

# COURSE PLANNER

Please note that not all activities for the course are listed, and many activities will be supplemented with additional activities such as diagram analysis, practice essays, etc.

## Intro to AP Biology/Scientific Method

This course begins with introducing students to the seven science practices, in addition to the Big Ideas that unify the course. Students complete the lab exercises that emphasize the need for controls in experiments as well as to identify and explain potential sources of error as part of the normal scientific process.

Reading in Campbell and Reece:

Topics:

- Intro to AP biology, the test and how to study.
  - ♣ Activity: Theme-teams: Students research and present scientist who represent each Big Idea in AP Biology.
  - ♣ Activity: Analyzing the AP multiple choice questions with diagrams.
- Scientific Method: Steps and controlled experiments
  - ♣ Activity: What is Science? Discussion/Poster Creation.
  - ♣ Activity: Lab Safety activity: NIH's Student Lab Safety Introduction Course. <https://www.safetytraining.nih.gov/introcourse/labsafetyIntro.aspx>
  - ♣ Activity: Identify risks in procedures and materials (MSDS analysis)
  - ♣ Activity: Guide to good graphing.
  - ♣ Activity: Examining bias in science.
  - ♣ Lab: Student Designed inquiry. The effect of environmental factors on the metabolic rate of yeast. In this student designed inquiry, students investigate environmental factors as they relate to CO<sub>2</sub> production or O<sub>2</sub> consumption in yeast. Students must select an independent variable and dependent variable, as well as design an experimental procedure based on an existing lab protocol.

## ECOLOGY

The ecology unit introduces the ideas of energy processes and interactions, which are the focus of Big Idea 2 and 4. Ecology introduces students to creating, analyzing, and evaluating mathematical models in biology and prepares students to tackle evolution, the central unit in AP Biology.

Students will complete a series of field trips to examine aquatic and marine biomes to expand on their knowledge of less frequently studied biomes. Students will also identify the conditions necessary for natural selection to take place (heritable variation, overproduction, and competition) during this unit, through a series of labs, field studies, and activities. This will allow for a relatively seamless transition to the evolution unit.

Students will watch segments from "Poisoned Waters", a documentary about pharmaceutical pollution and endocrine disrupters affecting the Potomac and Anacostia Rivers. Students will participate in a water-quality testing in the Chesapeake Bay watershed, demonstrating the effect pollution has on aquatic ecosystems.

Reading in Campbell and Reece:

- 51. Animal Behavior
- 52. An introduction to Ecology and the Biosphere
- 53. Population Ecology
- 54. Community Ecology
- 55. Ecosystems
- 56. Conservation Biology and Restoration Ecology

Topics:

- Animal behavior
  - ♣ Article Analysis: Do humans have fixed Action Patterns?
  - ♣ Lab: Can pill bugs learn? In this open-ended lab investigation, students attempt to classically condition pill bugs through teaching them to associate innate behaviors, such as chemo or thermo taxis with 'conditioning' variables. Students will analyze their results using statistical testing such as paired T-test.
  - ♣ Activity: Squirrel Case Study and selfish, cooperative, and competitive behaviors.
- Population Ecology and Community Ecology
  - ♣ Activity: Mathematical modeling of logistic and exponential growth
  - ♣ Activity: Calculating species Diversity
  - ♣ Field Trip: Cemetery Survivorship Curves. In this activity students will collect and analyze data at a local historical cemetery to test the hypothesis of how human survival rates have changed over time.
  - ♣ Activity: Converting data tables into age-survivorship diagrams.
  - ♣ Activity: Control of populations activity that examines predator-prey interactions.
  - ♣ Activity: Examining the effect of invasive species.
  - ♣ Activity: Analyzing the effect of removing keystone species in Yellowstone National Park through a case study.
  - ♣ Activity: Examining the competitive exclusion principle of barnacles.
  - ♣ Activity: Contrast types of symbiosis through video and article analysis.
  - ♣ Activity: Analyze types of protective coloration/camouflage through article analysis.
  - ♣ Field Study: Studying Urban Succession. In this field study students will identify stages of urban succession at Melvin Hazen Park. A park at the intersection of human development and urban forest. Students will formulate hypothesis concerning the stage of forest succession and plant community composition and soil quality, then collect soil samples and photographic data for in class analysis.
- Ecosystems and Nutrient Cycles
  - ♣ Activity: Compare biogeochemical cycles in terms of the role different organisms.
  - ♣ Activity: Activity: Analyze trophic levels and calculate flow of energy through food chain/web/pyramid. (Trophic structure calculation sheets).
  - ♣ Activity: Analyze trophic and non-trophic relationships in a case study concerning moose in Yellowstone National Park.
  - ♣ LAB: Energy transfer, part B: Adapted from the College Board. In this investigation students will design models of how energy may be transferred from producers to primary consumers.
- Biomes, human impact and environmental concerns.
  - ♣ Activity: Lab Field Study: In this set of activities students will:
    - Examine maps concerning nutrient pollution in the Chesapeake bay

