

\*ILS Lab curriculum

\*(all of which is subject to change based on weather, student interests, instructor caprice)

2004 Text: Campbell, 2nd edition, Essential Biology  
(Correlated reading assignments yet to be determined)

Sixteen Class Meetings

[Note: Doubtless you might have questions about this, such as “What about when students are absent?” or “How many names on a report?” and such. I don’t claim any expertise on those things but will gladly share what I do. Let me know of any questions via e-mail to [jeff.weld@uni.edu](mailto:jeff.weld@uni.edu)]

Big Question 1: What is Biology?

Night 1 – August 31, 2004

- “What is Biology” Socratic walk and discussion why things are as they are in nature.
- Investigation: “Using Your Head”. String used to measure cranium circumferences. Data is pooled from all lab groups on board. Descriptive statistics applied/graphed. Discussion ensues regarding natural forces that determine head size (from proximate to ultimate causes).
- Brief lecture: Darwinian evolution.
- Housekeeping issues: syllabus, introductions, grading scheme.
- Discuss ideas of day 1, segue into “Bug Futures.”
- Investigation: “Bug Futures”. Nets used to capture grasshoppers in jars. Rulers measure femur lengths. Ten measures per lab group. Data pooled from all groups. Descriptive statistics applied/graphed.
- Discussion: Why this range of femur length? Changes in femur length would result from...? Etc.

Night 2 – September 7, 2004

- Investigation: “Diversity out There.” Milkweed groups, Goldenrod groups, Thistle groups. Determine average height of 20 plants, average seed (bloom) of three plants. Pool data of other groups studying same plant. Descriptive statistics/graphed.
- Discussion: Why this size? Why so many seeds?
- Brief lecture: Natural Selection. Invasives.
- Extended Investigations: approved by me, then executed. [Extended Investigations for each unit are to pursue similar questions as those entertained by the class to this point. They may be similar in design to ones we did with maybe a slight twist to yield a new bit of information. Or, they may be radically different in design but still contributing new knowledge on the topic.]
- “Quiz”: oral whole group quiz using photos from Ntl. Geographic show did \_\_\_\_ come to have this or that feature?

[Big Question 1 write-up Due by next class meeting. See syllabus]

Big Question 2: What’s Up With Ecosystems?

### Night 3 – September 14, 2004

- Investigation: “Digging Iowa’s Treasure.” Coffee can and garden scoop. Teams dig up a plug of soil fitting within the coffee can. Under bright lamp soil is sifted and living organisms are censused. Data recorded in a chart: Name or picture of organism, # found, #/cm<sup>2</sup>, # per km<sup>2</sup>. (Soil volume formula:  $r^2 \times l$ )
- Infactomation (lecture): Ecosystem biotics and abiotics, Soil health/characteristics, interesting facts about soil.
- Investigation: “Study of a Quadrat.” (the above-ground story). String and sticks to designate 1m<sup>2</sup> of prairie. Teams census all living organisms in a square meter. One sample of each type of organism is weighed. Data chart: Picture or name of organism, # found, biomass (g/m<sup>2</sup>). Biomass pie chart.
- Prairie food chain diagrammed.
- Infactomation: 10:1 rule, trophic levels, grain versus beef and energy transfer, and other interesting factoids.

### Night 4 – September 21, 2004

- Investigation: “Golden Inter-relationships.” Parasitized plants such as goldenrod are identified in the field. Teams measure height, leaf surface area, bloom numbers for a sample of healthy and parasitized plants. Results are graphed.
- Ball galls dissected, gall fly larvae examined.
- Discussion: Role of parasites in goldenrod (or any other organism) evolution.
- Infactomation: Biotic balance (invasives, disease, pollution, overharvest, etc). Relationships: commensal, mutual, parasitic.
- Ideas for extended investigations discussed.
- Extended Investigations.
- Infactomation: Abiotic cycling in ecosystems (carbon and water esp.).

[Big Question 2 write-up Due by next class meeting]

### Big Question 3: What’s Up With Plants?

### Night 5 – September 28, 2004

- Investigation: “Don’t be a Pig-ment.” Water-soluble black markers are distributed to teams, along with chromatography paper strips, test tubes, corks, tack. A marker line on the chrom. Paper is separated out using water solvent in this simple chromatography chamber. The technique and result is discussed. Then spinach leaf is smashed onto a new strip of paper and the pigment separated using ether/acetone solvent. Paper strips are dried, the pigments identified.
- Infactomation: What is light? Electro-magnetic spectrum. Photosynthesis.
- Investigation: “How do those plants do what they do?” Four mini-labs: a) Coleus stems in blue dye are cross-sectioned and viewed microscopically for xylem chambers--sketched; b) Elodea leaf examined under microscope for chloroplasts--sketched; c) the Stomata of Wandering Jew is examined under a microscope dry and after distilled water saturation--sketched; d) Coleus leaf is sketched, boiled in ethanol, saturated in IKI solution, sketched again. Results are discussed.

