Course Title: AP Biology

Course Textbook: Campbell & Reece, et al, *AP Edition* Biology *6th Edition*, Pearson Benjamin Cummings, 2005

Lab Manuals:

A.P. Biology Laboratory Manual for Students, College Board, 2001
Helms, Helms, Cummings, & Kosinski, *Biology in the Laboratory, 3rd Edition*, W. H. Freeman, 1998.

Course Objective:

To promote an understanding that science is a complex process and the themes of science are interdependent on one another. Students are expected to become proficient at laboratory technique and will demonstrate an understanding of laboratory concepts via formal lab write ups. Finally, students will research one pertinent environmental issue and write a research paper including the following topics: Scientific evidence concerning the issue, ethical concerns, financial concerns, and a proposed solution to their specific environmental concern. In order to receive a weighted credit, students must take the AP exam. The test fee is paid for by the school district. Students may choose not to take the AP exam but this choice indicates their willingness to forego a weighted grade for the course.

Course Overview:

This course is on a traditional 50 minute time block and the class meets 5 times per week. Content will be covered through a variety of methods including: Lecture accompanied by guided notes, power point presentation, class discussion, assigned reading with teacher prepared questions, teacher prepared hands on activities to reinforce complicated concepts, and laboratory assignments will reinforce content previously learned. Lab time will exceed 25% of class time.

Content Overview:

The AP curriculum is thorough and aggressive and every attempt is made to cover all topics related to 8 major themes of biology which include:

Science as Process – This theme is interwoven into the fabric of the course, but one specific example follows. DNA to protein synthesis kinesthetic activity. Students manipulate a "hands on" activity which I designed. A zipper is used to demonstrate the double helix of DNA, 3' and 5' markers have been glued onto the zipper. Letters from the alphabet are included in the kit to demonstrate various enzymes IE – H = helicase, L = ligase, etc. cardboard pieces are designated as mRNA and have the appropriate codon sequence. Larger T cutouts represent tRNA which have the corresponding anticodon and the appropriate amino acid. Students see the relationship between the theory of protein synthesis and how it actually works. Furthermore they can see the evidence of another major theme of the book "form fits function" and they can see the importance of enzyme function and how that every biological process in the body relies on specific enzymes.

Evolution – This concept is the unifying theme of the class. Classical Darwinism is presented accompanied by the work of other prominent evolutionist. The idea of natural selection with adaptation as its mechanism is taught during the evolution unit. However, the idea of "form fits function" is taught continually through every chapter and every lab. Students will have an understanding that the "form" of anything in nature is not static but the result of millions of years of refinement through natural selection. This form fits function can be seen on a macro scale such as beaks of finches or the micro scale such as sugars having the Hydroxyl functional group allows them to be soluble in water.

Energy Transfer – This concept is reinforced throughout the year but I think the students can really see this during the unit on photosynthesis/ cell respiration when students manipulate another kinesthetic activity where they see the process of atp phosphorylation occur and how that drives the proton pumps. Or how the ETC, powered ultimately by the sunlight, drives the endergonic reaction of photosynthesis. This is hard to articulate but if you could see the manipulatives that I have designed I believe you would be confident that the students have been taught the concept of energy transfer.

Continuity and Change – This concept is taught through both traditional lecture and a unique teacher prepared assignment. I have developed about nine fabricated ecosystems for which a given student must design an animal which is adapted to thrive in that given ecosystem. The ecosystem might have volcanoes that spew a toxic gas or huge tar pits that an animal must be able to cross without having the luxury of flight. Each student's animal will be part of the ecosystem and may NOT be the primary predator of the food chain. The reason for animal not being the primary predator is because each animal must show how it will escape becoming prey. In each ecosystem the predator is described and how it chooses to "hunt" so the student's animal will have to find its Niche within the ecosystem. Once a sketch of the animal has been provided to me and I see how the animal is adapted to its environment, the student must originate their own variations of that ecosystem and show how a new set of adaptations would be required for that animal to exist. I also require the student to show a diagram of how advantageous features might have shown up through various chromosomal mutations such as deletion, inversion, translocation, etc. I assure you that student do realize these adaptations do not just appear but are the end product of millions of years of evolution within that ecosystem.