- Analyze human impact on ocean ecosystems through article analysis
- Analyze the effect of human pollution in sexual development and endocrine systems of fish through video.
- Evaluate the use of biotic and abiotic indicators on the health of the bay.
- Complete a field study using benthic macroinvertebrates as water quality indicators in the Chesapeake Bay Watershed.

## EVOLUTION

This unit represents the unifying idea in the course. As such, this unit focuses on Big Idea 1 with other concepts from Big Idea 2 through 4 interwoven. Once students have the foundations for evolution by natural selection that were established in the ecology unit, they can better grasp the mechanisms for genetic and phenotypic change within populations over time. This unit also lays the foundation for the genetic unit, since students understand that evolution relies on the conservation and transmittance of successful traits, as well as the potential for change that such transmittance presents. The taxonomy section of the unit emphasizes commonalities in survival and reproductive strategies across all taxa of life. Students are asked to consider the methods of classifying organisms into the presently accepted taxonomy. Students are also asked to consider how current classification schemes attempt to reflect evolutionary relationships and explore the use of bioinformatics as a means of classifying organisms.

Reading in Campbell and Reece:

- 22. Descent with modification : A Darwinian View of Life
- 23. The Evolution of Populations
- 24. The Origins of Species
- 25. The History of Life on Earth
- 26. Phylogeny and the Tree of Life

Topics:

- History and Origin of Life
  - ♣ Activity: Examining the Miller-Urey experiment.
  - ♣ Activity: Case study: The molecular Origins of Life: Replication or Metabolism First? Introductory Version
  - ♣ Lab: Making coacervates.
  - ♣ Lab: Yogurt and spontaneous generation: In this brief lab activity, students examine the connection between cell and germ theory by making yogurt: using yogurt bacteria and pasteurized milk.
  - ♣ Lab: Gram staining.
  - ♣ Activity: Modeling bacteria cells: Students model specific bacteria important to human interactions, and examine the details of bacterial cell walls.
  - ♣ Field Trip: Natural History Museum Sant Ocean Hall - History of Life on Earth: In this field trip, students visit Satit Ocean Hall's History of Life exhibit, and catalog the major innovations and events that shaped the history of life including the Cambrian explosion and several major extinction events, as well as the fossil evidence and chemical evidence for evolution. In addition, students observe transitional fossils of whale skeletons, which will be dissected in later activities/labs.
- History of evolutionary theories
  - ♣ Activity: Analyzing Darwin's influences through internet exploration: who is Charles Darwin Video?

