AP Biology 2012-2013 Syllabus.

Please Note: I have written this curriculum using features of the Syllabus 1 and 3, provided by the College Board as guides and inspiration, my previous experience teaching AP Biology over the past six years, and my experience teaching INTEL Science Research Program, which is a strictly enquiry-based course.

Curricular Requirement as per College Board.

CR1: Students and teachers use a recently published (within the last 10 years) college level biology textbook.
CR2: The course is structured around the enduring understandings within the big ideas as described in the AP Biology Curriculum Framework.
CR3a: Students connect the enduring understandings within Big Idea 1 (the process of evolution drives the diversity and unity of life) to at least one other big idea.
CR3b: Students connect the enduring understandings within Big Idea 2 (biological systems utilize free energy and molecular building blocks to grow, to reproduce, and to maintain dynamic homeostasis) to at least one other big idea.
CR3c: students connect the enduring understandings within Big Idea 3 (living systems store, retrieve, transmit, and respond to information essential to life processes) to at least one other big idea.
CR3d: Students connect the enduring understanding within Big Idea 4 (biological systems interact and these systems and their interactions possess complex properties) to at least one other big idea.
CR4a: The course provides students with opportunities outside of the laboratory investigation to meet the learning objectives of Big Idea 1.
CR4b: The course provides students with opportunities outside of the laboratory investigation to meet the learning objectives of Big Idea 2.
CR4c: The course provides students with opportunities outside of the laboratory investigation to meet the learning objectives of Big Idea 3.
CR4d: The course provides students with opportunities outside of the laboratory investigation to meet the learning objectives of Big Idea 4.
CR5: The course provides students with opportunities to connect their biological and scientific knowledge to major social issues (e.g. concerns, technological advances, innovations) to help them become scientifically literate citizens.
CR6: The students-directed laboratory investigations used throughout the course allow students to apply the seven science practices defined in the AP Biology Curriculum Framework and include at least two lab experiences in each of the four big ideas.

CR7: Students are provided the opportunity to engage in investigative laboratory work integrated throughout the course for a minimum of 25 percent of instructional time.
CR8: The course provides opportunities for students to develop and record evidence of their verbal, written and graphic communications kills through laboratory reports, summaries of literature or scientific investigations, and oral, written, or graphic presentations.

Course overview.
This AP Biology course will deliver content and skills to the students, by allowing them to develop their own inquiries, thinking and problem solving skills, while understanding the relationships between the Four Big Ideas, enduring understandings and science practices. Students will explore the relationships between Big Ideas, integrate other sciences in the study of biology and recognize the unifying principles common to all living beings in a diversified biological world. **CR2**

Students will practice scientific research from recognizing a problem and asking questions, drawing hypotheses and designing experiments to test the hypotheses. The teacher will guide the students in their inquiries. Students will learn proper data collection and analysis, as well as to present their result in a concise, clear and accurate manner, by the way of graphs, tables, presentations, papers, and posters. Students will learn to read, analyze and understand scientific papers published in peer reviews specialized publications. **CR6, CR7**

Students will apply their knowledge of science and the biotechnology derived from the current scientific research to understanding ethical problems, society and legal issues, which may have an impact on their future lives. **CR5**

Instructional Context
Our High School is a traditional high school with 40 minutes instructional periods, and an A/B schedule allowing a double period (80) minutes every other day for laboratory investigations. The AP Biology class has an open enrollment for juniors and seniors, with a strong recommendation for a previous chemistry class. Students will have already taken the Living Environment Regents class in 8^{th} grade. A chemistry assessment test is given the first week of school, to determine strength and weaknesses of students in the knowledge of basic chemistry. Based on this formative test, a brief review of chemistry basics is tailored to the needs of the students.

Instructional Resources.
Reece, Jane et al., Campbell Biology, 7^{th} Edition, 2005, Pearson Benjamin Cummings. **CR1**
AP Biology Investigative labs: an Inquiry Based Approach.

AP Biology Course and Exam Description.
Required reading: “The Immortal Life of Henrietta Lacks” by Rebecca Skloot.
Additional reading: “Rosalind Franklin, The Dark Lady of DNA” by Brenda Maddox.

Advanced Placement Biology Content and Curriculum
This course is structured around the four big ideas, the enduring understanding within the big ideas and the essential knowledge within the enduring understandings, as described in details in the AP Biology Course and Exam Description document released by the College Board. **CR2**

The big ideas:

Big idea 1: The process of evolution drives the diversity and unity of life.
Big idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis.
Big idea 3: Living systems store, retrieve, transmit and respond to information essential to life processes.
Big idea 4: Biological systems interact, and these systems and their interactions possess complex properties.

