AP Biology Syllabus/Pacing Guide

2016-2017 (adapted from Sample Syllabus 1 from College Board)

Course Overview: Biology, like any science, is a way of knowing. The inquiry process and critical thinking skills are essential to truly studying biology. This course is designed to allow students the opportunity to explore not only their own skills and abilities, but to foster curiosity of the living world.

At the end of the course, students will have an awareness of the integration of other sciences to biology. Students will understand how our both diversity and unity can be found with all organisms.

Instructional Context: AP Biology is offered to both juniors and seniors who have completed a year of biology and chemistry. Our high school employs a rotating block schedule. Students meet with me for 87 minute block periods every other day.

Students are given two summer assignments. In one assignment, students select to read either *Survival of the Sickest* by Dr. Sharon Moalem or *Your Inner Fish* by Neil Shubin. Students are asked to create a book journal highlighting what they want to preserve as a reader AND offer what future questions the text stimulated. The second assignment asks the students to explore basic ecological terminology and create an ecosystem story book.

Instructional Resources:

Campbell, Neil A. and Reece, Jane B., Campbell *Biology*, 10th Edition, 2014, Pearson Benjamin Cummings.

Heitz, Jean. *Practicing Biology* (to accompany Campbell-Reece Biology), 2nd Edition, 2005, Pearson Benjamin Cummings.

Giffen, Cynthia and Heitz, Jean. *Practicing Biology*, 3rd Edition, 2008, Pearson Benjamin Cummings.

www.campbellbiology.com (website that coincides with the textbook providing videos, animations, PowerPoint presentations, investigations, etc.)

AP Biology Investigative Labs: an Inquiry Based Approach

Flinn AP Biology Laboratory Kits, Flinn Scientific, Inc.

Advanced Placement Biology Content: This course will offer students a solid foundation in introductory college-level biology. The main focus of this course will be the following BIG IDEAS:

1 – The process of evolution drives the diversity and unity of life.

2- Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis.

3 – Living systems store, retrieve, transmit and respond to information essential to life processes.

4- Biological systems interact, and these systems and their interactions possess complex properties.

Investigative Laboratory Component: Beyond the BIG IDEAS, students will also be provided with the opportunity to complete the following:

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 content 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.

Throughout each unit, students will be given the opportunity to engage in student-directed laboratory investigations. Students will conduct minimally eight inquiry-based investigations. Additional labs will be conducted to deepen students' comprehension and reinforce the application of science practices. The inquiry laboratories and student- directed investigations will total a minimum of 25% of instructional time. Students will be required to display their learning from these experiences in a variety of ways: formal lab reports (word document with embedded charts/graphs), "informal" lab reports (collection of handwritten notes/outlines/calculations and or conclusions- used term lab folder/log) or display boards. These assessments are further explained under each unit's laboratory investigation.

UNITS OF INSTRUCTION – Based on Campbell and Reece, 7th edition text

Unit 1- Ecology/ Introduction

- TEXT CHAPTERS:
  - 1- Exploring Life
  - 51-Animal Behavior

- 52- An Introduction to Ecology and the Biosphere
- 53-Population Ecology
- 54-Community Ecology
- 55- Ecosystems and Restoration Ecology
- 56-Conservation Biology and Global Change

- LECTURE TOPICS:
  - Biological organization & life characteristics
  - Darwin and the Theory of Natural Selection
  - Taxonomy
  - Aspects of animal behavior
  - Aspects of biomes
  - Models describing population growth
  - Regulation of population growth
  - Community interactions
  - Species diversity and composition
  - Community biodiversity
  - Energy flow and chemical cycling in ecosystems
  - Primary productivity
  - Energy transfer between trophic levels
  - Human activities that threaten biodiversity
- ACTIVITIES/ INVESTIGATIONS:
  - **Fruit Fly Behavior Inquiry Investigation** – students design a controlled experiment to investigate a question they have about animal behavior (kinesis vs. taxis). Students will produce a laboratory report that includes a laboratory design, data (in appropriate chart/graph form), data analysis, conclusions from the experiment and discussion of the investigation's validity.
  - From www.campbellbiology.com – Students will submit their answers to the provided questions via email to the instructor.
    - Investigation 31.5 How Does the Fungus *Pilobolus* Succeed as a Decomposer?
    - Investigation 50.2 How do Abiotic Factors Affect Distribution of Organisms?
  - **ANIMAL PLANET VIDEO** – Blue Planet – as view DVD create representative food webs, identify and discuss various symbiotic relationships.
  - **STUDENT RESPONSE** – ASK – In order to improve richness, you decide to add phosphate to a pond. How might you determine how much phosphate to add in order to avoid eutrophication? After their own answer is formulate, form small groups to discuss and present their proposal.
  - **SUMMER ASSIGNMENT of ECOSYSTEM story books** – presented and discussed