- ♣ Activity: Distinguishing Lamarckian and Darwinian thinking.
- Evidence of Evolution
  - ♣ Activity: The Galapagos Finch Challenge: In this activity, students simulate the effect of adaptive radiation using the Grants' finch data as a case study.
  - ♣ Video and Activity: Evolution and Great Transformations: This video focuses on 'Great Transformations' in evolution - the transition of land to marine mammals; the transition of vertebrates from water to terrestrial tetrapods; and the evolution of body plans in the Cambrian explosion. Students watch and discuss the first segment before the BLAST activity in the taxonomy unit, following an examination of transitional whale fossils at the Natural history museum; the second segment before an activity examining homologous, analogous, and vestigial structures; and the third segment during examination of embryological development.
  - ♣ Activity: Homologous, analogous, and vestigial structures.
  - ♣ Reading: Evolution Gems from *Nature*
  - ♣ Activity: Biogeographic evidence for evolution
  - ♣ Activity: Bacterial resistance to antibiotics: In this set of activities, students convert a data table to a graph involving the incidence of antibiotic-resistant bacteria in a population, infer that antibiotic resistance is the product of genetic mutation and not acquired adaptation, and an video examination of the effects of MRSA.
- Mechanisms of evolution, population genetics, and Hardy-Weinberg
  - ♣ Natural selection
    - Activity: Modeling natural selection in paper 'butterflies'
    - Activity: Selection of Strawfish
  - ♣ Sexual Selection
    - Video: The Meaning of Sex: Genes and Gender
    - Reading: "Wholly Virgin" from *Dr. Tatiana's Sex Advice to AH Creation*
    - Podcast: The Mystery of the Bdelloid Rotifer
    - Discussion: Are men necessary?
  - ♣ Population genetics and Hardy-Weinberg
    - Video and activity: An Evolution Story: Evolution and Sickle Cell Anemia Population Genetics and Evolution (1 45-minute period plus 1 two-hour class period)
    - Activity: Hardy-Weinberg practice and simulation
    - Lab: Mathematical Modeling and Hardy-Weinberg
- Speciation
  - ♣ Activity: Article analysis of 'Mysteries that Hunt and Howl,' and video analysis of 'Dogs: Decoded' examining artificial selection in foxes as a model for the evolution of dogs.
  - ♣ Activity: Examination and mapping of ring species using California salamanders.
  - ♣ Activity: Concept mapping of pre- and post-zygotic barriers to hybridization.
- Phylogenetic Classifications and Cladistics
  - ♣ Activity: Comparing anatomical and genetic classification schemes using Cytochrome C.
  - ♣ Lab: Building cladograms, including BLAST sequence analysis: In this modification of the College Board lab, students will investigate three questions: two, teacher-assigned, concerning the evolution of marine and terrestrial mammals: and one, student-developed, about the evolutionary relationships between organisms of their choosing using FASTA sequence alignment and cladogram generation through BLAST, ClustalX and SeaView software.

## Chemistry of Life

This unit moves from the larger scale to the building blocks that make up living systems. Students relate the structure of atoms, molecules and macromolecules to their function within cells their effect on organisms, and on organisms' interactions in the context of ecosystems. Because this topic requires more abstraction than previous units, students access the material through hands-on activities, in addition to laboratory work.

Reading in Campbell and Reece

- 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

Topics:

- Structure of atoms
  - ♣ Activity: Modeling atoms using manipulatives
  - ♣ Activity: Charting CHONPS.
- Types of chemical bonding
  - ♣ Activity: Modeling bonds between atoms.
  - ♣ Lab: Testing solubility of ionic compounds, nonpolar covalent and polar covalent molecules.
- Properties of water
  - ♣ Lab: Properties of water - Cohesion, adhesion, surface tension, capillary action, and solubility.
  - ♣ Activity: Modeling properties of water with 3D Molecular Designs 'cups' of water.
- Acids and bases.
  - ♣ Lab: Buffers and pH
  - ♣ Activity: Examining pH in a logarithmic context
- Functional groups.
  - ♣ Activity: Functional Groups Bee
- The central role of carbon
  - ♣ Activity: Video "And that's why carbon is a tramp!"
- Classification and formation of macromolecules
  - ♣ Activity: Biochemistry pattern matching
  - ♣ Activity: Building macromolecules: In this extended activity, students build and demonstrate the formation of glucose, disaccharides, and glucose polymers: unsaturated and saturated fatty acids as components of triglycerides: cholesterol and its derivatives: and amino acids and dipeptides. Nucleic acids and their structures will be discussed during the molecular genetics unit.
  - ♣ Activity: Modeling protein structure  $1^\circ \rightarrow 4^\circ$  ( based on molecular modeling workshop)
  - ♣ Lab: Fun with milk and eggs: In this demo lab, students observe the effect of heat, agitation, and acid on protein structure by cooking eggs, making fresh cheese, and making whipped cream.

## Cells and Cell Membranes

This unit expands on the structure-function relationship begun in the chemistry unit. Students relate the polarity of molecules to ease of transport through cell membranes. This unit also reemphasizes inquiry as key to the methods and processes of science. Students investigate how cell size and shape influences the rate of diffusion into and out of the cell and use methods to determine the solute content of potatoes and other tubers.