The Investigative Laboratory Component

The course is also structured around inquiry in the lab and the use of the seven science practices throughout the course.

Students are given the opportunity to engage in student-directed laboratory investigations throughout the course for a minimum of 25% of instructional time. Likely, it will be 30%, as students-generated labs and lab extensions will build a strong research based component to this course. **CR7**
Students will conduct a minimum of eight inquiry-based investigations (two per big idea throughout the course). **CR6**
Additional labs will be conducted to deepen students’ conceptual understanding and to reinforce the application of science practices within a hands-on, discovery based environment. All levels of inquiry will be used and all seven science practice skills will be used by students on a regular basis in formal labs as well as activities outside of the lab experience.
The course will provide opportunities for students to develop, record, and communicate the results of their laboratory investigations. **CR8**

Students will chose a topic of research at the beginning of the year in a subject related to biology and research the peer-reviewed published scientific literature on their chosen topic. They will find a relevant scientific article, read it in detail for understanding, while particularly examining the questions addressed by the paper, the hypotheses, methods used, the experimental design (including the data collection methods), the way results are analyzed and conclusions drawn. They will explore the statistical analysis used in the paper and the various methods of presenting the results. Students will present the article in front of their peers in a poster or slide presentation format at the end of the first semester.
Students will continue reading on their chosen topic and identify a problem to research based on their readings, and draft hypotheses relevant to this problem. Students will then decide on a hypothesis to explore and then design experiments to test it. Students will present their research proposal at the end of the year in a slide presentation, which will be a summative assessment of their research. **CR5, CR8**

Science Practices (SP)

1. The student can use representations and models to communicate scientific phenomena and solve scientific problems.
2. The student can use mathematics appropriately.
3. The student can engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course.
4. The student can plan and implement data collection strategies appropriate to a particular scientific question.
5. The student can perform data analysis and evaluation of evidence.
6. The student can work with scientific explanations and theories.
7. The student is able to connect and relate knowledge across various scales, concepts and representations in and across domains.

Documenting the students' investigations, research and readings CR8:

Students will maintain a laboratory notebook and a portfolio throughout the course. In addition to the laboratory notebook, students will communicate to others in formats such as group presentations, PowerPoint presentations, poster sessions, and written reports. Communication tools are not only for the laboratory experiences, but represent examples of the collaboration, reflection, and articulation seen in the course as a whole. Students will use this collection of their work over time and reflect on the changes they can see in the quality or substance of their work through the year as they prepare to move into college courses and research experiences in the future. A key feature in the portfolio will be the requirement for student self-reflection in terms of the science practice skills that they have developed throughout the year. **CR8**

Units of Instructions

Unit 1: Introduction to Scientific Research (2 weeks at the beginning of the school year and 4 weeks after the AP exam)
CR5, CR6, CR7, SP1, SP3, SP4, SP6, SP7

Textbook Chapters:

- 1. Introduction: Theme in the Study of Life

Science Practices: In this unit, students will review science practices, methods of research and data collection strategies, modeling and mathematics, evaluation of evidence, validity of explanations, inferences and theories.

Discussion Topics and Skills:
Review of the Scientific Method
In this unit, we will explore in details the methods used in scientific research and investigation. Students will choose a topic they will study independently for the year. **CR4a, SP1, SP3, SP4, SP6, SP7.**
Students will review the scientific method and the critical steps in scientific investigation. Examples will be given on how the scientific method can be applied to test different kind of hypotheses and how scientific approaches differ based on the topic, subject or scope of the scientific study. The teacher will emphasize the importance of a multidisciplinary approach to scientific inquiry, the importance of connecting various methods, skills and approaches to solve a problem **SP7.**
Students will be able to explain the meaning of the word "theory" when used in a scientific context and illustrate their understanding with selected examples. **SP6**.
This scientific inquiry approach will be used with all units and lab work throughout the year.

Activities and Labs:

- Students practice in groups making hypotheses, designing experiments and models to answer scientific questions. They evaluate the best way to get data, best data representation, make graphs and tables and practice statistical analyses of mock data. **SP1, SP2, SP3, SP 4, SP5, SP 6, SP7**.
- Students define an area of research they want to independently explore during the school year. They learn how to use scientific literature databases and use examples of suitable work to research. During the school year, they will research independently some scientific publications on the topic of their choice.

- Students pick several scientific articles of interest, read them and briefly summarize them to the class and the class discusses their choices. They then decide which article to explore in depth based on class discussion.
- Over 4 weeks, they will completely analyze the articles of their final choice, explore methods and analysis of the results, discuss the conclusions drawn by the scientists and present their work to the class in the form of poster or slide presentation.
- Students start reading "The Immortal Life of Henrietta Lacks". Discussion of the book will take place throughout the year. **CR5**

Unit 2: Review of Chemistry. Introduction to Biochemistry. Introduction to the cell. CR2, CR3b, CR3d (8 weeks)

Big Ideas 1, 2 and 4.

Connected Enduring understandings:
1.B: Organisms are linked by lines of descent from common ancestry.
1.D: The origin of living systems is explained by natural processes.
2.A: Growth, reproduction and maintenance of the organization of living systems require free energy and matter.
2.B: Growth, reproduction and dynamic homeostasis require that cells create and maintain internal environments that are different from their external environments.
3.A Heritable information provides for continuity of life.
4.A Interactions within biological systems lead to complex properties.
4.B Competition and cooperation are important aspects of biological systems.
4.C Naturally occurring diversity among and between components within biological systems affects interactions with the environment.

Textbook Chapters:
- 1. Introduction: Theme in the Study of Life
- 2. The Chemical Context of Life
- 3. Water and the Fitness of the Environment.
- 4. Carbon and the Molecular Diversity of Life.
- 5. The Structure and Function of Large Biological Molecules
- 6. A Tour of the Cell
- 7. Membrane Structure and Function
- 11. Cell Communication.

Discussion Topics and Skills:

- Formative assessment in chemistry will be given to assess the chemistry basic knowledge of the students in that cohort. This will be a comprehensive multiple choice test addressing key concepts in chemistry to evaluate the level of the students and the specific concepts which need a deeper review.
- All life on earth is based on the same fundamental elements. All living beings on earth are connected by the same biochemistry. **CR3a, CR3b, CR3d**, **CR4a**.
- Brief review of organic chemistry.
- Importance of water in biological system and how the properties of water are critical to life. **CR3d**
- Relationship between structure and function of macromolecules. **CR3b**
- Relationship between structure and function of nucleic acids.**CR3c**
- Living beings interact with their environment and with each other, through biochemical and energetic processes. **CR4b** and **CR4d**.
- Can we create a life form that is not carbon based? What are the characteristics of living systems and can we create them in artificial systems? Is this ethical? Discussion of molecular self-assembly and emergent properties of systems. **CR5**
- First and second laws of thermodynamics. Energy flow between systems and within system. Enzymes, as biological catalysts, and their functions, as seen with examples of three dimensional modeling, data and graphs. **CR3b, CR4b**
- A tour of the cell with the emphasis on prokaryotes versus eukaryotes, plant versus animal cell, specialization of cell functions, and the relationship between structure and function of organelles.
- Cell membranes, Diffusion and Osmosis. The structure of cell membranes allows function such as membrane potential and compartmentalization of protein synthesis. **CR3b, CR3c.**
- Cell communication, reception, transduction and response. Apoptosis. Evolution of cell signaling. **CR3a, CR3b, CR3c, CR3d**.

Activities and Labs:

- Identifying organic compounds and building blocks of macromolecules.
- Constructing macromolecules using building blocks, carbohydrates, lipids, proteins and nucleic acids. **SP1**
- Discussion of non-carbon based life systems and creating artificial life systems, following viewing of TED.com talks on the topic. Students will write an essay on the ethics of such manipulation. **CR5**

- **Protein Models Lab:** Learning to use protein folding software to predict the three dimensional structures of proteins based on their primary structures. Relationship between folding of the proteins and the hydrophobic/hydrophilic properties of individual amino acids, depending on the folding environment (aqueous or transmembrane) of the protein. **SP1, SP3, CR4b**
- Enzyme Catalysis Model: Objective: create models to illustrate an enzyme/substrate complex, the interaction of a competitive inhibitor, and the interaction of a noncompetitive inhibitor. **CR4d**
- **Microscopy Lab (student- generated)**: Students generate hypotheses and methods to identify plants cells and animal cells, eukaryotes and prokaryotes based on just a microscopic observation. Students observe, identify, compare and contrast animal cells, plant cells, prokaryotes and eukaryotes. Using pond water and website resources, students identify organisms found in a droplet based on their observations (unicellular, multicellular, prokaryote, eukaryote, animal, or plant cell). They draw a representative of each type of living organism recognized and observed. **SP3, SP4, SP5, SP6, SP7**
- **Enzymatic activity lab (student-generated)**: Students will analyze background information, develop a hypothesis, and design and carry out an experiment to determine optimum pH or temperature for an enzyme after determining the best way to measure the activity for this enzyme. **CR4d**
- **Student-generated Diffusion through a membrane and osmosis lab:** students will design experiments to investigate relationship between surface area and diffusion, using phenolphtalein-basic solution agar blocks, placed in an acidic solution. The students will design experiments showing diffusion and osmosis across a membrane, using dialysis tubing. They will provide evidence of diffusion of various molecules based on their sizes. They will work with concentration gradients and hypothesize the outcome, collect data, calculate percent changes, construct appropriate graphs and discuss whether their hypothesis is confirmed by the data. All work will be kept in the laboratory notebook. **CR3b, CR6, CR8, SP1, SP2, SP3, SP4, SP5, SP6.**
- **Student- generated 'Osmosis in a Cell' lab:** students will design experiments to show that plants cells will respond differently in different osmolarity conditions. They will use Eloda and design experiments where the cells are placed in various salt concentration. They will observe the cells under a microscope and record their observations in their lab notebook. **CR3b, CR6, CR8, SP1, SP2, SP3, SP4, SP5, SP6.**

Assessments:

- Free response questions from previous AP exams:
    - 2010-2
    - 2002-2

    - 2005-1
    - 2003B-3
    - 2000-1
- Multiple Choice questions.

Unit 3: Metabolism, Cellular Energy and Related Processes. (3 weeks)
CR2, CR3b, CR3c, CR3d

Big Ideas 1, 2, 3, 4
Connected Enduring Understandings:
1A: Change in the genetic makeup of a population over time is evolution.
1D: The origin of living systems is explained by natural processes.
2B: Growth, reproduction and maintenance of the organization of living systems require free energy and matter.
4A: Interactions within biological systems lead to complex properties.
4B: Competition and cooperation are important biological systems.

Discussion topics and Skills:

- Metabolic pathways. **CR3b**
- Law of energy transformations, free energy and energy transfers**. CR3b**
- Role and function of ATP and electron carriers**. CR3b**
- Enzyme structure and function. **CR3b, CR3d**
- Cellular respiration, its steps and energy flow. **CR3b**
- Photosynthesis, comparison with cellular respiration. **CR3b**
- Evolution of cellular respiration and adaptations of cellular respiration and photosynthesis to different environments. **CR3a**
- Endosymbiotic theory. **CR3a, CR3b**.
- Plants nutrition, regulation of water homeostasis, and water transport in plants. **CR3a, CR3c, CR3d.**

Activities and labs:

- Modeling cellular respiration and photosynthesis, construction of a concept maps to contrast and compare both. **CR4a, CR4b. SP1**
- Students read an article on Dr. Margulis on the endosymbiotic theory and discuss it, **CR3a, CR4a, CR4b. SP6, SP7**.

- **Student-generated cellular respiration lab**. Students create their own lab to demonstrate that organisms use cellular respiration and measure output of CO_2 or usage of O_2. **SP3, SP4, SP5. CR6 and 7**. Students create a lab report of their inquiry. **CR8**.
- **Student-generated photosynthesis lab**. Students create their own labs to demonstrate photosynthesis. **SP3, SP4, SP5. CR6 and 7**. Students create a lab report of their inquiry. **CR8**.
- **Student-generated plant transpiration lab**. Students design an experiment to find out how much water plants lose in various conditions of temperature and humidity. **SP1, SP2, SP3, SP4, SP5, CR6 and 7**. Students record their experiment in a lab notebook **CR8**.
- **Activity**: Students create an illustration tracing the path of a carbon atom from the air into a plant during photosynthesis and then follow the journey of the same carbon atom from an ancient dinosaur and into a modern human through food webs (e.g., carbon cycle). **CR3a, CR3b, CR3d.**

Assessments:

- Free response questions from previous AP exams:
    - 2009B-2
    - 2011-4
    - 2010B-1
    - 2006B-3
    - 2003B-2
- Multiple Choice questions.

Unit 4: Evolution and Biodiversity. (4 weeks)
CR2, CR3a, CR4a, CR3b, CR4b, CR3d, CR4d, CR3c, CR4c, CR5, CR6

Big Ideas 1, 2, 3, and 4
Connected Enduring Understandings:
1.A: Change in the genetic makeup of a population over time is evolution.
1.B: Organisms are linked by lines of descent from common ancestry
1.C: Life continues to evolve within a changing environment
1.D: The origin of living systems is explained by natural processes.
2.A: Growth, reproduction and maintenance of the organization of living systems require free energy and matter.
2.B: Growth, reproduction and dynamic homeostasis require that cells create and maintain internal environments that are different from their external environments.
2.D: Growth and dynamic homeostasis of a biological system are influenced by changes in the system's environment.