Unit 2 ~ Chemistry of Life

- TEXT CHAPTERS:
  - 2 ~ The Chemical Context of Life
  - 3 ~ Water and Life
  - 4 ~ Carbon and the Molecular Diversity of Life
  - 5~ The Structure and Function of Large Biological Molecules
- LECTURE TOPICS:
  - Inquiry as a way to learn science
  - Structure of atoms
  - Properties of water
  - Impact of carbon as the "backbone" of life
  - How monomers build polymers, including the roles of nucleic acids
- ACTIVITIES/INVESTIGATIONS:
  - **WARD's Biology Molecules of Life activity** – students build models of organic macromolecules. Students will provide models of each organic molecule (for which they receive teacher approval in order to progress on within the activity) AND complete analysis questions that display their comprehension of biochemistry AND its importance to living things.
  - **From *Practicing Biology*, 2nd Edition and 3rd Edition**
    - Activity 4/5.1~ How can you identify organic macromolecules?
    - Activity 4/5.2 ~What predictions can you make about the behavior of organic macromolecules if you know their structure?
    - Activity 4.2/5.2 ~What predictions can you make about the behavior of organic molecules if you know their structures? (3rd Edition)

Unit 3~ Introduction to the Cell

- TEXT CHAPTERS:
  - 6 – A Tour of the Cell
  - 7~ Membrane Structure and Function
- LECTURE TOPICS:
  - Impact of carbon as the "backbone" of life
  - How monomers build polymers, including the roles of nucleic acids
  - Examples of how organelles are membrane bound to compartmentalize their functions
  - Membrane structure and function
- ACTIVITIES/INVESTIGATIONS:
  - **BUILD~A~MEMBRANE**: http://learn.genetics.utah.edu/ Cut, fold, and paste biological molecules to create a 3~D model of the fluid mosaic model followed by whole class discussion of membrane structure and function. Students complete animations under Amazing Cells from same website.

- **THE EVOLUTION OF THE CELL:** http://learn.genetics.utah.edu/ Endosymbiotic theory – whole class discussion on the evidence supporting this theory. Students are given write a conclusion or closure paragraph at end of discussion.
- **Research Project** – Investigate the discovery a specific organelle. Students select an organelle, research its discovery discussing the experimentation and data collected to reveal the uniqueness of that specific organelle. Information will be presented in a research paper format.
- **Diffusion and Osmosis Inquiry Investigation** – Students will provide a formal lab report detailing the following information: background information with regard to the processes of diffusion & osmosis, personal hypotheses, experimental design, data collected, calculations of percent changes, graphing of these percent changes, analysis of the data and conclusions from the investigation. A discussion of validity will also be incorporated into the lab report.
- **From *Practicing Biology*, 2nd Edition**
  - Activity 7.2- How is the structure of a cell membrane related to its function?

Unit 4- Cellular Energy and Related Processes

- TEXT CHAPTERS:
  - 8- An Introduction to Metabolism
  - 9- Cellular Respiration and Fermentation
  - 10- Photosynthesis
- LECTURE TOPICS:
  - Metabolic pathways
  - Laws of Energy Transformation
  - How ATP powers cellular work
  - Enzyme structure and function
  - Harvesting chemical energy – glycolysis, citric acid cycle, oxidative phosphorylation
  - Evolution of alternative mechanism of carbon fixation
- ACTIVITIES/INVESTIGATIONS:
  - **From *Practicing Biology*, 2nd Edition and 3rd Edition.**
    - Activity 8.1- What factors affect chemical reactions in cells?
    - Activity 9.1 - A Quick Review of Energy Transformations
    - Activity 9.2- Modeling Cellular Respiration: How can cells convert the energy in glucose to ATP?
    - Activity 10.1- Modeling Photosynthesis: How can cells use the sun's energy to convert carbon dioxide and water into glucose?
    - Activity 10.2- How do C_3, C_4, and CAM photosynthesis compare?
  - From www.campbellbiology.com – For all investigations listed below, students will complete analysis questions that will be emailed to the instructor.

