Course & Domain: AP BIOLOGY – LIFE SCIENCE **Grade: JUNIOR YEAR**

APPENDIX A NGSS & AP Biology Comparison Chart

What was evaluated and compared? • For this comparison, the specific language of each AP Essential Knowledge (AP EK) statement was compared to the Disciplinary Core Idea (DCI) elements associated with each Next Generation Science Standards (NGSS) Performance Expectation (PE) to determine whether the two share a similar content or conceptual foundation. • The NGSS and the AP course guides are very different in intended format, audience (the NGSS is for all students whereas the AP course guides cover college-level content), and content emphasis, particularly the emphasis in the NGSS on all three components of the foundation boxes. Therefore, this document focuses solely on the overlap of disciplinary content rather than on any similarities related to the practices or crosscutting concepts. When comparing the AP EK content to the NGSS, only the DCI elements associated with each PE were used in the comparison. This is not to be taken as a devaluation of the practices or crosscutting concepts. A discussion of practices and crosscutting concepts can be found on page 23.

How is the chart organized? • The charts are organized by the AP EK statements and include some possible DCI elements that overlap with or build a foundation for the AP content in each EK statement. AP EK statements are not included in the course chart if no similarity was found between them and the NGSS content. • The entirety of the EK text is not included in each row. Most EK statements have a general statement and then multiple supporting parts for the statement. While all parts of the EK text were evaluated for the comparison, the chart only includes the general EK statement. Where appropriate, the comments in each row refer to individual parts of the EK text. For the full EK text, please see the AP Biology Course and Exam Description from College Board. • The full text for each identified DCI is not included in the chart. Only the DCI elements that overlap with or provide a foundation for the AP EK statements are included in the chart.

RESOURCES

file:///C:/Users/pacevich/Downloads/NGSS%20Accelerated%20Model%20Course%20Pathways.pdf (PGS 23-28)

https://secure-media.collegeboard.org/digitalServices/pdf/ap/ap-biology-course-and-exam-description.pdf(NATIONAL STANDARDS)

http://www.biologycorner.com/APbiology/big_ideas.html(BIG IDEAS IN BIOLOGY)

Unit Title: BIG IDEA 1: EVOLUTION

Approximate # of Lessons: SCAFFOLDED THROUGH SCHOOL YEAR AND ALL UNITS.

ASSOCIATED STANDARDS

Students who demonstrate understanding can:

evaluate evidence provided by data to qualitatively and quantitatively investigate the role of natural selection in evolution.

make predictions about the effects of genetic drift, migration and artificial selection on the genetic makeup of a population.

pose scientific questions that correctly identify essential properties of shared, core life processes that provide insights into the history of life on Earth

evaluate evidence provided by a data set in conjunction with a phylogenetic tree or a simple cladogram to determine evolutionary history and speciation

design a plan to answer scientific questions regarding how organisms have changed over time using information from morphology, biochemistry and geology

CROSSCUTTING CONCEPTS

Patterns
Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.

Cause and Effect: Mechanism and Explanation
Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.

Scale, Proportion, and Quantity
In considering phenomena, it is critical to recognize what is relevant at different measures of size, time and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.

Systems and System Models
Defining the system under study – specifying its boundaries and making explicit a model of that system – provides tools for understanding and testing ideas that are applicable throughout science and engineering.

☐ **Energy and Matter: Flows, Cycles, and Conservation**
Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations.

Structure and Function
The way in which an object or living thing is shaped and its substructure determine many of its properties and functions.

Stability and Change
For natural and build systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

SCIENTIFIC AND ENGINEERING PRACTICES

Asking Questions and Defining Problems

A practice of science is to ask and refine questions that lead to descriptions and explanations of how the natural and designed world works and which can be empirically tested.
Engineering questions clarify problems to determine criteria for successful solutions and identify constraints to solve problems about the designed world.
Both scientists and engineers also ask questions to clarify the ideas of others.

Planning and Carrying Out Investigations

Scientists and engineers plan and carry out investigations in the field or laboratory, working collaboratively as well as individually. Their investigations are systematic and require clarifying what counts as data and identifying variables or parameters.
Engineering investigations identify the effectiveness, efficiency, and durability of deigns under different conditions.

Analyzing and Interpreting Data

Scientific investigations produce data that must be analyzed in order to derive meaning. Because data patterns and trends are not always obvious, scientists use a range of tools-including tabulation, graphical interpretation, visualization, and statistical analysis-to identify the significant features and patterns in the data. Scientists identify sources of error in the investigations and calculate the degree of certainty in the results. Modern technology makes the collection of large data sets much easier, providing secondary sources for analysis.
Engineering investigations include analysis of data collected in the tests of designs. This allows comparison of different solutions and determines how well each meets specific design criteria-that is, which design best solves the problem within given constraints. Like scientists, engineers require a range of tools to identify patterns within data and interpret the results. Advances in science make analysis of proposed solutions more efficient and effective.

Developing and Using Models

A practice of both science and engineering is to use and construct models as helpful tools for representing ideas and explanations. These tools include diagrams, drawings, physical replicas, mathematical representations, analogies, and computer simulations.
Modeling tools are used to develop questions, predictions and explanations; analyze and identify flaws in systems; and communicate ideas. Models are used to build and revise scientific explanations and proposed engineered systems. Measurements and observations are used to revise models and designs.

Constructing Explanations and Designing Solutions

The products of science are explanations and the products of engineering are solutions.
The goal of science is the construction of the theories that provide explanatory accounts of the world. A theory becomes accepted when it has multiple lines of empirical evidence and greater explanatory power of phenomena than previous theories.
The goal of engineering design is to find a systematic solution to problems that is based on scientific knowledge and models of the material world. Each proposed solution results from a process of balancing competing criteria of desired functions, technical feasibility, cost, safety, aesthetics, and compliance with legal requirements. The optimal choice depends on how well the proposed solutions meet criteria and constraints.

Engaging in Argument from Evidence

Argumentation is the process by which explanations and solutions are reached.

In science and engineering, reasoning and argument based on evidence are essential to identifying the best explanation for a natural phenomenon or the best solution to a design problem. Scientists and engineers use argumentation to listen to, compare, and evaluate competing ideas and methods based on merits.

Scientists and engineers engage in argumentation when investigating a phenomenon, testing a design solution, resolving questions about measurements, building data models, and using evidence to identify strengths and weaknesses of claims.

Using Mathematics and Computational Thinking

In both science and engineering, mathematics and computation are fundamental tools for representing physical variables and their relationships. They are used for a range of tasks such as constructing simulations; statistically analyzing data; and recognizing, expressing, and applying quantitative relationships.

Mathematical and computational approaches enable scientists and engineers to predict the behavior of systems and test the validity of such predictions. Statistical methods are frequently used to identify significant patterns and establish correlational relationships.

Obtaining, Evaluating, and Communicating Information

Scientists and engineers must be able to communicate clearly and persuasively the ideas and methods they generate. Critiquing and communicating ideas individually and in groups is a critical professional activity.

Communicating information and ideas can be done in multiple ways: using tables, diagrams, graphs, models and equations as well as orally, in writing, and through extended discussions.

Scientists and engineers employ multiple sources to acquire information that is used to evaluate the merit and validity of claims, methods, and designs.