- Infactomation: Role of each lab finding in photosynthesis/xylem/phloem transport, CO<sub>2</sub> and water exchange, chloroplasts and endosymbiosis, and starch storage (fiber in diet).

Night 6 – October 5, 2004

- Investigation: “What’s Stomata Wich’ you?” Discuss role of stomata, consider variations in distribution on a leaf after demonstrating weight of CO<sub>2</sub> bubbles blown in soap solution. Generate hypotheses regarding tall plant, medium plant, short plant stomatal distribution on upper and lower leaf surfaces. Teams pluck leaves from three different plants. Use nail polish to coat leaf surfaces (upper and lower). Apply clear tape to dried nail polish and slowly peel away epidermal leaf cell layers. Apply tape to a slide and view microscopically. Count density of stomata from upper and lower leaf surfaces. Sketch, graph. Discuss findings.
- Infactomation: Plant evolution, leaf structure. Extended investigation ideas.
- Extended investigations. Share findings.
- Brainstorm Ecological issues for independent investigations/presentations/biocolloquia in two weeks (see syllabus)

[Big Question 3 write-up Due by next class meeting]

Big Question 4: What’s Up With Genes?

Night 7 – October 12, 2004

- Investigation: “Genes Come out to Play.” (DNA extraction) A simple procedure involving scraping the cheek with a toothpick and separating the DNA using dish soap, ethanol (protocol is on my crashed hard drive).
- Infactomation: Brief history of DNA’s discovery from Hershey & Chase to Kelly Mullis.
- Investigation: “Gene Bugs.” Materials from hobby store used to craft a male or female imaginary bug with ten traits represented (one must be sex-linked). A chart is kept in which the bug’s genotype and phenotype are represented, as are its parents’ possible genotypes and phenotypes. Bug is photographed digitally for reproduction in report.
- Infactomation: Heredity, chromosomes, meiosis, etc.

Night 8 – October 19, 2004

- Extended investigation: DNA extractions from other living things: plant or animal material (liver, beef, fruits, etc.)
- Infactomation: Biotechnology: transgenics, gene therapy, criminalistics, etc.

\*I’ve substituted for this lab in the past with a “lady bug genetics” lab that requires student teams to collect ladybugs or boxelder bugs on inverted rings of tape. Then they quantify the observable traits of the bugspots or no spots, solid or broken “w” on the head, shield or no shield pattern on the boxelder. This provides a pretty clean dominant-recessive ratio.

[Big Question 4 write-up Due after Biocolloquia]

Night 9 – October 26, 2004

Biocolloquia: What’s the Latest on... (presentations of research)

(Teams are encouraged to present latest findings on ecological research topics chosen on day 12. Powerpoint, video productions, skits, etc. are permissible. See score sheet in syllabus)

STUDENT TEST ONE – student generated, various methods of evaluation.

Big Question 5: What's Up With Homeostasis?

Night 10 – November 2, 2004

- Discuss meanings and interpretations of the word homeostasis. What maintains it.
- Investigation: "Liver: My favorite Organ!" (a.k.a. Does your liver care what the temperature is?) 1 cm<sup>2</sup> cubes of liver are cut and placed in test tubes that are then subjected to four different temperatures (on ice, room temp, low heat, high heat) for ten minutes. Predict outcomes. Then 2 ml of H<sub>2</sub>O<sub>2</sub> delivered to each tube and bubble column height measured. Graph relationship between oxygen generation and catalase temp.
- Oxygen verification insert glowing splint into bubbles.
- Infactomation: Body temp and fever. Other hormones & enzymes and homeostasis role.
- Investigation: "Keep your hands off my anti-body!" Brainstorm role/components of immune system. Then two activities:
- Demonstration: The Party All class members get a beaker of water (one spiked with NaOH). They mill about and exchange "body fluids" with three people minimally. Then the "AIDS test" is administered a squirt of phenolphthalein. Pink means infected. Track down "patient zero."
- "Honeymoon in Fiji or Home with a Fever?" [Hand-out is on my crashed hard drive. Should recover it soon.] A scenario is presented in which a woman fears she was exposed to chicken pox at her bachelorette party. Is there a way to test her to see if she is "immuno-competent" to go on her honeymoon? Vials of her "serum" and of chicken pox antigen are distributed along with well plates and distilled water, droppers. At what concentration will her serum fail to react with (precipitate) the antigen? Serial dilutions are made and systematically "reacted" with the antigen until her immune threshold or immunocompetency level is determined (somewhere around 20%). Serum is PbNO<sub>3</sub> solution while antigen is NaI solution.
- Infactomation: Immune parts, roles, interesting factoids.

