS1-2 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
transpiration vascular tissue	Design an experiment to test hypotheses about the effect of temperature or humidity on transpiration rates (DOK 4) Analyze experimental data measuring phloem transport rates (DOK 3)	HS-LS1-3 Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
feedback mechanisms germination	Design experiments to test hypotheses about factors affecting plant germination (DOK 4)	HS-LS1-3 Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
	Follow precisely a complex multistep procedure when carrying out experiments (DOK 1)	RST.11-12.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
	Attend to precise meaning of terms as they are used in particular scientific or technical contexts (DOK 2)	RST.11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.
	Write arguments that logically sequences claims, reasons, and evidence (DOK 4)	WHST.11-12.1 Write arguments focused on discipline-specific content.

BIOLOGY HL, YEAR 2 **SUGGESTED DURATION:**
UNIT 10: Genetics and Evolution **3 WEEKS**

UNIT OVERVIEW	
UNIT LEARNING GOALS	
Students will analyze and connect change at the genetic level with biodiversity and evolution.	
UNIT LEARNING SCALE	
4	In addition to score 3 performances, the student can: • evaluate the validity and application of data generated; • propose solutions to topic problems; and • analyze and explain improvements to topic investigations.
3	The student can: • compare the process of meiosis to mitosis; • draw conclusions that meiosis is important for variation and evolution of a species; • differentiate between discrete and continuous variation; • prove that the phenotypes of polygenic characteristics tend to show continuous variation; • use chi-squared tests to determine differences between observed and expected frequency distribution of inheritance patterns; • hypothesize how allele frequencies may change over time; and • compare and contrast the different ways speciation may occur.
2	The student sometimes needs assistance from a teacher, makes minor mistakes, and/or can do the majority of level 3 performances.
1	The student needs assistance to avoid major errors in attempting to reach score 3 performances.
0	Even with assistance, the student does not exhibit understanding of the performances listed in score 3.

ENDURING UNDERSTANDINGS	ESSENTIAL QUESTIONS
EU1: Meiosis leads to independent assortment of chromosomes and unique composition of alleles in daughter cells.	EQ1a: Why is crossing over so important to allow for variation of individuals? EQ1b: Why is crossing over important for independent assortment of genes?
EU2: Genes may be linked or unlinked and are inherited accordingly.	EQ2: Why would linked and/or unlinked genes have an effect on inheritance patterns?
EU3: Gene pools change over time.	EQ3a: Why should gene pools change over time? EQ3b: Why would evolution rely on gene pools changing or staying the same?

COMMON ASSESSMENT	
ALIGNMENT	DESCRIPTION
LG1 EU1, EQ1a, b EU2, EQ2, EU3, EQ3a, b HS-LS2-8, HS-LS4-2, 5 HS-LS3-1, 2, 3 RST.11-12.3, 4 WHST.11-12.1 DOK 4	Students will design/conduct investigations, generate hypotheses, analyze collected data, and generate conclusions through the following laboratory activities: • model a construction illustrating the crossing over process during meiosis; • determine genotypic and phenotypic ratios of dihybrid crosses, including chi-square analysis; • determine recombinants involving linked genes; and • compare allele frequencies of geographically isolated populations.

TARGETED STANDARDS		
DECLARATIVE KNOWLEDGE	PROCEDURAL KNOWLEDGE	STANDARDS TO INTRODUCE
	Analyze recombinants in crosses involving two linked genes (DOK 3)	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.
Hardy-Weinberg equation	Connect allele frequencies of geographically isolated populations (DOK 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.
DECLARATIVE KNOWLEDGE	PROCEDURAL KNOWLEDGE	STANDARDS TO FURTHER DEVELOP
	Compare examples of directional, stabilizing and disruptive selection (DOK 3)	HS-LS2-8 Evaluate the evidence for the role of group behavior on individual and species chances to survive and reproduce.
dihybrid cross epistasis gene linkage polygenic inheritance	Calculate the predicted genotypic and phenotypic ratio of offspring of dihybrid crosses involving unlinked autosomal genes (DOK 2) Analyze a chi-square test on data from dihybrid crosses (DOK 3)	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.
chiasmata	Draw diagrams to show chiasmata formed by crossing over of chromosomes (DOK 1)	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.
	Follow precisely a complex multistep procedure when carrying out experiments (DOK 1)	RST.11-12.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
	Attend to precise meaning of terms as they are used in particular scientific or technical contexts (DOK 2)	RST.11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.
	Write arguments that logically sequences claims, reasons, and evidence (DOK 4)	WHST.11-12.1 Write arguments focused on discipline-specific content.