Readings in Campbell and Reece:

- 6. A Tour of the Cell
- 7. Membrane Structure and Function

Topics:

- Evolution of Cells (review from evolution unit) Organelle Structure and Function,
  - ♣ Reading: Excerpt from A Short History of Nearly Everything on the history of microscopy
  - ♣ Activity: Microscopy of basic cell types: (More extensive microscopy will be done during the cell membranes and energetics units.)
  - ♣ Activity: Modeling Organelle Systems
  - ♣ Activity: Diagram analysis of the export of a protein
  - ♣ Activity: Cell organelle system campaign
  - ♣ Activity: Examining cell specialization in protists, plants, and animals
- Membrane Structure and Function
  - ♣ Activity: Building Cell Membranes
  - ♣ Lab: Cell Races with Inquiry Extension
  - ♣ Lab: Diffusion and Osmosis: In this set of labs, students determine solute size by examining the diffusion of solutes across a model membrane; observe osmosis of sugar solutions in and out of dialysis tubing and design an experiment to predict the molarity of a set of unknown solutions; determine the molar concentration of potatoes and other tubers; and observe plasmolysis of plant cells.
  - ♣ Activity: Examining and comparing transport.
  - ♣ Activity: Calculating water potential in plant and animal cells.
- Membrane Transport and Organismal Physiology
  - ♣ Activity: Lights, camera, action potential: Examining transport in nerve cell signaling.
  - ♣ Activity: Examining potassium channel selectivity and the effects of competitive inhibitors
  - ♣ Activity: Anatomy of the human brain
  - ♣ Activity: Modeling Kidney Function
  - ♣ Activity: Reading: Aquaporins
  - ♣

## Cell Energetics

This unit continues the discussion of energy transfer begun in the ecology unit and emphasizes the conservation of matter and transformation of energy in living systems. Students model various conditions that affect enzyme activity as well as the action of inhibitors and activators on enzyme function. Students also examine the conserved features of cell respiration, particularly glycolysis, and the relationship between structure and function in the electron transport chain and chemiosmosis. This unit also revisits the theory of endosymbiosis that was introduced in the evolution unit.

Reading in Campbell and Reece:

- 8. An Introduction to Metabolism
- 9. Cellular Respiration: Harvesting Chemical Energy

## Topics:

- Free energy changes
  - ♣ Activity: Examining enthalpy and entropy
- Coupled Reactions
  - ♣ Activity: Blue Bottle Demo and Redox Reaction
  - ♣ Activity: the effect of pH on oxidation reactions
- Enzymes Activity: Liver and hydrogen peroxide demo
  - ♣ Activity: Toothpickase
  - ♣ Activity: Modeling enzyme inhibition and regulation
  - ♣ AP Lab Alternative: the effect on Environmental Variables on the Activity of Catalase
- Cellular Respiration
  - ♣ Activity: ATP Modeling
  - ♣ Activity : Calculating the harvestable ATP in a candy bar
  - ♣ Activity: Modeling and diagramming Cell Respiration
  - ♣ Activity: Modeling ATP production: Students use paper cut outs of phosphate groups, ADP, etc. to simulate ETC and chemiosmosis with a poster paper background of a membrane and watch a video on ATP synthesis.
  - ♣ Lab: An Inquiry into Cell Respiration.
  - ♣ Activity: the mystery of the seven deaths: a case study in respiration.
  - ♣ Activity: Comparing gas exchange surfaces in mammals and fish.
- Fermentation
  - ♣ Review of alcoholic and lactic acid fermentation from intro and evolution units.
  - ♣ Activity: Lactic acid fermentation of pickles
- Metabolism and energy
  - ♣ Activity: Cricket Science Inquiry with Q10 calculations with “Frozen Iguanas’ video.
  - ♣ Activity: Comparing animal thermoregulation strategies
  - ♣ Activity: Comparing metabolism and body size
  - ♣ Activity: Video and diagram analysis of fish, reptile, mammalian, and bird hearts.
  - ♣ Activity: The effect of activity on human heart rate
  - ♣ Reading: Evolution of the 4-chambered heart and endothermy.

## PHOTOSYNTHESIS

This unit continues to discuss energy transfer and transformation and places photosynthesis within the context of plant systems. This unit also revisits the theory of endosymbiosis that was introduced in the evolution unit. Students will also explore the use of solvents in separating plant pigments and design their own experiments to determine the effect of environmental conditions and varieties of light on the rate of photosynthesis.