Night 11 – November 9, 2004

- Investigation: "You Got Some Nerve!" Brainstorm role/parts of nervous system involved in homeostasis. Pin heads stick out from small corks as either single or paired pins. Teams of students choose body regions to test for touch sensitivity, predicting outcomes. Systematically they apply randomly the single or double-pinheaded cork to wrist, ankle, lip, forehead, etc., recording accuracy of blindfolded subject at identifying number of pins. Data chart is kept. Then, cold or hot is measured using a single-headed pin soaked in ice water or hot water. Dabbed dry and immediately applied to subject's wrist or elsewhere, a data table is kept recording accuracy of temperature sensitivity. Graphs of various sorts are encouraged (including a human body rendition, depicting receptor density).
- Infactomation: Nervous system anatomy, nerve signal conduction, factoids.
- Brainstorm extended investigations.
- Extended investigations
- Infactomation: neuropathies causes and effects.

[Big Question 5 write-up Due by next class meeting]

### Big Question 6: What's Up With Microbes?

Night 12 – November 16, 2004

- Investigation: “Ubiquitous Bacteria!” First, cell sizes are compared by examining a human cheek cell and a bacterial cell (from a prepared slide). Discuss: Why the difference? Then, agar plates are distributed to teams, along with wax pencil and sterile q-tips. Groups divide dish into quads and spread smears in each of the four quadrants from areas of their choice (noses are a favorite, as are door handles and toe gaps). Dishes are incubated. Finally, Methylene blue-stained slides of yogurt and buttermilk are prepared and the bacteria compared to those three types seen in the prepared slide from part 1. Three results required: a) sketch of relative size of eukaryote and prokaryote cells, with explanation; b) sketched depictions of bacterial growth on agar plates after incubation; c) sketches and identification of bacterial types in yogurt and buttermilk.
- Infactomation: microbes. Cell size. Endosymbiosis. Bacterial growth requirements. Microbes good and evil.
- Investigation: “Protists with the Mostist!” Jars of muck from several different fish tanks are brought in. Students prepare slides and go on a hunt for different types of protists. A chart is kept in which the protist type (by picture), location (jar) and mode of locomotion is recorded.
- Infactomation: Various cool and gruesome protozoan diseases.

Night 13 – November 23, 2004

- Investigation: “You’re a Real Fun-gi.” Many moldy food samples and other types of fungi are brought in. (Hypersensitive students are given surgical masks and gloves). Students prepare slides in search of microscopic fungal structures (hyphae, sporangia to be named later, for now just sketched).
- Infactomation: Anatomy of a fungus, reproductive structures. History of fungi and humansergot, Salem witches, etc.
- Brainstorm extended investigations
- Extended investigations.
- Brainstorm ideas for Biocolloquium #2 (human bio themes)

[Big Question 6 write-up Due by next class meeting]

### Big Question 7: What's Up With Metabolism?

Night 14 – November 30, 2004

- Investigation: “How Many Calories are in this?” Discuss the idea of calorie, energy, human needs. Then, peanuts, dorito chips, and other food samples are measured using crude calorimeters fashioned from pop cans. Food is stuck on a dissecting probe and ignited under 100 ml of water within a pop can. Initial temp and final temp are recorded. A data table is kept in which the food is named, the mass of the food is measured and recorded, start temp, final temp, temp, cal./gram (cal=t 100). Data is graphed.
- Infactomation: Caloric needs, mitochondria, cellular respiration, obesity factoids.

- Investigation: “A Jolt for Daphnia.” Black coffee is brewed, cigarettes are ground and liquefied in a mortar bowl. Students determine daphnia base-line heart rate, then prepare serial dilutions of coffee and tobacco juice that range from 1% to 100% (ten solutions). A drop of solution is applied to the microscope slide holding the daphnia and heart rate is determined. Solution is drawn off with paper towel and next concentration is dropped on. It ain't perfect, but saves on daphnia! Both caffeine and nicotine effects are determined. Effects are graphed.
- Infactomation: Caffeine and nicotine and human metabolism/homeostasis.

Night 15 – December 7, 2004

- Investigation: “Tommy Termite Show his innerds.” Gut symbionts discussed do we have 'em? What are they doing in there? Etc. Then termites are distributed to teams, along with a probe and forceps, slides and microscope. Intestines are teased from termite and smashed in tap water, examined under magnification for gut protozoans. Sketches made.
- Infactomation: Intestinal flora, fiber, digestion, health, and other factoids.
- Brainstorm extended investigations
- Extended investigations.
- Infactomation: Odd new technologies diet pills and regimens, cryogenics, other “miracle” pills and fads.

[Big Question 7 write-up Due after biocolloquia]

Night 16 – December 14, 2004

Biocolloquia: What's the Latest on... (presentations of human bio research)

(Teams are encouraged to present latest findings on ecological research topics chosen on day 12. Powerpoint, video productions, skits, etc. are permissible. See score sheet in syllabus)

STUDENT TEST TWO - student generated, various methods of evaluation.

Day 17

FINAL EXAM

Six student teams are presented with six different encompassing essay questions that span the semester or segments of it. They compose a one-page answer on an acetate sheet and present it to the class. After the entire class has had a chance to comment/adjust it, it goes “in the books.” After all six questions are similarly dealt with, the final exam is over. (I will provide sample questions to anyone interested).