2.E: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination.
3.A: Heritable information provides for continuity of life.
3.C: The processing of genetic information is imperfect and is a source of genetic variation.
3.E: Transmission of information results in changes within and between biological systems.
4.A: Interactions within biological systems lead to complex properties.
4.B: Competition and cooperation are important aspects of biological systems.
4.C: Naturally occurring diversity among and between components within biological systems affects interactions with the environment.

Discussion topics and Skills:

- Origins of Life and early life evolution. **CR3a**
- Evidence of Evolution. **CR3a**
- Distinction between evolution and proposed mechanisms of evolution, Lamarck versus Darwin/Wallace. **CR3a**
- Non-Darwinian mechanisms of evolution, epigenetics. **CR3a, CR3c**.
- Brief review of Mendelian genetics and how Darwin's interpretation of natural selection was incomplete by his lack of understanding of the mechanisms of genetics. NeoDarwinism and Punctuated Equilibrium. **CR3a, CR3c, CR3d**.
- Micro and macro evolution. **CR3a, CR3c, CR3d**.
- Population genetics and Hardy-Weinberg equilibrium. Role of the environment on natural selection. **CR3a, CR3c, CR3d**.

Activities and Labs:

- **Cladogram Lab:** Students create cladograms based on the DNA sequence and Amino Acid sequence of selected proteins across species. Students learn and use BLAST and Genomic databases. Students. Students use homologies to create cladograms based on morphological data rather than molecular and compare the two. Students use a dichotomous key based on morphology**. SP5, SP6, SP7, CR6, CR8, CR4a**.
- Students watch two TED lectures, where scientists created coacervates/protobions and discuss them and the ethics of 'creating life'. **CR5.**
- **Student-generated Artificial Selection lab:** Students simulate evolution and artificial selection in Wisconsin fast growing plants. They record their data over several weeks in their laboratory notebook. **SP3, SP4, SP5, CR6, CR7, CR8**.
- **Mathematical Simulation Lab**: Students simulate population genetics in Excel, by building a spreadsheet to simulate populations genetics, the Hardy-Weinberg equilibrium and practice working with the Hardy-Weinberg equation and Chi square testing. **SP1, SP2**

- Students watch a documentary on the teaching of evolution “A Flock of Dodos” and discuss the movie in a debate about the teaching of evolution. **CR5, CR4a**.
- Students will read a ‘pseudo-scientific’ paper claiming the origin of life originated in outer space based on evidence from a meteorite. This paper is flawed and students will review the idea, debunk the paper for any flaws in the science presented, and read a rebuttal of the paper, written by an astrophysicist. Students will reflect on how scientific ideas may be misrepresented in the media and how pseudo-science can be found on certain websites. **CR5, CR4a**

Assessments:

- Free response questions from previous AP exams:
    - 2011B-4
    - 2009-3
    - 2008B-4
    - 2008B-3
    - 2004-2
- Multiple Choice questions.

Unit 5: Cell division and Genetic Basis of Life. CR2 (5 weeks)

Big Ideas 1, 3, 4
Connected Enduring Understandings:
1.A: Change in the genetic makeup of a population over time is evolution.
1.B: Organisms are linked by lines of descent from common ancestry.
2.E: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination.
3.A: Heritable information provides for continuity of life.
3.C: The processing of genetic information is imperfect and is a source of genetic variation.
3.E: Transmission of information results in changes within and between biological systems.
4.A: Interactions within biological systems lead to complex properties.

Discussion topics and Skills CR2:

- Mitosis and Life Cycles**. CR3a, CR3c**
- Cell cycles **CR3c**
- Evolutionary significance of Mitosis versus binary fission. **CR3a, CR3c**
- Evolutionary significance of sexual reproduction versus asexual reproduction. **CR3a, CR3c.**

- Meiosis and Sexual life cycles. Alternation of generations, Haploid and diploid life cycles. **CR3c, CR3d**
- Mendel and the gene idea. Probabilities, mathematical modeling of genetics, Chi square analysis. **CR3c**
- Chromosomal basis of inheritance, non-Mendelian genetics. Gene linkage, mapping gene distance, sex linked genes, defects of meiosis. **CR3c**
- Epigenetics, and how epigenetics differ from Mendelian genetics. **CR3c, CR3d**.

Activities and Labs:

- **Mathematical Model:** Students will simulate Mendelian inheritance first with index cards bearing alleles and calculate probabilities of gene transmission and apply the chi square test on their data. They will then create a computer model calculating Punnett squares and probabilities of inheritance. **SP2, CR4c.**
- Students will be given data from the Genetics of a Drosophila laboratory. All the observations will be given to them. They will develop a null hypothesis as of the mode of inheritance based on the data and use the Chi square test to determine whether to accept or reject the hypothesis. **SP2, SP5**.
- Students will practice recognizing different types of inheritance based on data and do probabilities calculations and Chi square testing. **SP2**.
- **Student-generated Mitosis lab:** Students will recognize phases of mitosis by preparing onion root slides and observing mitosis of the onion root under the microscope. Students design a method to measure the time spent in each phase of mitosis, based on their methods, they will calculate the time spent in each phase based on their observations. **SP1, SP2, SP5**.
- **Meiosis Lab:** Students will analyze the outcome of Sordaria crosses, determine the phenotypes due to crossover and non-crossover, and determine percent recombination and map units. They will compare their observations with the known map distance from gene to centromere. **SP2, SP5**
- **Activity:** Students read a scientific breakthrough paper relating how the expression of genes can be modified by epigenetic tags and how these tags are passed to future generations. They write an essay comparing and contrasting this to traditional inheritance. **CR3c**

Assessments:

- Free response questions from previous AP exams:
    - 2011-3
    - 2011B-1
    - 2008-4

    - 2002B-4
    - 2005B-3
    - 2004-1
    - 2006B-1
- Multiple Choice questions.

Unit 6: Molecular basis of inheritance and biotechnology. CR2, (5 weeks)

Big Ideas 1, 2, 3, 4
Connected Enduring Understandings:
1.A: Change in the genetic makeup of a population over time is evolution.
1.B: Organisms are linked by lines of descent from common ancestry.
2.E: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination.
3.A: Heritable information provides for continuity of life.
3.C: The processing of genetic information is imperfect and is a source of genetic variation.
3.E: Transmission of information results in changes within and between biological systems.
4.A: Interactions within biological systems lead to complex properties.

Discussion topics and Skills:

- Molecular basis of inheritance. Relationship between structure and functions of DNA and RNA. Historical perspective on the discovery and experiments leading to the current understanding of role and function of DNA. **CR3c**
- Organization of the nucleus and structure of chromatin. Evolution of the nuclear structure. **CR3a, CR3c**
- DNA replication. **CR3b, CR3c**
- From Gene to protein. Universality of the genetic code and its evolutionary implications. Transcription and translation. Mutations. **CR3b, CR3c.**
- Regulations of Gene expression, Lac and Trp Operons, eukaryotic transcription and translation regulations. Similarities and differences between prokaryotic and eukaryotic gene expression. **CR3c, CR3d**
- Viruses and Bacteria. Evolution of genomes. **CR3a, CR3c**
- Biotechnology, gene sequencing, analysis of gene expression, cloning. Uses of bacteria and viruses for biotechnology. Restriction enzymes. Ethical implications of biotechnology. **CR3c, CR5**
- Stem cell therapy and genetic engineering. Cellular differentiation and the mechanisms behind it. Ethical implications of stem cell therapy. **CR3c, CR5**
- Genomes and their evolution. **CR3a, CR3c**

Activities and labs:

- **Students- generated Models**: Models of the operons, Lac and Trp Operons. Students create a model of one type of operon. **SP1, SP6**
- Students watch "Rosalind Franklin, dark lady of DNA" PBS documentary, and discuss the role of women in scientific discovery. **CR5**.
- Students watch the movie "Gattaca" and discuss the ethics of genetic engineering. **CR5.**
- Students read and write a book report on the "Immortal Life of Henrietta Lacks". **CR5**.
- DNA sequencing. Using BLAST and the Human Genome website, students read data from a sequencing gel and identify the gene in the database. They find evolutionary conserved sequences in the database and build a cladogram. **SP1, SP2, SP5, SP6, SP7**.
- **Biotechnology lab 1: Transformation.** Students will perform a transformation experiment in which they transform a bacterial cell to contain a plasmid, cloned with a fluorescent protein gene, which allows cells to glow. Students will study the structure of the plasmid and the method used to produce it, then they will predict if the transformed bacteria will grow on various agar plates containing antibiotics. They will collect and analyze their data and compare it to their prediction. They will plan experiments to increase the efficiency of transformation. **CR3c, CR6, CR8 SP2. SP3, SP4, SP5, SP6**.
- **Biotechnology lab 2**. **Restriction analysis.** Students will perform restriction enzyme analysis and gel electrophoresis. They will understand the principles of gel electrophoresis. They will collect quantitative data by using marker DNA results to graph a reference scale for size of the bands. They will document their work in their lab notebook. **CR3c, CR6, CR8, SP2, SP3, SP4, SP5, SP6**.
- **Biotechnology lab 3**. **Polymerase chain reaction.** Students will understand the principles of polymerase chain reaction, the way Taq polymerase works and perform Polymerase Chain Reaction to find if the gene of interest has been cloned in a plasmid and analyze their results on gel electrophoresis. **SP2, SP3, SP4, SP5, SP6.**