## Reading in Campbell and Reece

- 10. Photosynthesis
- Selections from 35. Plant Structure, Growth, and Development
- 36. Transport in Vascular Plants
- 37. Soil and Plant Nutrition
  
- Photosynthesis and its Variations
  - ♣ Activity: Modeling and Diagramming Photosynthesis
  - ♣ Activity: Graphing Photosynthesis: Students examine the absorption spectra
  - ♣ Lab Chromatography of Spinach and Chard with Inquiry Extension
  - ♣ Lab: Leaf Disk Assay with Inquiry Extension
  - ♣ Activity: Video 'Endosymbiosis'
  - ♣ Activity: Variations on Photosynthesis is: Article analysis and review of horizontal gene transfer
  - ♣ Lab Demo: Blood Chlorophyll
  - ♣ Lab: Winogradsky columns on nonoxygenic and oxygenic photosynthesis
- Systems that support photosynthesis
  - ♣ Lab: Transpiration: In this inquiry-based lab, students complete an initial online investigation into factors that affect photosynthesis, and then devise a methodology to answer three questions: Is transpiration more affected by intake of water through roots or transpirational pull from leaves? How does leaf surface area affect rate of transpiration? And how do environmental factors affect rate of transpiration?
  - ♣ Activity: Diagramming and examining leaf gas exchange
  - ♣ Demo: Going bananas for plants: stomate structure and function
  - ♣ Field Trip: In this field trip to the US Botanic Gardens, students examine plant adaptations to their environments including evolution of vascular tissue, varieties of photosynthesis, etc.

## Cell communication and Organismal Physiology

This unit focuses on communication and regulation at the organismal level, connecting organisms' gene expression to homeostatic mechanisms to regulate their internal environments in light of external stimuli. This unit will explore three animal systems -nervous, immune, and endocrine - as well as their non-animal analogs.

## Reading in Campbell and Reece:

- 11. Cell Communication
- Selections from:
  - 41. Animal Nutrition
  - 42. Circulation and Gas Exchange
  - 43. The Immune System
  - 44. Osmoregulation and Excretion
  - 45. Hormones and the Endocrine System
  - 48. Neurons. Synapses, and Signaling
  - 49. Nervous Systems
  - 50. Sensory and Motor Mechanisms
  - 39. Plant Responses to Internal and External Signals

Topics:

- Cell communication and signaling
  - ♣ Activity: Video: Quorum sensing bacteria
  - ♣ Activity: Modeling Quorum sensing
  - ♣ Activity: Diagrammatic and video analysis of communication between nerve cells
  - ♣ Activity: Mouse Party: This is your brain on drugs!
  - ♣ Activity: Modeling muscle movement
  - ♣ Reading: Acetylcholinesterase inhibitors and mosquito pesticide resistance
- Regulation of body systems by hormones through positive and negative feedback
  - ♣ Activity: Modeling cell signal cascades for steroid and non-steroid hormones.
  - ♣ Activity: Insulin, Glucagon, and Negative Feedback
  - ♣ Activity: Hormone Pairs: Students will select, research and present a short advertisement for two to three hormones (plant and animal) that work antagonistically or in concert.
  - ♣ Activity: Using virtual rats to teach endocrine physiology
    - ♣ Mammalian immune system
    - ♣ Activity: Video: An Introduction to the Immune System
    - ♣ Activity: The Immune System Play and the Adaptive Immune System

## Molecular Genetics

This unit focuses on the continuity of life, as well as mechanisms of change that provide raw material for evolution by natural selection. This unit explores the Central Dogma of molecular genetics and expands on gene regulation and epigenetics, which students were introduced to in the summer reading. This unit also presents students the opportunity to discuss and debate issues of ethical uses of biotechnology.

Reading in Campbell and Reece:

Topics:

- DNA and RNA structure and function
  - ♣ Reading: Excerpt from "A Short History of Nearly Everything" re: characterization of DNA as genetic material and its structure
  - ♣ Lab: DNA Extraction from fruit
  - ♣ Activity: Case study examining experiments leading to the characterization of DNA as the genetic material.
  - ♣ Activity: Analyzing Chargaff's DNA Data
  - ♣ Activity: Modeling DNA Structure
  - ♣ Activity: Restriction Enzyme Digest Simulation
  - ♣ Activity: Restriction Enzyme and Plasmid Mapping
  - ♣ Lab: Biotechnology: Restriction Enzyme Analysis Of DNA
- Structure of prokaryotic and eukaryotic chromosomes
  - ♣ Activity: Modeling DNA and histones and the effect of methylation and acetylation.
- DNA Replication
  - ♣ Activity: Modeling DNA replication
- Protein synthesis
  - ♣ Activity: Modeling Protein synthesis
  - ♣ Activity: Inferring DNA from protein (adapt from Molecular Modeling workshop).
  - ♣ Activity: Alternative gene splicing
  - ♣ Activity: Modeling peptide bonds
  - ♣ Activity: Modeling protein structure ( cont. from biochemistry unit)