BIOLOGY HL, YEAR 2 **SUGGESTED DURATION:**
UNIT 11: Animal Physiology **4 WEEKS**

UNIT OVERVIEW

UNIT LEARNING GOALS

Students will compare organ systems of different phyla and analyze the similarities and differences.

UNIT LEARNING SCALE

4	In addition to score 3 performances, the student can: • evaluate the validity and application of data generated; • propose solutions to topic problems; and • identify and explain improvements to topic investigations.
3	The student can: • classify various unique immune systems of animals; • compare the similarities and difference between immune systems; • investigate the various ways muscular/skeletal systems can be arranged in different animals; • differentiate between animals that are osmoregulators or osmoconformers; • correlate evolutionary history and habitat with the type of nitrogenous waste in animals; • differentiate between the processes of spermatogenesis and oogenesis; and • interpret the process of embryo and fetal development.
2	The student sometimes needs assistance from a teacher, makes minor mistakes, and/or can do the majority of level 3 performances.
1	The student needs assistance to avoid major errors in attempting to reach score 3 performances.
0	Even with assistance, the student does not exhibit understanding of the performances listed in score 3.

ENDURING UNDERSTANDINGS	ESSENTIAL QUESTIONS
EU1: Immunity is based on recognition of self and destruction of foreign material.	EQ1: Why would there be advantages and disadvantages to an immune system?
EU2: The roles of the musculoskeletal system are movement, support and protection.	EQ2: What would it be like for an animal to be lacking a musculoskeletal system?
EU3: All animals excrete nitrogenous waste products, and some animals also balance water and solute concentrations.	EQ3: What would it be like for an animal to not have an excretory system?
EU4: Sexual reproduction involves the development and fusion of haploid gametes.	EQ4: How can sexual reproduction be a disadvantageous to the evolution of a species?

COMMON ASSESSMENT

ALIGNMENT	DESCRIPTION
LG1 EU1, EQ1, EU2, EQ2 EU3, EQ3 HS-LS1-2,3 RST.11-12.3, 4 WHST.11-12.1 DOK 4	Students will design/conduct investigations, generate hypotheses, analyze collected data, and generate conclusions through the following laboratory activities: • research and analyze the global and United States epidemiological data related to vaccination programs; • analysis of electron micrographs to find the state of contraction of muscle fibers; and • design an experiment to model kidney function and the homeostasis effects.

TARGETED STANDARDS		
DECLARATIVE KNOWLEDGE	PROCEDURAL KNOWLEDGE	STANDARDS TO FURTHER DEVELOP
actin bone marrow cartilage joints muscular system myofibrils myosin osteocyte sarcomeres skeletal system tendon	Analyze and compare diagrams of human muscle fibers, cartilage, and joints (DOK 3)	HS-LS1-2 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
glomerulus nephron renal system	Draw and label a diagram of the human kidney (DOK 1) Annotate diagrams of the nephron (DOK 2) Design a web illustrating the interactive relationship the renal system has with the other major body systems (DOK 3)	HS-LS1-2 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
gametogenesis ovaries reproductive hormones reproductive system seminiferous tubules	Annotate diagrams of the seminiferous tubule and the ovary to show the stages of gametogenesis and maturation (DOK 2)	HS-LS1-2 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
allergen blood transfusion epidemiology Immunization mediated immune response vaccine	Compare antigens on the surface of red blood cells, and how antibody production is stimulated by blood transfusions (DOK 3) Analyze epidemiological data related to vaccination programs (DOK 4)	HS-LS1-3 Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
	Follow precisely a complex multistep procedure when carrying out experiments (DOK 1)	RST.11-12.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
	Attend to precise meaning of terms as they are used in particular scientific or technical contexts (DOK 2)	RST.11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.
	Write arguments that logically sequences claims, reasons, and evidence (DOK 4)	WHST.11-12.1 Write arguments focused on discipline-specific content.