Assessments:

- Free response questions from previous AP exams:
    - 2009B-1
    - 2009-4
    - 2005-2
    - 2005B-3
    - 2002-1
    - 2001-4
- Multiple Choice questions.

Unit 7: Diversity in the Biological World: Organism Form and Function. CR2 (5 weeks)

Big Ideas 1, 2, 3, 4
Connected Enduring Understandings:
1.A: Change in the genetic makeup of a population over time is evolution.
1.B: Organisms are linked by lines of descent from common ancestry.
2.A: Growth, reproduction and maintenance of the organization of living systems require free energy and matter.
2.B: Growth, reproduction and dynamic homeostasis require that cells create and maintain internal environments that are different from their external environments.
2.D: Growth and dynamic homeostasis of a biological system are influenced by changes in the system's environment.
2.E: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination.
3.E: Transmission of information results in changes within and between biological systems.
4.A: Interactions within biological systems lead to complex properties.
4.B: Competition and cooperation are important aspects of biological systems.

Discussion topics and skills:

- Evolutionary trends are reflected in the physiology of animals and plants. Endosymbiosis, adaptations to move from water to land in both plants and animals, animal body plans, increasing complexity of body systems. Emergent properties of systems. **CR3a, CR3d**
- Angiosperm life cycles and reproduction. **CR3a, CR3d**
- Plant evolution and adaptations to their environment, from water to land. **CR3a, CR3d**
- Photoperiodism in plants. **CR3d**
- Hormones in plants and animals. Review of signal transduction pathways. Feedback loops in animal endocrine regulations. **CR3b, CR3d**
- Evolution of various physiological systems to maintain homeostasis, animal excretion, kidney function, water regulation, blood pressure regulation. **CR3d**
- Thermoregulation in animals. **CR3a, CR3d**
- Importance of diffusion surface for alveoli function in lungs, food absorption in the villi of the intestine, excretion of nephron in kidneys.**CR3d**
- Structure and function of the nervous system. Emergent properties in the brain. Brain evolution. Synapses and review of action potentials.**CR3d**
- Structure and function of the immune system and importance of cellular communications in the immune function. Genetic plasticity of immune cells. **CR3c, CR3d**

Activities and labs:

- Based on the structure and morphology of certain plants, students will reconstruct the evolutionary relationships between the plants provided and construct a cladogram and phylogenic tree representing their findings. They will verify their evolutionary findings by analyzing the sequence of one protein across species and compare the evolutionary relationships based on the DNA sequence and on the morphology. **CR4a, CR4d**
- Students will model cellular communications in physiological systems, comparing and contrasting endocrine control and regulation with synapses and their regulation. **CR4d, SP1**
- Students will reflect and summarize the importance of surface to provide maximum exchanges, in cells, endocrine systems, kidney for water filtration, intestine for food absorption, lungs for gas exchange. They will create graphic organizers representing various examples where surface is important for diffusion and exchange. **CR4d, SP1**.
- **Nervous System physiology lab:** Students design experiments to test their five senses, and the dominance of their right and left brain hemispheres. They investigate vision by testing their eye sight, finding their blind spot and their eye dominance. They test each other's hearing and their ability to locate a sound coming from various part of the room. They map the taste buds on their tongue for several basic tastes, sweet, salty, sour and bitter. And they investigate the spatial distribution of their touch receptors on various part of their skin and find that receptors are in higher density on fingers than on the arm. They record their findings in their lab notebooks and present them to their peers. **CR4c, CR4d, CR6 and CR8. SP3, SP4, SP5, SP6, SP7.**

Assessments:

- Free response questions from previous AP exams:
    - 2011-2
    - 2010-1
    - 2009-2
- Multiple Choice questions.