- ♣ Activity: Examining the melanin pathway including UV stimulation of melanin production
- ♣ Lab: the effects of UV light on the production of archaean rhodopsin
- ♣ Activity: Reading “The cellular Chamber of Death”
- Mutation
  - ♣ Activity: Types of mutation analysis
  - ♣ Activity: Calculating the effect of mutation and wobble.
  - ♣ Activity: Mutation and antibiotic resistance- continued from evolution unit.
  - ♣ Activity: Mutation and Sickle Cell- cont. from evolution unit
- Function of DNA and RNA viruses
  - ♣ Activity: Video : Life Cycle of HIV, a retrovirus
  - ♣ Activity: Modeling transgenic shift and drift with influenza
  - ♣ Lab: PCR: Detection of Alu Elements in the Human Genome
  - ♣ Activity: Reading: “The unusual Origin of PCR”
  - ♣ Activity: Simulated PCR-The Dolan Learning Center
- Regulation of gene expression in Prokaryotes
  - ♣ Activity: Modeling Lac and Trp operons
  - ♣ Activity: Paper plasmids
  - ♣ Lab: Biotechnology and Bacterial Transformation
- Regulation of gene expression in Eukaryote
  - ♣ Activity: Modeling DNA and histones, and the effect of methylation and acetylation.
  - ♣ Activity: RNAi video and modeling
  - ♣ Activity: Modeling transcriptional regulation in prokaryotes and eukaryotes
  - ♣ Activity: Pre-writing and practice essay comparing and contrasting prokaryotes and eukaryotic genes.

## **Principles of Heredity: Cell Reproduction and Life Cycles**

This unit focuses on the continuity of life, as well as mechanisms of change that provide raw material for evolution by natural selection. The unit revisits the evolutionary advantages and disadvantages of sexual reproduction and introduces the life cycles of prokaryotes, fungi, algae, various protists, various plants, and various animals.

Readings from Campbell and Reece:

- 12. The Cell Cycle
- 13. Meiosis and Sexual Life Cycles
- 30. Plant Diversity II: The Evolution of Seed Plants
- 38. Angiosperm Reproduction and Biotechnology
- 46. Animal Reproduction
- 47. Animal Development

Topics:

- Cell cycle
  - ♣ Lab: Mitosis garlic root tip squash: In this inquiry-based lab, students examine the effects of different concentrations of caffeine on garlic root-tip mitosis.
  - ♣ Activity: Control of the Cell Cycle Game and diagrammatic analysis of cyclin-CDK levels in cells.
- Cancer
  - ♣ Activity: Comparing cancer and non-cancer cell division rates: in this activity, students examine blood smears that exhibit characteristic symptoms of blood cancers and compare them with non-cancerous smears, (Blood smears obtained from a NIH researcher's lab.) Students also examine data from cancerous and non-cancerous stomach cells and calculate rate of mitosis and percent time spent in interphase

versus mitosis.

- ♣ Activity: Examining cancer and apoptosis: An online exploration of various genetic factors, such as mutations in tumor-suppressor genes that lead to the development of cancerous cells.
- ♣ Activity: Chi Square and M&M's
- ♣ Activity: A cancer story: Examining ALB-2 and Gleevec
- ♣ Activity: reading: The immortal life of Henrietta lacks
- Meiosis
  - ♣ AP Lab Alternative: Modeling meiosis
  - ♣ Lab: C-Ferns and the alternation of generations
  - ♣ Activity: Assembling Human Karyotypes
- Life cycles
  - ♣ Activity: Examining and comparing protist, plant, and animal life Cycles
  - ♣ Activity: Flower Dissection
  - ♣ Activity: Designing the world's best artificial flower from CIBT
  - ♣ Lab: the effect of environmental signals on seed germination
  - ♣ Activity: Seed Dissection
  - ♣ Activity: video – The Botany of Desire and the effects of monoculture
  - ♣ Activity: Examining phototropism and photoperiodism in plants through analysis of experimental data
  - ♣ Activity: Hormones of human menstrual cycle
  - ♣ Activity: Modeling of animal fertilization and development
  - ♣ Activity: Genetic controls of embryological development
  - ♣ Activity: Video – Great transformation and the evolution of body plans and/or what Darwin never knew.
  - ♣ Activity: Human sex determination and the SRY gene
  - ♣ Discussion: Gender testing of female athletes

### **Principles of Heredity: Classical Genetics**

This unit focuses on the chromosomal basis of inheritance, focusing on inheritance principals and patterns. We model these both using an online simulation of fruit flies and through Wisconsin Fast Plants. This unit will also emphasize mechanisms of change that provide the material for evolution by natural selection.

Reading in Campbell and Reece:

- Mendelian genetics, probability, segregation, independent assortment
  - ♣ Activity: Basic Mendelian Genetics Review webquest.
  - ♣ Activity: Punnett Squares
  - ♣ Lab: Virtual Genetics Lab. In this series of online labs students across virtual insects and determine inheritance patterns for simple dominance at one locus; incomplete dominance at one locus; sex-linked genes at one locus; simple dominance at two unlinked loci; and simple dominance at two linked loci. For the last case, results are analyzed using Chi square analysis.
- Non-Mendelian inheritance patterns
  - ♣ Activity: Punnett Squares
  - ♣ Activity: Human Blood Types
  - ♣ Activity: Calculating recombination distance for linked genes

- ♣ Activity: Fun with incest! Population genetics and the effects of FSTAT
- ♣ Activity: Pedigree analysis
- ♣ Activity: Recovering the Romanovs Pedigree Video
- Genetic disorders
  - ♣ Activity: Human Genetic Disorders Project

## **Merge with the Organismal Physiology unit or incorporate into other units**

### Animal Structure and Function: Animal Reproduction and Development

This unit focuses on the continuity<sup>7</sup> of life and the regulation of embryological development. Students will visit the zebrafish laboratory at the National Institutes of Health, as well as having a guest lecture on mouse development. This unit will continue to emphasize comparative anatomy and physiology between the organisms dissected in previous units and fetal pigs,

- Lecture/Discussion Topics:
  - ♣ Reproductive System: Evolution of animal reproductive systems, overview of mammalian reproductive systems,
  - ♣ Development: Role of genetics in embryological development. Comparative embryology of amphibian, bird and, human embryo.

Lab: Evolutionary Dissection of Fetal Pigs (adapted from *Biology Inquiries*)  
(Completed earlier)

Lab: Development of the Sea Urchin (done with sea urchin dissection)

### Plant Structure and Function

This unit introduces students to plant systems and the regulation of those systems. The relationship between structure and function is once again emphasized, as well as the evolution of land plants from ancestral algae. Students also revisit water chemistry and the regulation of water uptake begun in discussing cell membranes. Students also examine plant reproduction and development and how these processes are regulated internally and by the plants' environment. In addition to numerous labs and field trips, students are tasked with designing a lab to determine if bags that claim to reduce the buildup of ethylene gas do in fact slow fruits from ripening.

- Lecture/Discussion Topics:
  - History of plants.
  - Types of plant tissue.
  - Asexual and sexual reproduction in plants: pollination, fertilization, fruiting seeds
  - Plant physiology
  - Water movement in plants: Transpiration
  - Sugar movement in plants: Translocation
  - Hormones and Regulation of Plant Growth
  - Plant responses to internal and external signal
  - Field Trip: U.S. Botanic Gardens - Examining Plant Evolution
  - Virtual Field Trip: Plants in Motion Interactive from Slow Life
  - Lab: Flower and Fruit Dissection Lab: Examining Plant Behavior
  - Lab: Leaf and Stem Structure (1 45-minute period)
  - AP Lab 9 Alternative: Examining Transpiration in Radish Plants
  - Lab: Pollen Tube Growth (1 45-minute period)
  - Lab: Student Designed: Do Green Bags Slow Fruit Ripening?
  - Activity: The Plant Game from CIBT (1 45-minute period)
  - Activity: Designing the World's Best Artificial Flower from CIBT (1 45-minute period)

- Lab: Comparing Monocots and Dicots
- Lab: The Effect of Germination Inhibitors on Tomatoes
- Reading:

### **Animal Structure and Function: Nutrition/Digestion; Circulatory System/Gas Exchange; Motor and Skeletal System**

This unit continues the discussion of transport, across cell membranes and the role of energy transfer in biological systems discussed in the cell membrane and cell energetics units. Students will once again to see the connection between structure and function and the interdependence between body systems. This unit will continue to emphasize comparative anatomy and physiology between the organisms dissected in previous units and fetal pigs.