The Performance Expectations above were developed using the following elements from A Framework for K-12 Science Education:

Possible DCIs to be taught concurrently

Chemistry	Physics
PS1.C: Nuclear Processes	ESS2.B: Plate Tectonics & Large-Scale System Interactions
PS3.B: Conservation of Energy & Energy Transfer	PS3.A: Definitions of Energy
PS3.D: Energy in Chemical Processes & Everyday Life	PS3.C: Relationship Between Energy & Forces
ESS2.C: Role of Water in Earth's Surface Processes	ESS2.A: Earth Materials & Systems
ESS2.D: Weather & Climate	

Possible DCIs to be taught concurrently

Biology	Chemistry
LS1.C: Organization for Matter & Energy Flow in Ecosystems	PS1.B: Chemical Reactions
LS2.B: Cycles of Matter & Energy Transfer in Ecosystems	PS3.B: Conservation of Energy & Energy Transfer
	PS3.D: Energy in Chemical Processes & Everyday Life
ESS2.E: Biogeology	ESS2.C: The Roles of Water in Earth Surface Processes
	ESS2.D: Weather & Climate
ESS3.B: Natural Hazards	ESS3.D: Global Climate Change
ESS3.C: Human Impacts on Earth Systems	

Possible DCIs to be taught concurrently

Biology	Physics
LS1.C: Organization for Matter & Energy Flow in Ecosystems	PS3.A: Definitions of Energy
LS2.B: Cycles of Matter & Energy Transfer in Ecosystems	
LS1.D: Information Processing	PS4.A: Wave Properties
ESS1.C: History of Planet Earth	ESS1.A: The Universe and Its Stars
	ESS1.B: Earth & the Solar System
ESS2.E: Biogeology	ESS2.A: Earth Materials
	ESS2.B: Plate Tectonics & Large-Scale System Interactions

AP EK	**NGSS PE(s)**
1.A.1	HS-LS2-6, HS-LS3-2, HS-LS3-3, HS-LS4-2, HS-LS4-3, HS-LS4-4, HS-LS4-5
1.A.2	HS-LS2-7, HS-LS3-2, HS-LS3-3, HS-LS4-2, HS-LS4-3, HS-LS4-4, HS-LS4-6
1.A.4	HS-LS4-1, HS-ESS1-5
1.B.2	HS-LS4-1
1.C.1	HS-LS2-7, HS-LS4-5
1.C.2	HS-LS4-4, HS-LS4-5
1.C.3	HS-LS4-1, HS-LS4-5

LESSON 1 (TITLE): **MICRO/MACROEVOLUTION "BEAN" THERE DONE THAT**

# of Periods Required: 2

The student will…

CALCULATE HARDY WEINBERG
ASSIGN GENOTYPES AND PHENOTYPES
BLINDLY/RANDOMLY COLLECT DATA
LOOK FOR PATTERNS BETWEEN DOMINANCE AND RECESSIVENESS
COMPARE COMPLETE, INCOMPLETE AND CODOMINANCE
DISCUSS FITNESS AND SUCCESS IN AN ECOSYSTEM

ACTIVITY:2 DIFFERENT KINDS OF BEANS WILL BE EQUALLY REPRESENTED WITH IN A PAPER BAG, NUMBERING OVER 30 PER TYPE OF BEAN TO HAVE A STATISTICALLY RELEVENT SAMPLE SIZE ACCORDING TO CHI SQUARE. STUDENTS WILL CHOOSE 2 BEANS AT A TIME AND RECORD THEIR ZYGOSITY WITHIN A TABLE THAT THEY DESIGNED. ANALYSIS OF PAIRING WILL RELATE TO ALLELIC FREQUENCY WITHIN A POPULATIONS GENE POOL, HARDY WEINBERG'S EQUATION WILL BE USED TO CALCULATE THE PERCENT OF EACH NEW GENERATION. THE CLASSIC RATIO OF 1:2:1 IS THE PREDICTED OUTCOME FOR A 2 TRAIT CROSS. THIS ACTIVITY CAN BE MODELED USING AN EXCEL PROGRAM. THIS SHOWS THE POWER OF TECHNOLOGY WHEN TRYING TO PREDICT LARGE POPULATIONS OVER MANY GENERGATIONS. DATA CAN BE COLLECTED IN MINUTES RATHER THAN DECADES OR CENTURIES.

MATERIALS: 2 TYPES OF BEANS, PAPER BAG, EXCEL PROGRAM

ASSESSMENT: FREE RESPONSE QUESTIONS, GRID INS, AND MULTIPLE CHOICE QUESTIONS ARE PROVIDED BY THE COLLEGE BOARD. EVERY TEST IS POSTED TO THE INTERNET AND IS TO BE USED TO ASSESS THE 4 BIG IDEAS. TIME RESTRAINTS SHOULD BE USED WHILE ANSWERING. SHORT FRQS ARE 7 MINUTES, LONG FRQS ARE 17 MINUTES, GRID INS ARE 7 MINUTES, AND MULTIPLE CHOICE ARE 1 MINUTE PER QUESTION. 6 SHORT FRQS AND 2 LONG FRQS MAKE UP THE 90 MINUTE PORTION OF PART 1 OF THE AP TEST, THE EXTRA TIME IS USED AS A MANDATORY PREWRITE PRIOR TO THE START. 63 MULTIPLE CHOICE AND 6 GRID-INS MAKE UP THE 90 MINUTE TEST FOR PART 2. ASSESSMENTS CAN BE DESIGNED IN ANY ORDER AS LONG AS THE TIME FRAME IS ABIDED BY, FOR INSTANCE 1 LONG AND 1 SHORT FRQ MAY BE USED AS A QUIZ. STUDENTS WILL GET A 10 MINUTE PREWRITE AND 24 MINUTES TO COMPLETE THE QUESTIONS. FRQS MUST BE COMPLETED IN BLUE OR BLACK INK, AND MC/GRID IN WITH #2 PENCIL. A 4 FUNCTION CALCULATOR IS ALLOWED AS WELL AS A FORMULA SHEET.

LESSON 2 (TITLE): **ROCK POCKET MOUSE: PREDATOR PREY BEAN PICKING COMPETITION**

# of Periods Required: 3

The student will…

Understand that the environment contributes to determining whether a mutation is advantageous, deleterious, or neutral.

• Mutations that increase fitness of an organism increase in frequency in a population. Students will be able to

• explain how variation, selection, and time fuel the process of evolution; and • analyze and organize data.

ACTIVITY: WATCH THE VIDEO FROM AP CENTRAL ON THE ROCK POCKET MOUSE AND IT'S ABILITY TO BLEND INTO IT'S ENVIRONMENT. THIS MOVIE BRINGS ABOUT THE CONCEPT OF AN ORGANISMS DEPENDENCE ON CAMOUFLAGE, AND HOW THIS CAMOUFLAGE IS A TRIAL AND ERROR, WHERE THE ERROR MEANS YOU DIDN'T BLEND IN, YOU DIE, AND YOU CAN'T PASS ON YOUR GENES. SO ONLY THOSE THAT BLEND MOVE ON AND CONTRIBUTE TO THE GENE POOL. TEAMS WILL BE FORMED AND TRAYS OF AQUARIUM GRAVEL WILL ACT AS THE ENVIRONMENT, THE BEANS WILL BE SCATTERED THROUGHOUT THE GRAVEL. THE COMPETITORS WILL ALL BE PICKING FROM THE SAME TRAY AND THE WINNER WILL BE THE PREDITOR THAT HAS THE MOST BEANS AFTER THE TIMED EVENT. COMPETITORS WILL BE CHALLENGED WITH CONTROLS SUCH AS 3D GLASSES, ONE ARM BEHIND THE BACK, ONE LEG, CHOP STICKS, GLOVES, AND A VARIETY OF OTHER HANDICAPS THAT WILL TEST THEIR ABILITY TO HUNT THE BEAN. IN THE END THE VARIETY OF BEANS WILL BE TABULATED TO FIND WHICH COLOR/SHAPE BEAN WAS THE BEST AT FITTING IN TO THE GRAVEL.