        - Investigation 8.4 -How is the rate of enzyme catalysis measured?
        - Investigation 9.4- How is the rate of cellular respiration measured?
        - Investigation 10.3- How is the rate of photosynthesis measured?

    - **Cellular Respiration Inquiry Investigation** –students measure baseline data of oxygen consumption by bean seeds, and then explore "what environmental factors may affect respiration rate?" Students will prepare a lab report that displays their understanding of the major concepts of this investigation. The report will include a hypothesis, experimental protocol, data, data analysis, conclusions, error discussion and improvements for further research.
    - **Photosynthesis in Leaf Disks Inquiry Investigation** – measure rate of photosynthesis and then explore either abiotic or biotic factors OR leaf type with regard to photosynthesis rate. Students will create a poster/display board (much like found in a science fair) that provides not only information with regard to the experimental design, data and conclusions but also include many visual images/aids to show what was learned in this exercise.
    - **WARD's Biology Lab – Plant Pigments and Photosynthesis** – students utilize paper chromatography to separate plant pigments AND analyze given spectrophotometer data to measure photosynthesis rates. Student answers to given analysis questions and word problems will measure success of this investigation.

Unit 5- Cell Communication and the Cell Cycle

- TEXT CHAPTERS:
    - 11- Cell Communication
    - 12- The Cell Cycle
- LECTURE TOPICS:
    - Evolution of cell signaling
    - Reception, transduction, response
    - Apoptosis
    - How mitosis produces genetically identical daughter cells
    - Evolution of mitosis
    - How the eukaryotic cell is regulated by a molecular control system
    - Origin of cell communication
- ACTIVITIES/INVESTIGATIONS:
    - **PATHWAYS WITH FRIENDS**: www.learn.genetics.utah.edu/ - students act out cell communication given direction cards. A whole class discussion follows assessing student comprehension. Further animations from the website are utilized- An Example of Cell Communication, The

Fight or Flight Response, and How Cells Communicate during the Fight or Flight Response.

- **From Practicing Biology, 2nd Edition**
  - Activity 11.1 How are chemical signals translated into cellular responses?
- **Using prepared *Allium* root tip slides**, students estimate the time a cell spends in each of the mitotic stages and develops an appropriate graph to reveal data. Students will provide a laboratory report that includes a discussion of the experimental design and outcome as well as include calculations and analysis of the data.
- **Cancer and the Loss of Cell Cycle Control** – students construct both normal and abnormal karyotypes followed by research investigating a specific type of cancer. A mini-poster will be created to present to the class.
- **Environmental Effects on Mitosis Inquiry Investigation** – Students will provide a laboratory report with detailed discussion of the problem investigated, hypothesis developed, experimental protocol, data collected, graphic data presentation/calculations, data analysis and conclusions derived from this experience.

Unit 6- Genetic Basis of Life

- TEXT CHAPTERS:
  - 13- Meiosis and Sexual Life Cycles
  - 14- Mendel and the Gene Idea
  - 15- The Chromosomal Basis of Inheritance
- LECTURE TOPICS:
  - Genes are passed from parents to offspring by the inheritance of chromosomes
  - How meiosis reduces the number of chromosomes
  - Evolutionary significance of genetic variation that results from sexual life cycles
  - Concepts of Mendelian genetics
  - Genes are located along chromosomes (gene linkage, gene mapping, causes of genetic disorders)

- ACTIVITES/INVESTIGATIONS:
  - From www.campbellbiology.com – Students will email instructor answers to analysis questions.
    - Investigation 13.4 How can the frequency of crossing over be estimated?
  - **M&M Chi square labs** – Students count colors in various M&M packages and apply the null hypothesis concept and Chi Square calculations on

data. Students will provide paperwork illustrating all of their calculations AND a brief paragraph outlining what conclusions can be drawn from that data.
    - **Drosophila Chi square example** – provide sample data for calculations
    - ***Sordaria* Genetics Inquiry Investigation** – observe crossing over using a fungi specimen. Students analyze outcomes of *Sordaria* crosses, determine phenotypes due to crossover or non-crossover, and calculate percent recombination and map units. They will compare their observations with the known map distance from gene to centromere.
    - **The Genetics of *Drosophila* Eye Color Inquiry Investigation** – Student will prepare a lab report discussing the following in detail: identify problem, hypothesis, experimental design, data – collection, presentation & analysis, conclusion and validity.