- Lecture/Discussion Topics:
  - ♣ Digestive System: Evolution of vertebrate digestion, comparisons of animal digestive systems, overview of mammalian digestive system.
  - ♣ Circulatory System: Evolution of vertebrate circulation, comparisons of animal circulatory systems, overview of mammalian circulatory system, structure and function of mammalian heart.
  - ♣ Respiratory System: Evolution of vertebrate respiratory system, comparisons of animal respiratory systems, overview of mammalian respiratory system, structure and function of mammalian lung.
  - ♣ Motor/skeletal system: Evolution of vertebrate skeletal and motor systems: comparison of animal body plans, overview of mammalian skeletal/motor systems, structure and function
- Lab: Digestion of Nutrients (1 1-hour period)
- Activity: Assembling the Digestive System
  - Lab: Evolutionary Dissection of Fetal Pigs (adapted from Biology Inquiries) ○
- Lab 10: Blood Physiology and the Circulatory System
  - Activity: Paper Plate Hearts
  - Field Trip: Buried in Bone Forensic Anthropology Lab
  - Activity: Modeling Muscle Movement
  - Lab: Dissection of Chicken Wing ○ Reading:

### **Animal Structure and Function: Excretory System/Osmoregulation: Hormones and Regulatory System: Nervous System**

This unit addresses the structure-function relationship within and between body structures as well as how these processes are regulated. This unit reviews much of the material of the cells and cell membranes unit placing it in an organismal context This unit will continue to emphasize comparative anatomy and physiology between the organisms dissected in previous units and fetal pigs.

- Lecture/Discussion Topics:
  - ♣ Excretory System: Evolution of animal excretory system, overview of Mammalian excretory<sup>7</sup> system. Structure and function of mammalian kidney.
  - ♣ Regulatory System: Evolution of animal regulatory systems, overview of mammalian nervous and endocrine systems. Structure and function of human brain. Structure and function of neuron.
  - ♣ Lab: Evolutionary Dissection of Fetal Pigs (adapted from Biology Inquiries) (1 week)
    - Activity: Modeling Kidney Function Lab, Activity and Webquest ○ Activity: Charting the Menstrual Cycle ( f 45-minute period)
    - Activity: Charting Hormone Interactions ○ Activity:

- ♣ How Cells Communicate During the Fight or Flight Response (1 45-minute period)
  - Activity<sup>7</sup>: Cell Signaling Cascade Play
  - Activity: Mouse Party - This is Your Brain on Drugs!
  - Reading:

## Animal Structure and Function: Immune System

This unit continues to discuss the regulation and interdependence of body systems. Although much of this unit will be completed online, including a virtual Elisa Assay and participation in a National Academies of Science study, students will also examine the relevant anatomy in a fetal pig. This unit will continue to emphasize comparative anatomy and physiology between the organisms dissected in previous units and fetal pigs.

- Lecture/Discussion Topics:
  - ♣ Immune System: Evolution of animal immune system, overview of mammalian immune system. Structure and function of mammalian humoral and cell-mediated immune response.
    - Activity: Elisa Assay (online)
    - Activity: Immune System Play

## Animal Diversity

This unit continues to examine animal diversity<sup>7</sup>, extending on themes begun in the taxonomy unit. Students will examine animals from multiple phyla, looking for commonalities as well as differences in structure and physiological systems. Students will be tasked with designing an experiment to test the effect of stimuli on isopods, as well as the effect of pheromones on termites.

- Lecture/Discussion Topics:
  - ♣ Evolution of multicellularity in animals
  - ♣ Animal characteristics
  - ♣ Splits in animal diversity
  - ♣ Invertebrate diversity including comparative anatomy and physiology
    - Study Guides: Invertebrates
    - Study Guides: Vertebrates
    - Virtual Lab: Histology
    - Virtual Field Trip: Invertebrates at the National Zoo
  - ♣ Virtual Field Trip: Hall of Mammals
- \_\_\_\_\_ Lab: Dissecting Crickets
- \_\_\_\_\_ Lab: Dissecting Sea Urchins
- \_\_\_\_\_ Lab: Dissecting Crabs
- \_\_\_\_\_ Lab: Dissecting Earthworms
- \_\_\_\_\_ Listening: Podcast of Life