MATERIALS:BEANS OF A VARIETY OF COLORS, GRAVEL, TRAY, TIMER, VARIETY OF HANDICAPS SUCH AS GLOVES, CHOPSTICKS, 3D GLASSES, SPOONS

ASSESSMENT: FREE RESPONSE QUESTIONS, GRID INS, AND MULTIPLE CHOICE QUESTIONS ARE PROVIDED BY THE COLLEGE BOARD. EVERY TEST IS POSTED TO THE INTERNET AND IS TO BE USED TO ASSESS THE 4 BIG IDEAS. TIME RESTRAINTS SHOULD BE USED WHILE ANSWERING. SHORT FRQS ARE 7 MINUTES, LONG FRQS ARE 17 MINUTES, GRID INS ARE 7 MINUTES, AND MULTIPLE CHOICE ARE 1 MINUTE PER QUESTION. 6 SHORT FRQS AND 2 LONG FRQS MAKE UP THE 90 MINUTE PORTION OF PART 1 OF THE AP TEST, THE EXTRA TIME IS USED AS A MANDATORY PREWRITE PRIOR TO THE START. 63 MULTIPLE CHOICE AND 6 GRID-INS MAKE UP THE 90 MINUTE TEST FOR PART 2. ASSESSMENTS CAN BE DESIGNED IN ANY ORDER AS LONG AS THE TIME FRAME IS ABIDED BY, FOR INSTANCE 1 LONG AND 1 SHORT FRQ MAY BE USED AS A QUIZ. STUDENTS WILL GET A 10 MINUTE PREWRITE AND 24 MINUTES TO COMPLETE THE QUESTIONS. FRQS MUST BE COMPLETED IN BLUE OR BLACK INK, AND MC/GRID IN WITH #2 PENCIL. A 4 FUNCTION CALCULATOR IS ALLOWED AS WELL AS A FORMULA SHEET.

Unit Title: BIG IDEA 2: ENERGY

Approximate # of Lessons: SCAFFOLDED THROUGH SCHOOL YEAR AND ALL UNITS

ASSOCIATED STANDARDS
Students who demonstrate understanding can:

explain how biological systems use free energy based on empirical data that all organisms require constant energy input to maintain organization, to grow and to reproduce

predict how changes in free energy availability affect organisms, populations and ecosystems

construct explanations of the mechanisms and structural features of cells that allow organisms to capture, store or use free energy

use calculated surface area-to-volume ratios to predict which cell(s) might eliminate wastes or procure nutrients faster by diffusion

construct models that connect the movement of molecules across membranes with membrane structure and function

explain how internal membranes and organelles contribute to cell functions.

analyze data to identify possible patterns and relationships between a biotic or abiotic factor and a biological system

The student can create representations and models to describe immune responses

CROSSCUTTING CONCEPTS		
X **Patterns** Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them. X **Cause and Effect: Mechanism and Explanation** Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.	X **Scale, Proportion, and Quantity** In considering phenomena, it is critical to recognize what is relevant at different measures of size, time and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance. X **Systems and System Models** Defining the system under study – specifying its boundaries and making explicit a model of that system – provides tools for understanding and testing ideas that are applicable throughout science and engineering.	X **Energy and Matter: Flows, Cycles, and Conservation** Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations. ☐ **Structure and Function** The way in which an object or living thing is shaped and its substructure determine many of its properties and functions. X **Stability and Change** For natural and build systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

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Possible DCIs to be taught concurrently

Chemistry	Physics
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PS3.B: Conservation of Energy & Energy Transfer	PS3.A: Definitions of Energy PS3.C: Relationship Between Energy & Forces
PS3.D: Energy in Chemical Processes & Everyday Life	
ESS2.C: Role of Water in Earth's Surface Processes	ESS2.A: Earth Materials & Systems
ESS2.D: Weather & Climate	

Possible DCIs to be taught concurrently

Biology	Chemistry
LS1.C: Organization for Matter & Energy Flow in Ecosystems	PS1.B: Chemical Reactions
LS2.B: Cycles of Matter & Energy Transfer in Ecosystems	PS3.B: Conservation of Energy & Energy Transfer PS3.D: Energy in Chemical Processes & Everyday Life
ESS2.E: Biogeology	ESS2.C: The Roles of Water in Earth Surface Processes ESS2.D: Weather & Climate
ESS3.B: Natural Hazards	ESS3.D: Global Climate Change
ESS3.C: Human Impacts on Earth Systems	

Possible DCIs to be taught concurrently

Biology	Physics
LS1.C: Organization for Matter & Energy Flow in Ecosystems LS2.B: Cycles of Matter & Energy Transfer in Ecosystems	PS3.A: Definitions of Energy
LS1.D: Information Processing	PS4.A: Wave Properties
ESS1.C: History of Planet Earth	ESS1.A: The Universe and Its Stars ESS1.B: Earth & the Solar System
ESS2.E: Biogeology	ESS2.A: Earth Materials ESS2.B: Plate Tectonics & Large-Scale System Interactions

AP EK	**NGSS PE(s)**
2.A.1	**HS-LS1-7, HS-LS2-4, HS-PS1-4, HS-PS3-4**
2.A.2	**MS-LS1-2, HS-LS1-5, HS-LS1-6, HS-LS1-7, HS-LS2-3, HS-PS1-4, HS-PS3-2**
2.A.3	**HS-LS1-6, HS-LS2-5, HS-ESS2-5**
2.B.1	**MS-LS1-2, HS-PS1-3**

2.B.2	MS-LS1-2, HS-PS3-4
2.B.3	MS-LS1-2
2.C.1	HS-LS1-3
2.C.2	HS-LS1-3
2.D.1	HS-LS2-1, HS-LS2-2, HS-LS2-4, HS-LS2-6
2.D.3	HS-LS2-6, HS-LS2-7, HS-LS4-6
2.E.1	HS-LS1-4, HS-LS3-1, HS-LS3-2
2.E.3	HS-LS2-8, HS-LS4-5

The Performance Expectations above were developed using the following elements from A Framework for K-12 Science Education:

LESSON 1 (TITLE): <u>WHY CAN'T THE BLOB EXIST? SURFACE AREA TO VOLUME RATIO</u>
# of Periods Required: 1

The student will…

PROVE THAT A CUBOIDAL CELL'S VOLUME WILL OVERWHELM IT'S SURFACE AREA TRIGGERING ACTIVIATION OF THE ENZYME CYCLIN TO START M PHASE OF THE CELL CYCLE.

ACTIVITY:WATCH THE TRAILOR FROM THE ORIGINAL MOVIE <u>THE BLOB.</u> ASK THE QUESTION "COULD A BLOB THIS LARGE EVER EXIST? WHY OR WHY NOT? THE ACTIVITY THAN ASKS THE STUDENTS TO PROVE THE SURFACE AREA TO VOLUME RATIO USING A 6 SIDED FIGURE LIKE A CUBE. THIS PROOF WILL SHOW THAT THE WASTE AND NUTRITIONAL NEEDS OF A CELL WHOSE SURFACE AREA CAN'T KEEP UP WITH IT'S VOLUME WILL BASICALLY STARVE OR BECOME INUNDATED WITH WASTE PRODUCT. THIS WILL PROMPT THE CELL TO START DIVISION AND ENTER THE M PHASE OF THE CELL CYCLE. AGAR CUBES CREATED WITH PHENYTHALEAN AND NAOH (STRONG BASE) THE PINK COLOR IS A PH INDICATOR AND WILL REACT WITH AN ACID BY TURNING CLEAR. THE AMOUNT OF TIME IT TAKES THE ACID (VINEGAR) TO PENETRATE THE CUBE CAN BE MEASURED USING A CLOCK AND RULER. STUDENTS WILL REALIZE THE ABSORPTION IS EQUAL ACROSS ALL CUBE SIZES, BUT THE SMALLER CUBE BECOMES CLEAR WELL BEFORE THE LARGE CUBE. THIS WILL TEACH THEM THAT THE LARGER CUBE WILL NOT BE AS EFFICIENT AT FEEDING ITSELF OR REMOVING IT'S WASTE. THIS ACTIVITY CAN BE TAKEN TO AN INQUIRY LEVEL BY ALLOWING THE STUDENTS TO CREATE A SHAPE FROM THE LEFT OVER AGAR (HINT: THE MORE CONVOLUTIONS THE BETTER…IT INCREASES IT'S SURFACE AREA). THIS COULD BE A CLASS CHALLENGE/COMPETITION AS WELL. WHO CAN GET THEIR SHAPE TO TURN CLEAR THE FASTEST (WHO'S CELL CAN EXCHANGE FOOD AND WASTE THE FASTEST) THIS LINKS BACK TO THE MOST FIT CONCEPT, AND SURVIVAL.

MATERIALS:NON NUTRITIVE AGAR, PHENYLTHALEIN, NAOH, VINEGAR, KNIFE, PAN, HOT PLATE, WATER

ASSESSMENT: FREE RESPONSE QUESTIONS, GRID INS, AND MULTIPLE CHOICE QUESTIONS ARE PROVIDED BY THE COLLEGE BOARD. EVERY TEST IS POSTED TO THE INTERNET AND IS TO BE USED TO ASSESS THE 4 BIG IDEAS. TIME RESTRAINTS SHOULD BE USED WHILE ANSWERING. SHORT FRQS ARE 7 MINUTES, LONG FRQS ARE 17 MINUTES, GRID INS ARE 7 MINUTES, AND MULTIPLE CHOICE ARE 1 MINUTE PER QUESTION. 6 SHORT FRQS AND 2 LONG FRQS MAKE UP THE 90 MINUTE PORTION OF PART 1 OF THE AP TEST, THE EXTRA TIME IS USED AS A MANDATORY PREWRITE PRIOR TO THE START. 63 MULTIPLE CHOICE AND 6 GRID-INS MAKE UP THE 90 MINUTE TEST FOR PART 2. ASSESSMENTS CAN BE DESIGNED IN ANY ORDER AS LONG AS THE TIME FRAME IS ABIDED BY, FOR INSTANCE 1 LONG AND 1 SHORT FRQ MAY BE USED AS A QUIZ. STUDENTS WILL GET A 10 MINUTE PREWRITE AND 24 MINUTES TO COMPLETE THE QUESTIONS. FRQS MUST BE COMPLETED IN BLUE OR BLACK INK, AND MC/GRID IN WITH #2 PENCIL. A 4 FUNCTION CALCULATOR IS ALLOWED AS WELL AS A FORMULA SHEET.

LESSON 2 (TITLE): SORDARIA ASCI AND ONION ROOT TIP (MEIOSIS AND MITOSIS)

# of Periods Required: 2

The student will…

USE A MICROSCOPE TO OBSERVE CROSSING OVER WITHIN THE SPORES (ASCI) OF FUNGAL SORDARIA,
SEARCH FOR PATTERNS WITHIN THE ASCI
QUANTIFY THE AMOUNT OF CROSSING OVER AND CORRELATE THIS WITH INCREASED DIVERSITY OF GENOTYPES PASSED TO OFFSPRING OF THE SORDARIA
CONNECT THE DIVERSITY TO FITNESS WITHIN THE SPECIES
BENEFITS OF HETEROZYGOSITY OR HYBRID
USE A MICROSCOPE TO OBSERVE PHASES OF MITOSIS
QUANTIFY THE LENGTH OF TIME A CELL SPENDS IN INTERPHASE (80%)
EXPLAIN THE IMPORTANCE OF G1,S,G2 FOR ENTHALPY THAT WILL DRIVE ENTROPY OF M PHASE
DISCUSS CDK (CYCLIN DEPENDENT KINASES) AND ACTIVATION OF EACH PHASE OF MITOSIS
EXPLAIN APOPTOSIS, ABSCISSION, AND THE PRACTICALITY OF THIS PHYSIOLOGY IN LIFE PROCESSES

ACTIVITY:STUDENTS WILL USE A MICROSCOPE FOLLOWING THE PROPER METHOD OF OPERATION. PROPER FOCUS WILL ALLOW OBSERVATION OF SORDARIA ASCI IN A PREPARED SLIDE. IT IS POSSIBLE TO COUNT THE INDIVIDUAL COMPARTMENTS AND RECORD THEIR COLOR. ANY PATTERN THAT IS NOT A RATIO OF 4:4 (THAT IS 4 BROWN NEXT TO EACH OTHER AND FOUR TAN NEXT TO EACH OTHER) IS PROOF OF CROSSING OVER BETWEEN 2 HOMOLOGOUS CHROMOSOMES. THIS "SHUFFLING" OF THE ASCI LEADS TO GENETIC VARIATION AND ULTIMATELY THIS LEADS TO MORE CHANCES FOR THE SORDARIA TO THRIVE BY NOT "PUTTING ALL OF IT'S EGGS IN ONE BASKET". THE OBSERVATION OF THE ONION ROOT TIP WILL SHOW THE PHASES OF MITOSIS. MITOSIS IS THE REPRODUCTION OF AN ALREADY EXHISTING TYPE OF CELL, AND LEADS TO GROWTH WHERE AS MEIOSIS IS THE PRODUCT OF A BRAND NEW CELL AS A RESULT OF SEXUAL REPRODUCTION, TWO LIVING THINGS PUTTING HALF (HAPLOID/GAMETE) OF THEIR GENETIC INFORMATION TOGETHER TO CREATE A NEW ZYGOTE. STUDENTS WILL COUNT THE PHASES AND CALCULATE THE PERCENTAGE OF TIMES THEY SEE EACH PHASE. THIS LAB WILL PROVE THAT A CELL MUST PREPARE WELL BEFORE A DIVISION IS POSSIBLE.

MATERIALS: LIGHT MICROSCOPE AT 400X NAKED EYE, PREPARED SORDARIA AND ONION ROOT, CALCULATOR, COLORED PENCILS.

ASSESSMENT: FREE RESPONSE QUESTIONS, GRID INS, AND MULTIPLE CHOICE QUESTIONS ARE PROVIDED BY THE COLLEGE BOARD. EVERY TEST IS POSTED TO THE INTERNET AND IS TO BE USED TO ASSESS THE 4 BIG IDEAS. TIME RESTRAINTS SHOULD BE USED WHILE ANSWERING. SHORT FRQS ARE 7 MINUTES, LONG FRQS ARE 17 MINUTES, GRID INS ARE 7 MINUTES, AND MULTIPLE CHOICE ARE 1 MINUTE PER QUESTION. 6 SHORT FRQS AND 2 LONG FRQS MAKE UP THE 90 MINUTE

PORTION OF PART 1 OF THE AP TEST, THE EXTRA TIME IS USED AS A MANDATORY PREWRITE PRIOR TO THE START. 63 MULTIPLE CHOICE AND 6 GRID-INS MAKE UP THE 90 MINUTE TEST FOR PART 2. ASSESSMENTS CAN BE DESIGNED IN ANY ORDER AS LONG AS THE TIME FRAME IS ABIDED BY, FOR INSTANCE 1 LONG AND 1 SHORT FRQ MAY BE USED AS A QUIZ. STUDENTS WILL GET A 10 MINUTE PREWRITE AND 24 MINUTES TO COMPLETE THE QUESTIONS. FRQS MUST BE COMPLETED IN BLUE OR BLACK INK, AND MC/GRID IN WITH #2 PENCIL. A 4 FUNCTION CALCULATOR IS ALLOWED AS WELL AS A FORMULA SHEET.

Unit Title: BIG IDEA 3: INFORMATION

Approximate # of Lessons: SCAFFOLDED THROUGH SCHOOL YEAR AND ALL UNITS

ASSOCIATED STANDARDS
Students who demonstrate understanding can:

justify the selection of data from historical investigations that support the claim that DNA is the source of heritable information.

describe models illustrating how genetic information is translated into polypeptides.

predict how a change in DNA or RNA can result in changes in gene expression

describe the events that occur in the cell cycle

construct a representation that connects the process of meiosis to the passage of traits from parent to offspring

explain how the inheritance patterns of many traits cannot be accounted for by Mendelian genetics.

explain how the regulation of gene expression is essential for the processes that support cell function

explain the connection between genetic variations in organisms and phenotypic variations in populations

use models to describe how viral replication introduces genetic variation in the viral population.

create representation(s) that depict how cell-to-cell communication occurs

CROSSCUTTING CONCEPTS		
☐ **Patterns** Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them. ☐ **Cause and Effect: Mechanism and Explanation** Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.	☐ **Scale, Proportion, and Quantity** In considering phenomena, it is critical to recognize what is relevant at different measures of size, time and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance. ☐ **Systems and System Models** Defining the system under study – specifying its boundaries and making explicit a model of that system – provides tools for understanding and testing ideas that are applicable throughout science and engineering.	☐ **Energy and Matter: Flows, Cycles, and Conservation** Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations. ☐ **Structure and Function** The way in which an object or living thing is shaped and its substructure determine many of its properties and functions. ☐ **Stability and Change** For natural and build systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

SCIENTIFIC AND ENGINEERING PRACTICES

Asking Questions and Defining Problems
A practice of science is to ask and refine questions that lead to descriptions and explanations of how the natural and designed world works and which can be empirically tested.
Engineering questions clarify problems to determine criteria for successful solutions and identify constraints to solve problems about the designed world.
Both scientists and engineers also ask questions to clarify the ideas of others.

Planning and Carrying Out Investigations
Scientists and engineers plan and carry out investigations in the field or laboratory, working collaboratively as well as individually. Their investigations are systematic and require clarifying what counts as data and identifying variables or parameters.
Engineering investigations identify the effectiveness, efficiency, and durability of deigns under different conditions.

Analyzing and Interpreting Data
Scientific investigations produce data that must be analyzed in order to derive meaning. Because data patterns and trends are not always obvious, scientists use a range of tools-including tabulation, graphical interpretation, visualization, and statistical analysis-to identify the significant features and patterns in the data. Scientists identify sources of error in the investigations and calculate the degree of certainty in the results. Modern technology makes the collection of large data sets much easier, providing secondary sources for analysis.
Engineering investigations include analysis of data collected in the tests of designs. This allows comparison of different solutions and determines how well each meets specific design criteria-that is, which design best solves the problem within given constraints. Like scientists, engineers require a range of tools to identify patterns within data and interpret the results. Advances in science make analysis of proposed solutions more efficient and effective.

Developing and Using Models
A practice of both science and engineering is to use and construct models as helpful tools for representing ideas and explanations. These tools include diagrams, drawings, physical replicas, mathematical representations, analogies, and computer simulations.
Modeling tools are used to develop questions, predictions and explanations; analyze and identify flaws in systems; and communicate ideas. Models are used to build and revise scientific explanations and proposed engineered systems. Measurements and observations are used to revise models and designs.

Constructing Explanations and Designing Solutions
The products of science are explanations and the products of engineering are solutions.
The goal of science is the construction of the theories that provide explanatory accounts of the world. A theory becomes accepted when it has multiple lines of empirical evidence and greater explanatory power of phenomena than previous theories.
The goal of engineering design is to find a systematic solution to problems that is based on scientific knowledge and models of the material world. Each proposed solution results from a process of balancing competing criteria of desired functions, technical feasibility, cost, safety, aesthetics, and compliance with legal requirements. The optimal choice depends on how well the proposed solutions meet criteria and constraints.

Engaging in Argument from Evidence

Argumentation is the process by which explanations and solutions are reached.

In science and engineering, reasoning and argument based on evidence are essential to identifying the best explanation for a natural phenomenon or the best solution to a design problem. Scientists and engineers use argumentation to listen to, compare, and evaluate competing ideas and methods based on merits.

Scientists and engineers engage in argumentation when investigating a phenomenon, testing a design solution, resolving questions about measurements, building data models, and using evidence to identify strengths and weaknesses of claims.

Using Mathematics and Computational Thinking

In both science and engineering, mathematics and computation are fundamental tools for representing physical variables and their relationships. They are used for a range of tasks such as constructing simulations; statistically analyzing data; and recognizing, expressing, and applying quantitative relationships.

Mathematical and computational approaches enable scientists and engineers to predict the behavior of systems and test the validity of such predictions. Statistical methods are frequently used to identify significant patterns and establish correlational relationships.

Obtaining, Evaluating, and Communicating Information

Scientists and engineers must be able to communicate clearly and persuasively the ideas and methods they generate. Critiquing and communicating ideas individually and in groups is a critical professional activity.

Communicating information and ideas can be done in multiple ways: using tables, diagrams, graphs, models and equations as well as orally, in writing, and through extended discussions.

Scientists and engineers employ multiple sources to acquire information that is used to evaluate the merit and validity of claims, methods, and designs.

Possible DCIs to be taught concurrently

Chemistry	Physics
PS1.C: Nuclear Processes	ESS2.B: Plate Tectonics & Large-Scale System Interactions
PS3.B: Conservation of Energy & Energy Transfer	PS3.A: Definitions of Energy PS3.C: Relationship Between Energy & Forces
PS3.D: Energy in Chemical Processes & Everyday Life	
ESS2.C: Role of Water in Earth's Surface Processes	ESS2.A: Earth Materials & Systems
ESS2.D: Weather & Climate	

Possible DCIs to be taught concurrently

Biology	Chemistry
LS1.C: Organization for Matter & Energy Flow in Ecosystems	PS1.B: Chemical Reactions
LS2.B: Cycles of Matter & Energy Transfer in Ecosystems	PS3.B: Conservation of Energy & Energy Transfer
	PS3.D: Energy in Chemical Processes & Everyday Life
ESS2.E: Biogeology	ESS2.C: The Roles of Water in Earth Surface Processes
	ESS2.D: Weather & Climate
ESS3.B: Natural Hazards	ESS3.D: Global Climate Change
ESS3.C: Human Impacts on Earth Systems	

Possible DCIs to be taught concurrently

Biology	Physics
LS1.C: Organization for Matter & Energy Flow in Ecosystems	PS3.A: Definitions of Energy
LS2.B: Cycles of Matter & Energy Transfer in Ecosystems	
LS1.D: Information Processing	PS4.A: Wave Properties
ESS1.C: History of Planet Earth	ESS1.A: The Universe and Its Stars
	ESS1.B: Earth & the Solar System
ESS2.E: Biogeology	ESS2.A: Earth Materials
	ESS2.B: Plate Tectonics & Large-Scale System Interactions

AP EK	**NGSS PE(s)**
3.A.1	HS-LS1-1, HS-LS3-1, HS-LS3-2
3.A.2	MS-LS3-2, HS-LS1-4, HS-LS3-1, HS-LS3-2
3.A.3	MS-LS3-2, HS-LS3-1, HS-LS3-2
3.B.1	HS-LS1-4, HS-LS3-1
3.B.2	HS-LS1-4

3.C.1	MS-LS3-1, HS-LS3-2, HS-LS4-3
3.C.2	HS-LS3-2
3.D.2	MS-LS1-8
3.E.1	HS-LS2-8, HS-LS4-3
3.E.2	MS-LS1-8, HS-LS1-2, HS-PS3-5

LESSON 1 (TITLE): PROTEIN SYNTHESIS AND MODELING AMINO ACID AND PROTEIN ASSEMBLY

# of Periods Required: 10

The student will…

SEQUENCE THE STEPS OF PROTEIN SYNTHESIS FROM TRANCRIPTION TO TRANSLATION
BUILD A PROTEIN AND COMPARE IT'S STRUCTURE TO THAT OF THE OTHER MACROMOLECULES LIPID, CARBOHYDRATE AND NUCLEIC ACID
COMPARE CODONS TO A TABLE OF THE 20+ AMINO ACIDS
CONSTRUCT A MAP OF AMINO ACIDS ORGANIZING THEM ACCORDING TO PH AND AFFINITY FOR WATER
CONSTRUCT THE PRIMARY, SECONDARY, TERTIARY AND QUARTERNARY MODEL OF A PROTEIN.
DISCUSS THE IMPORTANCE OF PROTEIN SHAPE TO IT'S FUNCTION
EXPLAIN THE EFFECT OF DENATURING A PROTEIN (CHANGING IT'S SHAPE)
MODEL ENZYMATICE ACTION, ENZYME SUBSTRATE COMPLEXES
LIST THE 5 FUNCTIONS OF PROTEINS
BUILD A PROTEIN CHANNEL USING ORIGAMI
*****GUEST SPEAKER LEONARD SMITH (COMMERCIAL ENZYMES) CREATOR OF BEANO AND PAST PRESIDENT OF LACTAID**
HISTORICALLY CONNECT SCURVY TO COENZYME VITAMIN C AND IT'S ABILITY TO DIGEST PROTEINS FOUND IN SALTED PORK.

ACTIVITY: STUDENTS WILL US 3D MOLECULAR DESIGN MODELS THAT FORCE STUDENTS TO ORGANIZE THE PARTS OF A PROTEIN, PLACE PARTS ON A FLEXIBLE BASE, ABIDE BY CHEMICAL PROPERTIES OF THE PARTS, AND ULTIMATELY SEE THE RESULT OF CHEMICAL PROPERTIES IN FORCING A PROTEIN INTO A PARTICULAR SHAPE. THESE SHAPES WILL BE THE HINGE PIN WITH WHICH THE REST OF THE UNIT IS FOCUSED UPON. LOSS OF SHAPE LEADS TO CHANGE IN FUNCTION. THE ACTIVITY SET COMES WITH A SET OF DIRECTIONS THAT ARE WITHIN EVERY SET AND MUST BE FOLLOWED FOR THIS LAB TO WORK.

MATERIALS: 3D MOLECULAR DESIGN MODELS

ASSESSMENT: FREE RESPONSE QUESTIONS, GRID INS, AND MULTIPLE CHOICE QUESTIONS ARE PROVIDED BY THE COLLEGE BOARD. EVERY TEST IS POSTED TO THE INTERNET AND IS TO BE USED TO ASSESS THE 4 BIG IDEAS. TIME RESTRAINTS SHOULD BE USED WHILE ANSWERING. SHORT FRQS ARE 7 MINUTES, LONG FRQS ARE 17 MINUTES, GRID INS ARE 7 MINUTES, AND MULTIPLE CHOICE ARE 1 MINUTE PER QUESTION. 6 SHORT FRQS AND 2 LONG FRQS MAKE UP THE 90 MINUTE PORTION OF PART 1 OF THE AP TEST, THE EXTRA TIME IS USED AS A MANDATORY PREWRITE PRIOR TO THE START. 63 MULTIPLE CHOICE AND 6 GRID-INS MAKE UP THE 90 MINUTE TEST FOR PART 2. ASSESSMENTS CAN BE DESIGNED IN ANY ORDER AS LONG AS THE TIME FRAME IS ABIDED BY, FOR INSTANCE 1 LONG AND 1 SHORT FRQ MAY BE USED AS A QUIZ. STUDENTS WILL GET A 10 MINUTE PREWRITE AND 24 MINUTES TO COMPLETE THE QUESTIONS. FRQS MUST BE COMPLETED IN BLUE OR BLACK INK, AND MC/GRID IN WITH #2 PENCIL. A 4 FUNCTION CALCULATOR IS ALLOWED AS WELL AS A FORMULA SHEET.

LESSON 2 (TITLE): <u>CATALASE LAB</u>

# of Periods Required: <u>1</u>

The student will…

- **DESIGN AN EXPERIMENT TO MEASURE THE MOST EFFICIENT WAY TO RELEASE CATALASE**
- **UNDERSTAND THE IMPORTANCE OF CATALASE TO ALL LIVING THINGS (ANTIOXIDENT)**
- **EXPLAIN THE POSITIVE AN NEGATIVE EFFECTS THAT OXYGEN HAS ON LIVING THINGS**
- **LIST OTHER ANTIOXIDANTS AND WHERE THEY CAN BE FOUND.**
- **JUSTIFY THE USE OF HYDROGEN PEROXIDE ON AN INJURY**

ACTIVITY: STUDENTS WILL LEARN THAT CATALASE IS AN ANTIOXIDANT THAT IS FOUND WITHIN ALL ORGANISMS AND CAN BE RELEASED IF THEIR DERMIS IS OPENED TO THE AIR OR THEIR MEMBRANES ARE FORCED OPEN IN A MECHANICAL MANNER. STUDENTS WILL BRING IN ANY MATERIAL THAT WAS ONCE ALIVE, OR IS STILL ALIVE (TYPICALLY FRUITS, VEGGIES, GORDS ARE GREAT). A VARIETY OF CONCENTRATIONS OF H202 WILL BE PREPARED AND STUDENTS WILL ADD THEIR BROKEN UP ORGANISM. STUDENTS WILL HAVE TO WORK IN A TEAM TO FIND A WAY TO QUANTIFY THEIR OBSERVATIONS, THERE WILL BE PLENTY OF BUBBLES FROM THE RELEASE OF THE OXYGEN THANKS TO THE CATALASE.

MATERIALS: HYDROGEN PEROXIDE, PRODUCE, BEAKERS, BLENDERS/KNIVES, STOPWATCHES

ASSESSMENT: FREE RESPONSE QUESTIONS, GRID INS, AND MULTIPLE CHOICE QUESTIONS ARE PROVIDED BY THE COLLEGE BOARD. EVERY TEST IS POSTED TO THE INTERNET AND IS TO BE USED TO ASSESS THE 4 BIG IDEAS. TIME RESTRAINTS SHOULD BE USED WHILE ANSWERING. SHORT FRQS ARE 7 MINUTES, LONG FRQS ARE 17 MINUTES, GRID INS ARE 7 MINUTES, AND MULTIPLE CHOICE ARE 1 MINUTE PER QUESTION. 6 SHORT FRQS AND 2 LONG FRQS MAKE UP THE 90 MINUTE PORTION OF PART 1 OF THE AP TEST, THE EXTRA TIME IS USED AS A MANDATORY PREWRITE PRIOR TO THE START. 63 MULTIPLE CHOICE AND 6 GRID-INS MAKE UP THE 90 MINUTE TEST FOR PART 2. ASSESSMENTS CAN BE DESIGNED IN ANY ORDER AS LONG AS THE TIME FRAME IS ABIDED BY, FOR INSTANCE 1 LONG AND 1 SHORT FRQ MAY BE USED AS A QUIZ. STUDENTS WILL GET A 10 MINUTE PREWRITE AND 24 MINUTES TO COMPLETE THE QUESTIONS. FRQS MUST BE COMPLETED IN BLUE OR BLACK INK, AND MC/GRID IN WITH #2 PENCIL. A 4 FUNCTION CALCULATOR IS ALLOWED AS WELL AS A FORMULA SHEET.

Unit Title: BIG IDEA 4: SYSTEMS

Approximate # of Lessons: SCAFFOLDED THROUGH SCHOOL YEAR AND ALL UNITS

ASSOCIATED STANDARDS
Students who demonstrate understanding can:

use models to explain how the subcomponents of a biological polymer determine the properties of that polymer

construct explanations as to how interactions of subcellular structures provide essential functions

predict the effects of a change in a component of a biological system on the functionality of an organism

illustrate how interactions among living systems with their environment result in the movement of matter and energy

explain how the distribution of ecosystems changes over time by identifying large-scale events in the past.

predict consequences of human actions on both local and global ecosystems.

make predictions about how species diversity influences ecosystem stability

CROSSCUTTING CONCEPTS		
X **Patterns** Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them. X **Cause and Effect: Mechanism and Explanation** Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.	X **Scale, Proportion, and Quantity** In considering phenomena, it is critical to recognize what is relevant at different measures of size, time and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance. X **Systems and System Models** Defining the system under study – specifying its boundaries and making explicit a model of that system – provides tools for understanding and testing ideas that are applicable throughout science and engineering.	X **Energy and Matter: Flows, Cycles, and Conservation** Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations. ☐ **Structure and Function** The way in which an object or living thing is shaped and its substructure determine many of its properties and functions. ☐ **Stability and Change** For natural and build systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

SCIENTIFIC AND ENGINEERING PRACTICES

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Planning and Carrying Out Investigations
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Engineering investigations identify the effectiveness, efficiency, and durability of deigns under different conditions.

Analyzing and Interpreting Data
Scientific investigations produce data that must be analyzed in order to derive meaning. Because data patterns and trends are not always obvious, scientists use a range of tools-including tabulation, graphical interpretation, visualization, and statistical analysis-to identify the significant features and patterns in the data. Scientists identify sources of error in the investigations and calculate the degree of certainty in the results. Modern technology makes the collection of large data sets much easier, providing secondary sources for analysis.
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Developing and Using Models
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Modeling tools are used to develop questions, predictions and explanations; analyze and identify flaws in systems; and communicate ideas. Models are used to build and revise scientific explanations and proposed engineered systems. Measurements and observations are used to revise models and designs.

Constructing Explanations and Designing Solutions
The products of science are explanations and the products of engineering are solutions.
The goal of science is the construction of the theories that provide explanatory accounts of the world. A theory becomes accepted when it has multiple lines of empirical evidence and greater explanatory power of phenomena than previous theories.
The goal of engineering design is to find a systematic solution to problems that is based on scientific knowledge and models of the material world. Each proposed solution results from a process of balancing competing criteria of desired functions, technical feasibility, cost, safety, aesthetics, and compliance with legal requirements. The optimal choice depends on how well the proposed solutions meet criteria and constraints.

Engaging in Argument from Evidence
Argumentation is the process by which explanations and solutions are reached.
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Scientists and engineers engage in argumentation when investigating a phenomenon, testing a design solution, resolving questions about measurements, building data models, and using evidence to identify strengths and weaknesses of claims.

Using Mathematics and Computational Thinking
In both science and engineering, mathematics and computation are fundamental tools for representing physical variables and their relationships. They are used for a range of tasks such as constructing simulations; statistically analyzing data; and recognizing, expressing, and applying quantitative relationships.
Mathematical and computational approaches enable scientists and engineers to predict the behavior of systems and test the validity of such predictions. Statistical methods are frequently used to identify significant patterns and establish correlational relationships.

Obtaining, Evaluating, and Communicating Information
Scientists and engineers must be able to communicate clearly and persuasively the ideas and methods they generate. Critiquing and communicating ideas individually and in groups is a critical professional activity.
Communicating information and ideas can be done in multiple ways: using tables, diagrams, graphs, models and equations as well as orally, in writing, and through extended discussions. Scientists and engineers employ multiple sources to acquire information that is used to evaluate the merit and validity of claims, methods, and designs.

Possible DCIs to be taught concurrently

<u>Chemistry</u>
PS1.C: Nuclear Processes
PS3.B: Conservation of Energy & Energy Transfer
PS3.D: Energy in Chemical Processes & Everyday Life
ESS2.C: Role of Water in Earth's Surface Processes
ESS2.D: Weather & Climate

<u>Physics</u>
ESS2.B: Plate Tectonics & Large-Scale System Interactions
PS3.A: Definitions of Energy
PS3.C: Relationship Between Energy & Forces
ESS2.A: Earth Materials & Systems

Possible DCIs to be taught concurrently

<u>Biology</u>
LS1.C: Organization for Matter & Energy Flow in Ecosystems
LS2.B: Cycles of Matter & Energy Transfer in Ecosystems
ESS2.E: Biogeology
ESS3.B: Natural Hazards
ESS3.C: Human Impacts on Earth Systems

<u>Chemistry</u>
PS1.B: Chemical Reactions
PS3.B: Conservation of Energy & Energy Transfer
PS3.D: Energy in Chemical Processes & Everyday Life
ESS2.C: The Roles of Water in Earth Surface Processes
ESS2.D: Weather & Climate
ESS3.D: Global Climate Change

Possible DCIs to be taught concurrently

Biology	Physics
LS1.C: Organization for Matter & Energy Flow in Ecosystems	PS3.A: Definitions of Energy
LS2.B: Cycles of Matter & Energy Transfer in Ecosystems	
LS1.D: Information Processing	PS4.A: Wave Properties
ESS1.C: History of Planet Earth	ESS1.A: The Universe and Its Stars
	ESS1.B: Earth & the Solar System
ESS2.E: Biogeology	ESS2.A: Earth Materials
	ESS2.B: Plate Tectonics & Large-Scale System Interactions

AP EK	**NGSS PE(s)**
4.A.1	HS-LS1-1, HS-LS1-6, HS-PS2-6
4.A.2	MS-LS1-2, HS-LS1-5
4.A.3	HS-LS1-1, HS-LS1-2, HS-LS1-4, HS-LS3-1, HS-LS3-3
4.A.4	HS-LS1-2
4.A.5	MS-LS2-2, HS-LS2-1, HS-LS2-2, HS-LS2-6, HS-LS2-7, HS-LS4-6, HS-ESS3-5, HS-ESS3-6
4.A.6	HS-LS2-1, HS-LS2-2, HS-LS2-4, HS-LS2-5, HS-LS2-7, HS-LS4-6, HS-ESS3-6
4.B.1	HS-PS2-6
4.B.2	MS-LS1-2, HS-LS1-1, HS-LS1-2
4.B.3	MS-LS2-2, HS-LS2-2, HS-LS2-6, HS-LS2-7, HS-LS2-8, HS-LS4-6
4.B.4	HS-LS2-7, HS-LS4-6, HS-ESS2-2, HS-ESS3-1, HS-ESS3-6
4.C.1	MS-LS3-2
4.C.2	HS-LS3-3
4.C.3	HS-LS3-3, HS-LS4-5
4.C.4	HS-LS2-2, HS-LS4-5

LESSON 1 (TITLE): BIOME DIARAMA AND BIOGEOCHEMICAL CYCLES

# of Periods Required: 5

The student will…

FORM TEAMS TO BUILD A DIARAMA OF A RANDOMLY ASSIGNED BIOME
PRESENT DIARAMA TO THE CLASS
DESCRIBE THE IMPORTANCE OF ONE OF THE BIOGEOCHEMICAL CYCLES TO THE HEALTH

OF THE ASSIGNED BIOME
EXPLAIN HUMAN INTERACTIONS WITH THE BIOME AND LIST PROS AND CONS
LIST SYMBIOTIC RELATIONSHIPS FOUND WITH THE BIOME'S ORGANISMS

ACTIVITY: STUDENTS WILL FORM TEAMS AND PICK A BIOME FROM A "HAT". THEY WILL HAVE 2 WEEKS TO DESIGN THE BIOME DIARAMMA AND THEN BRING IT IN FOR A PRESENTATION. THESE BOXES WILL BE HUNG FROM THE SCIENCE WINGS BULLETIN BOARD ON DISPLAY FOR THE SCHOOL TO SEE. THE BOXES ARE ALL STUDENT FUNDED WITH RECYCLABLES AND ITEMS FROM HOME. THE ONLY RULES ARE THAT THE BOX MUST BE ABLE TO HANG FROM THE BULLETIN BOARD AND NOT BE TO IMPOSING ON HALL TRAFFIC. STUDENTS WILL BE GIVEN A CRITERIA THAT TAKES THE DIARAMMA FROM A ELEMENTARY PROJECT TO AN AP PROJECT. THESE UPGRADES WILL CONSIST OF SYMBIOTIC RELATIONSHIPS, HUMAN INTERACTIONS, BIOGEOCHEMICAL CYCLES PRESENT, AND POPULATION ECOLOGY WHICH INCLUDES EFFECTS OF DENSITY (IN)DEPENDENT FACTORS AND CARRYING CAPACITIES.