Unit 7- Gene Activity and Biotechnology

- TEXT CHAPTERS:
    - 16- The Molecular Basis of Inheritance
    - 17- Gene Expression: From Gene to Protein
    - 18- Regulation of Gene Expression
    - 19- Viruses
    - 20- DNA Tools and Biotechnology
    - 21-Genomes and Their Evolution

- LECTURE TOPICS:
    - DNA is the genetic material (history, DNA structure, DNA replication)
    - Flow of genetic information (genetic code, role of other polymers, transcription, translation)
    - Mutations
    - Gene expression (operon systems in prokaryotes, eukaryotic gene expression)
    - Virus structure and activity
    - Restriction enzymes, plasmids, transformation
    - DNA technology (gel electrophoresis – applications & how it works)
- ACTIVITIES/INVESTIGATIONS:
    - **From *Practicing Biology,* 2nd Edition – For all activities listed below, students will complete the analysis questions given.**
        - Activity 16.1 Is the hereditary material DNA or protein?
        - Activity 16.2 How does DNA replicate?
        - Activity 17.1 Modeling Transcription and Translation: What processes produce RNA from DNA and protein from mRNA?
    - From www.campbellbiology.com- For the activity listed below, students will email instructor with answers to the analysis questions given.

        - Investigation 16.2 What is the correct model for DNA replication?
    - **Lac Operon Interactive website** – work through information/lectures and animations at www.dnai.org – report findings in an essay format that will display knowledge of the mechanics of the lac operon.
    - **DNA and HISTONE MODEL** – www.learn.genetics.utah.edu/ - cut and paste papers to create a 3-D model explaining the actions of acetyl and methyl molecules in gene expression. Students will then utilize their models to put on a "show" that explains HOW this model works.
    - **Bacterial Transformation Inquiry Investigation** – transform E.coli with GFP (green fluorescent protein). Students will study the structure of the plasmid and make predictions regarding growth on various agar plates. They will then examine the bacterial growth afterwards and collect quantitative data. Calculations of transformation efficiency will be made. Students will then plan a controlled experiment that they think would improve the transformation efficiency. All of this information will be compiled in a laboratory log/folder (a lab log/folder is a more informal approach than a lab report – it should include hand written notes, detailed explanations and labeled charts/graphs that have been collected over a period of several days/weeks).
    - **Various interactive gel electrophoresis simulations – paper version titled Who Stole the Cheese and a virtual version from** www.learn.genetics.utah.edu/ . Students will provide a paper model of an electrophoresis gel. A paragraph will be created outlining what can be learned from the gel AND how this activity – and each part of the activity- models that of a real gel electrophoresis.

Unit 8- Evolution and Phylogeny

- TEXT CHAPTERS:
    - 22- Descent with Modification: A Darwinian View of Life
    - 23- The Evolution of Population
    - 24- The Origin of Species
    - 25- The History of Life on Earth
    - 26- Phylogeny and the Tree of Life
    - 27- Bacteria and Archaea

- LECTURE TOPICS:
    - How natural selection serves as a mechanism for evolution
    - Scientific evidence supporting evolution
    - Hardy-Weinberg concept
    - How allele frequencies can be altered in a population
    - Concepts of speciation
    - Origin of Life; fossil records