BIOLOGY HL, YEAR 2 **UNIT 12: Option C: Ecology and Conservation**	**SUGGESTED DURATION:** **6 WEEKS**

UNIT OVERVIEW	
UNIT LEARNING GOALS	
Students will connect human activities with ecosystems to make predictions about future disruptions and draw conclusions about how to prevent further disruptions.	
UNIT LEARNING SCALE	
4	In addition to score 3 performances, the student can: • evaluate the validity and application of data generated; • propose solutions to topic problems; and • identify and explain improvements to topic investigations.
3	The student can: • prove that the distribution of species is dependent on carrying capacity and limiting factors; • investigate how interactions between species will have an impact on the ecosystem; • relate how different species niches play a role on the ecosystem; • assess the process of energy flow through an ecosystem; • differentiate how the different types of matter are recycled in ecosystems; • know that disturbances influence the structure and rate of change within ecosystems; • prove how introduced alien species, including humans can have a positive or negative effect on ecosystems; • analyze how pollutants, caused by humans have had impacts on ecosystems; • be able to use indicator species to assess the health of environments; • recognize that richness and evenness are components of biodiversity; and • learn and understand sampling techniques to estimate population size.
2	The student sometimes needs assistance from a teacher, makes minor mistakes, and/or can do the majority of level 3 performances.
1	The student needs assistance to avoid major errors in attempting to reach score 3 performances.
0	Even with assistance, the student does not exhibit understanding of the performances listed in score 3.

ENDURING UNDERSTANDINGS	ESSENTIAL QUESTIONS
EU1: Community structure is an emergent property of an ecosystem.	EQ1a: Why is the distribution of species so dependent on limiting factors, keystone species, and competition? EQ1b: Why is community structure considered an emergent property?
EU2: Changes in community structure affect and are affected by organisms.	EQ2: Why would changes affect evolutionary trends in communities?
EU3: Human activities impact on ecosystem function.	EQ3: Could there be examples of positive human impact on ecosystems?
EU4: Entire communities need to be conserved in order to preserve biodiversity.	EQ4: Could there be a positive result to a decrease in biodiversity?
EU5: Dynamic biological processes impact population density and population growth.	EQ5: Why would limiting factors be top down or bottom up, and would this have different effects on population growth?
EU6: Soil cycles are subject to disruption.	EQ5: How can human impact help or harm soil cycles?

COMMON ASSESSMENT	
ALIGNMENT	DESCRIPTION
LG1 EU1, EQ1a EU2, EQ2 EU3, EQ3 EU5, EQ5 HS-LS2-3, 4, 6, 7 HS-LS4-6 RST.11-12.3, 4 WHST.11-12.1 DOK 4	Students will design/conduct investigations, generate hypotheses, analyze collected data, and generate conclusions through the following laboratory activities: • use of a transect to correlate the distribution of plant and animal species with an abiotic variable; • analysis of a climatogram showing the relationship between temperature, rainfall and the type of ecosystem; • investigation into the effect of an environmental disturbance on an ecosystem; • experiment/model to illustrate biomagnification; • evaluate the effectiveness of eradication programs and biological control as measures to reduce the impact of alien species; • model the growth curve of a simple organism; and • assess the nutrient content of a soil sample.

TARGETED STANDARDS		
DECLARATIVE KNOWLEDGE	PROCEDURAL KNOWLEDGE	STANDARDS TO INTRODUCE
	Draw and label a diagram of the nitrogen cycle (DOK 1)	HS-LS2-3 Construct an revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.
	Critique captive breeding programs and reintroduction of endangered species (DOK 4)	HS-LS2-6 Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions may result in a new ecosystem.
desertification eutrophication	Analyze how humans interfere with nutrient cycling (DOK 3) Evaluate the impact of plastic debris on marine species (DOK 3) Analyze the effects alien species have on ecosystems (DOK 3)	HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
DECLARATIVE KNOWLEDGE	PROCEDURAL KNOWLEDGE	STANDARDS TO FURTHER DEVELOP
	Compare pyramids of energy from different ecosystems (DOK 3)	HS-LS2-4 Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.
coevolution commensalism facultative mutualism interspecific competition obligatory mutualism symbiosis	Infer limits of tolerance and zones of stress related to the distribution of plant and/or animal species (DOK 2) Differentiate the range of ways in which species can interact within a community, including symbiosis (DOK 2)	HS-LS2-6 Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions may result in a new ecosystem
	Evaluate methods used to estimate population size (DOK 4) Compare the effect of natality, mortality, immigration, and emigration on population size (DOK 3)	HS-LS4-6 Evaluate the evidence for the role of group behavior on individual and species chances to survive and reproduce.

DECLARATIVE KNOWLEDGE	PROCEDURAL KNOWLEDGE	STANDARDS TO FURTHER DEVELOP
	Follow precisely a complex multistep procedure when carrying out experiments (DOK 1)	RST.11-12.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
	Attend to precise meaning of terms as they are used in particular scientific or technical contexts (DOK 2)	RST.11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.
	Write arguments that logically sequences claims, reasons, and evidence (DOK 4)	WHST.11-12.1 Write arguments focused on discipline-specific content.