MATERIALS: STUDENT FUNDED ITEMS AND A SHOE BOX.

ASSESSMENT: FREE RESPONSE QUESTIONS, GRID INS, AND MULTIPLE CHOICE QUESTIONS ARE PROVIDED BY THE COLLEGE BOARD. EVERY TEST IS POSTED TO THE INTERNET AND IS TO BE USED TO ASSESS THE 4 BIG IDEAS. TIME RESTRAINTS SHOULD BE USED WHILE ANSWERING. SHORT FRQS ARE 7 MINUTES, LONG FRQS ARE 17 MINUTES, GRID INS ARE 7 MINUTES, AND MULTIPLE CHOICE ARE 1 MINUTE PER QUESTION. 6 SHORT FRQS AND 2 LONG FRQS MAKE UP THE 90 MINUTE PORTION OF PART 1 OF THE AP TEST, THE EXTRA TIME IS USED AS A MANDATORY PREWRITE PRIOR TO THE START. 63 MULTIPLE CHOICE AND 6 GRID-INS MAKE UP THE 90 MINUTE TEST FOR PART 2. ASSESSMENTS CAN BE DESIGNED IN ANY ORDER AS LONG AS THE TIME FRAME IS ABIDED BY, FOR INSTANCE 1 LONG AND 1 SHORT FRQ MAY BE USED AS A QUIZ. STUDENTS WILL GET A 10 MINUTE PREWRITE AND 24 MINUTES TO COMPLETE THE QUESTIONS. FRQS MUST BE COMPLETED IN BLUE OR BLACK INK, AND MC/GRID IN WITH #2 PENCIL. A 4 FUNCTION CALCULATOR IS ALLOWED AS WELL AS A FORMULA SHEET.

LESSON 2 (TITLE): FOX AND RABBIT DENSITY VS DISPERSION MODELS OF POPULATING A DEFINED AREA

# of Periods Required: 5

The student will…

MEASURE 4 SQUARE AREAS THAT ARE MULTIPLES OF EACH OTHER (17.5''X17.5'', 35''X35''…)
TABULATE DATA FROM REPEATED TRIALS OF DROPPING A PREDATOR ONTO A FIELD OF PREY
GRAPH RESULTS AND EXTRAPOLATE THE CARRYING CAPACITY OF THE SQUARE AREAS.
DISCUSS DENSITY DEPENDENT AND DENSITY INDEPENDENT FACTORS THAT CONTROL POPULATION SIZE.
RELATE THIS LESSON BACK TO ROCK POCKET MOUSE AND FITNESS OF A SPECIES WITHIN IT'S ENVIRONMENT
ANALYZE AGE STRUCTURE PYRAMIDS FROM DIFFERENT COUNTRIES
JUSTIFY THE CONCERNS OF HUMAN POPULATION ON PLANET EARTH

PREDICT WHAT THE FUTURE OF HUMAN HABITATS IN RELATION TO THE DENSITY OR DISPERSION MODEL.
DEBATE THE PROS AND CONS OF GENETICALLY MODIFIED ORGANISMS WITHIN A STRESSED FOOD SUPPLY.

ACTIVITY: STUDENTS WILL MEASURE SQUARE AREAS THAT MEASURE 17.5X17.5, 30X30, 60X60, AND 120X120. PREDATORS WILL BE CUT OUT OF RED OAKTAG AND PREY FROM GREEN OAKTAG. THE OAKTAG IS STIFF ENOUGH TO LAST THROUGHOUT THE TRIALS. STUDENTS WILL BE BLINDFOLDED SO THAT THEIR DECISIONS AS TO WHERE TO DROP THEIR PREDATORS IS RANDOM, BUT CONTROLLED BY THE DESIGNATED SQUARE AREA. STUDENTS WILL PERFROM BOTH A DENSITY AND DISPERSION METHOD OF LAYING OUT THE PREY, THE DENSITY MODEL ALLOWS FOR PREY TO LAY ON TOP OF EACH OTHER WHICH MAKES IT EASY FOR THEM TO HIDE, BUT DANGEROUS AND TRAGIC IF THE PREDATOR FINDS THEM. THE DENSITY MODEL MIMICS THE LIVING CONDITIONS IN A METROPOLIS, OR A COLONIZING POPULATION. STUDENTS WILL RUN A STATISTICALLY RELEVANT 30 TRIALS, THE RESULTS OF HOW MANY RED AND GREEN EXIST AFTER EACH TRIAL WILL BE RECORDED ON A STUDENT GENERATED TABLE AND WILL EVENTUALLY BE GRAPHED. THE GRAPH WILL SHOWCASE THE RISE AND FALL OF POPULATIONS WHEN THERE IS EXPONENTIAL OR LOGISTIC GROWTH MODELS. STUDENTS WILL USE THE GRAPH TO EXTRAPOLATE WHAT WOULD BE THE PERFECT SIZE POPULATION OF BOTH PREDATOR AND PREY, MUCH LIKE THE JOB A GAME WARDEN PERFORMS. THIS IS ALSO CORRELATED TO A CARRYING CAPACITY (HOW MANY OF ANY ANIMAL AN ECOSYSTEM CAN HANDLE). THE RULES ARE AS FOLLOWS: IF A RED FALLS ON 2 OR MORE GREENS ANOTHER RED CAN BE ADDED TO THE PREDATORS PILE AND DROPPED DURING THE NEXT GENERATION. EVERY GREEN THAT IS UNTOUCHED IS ALLOWED TO REPRODUCE 1 GREEN TILE. ALL TILES MUST REMAIN WITHIN THE SQUARED AREA AND DROPPERS MUST BE BLINDFOLDED BUT DIRECTED OVER THE SQUARE AREA. 30 TRIALS WILL BE RECORDED.

MATERIALS: RED AND GREEN OAKTAG, BLIND FOLDS, MASKING TAPE TO CREATE PLAYING AREAS ON LAB TOPS AND FLOORS IF NEEDED

ASSESSMENT: FREE RESPONSE QUESTIONS, GRID INS, AND MULTIPLE CHOICE QUESTIONS ARE PROVIDED BY THE COLLEGE BOARD. EVERY TEST IS POSTED TO THE INTERNET AND IS TO BE USED TO ASSESS THE 4 BIG IDEAS. TIME RESTRAINTS SHOULD BE USED WHILE ANSWERING. SHORT FRQS ARE 7 MINUTES, LONG FRQS ARE 17 MINUTES, GRID INS ARE 7 MINUTES, AND MULTIPLE CHOICE ARE 1 MINUTE PER QUESTION. 6 SHORT FRQS AND 2 LONG FRQS MAKE UP THE 90 MINUTE PORTION OF PART 1 OF THE AP TEST, THE EXTRA TIME IS USED AS A MANDATORY PREWRITE PRIOR TO THE START. 63 MULTIPLE CHOICE AND 6 GRID-INS MAKE UP THE 90 MINUTE TEST FOR PART 2. ASSESSMENTS CAN BE DESIGNED IN ANY ORDER AS LONG AS THE TIME FRAME IS ABIDED BY, FOR INSTANCE 1 LONG AND 1 SHORT FRQ MAY BE USED AS A QUIZ. STUDENTS WILL GET A 10 MINUTE PREWRITE AND 24 MINUTES TO COMPLETE THE QUESTIONS. FRQS MUST BE COMPLETED IN BLUE OR BLACK INK, AND MC/GRID IN WITH #2 PENCIL. A 4 FUNCTION CALCULATOR IS ALLOWED AS WELL AS A FORMULA SHEET.