Unit 8: Ecology and Behavior. CR2. (3 weeks).

Big Ideas 1, 2, 3, 4

Connected enduring understandings:

1.A. Change in the genetic makeup of a population over time is evolution.

1.C. Life continues to evolve within a changing environment.

2.A. Growth, reproduction and maintenance of the organization of living systems require free energy and matter.
2.C. Organisms use feedback mechanisms to regulate growth, reproduction and dynamic homeostasis.
2.D. Growth and dynamic homeostasis of a biological system are influenced by changes in the system's environment.
2.E. Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination.
3.E. Transmission of information results in changes within and between biological systems,
4.A Interactions within biological systems lead to complex properties.
4.B. Competition and cooperation are important aspects of biological systems.
4.C. Naturally occurring diversity among and between components within biological systems affects interactions with the environment.

Discussion topics and skills:

- Aspects of animal behavior **CR3d**
- Aspects of biomes **CR3d**
- Models describing population growth, **CR3d, SP1**
- Community interactions **CR3d.**
- Species diversity and composition. **CR3c, CR3d.**
- Community biodiversity **CR3d.**
- Energy flow and chemical cycling in ecosystems **CR3b, CR3d.**
- Primary productivity **CR3d.**
- Energy transfer between trophic levels **CR3b, CR3d.**
- Human activities that threaten biodiversity. **CR3d, CR5**

Activities and Labs:

- **Student-generated Fruit Fly Behavior Lab:** Students design their own controlled experiments to investigate a question they have about animal behavior (kinesis and taxis in isopods, fruit fly behavior with respect to selected stimuli). The entire experimental design, results and data analysis and conclusions will be written in the laboratory notebook. **CR6, CR8, SP1, SP2, SP3, SP4, SP5, SP6, SP7**.
- **Student-generated Dissolved Oxygen and Primary Productivity Lab:** Through guided inquiry, students will investigate how to measure dissolved oxygen using the Winkler method. Students will then design experiments and use their technical skill to measure dissolved oxygen in various conditions (for instance temperature). Students will explore respiration and photosynthesis processes in samples of a Chlorella culture as they study gross and net primary productivity. Students will design an experiment, testing the

effect of one variable on primary productivity. They will hypothesize, design the experimental method and collect dissolved oxygen data, calculate primary productivity, report their results in graphs and tables and draw conclusions. The investigation will be written in the students' lab notebook. **CR6, SP1, SP2, SP3, SP4, SP5, SP6, SP7**.

- Students will design a model of biome that demonstrates knowledge of biological processes and concepts across scales. The premise of this activity is to design a self-contained chamber to grow basil plants, allowing water to recycle and enough nutrition for the plants to grow. Models of hydroponic cultures will be studies for this project. Students will build their chambers and test it. They will record their observations in the lab notebook. **CR3d, CR4d, CR8**
- Students will watch two documentaries on climate change (PBS Frontline, "Climate of Doubt" and "An Inconvenient Truth"). They will discuss these documentaries with present them with society issues, urbanization, farming, and carbon dioxide release in the atmosphere. **CR5**
- Pose the following question to students: In order to improve species richness, you decide to add phosphate to a pond. How might you determine how much phosphate to add in order to avoid eutrophication? Students will prepare a poster of their findings. **CR4d, CR5, SP3, SP4**.
- Animated investigation: How Does the Fungus Pilobolus Succeed as a Decomposer? From: www.campbellbiology.com Chapter 31. Students investigate this fungus as a decomposer, hypothesizing and collecting data in this animated investigation; they will study the adaptiveness of certain spore dispersal methods. **CR4d, SP5, SP6, SP7**.
- Animated investigation: How do Abiotic Factors Affect Distribution of Organisms? From www.campbellbiology.com chapter 52. Students will use a simple model for observing ecological impact that occurs when single abiotic factors are changed. By changing abiotic factors, data can be collected and analyzed. **CR4d**.

Assessments:

- Free response questions from previous AP exams:
    - 2011B-2
    - 2011B-3
    - 2010-4
    - 2008-2
    - 2007-3
- Multiple Choice questions.

Practice Tests and End of year work:

- Students will practice full length released test throughout the course for diagnostics purpose.
- They will review material based on their needs.
- Post-AP assignment will be the development of a research question based on the topic selected at the beginning of the year, with students presenting papers they have read and elaborating on the research. **CR8**
- Students will have the opportunity to test and make experiments for that research, and present it to the class. **CR8**