    - Events in the "history of life" (origin of single-celled and multicellular organisms; mass extinctions; adaptive radiations)
- ACTIVITIES/INVESTIGATIONS:
    - **Understanding Evolutionary Relationships Inquiry Investigation** – Students will utilize data from BLAST to create analyze and create cladograms. Then student will use the tool to answer questions of their choice regarding sequences. A formal lab report will be submitted illustrating what was learned.
    - **NOVA; PBS video "What Darwin Never Knew"** – use as a springboard into a whole class discussion of Charles Darwin's observations and how current molecular biology influences evolution
    - **WARD's Biology Lab – Population Genetics and Evolution** – simulate mating in various scenarios (lethal mutations, heterozygote advantage) and utilize data in Hardy Weinberg calculations. Students will collect class data, perform necessary calculations and utilize those calculations to answer specific analysis questions – cover comprehension of Hardy Weinberg AND applying Hardy Weinberg to real world examples.
    - From www.campbellbiology.com – Students will email instructor answers to analysis questions.
        - Investigation 25.3 How is phylogeny determined by comparing proteins?
    - **From *Practicing Biology*, 2nd Edition**
        - 23.1 A Quick Review of Hardy-Weinberg Population Genetics
    - **Artificial Selection Inquiry Investigation** – At the conclusion of this exercise, students will provide a lab folder/log that provides evidence of the problem investigated, hypothesis developed, procedure followed, data collected, data analyzed, conclusions made and validity discussed.

Unit 9- Diversity in the Biological World

- TEXT CHAPTERS:
    - 40-Basic Principles of Animal Form and Function
    - 41-Animal Nutrition
    - 42-Circulation and Gas Exchange
    - 43- Immune System
    - 44-Osmoregulation and Excretion
    - 45-Hormones and the Endocrine System
    - 46-Animal Reproduction
    - 47-Animal Development
    - 48- Neurons, Synapses, and Signaling
    - 49-Nervous Systems
- LECTURE TOPICS:
    - Evolutionary trends (endosymbiosis, animal body plans)
    - Feedback control loops in animals

- Thermoregulation in animals
- Energy allocation and use in animals
- Examples of functioning units in mammal systems (alveoli in lungs, villi of small intestines, nephrons in kidneys)
- Structure and function in immune systems
- Structure and function in nervous systems (neurons, resting potential, action potential, synapses)
- Structure and function of the human brain
- Signal transduction pathways (animal hormones)

- ACTIVITIES/INVESTIGATIONS:
  - **JUMPIN' THE GAP** – www.learn.genetics.utah.edu – students act our communication at the neural level by behaving as vesicles, neurotransmitters, receptors, secondary messengers and transporters.
  - From www.campbellbiology.com – Answers to the given questions that correlate to these investigations will be submitted to the teacher via email.
    - Investigation 44.5 What affects urine production?
    - Investigation 43.5 What causes infection in AIDS patients?
  - **From *Practicing Biology*, 2nd Edition**
    - Activity 41.1 How are form and function related in the digestive system?
    - Activity 42.1 How is mammalian heart structure related to function?
    - Activity 42.2 How do we breathe, and why do we breathe?
    - Activity 48.1 How do neurons function to transmit information?
  - **WARDS Biology Urinalysis Lab** – students perform chemical tests on 4 "patients" to determine a medical diagnosis based on the contents of their urine. Students will compile and analyze both the quantitative and qualitative data from this lab. The data will be utilized to determine the diagnosis of four hypothetical patients. Students will compose answers to given questions as well as create a mini –poster outlining how the structure of the kidney enables its function.

Unit 10- Botany

- TEXT CHAPTERS:
  - 29- Plant Diversity I-How Plants Colonized Land
  - 30-Plant Diversity II – The Evolution of Seed Plants
  - 31- Fungi
  - 35- Plant Structure, Growth and Development
  - 36-Transport in Vascular Plants
  - 37- Plant Nutrition
  - 38- Angiosperm Reproduction and Biotechnology
  - 39-Plant Responses to Internal and External Signals
- LECTURE TOPICS:
  - Adaptations that allowed plants to move from water to land

    - Reproductive adaptations of angiosperms
    - Environmental roles of fungi
    - Unique features of the angiosperm life cycles
    - Signal transduction pathways (plant hormones)
    - Photoperiodism in plants
- ACTIVITIES/INVESTIGATIONS
    - **From *Practicing Biology*, 2nd Edition**
        - Activity 29/30.2 What can a study of extant species tell us about the evolution of form and function in the plant kingdom?
    - **Rate of Transpiration Inquiry Investigation** – Student determine baseline transpiration rate and then explore one variable that could affect transpiration rates. Students will then prepare and submit a formal lab report highlighting the problem investigated, hypothesis created, protocol followed, data collected, data presentation and analysis, conclusions that can be drawn and validity discussion.