Relationship of Structure To Function – You have probably already seen evidence of this topic being taught but an additional example would be when students have to provide cardboard / poster board cuts out of the enzyme substrate complex including allosteric binding, competitive inhibition, non competitive inhibition, etc. The students have demonstrate these processes using their cut out models.

Regulation – This topic is covered through a variety of topics: The Daphnia lab on Homeostasis and seeing how specific stimuli affects heart rate. The transpiration lab, seeing how temperature causes the stomata to close. From lecture, the discussions of the trp operon and how that the end product (tryptophan) becomes the active repressor, thus shutting down the operator and ending that metabolic pathway. This is a wonderful example of feedback inhibition which is a primary example of "Regulation". All of these example and countless others are taught on the topic of regulation.

Interdependence in Nature- This topic is primarily taught during ecology unit when topics such as symbiotic relationships are covered. Also, this is reinforced during the "designing your animal" activity and is also taught on the micro scale with the

explanation of a variety of biological processes. One simple example might be seen through the examination of two metabolic pathways: Cell respiration Vs photosynthesis. During a lecture of photosynthesis, students would see how animals rely on the product of photosynthesis (O_2). Then during a discussion of cell respiration, the student would see the dependence the plant has on the animal because the plants requires the CO_2 to run its own metabolic pathway (photosynthesis). This would be just one of many discussions the student would be exposed to demonstrating the interdependence of nature.

Science, Technology and Society – Students will demonstrate their knowledge of this topic through his/her research paper on their environmental issue, but also this topic is covered through various content related topics. For example when discussing genetic engineering, students would see the importance of pesticide resistant corn. Or the during the study of immunology the students would see the affects of overusing antibiotics and how that has led to the evolution of antibiotic resistant bacteria.

It should be noted that these eight themes listed above are not taught and dropped but rather are woven into the fabric of the course. I could write volumes of notes describing how this is done. The examples above are a just a few to demonstrate that I teach those topics.

I attempt to allocate my time based on the percent recommendations provided by the Acorn guide. Due to the demanding time constraints of the curriculum I assign an Ecology unit for summer work. Major topics of that unit are discussed briefly at the beginning of the 1st semester and then reinforced through the rest of the year during appropriate times.

Topical outline/timeline

Ecology and Behavior: (10 days total) [Ch: 50 – 55] Major topic covered include but are not limited to the following: Biomes, climates, behavior patterns, population patterns, predation, ecological succession, various cycles: water, nitrogen, carbon, biological magnification, habitat destruction, and speciation. **Total Lab time (4 days): AP lab 11 Animal Behavior;1 day, Ecosystem/Designing your own animal – Teacher created; 2 days, Dissection of an owl pellet 1 day**
Assigned summer questions due 1st day, **(note: these 10 days should be considered as part of the Organisms and populations (50%)**

Chemistry of life: (25 days) [Ch: 2 – 6] Major topic covered include but are not limited to the following: atoms, molecules, bonds, water and its importance, carbon, acids, bases, isomers, functional groups, carbohydrates, proteins, lipids, polymers vs monomers, enzyme/substrate complex, catabolism vs anabolism etc. **Total Lab time (5 days): AP lab 2/ Enzyme lab 2 day, Water adhesion/penny lab 1 day, Toothpickase 1 day, Organic Chemistry ball/stick model kit/ functional groups 1 day**

The cell: (27days) [Ch: 7, 8, 9, 10, 12, 13] Major topic covered include but are not limited to the following: Microscopes, organelles, membranes, diffusion, osmosis, cellular respiration, fermentation, photosynthesis (glycolysis, Krebs, ETC) chemiosmosis,

cell division (mitosis and meiosis) **Total Lab time (5 days): AP lab 1/diffusion and osmosis 2 day, AP lab 3/Mitosis and Meiosis 1 day, , AP lab 5 cell respiration = 2 day**

***Genetics*:** (24 days) [Ch:14, 15, 16, 17, 20,] Major topic covered include but are not limited to the following: Gregor Mendel, laws of segregation and independent assortment, complete, incomplete, co-dominance, sex linked, recombinant DNA, Chi Square, Central Dogma of Protein Synthesis, mutations, cloning, gel electrophoresis, DNA technology **Total lab time: (8 days):, DNA extraction from cheek epithelia cell 1 day, M&M Chi square analysis 1 day, AP lab 7/Genetics and Chi Square 6 days**

Evolution: (22 days) [Ch:22, 23, 24, 25, 26] Major topic covered include but are not limited to the following: Darwin, Lyell, Lamarck, Wallace, Mathus, gradualism, uniformitarianism, populations, artificial vs natural selection, decent with modification, adaptation, morphology, cladistics, founder effect, bottleneck effect, genetic drift, divergent vs convergent evolution, co evolution, speciation, relative vs radioactive dating, phylogeny, classifications systems, dichotomous keys, Hardy-Weinberg theorem **Total lab time: (5 days)** ***Note: I actually do this lab a little late. It probably should be done with the Genetics unit, but there are already 8 days of lab in the Genetics unit due to the length of the Drosophila fly la. Furthermore; the plasmid lab still deals with the concept of how genes are transferred so I feel this is still topical during the Evolution unit*. AP Lab 6a/plasmids transfer 2 days, AP Lab 6b Gel Electrophoresis 1 day AP lab 8/population genetics 1 day, Phenolphthalein in beakers used to demonstrate Genetic Drift 1 day**

Plants (30 days) [Ch:29, 30, 35-39] Major topic covered include but are not limited to the following: Plant structures, tissues, organs and systems (including symplast and apoplast,) transport mechanisms, xylem, phloem, root pressure, source to sink, water potential, turgor pressure, stomata, adhesion vs cohesion, phototrophism, gravitropism, thigmotrophism, photoperiodism, plant response to stimuli, plant hormones, -auxin, cytokinins, gibberellins, abscisic acid, ethylene, cell elongation, alternation of generations life cycle. Major plant phylas and chronological order of their emergence **Total lab time: (5 days) AP lab 9/Transpiration lab 2 day AP lab 4/ photosynthesis 1 day, Examining Xylem/Coloration of Carnations 1 day, Dissection of a Flower 1 day**

Animals (40 days) [Ch: 41-48] Major topic covered include but are not limited to the following: Homeostasis mechanisms, amino acids, essential nutrients, metabolic pathways, evolutionary pathway of body plans, reproduction – sexual an asexual, embryonic development, animal hormones, neuron transmission, parts of the brain, feedback mechanisms – lac operon, trp operon, etc, Naming the major phyla of the animal kingdom and distinguishing significant evolutionary advantageous features for each "higher" phyla. A survey of system of the human body and their comparative features to other animals. **Total lab time: (14 days) AP lab 12/ dissolved oxygen 1 day, AP lab 10/Physiology and the Circulatory System 2 days, Dichotomous key on Beetles 1 day, Dissection of Earthworm 1 day, Dissection of Crayfish 1 day, Dissection of fetal pig 8 days.**

Total teaching days = 178
Total lab days = 46

Test component:

I cover 2 chapters per test. I use to attempt 3 chapters but it was just too much information. The test are multiple choice format. After the test, the student may earn back 1/3 of a point for every question they miss. In order to do this, the student must rewrite the original question and write the correct answer. Next, I have provided them with a test correction sheet with a list of answers that I previously. I choose an answer which I know is incorrect and I know that I have taught them as to why that is wrong. The student must explain why that answer is not correct and they may **not restate the obvious**. If the question was

> Ex: 1. Which enzyme functions to match the correct nucleotide to an unwinding strand of DNA?
>
> a. Helicase
> b. DNA polymerase
> c. Ligase
> d. Primase
> e. Carboxylase
>
> The correct answer is DNA polymerase (B). If a student missed that question they would rewrite the question with the correct answer.
>
> However, my test correction sheet might list 1. as (A). That means I know A is not correct but I want you to explain why is not correct. The student is **NOT** allowed to say **the answer is not Helicase b/c helicase does not function in matching the correct nucleotide to an unwinding strand of DNA**.! (that would be restating the obvious)
>
> Rather, the appropriate test correction might be something like this. Helicase is not the correct answer b/c the role of helicase is to unzip the double helix by breaking the hydrogen bonds between nitrogen bases.

