If you strive to think and communicate like a scientist in your work throughout the semester, in the end, you will be a scientist and really know biology (Think like a serious scientist, not like a pretend one).

LECTURERS
Douglas B. Luckie, Ph.D., Associate Professor, Lyman Briggs College / Dept. Physiology
Holmes Hall Office: W-26D, Phone: 353-4606, E-mail: luckie@msu.edu
Kendra S. Cheruvelil, Ph.D., Associate Professor, Lyman Briggs College / Fisheries & Wildlife
Holmes Hall Office: E-189, Phone: 353-9528, E-mail: ksc@msu.edu

TEXTBOOK

COURSE PACK

COURSE WEBSITE http://msu.edu/course/lb/144/

LB-144 = LB-144 (LECTURE) & LB-144L (LAB) OVERVIEW OF CLASSES
There are two overarching goals in these two connected classes.
1.) To gain a fundamental comprehension of the cellular & organismal processes of life and an appreciation why it is important to understand these processes.
2.) To learn how to think like a scientist and be able to adaptively negotiate a question or problem.

BioCore (lecture and lab combined) is formally a year-long introductory biology course, but in reality is an exploration of life at all levels. It examines the interplay of genes, cells, and chemistry allowing organisms to live, survive, and interact with each other and the environment, all within a scientific framework. Specifically, we will study genes (molecular biology) and the chemistry of living cells inside organisms (cell biology), organisms and their environments (ecology), genetic variation and inheritance (genetics), and the interactions of the environment, ecology, and genetics over time (evolution) that led to the diversity of life observed on the planet today. BioCore I lecture meets twice a week as two 80-minute class meetings. In this class, you will have daily homework yet lecture will not "cover" all of it. In lecture we will review some of the readings and examine how the scientists performed their work. This approach is aimed at mentoring you so you master the ability to Think like a serious scientist, not like a pretend one.

WORKLOAD
The first semester of BioCore is a 4-credit course (LB144) that consists of two connected classes (lecture 3 credits, laboratory 1 credit) and because it is two classes it requires twice as many hours of work as one class. Since the laboratory is worth 1 credit, MSU requires that you work in-lab at least 3 hours each week. In addition to the in-class and in-lab work, for any 4-credit course, MSU expects you to spend 8-16 hours/week outside of class studying and working on homework assignments. There will be a certain amount of preparation that you, and your group, will need to do before each lab and readings that you will need to complete (with notes taken) before each lecture. You will be expected to master quite a bit of new material to expand your knowledge of life and science. Come to lecture and lab well-prepared, or mastering the new material may take much longer and may be far more difficult than you expect, or is necessary.
SCHEDULE
Both the lecture schedule and the lab schedule are found in the syllabi pages. We reserve the right to modify the schedule if necessary. You will be given advance warning if the schedule needs changed.

OFFICE HOURS (BREAKFAST & LUNCH WITH PROFS)
Prof. Douglas B. Luckie: "Lunch with the Prof," Holmes cafeteria, Tues/Thurs. 12-1pm, as well as appts.
Prof. Kendra S. Cheruvelil: "Breakfast with the Prof," Holmes Hall Sparty’s café, Th 9-10am, and appts.

ACADEMIC HONESTY
It is your responsibility to know what constitutes cheating. Ignorance is not a defense. Turnitin.com will allow you and your group members to review written assignments prior to submission. If you are caught cheating you may be assigned a “0” for the assignment, or for the entire course. The policy for academic honesty at LBC can be found at http://www.lymanbriggs.msu.edu/current/honestyPolicy.cfm

GRADING
Your grade in BioCore (LB144) is based on the total number of points earned in the both the lecture portion and the laboratory portion of the course. The course will be graded on a flat scale. This means all students can earn a 4.0 grade and you know in advance that someone else's performance on assignments cannot impact your grade. Thus there is no reason to resist or hesitate helping other students learn.

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<tr>
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Late Policy: Assignments are due in lab/recitation/lecture at the beginning of the session indicated (at time of entering room) unless otherwise specified. If an assignment is 1 day late, 1 point will be deducted from the final score. After this 24 hr grace period, the penalty becomes more severe: 20% off for two days late, 30% off for three days and so on. After 5 days, you will receive a “0” for the assignment. If an assignment is deemed incomplete by an instructor (Example: you do not follow the instructions), it is considered late, and it can be returned or 1 point is deducted.

*Formal written grade appeal process:* If you feel that your exam, paper, or quiz was not graded properly you must submit your complaint in writing (on paper, not via email). You must concisely explain why you object to the assigned grade and what elements of your work demonstrate you mastered the material. Please be advised that if you submit a formal grade appeal about one element of an assignment, we always re-grade your entire exam, paper or quiz and the score may increase, decrease or stay the same. For group assignments, all authors must sign the written request. How much and how well you provide evidence to support your argument is assessed and students who provide good logical arguments supported well by solid relevant evidence will earn approval (you may cite pages of textbooks or even better published research papers). Avoid emotional arguments that blame others or arguments based on hearsay, e.g. “I heard from a student” “A TA told me this was correct.” If you neither make logical arguments or provide thoughtful evidence to support them, your appeal will not gain traction or be approved. All discussion concerning score changes must be completed within 7 days from the date the grade was officially posted online. No grade changes will be considered after this time. If illness or other emergency prevents you from completing assignments on time, you must make arrangements with your instructor before the due date.
BioCore (LB144-145) Biology Learning Goals

Our "skills" learning goals are for you to gain practice and excel in these scientific methods:

1. **Design**: Apply science process skills, such as: developing hypotheses, making predictions, and designing experiments to test them (e.g. design an experiment to determine whether it's change in temperature or sunlight that causes leaves to turn red in Fall).
2. **Analyze**: Interpret evidence collected during experiments, looking for patterns and different ways to represent data, and using logical and/or quantitative reasoning to defend or reject hypotheses (claims).
3. **Collaborate**: Confidently cooperate in teamwork, and practice team building, team communication and leadership. (e.g. use techniques like "that's a good idea, OK, how can we improve it even more?" "Jon, you haven't spoken much, what do you think?")
4. **Communicate**: Conversation aimed at a variety of audiences important for scientists: (Ben says: "Their data predicts squirrels will hit light speed!" Jen responds: "But they have zero data at that part of the graph.")
   1) