FREEHOLD REGIONAL HIGH SCHOOL DISTRICT

OFFICE OF CURRICULUM AND INSTRUCTION

INTERNATIONAL BACCALAUREATE PROGRAM

BIOLOGY SL, YEAR 2

Grade Level: 12

Credits: 5

BOARD OF EDUCATION ADOPTION DATE:

AUGUST 29, 2016

FREEHOLD REGIONAL HIGH SCHOOL DISTRICT

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BIOLOGY SL, YEAR 2

COURSE PHILOSOPHY

The International Baccalaureate Organization aims to develop inquiring, knowledgeable and caring young people who help to create a better and more peaceful world through intercultural understanding and respect. Biology is the study of life. 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. Biologists attempt to understand the living world at all levels using many different approaches and techniques. 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

Through studying biology, students should become aware of how scientists work and communicate with each other. While the scientific method may take on a wide variety of forms, it is the emphasis on a practical approach through experimental work that characterizes IB Biology SL. During this course, which must include at least 150 instruction hours, students will engage in at least 40 hours on practical activities and scientific investigation. These aims enable students, through the overarching theme of the nature of science, to appreciate scientific study and creativity within a global context through stimulating and challenging opportunities. In addition, students will acquire a body of knowledge, methods and techniques that characterize science and technology. They will be able to analyze, evaluate and synthesize scientific information, develop critical awareness of the need for, and the value of, effective collaboration and communication during scientific activities and develop experimental and investigative skills including the use of current technologies and apply 21st century communication skills in the study of science. Students will, as global citizens, become aware of the ethical implications and limitations of using science and technology, and they will develop an understanding of the relationships amongst scientific disciplines and their influence on other areas of knowledge. 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 communicate 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.	12 weeks
Unit 6: Human Physiology	Students will analyze 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.	12 weeks
Unit 7: 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.	10 weeks

BIOLOGY SL, 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 SL, 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 SL, YEAR 2 **SUGGESTED DURATION:**
UNIT 7: Option C: Ecology and Conservation **10 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; • investigate 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.