I like this method b/c it prevents the students from saying I don't know why I chose that answer and it forces them to rethink content that perhaps I did not get to ask on the original test. This assignment tends to help the student who scores the lowest the most. However, it is also the most work for that student. It also helps the student that only missed a few questions but it will not inflate their grade b/c they can only make back a few percentage points. The student who was better prepared is also benefited because they have to do fewer corrections. It is fair b/c although the student that scored a lower grade stands to make up more points, every question is worth 1/3 point so the scale is consistent for all students. Also, the student that scored extremely low might make up as much as 8 or 9 percentage points, it still tends to only put them in the C range for the test.

Lab component:

Lab work expectations vary from lab to lab.

Concerning the 12 AP Biology labs, the students are required to preread the lab, take a prelab qz, and write a formal lab write up. The lab write up includes: A hypothesis or summarizing the purpose of the lab, the questions given in the lab manual, graph/charts,

and a conclusion which is supported by data retrieved and conceptual knowledge of the lab's purpose.

Concerning the supplemental labs, expectations vary from a formal write up to diagramming and labeling pictures, to writing their own lab procedure. Every lab contains some type of write up expectation so that I can individually assess their understanding of the material within that particular lab.

Environmental Research Paper (1st semester)

Students are allowed to choose a current environmental issue for a research paper. Topics include: Global warming, fossil fuel shortages, acid rain, stream quality, waste water treatment, etc. Length of paper is 5 – 7 pages. I require a minimum of 6 sources and 1 must be a scientific journal article. The other 5 may be internet sources or periodicals. Sources must be submitted in one of the 3 commonly accepted formats. Student are given 3 weeks to complete the assignment.

Student are also expected to give a brief oral presentation of their research which must include the explanation of a minimum of 2 graphs/charts concerning their topic.

Book review (fictional or nonfiction) (2nd semester)

Because AP is such a demanding course, I want the students to have opportunities to experience some "guaranteed" points if they follow instructions and complete the assignment on time. I allow the students to choose a book that interest them. Even the fictional work IE "Jurassic Park" is riddled with scientific themes. I require the students to make a minimum of 5 "connections" between content we have learned in class and content within the book. This requires critical thinking and allows them to read an enjoyable book. The book review should be a minimum of 3 pages typed.

Teaching strategies

In order to maximize time I have typed notes that have blanks for the student to fill in. This allows me to cover material more quickly, keeps me on track, prevents me from skipping critical topics, and allows the students to have their own study guide.

I also have developed several "hands on" activities. I believe this should be included in Lab Time, but I did not know if they would qualify so I did not count them toward my 25%. These activities are an invaluable part of my curriculum. I mentioned some of these activities in the "content overview" but I will mention just one in more detail here. For photosynthesis, I have a large piece of poster board with a big round disk glued to it. The entire structure is the chloroplast, the green structure is the thylakoid disk, there is a "door" on the side of the membrane to allow the electron carriers to carry the electron from the ETC to the stroma/Calvin Cycle. A toy car represents the electron carrier NADP+ which is reduced to become NADPH and how that transports the electron over to the Calvin Cycle. In the side of the thylakoid disk membrane is the proton pump for chemiosmosis. The ETC is represented by an egg carton (bottom half). The student must

explain oxidation/reduction as the electron "Lego" fall from a less electronegative carrier protein to a more electronegative carrier protein. The sun is represented by a desk lamp. The electron is represented by a Lego piece. Cyclic and noncyclic electron flow are taught, glycolysis is taught, RuBP regeneration is taught, sugar production is taught, photolysis is taught, the creation of water with Oxygen as the terminal electron acceptor is taught, endergonic reaction and anabolism is taught, all these processes and more are "modeled" or "acted out" by the students in this kinesthetic activity. I have many of these but time prohibits further explanation.

I allow the students to work in groups of 2 or 3 and answer the essays from previously released AP test. Each student must turn in their own essay, but they can brainstorm together to get the material. I also allow them to see the grading rubric in advance.

Finally I use power point presentation for review and of course class discussion when possible.

Field Trip

I am currently in contact with Ms. Jennifer Taylor, Director of Education at the Tulsa Zoo. She and I are working on an additional lab that students could do on site. The student would make a dichotomous key of mammal skulls. Also, I am looking into the possibility of having the students use an ethogram to study animal behavior of the primates. The protocol for these labs are still in the making but that will happen in 2007-2008.

Student Evaluation

Reading quizzes 10%

Research paper/book review 10%

Lab component 20%

Multiple choice test 40%

Test corrections 5%

Essays 15%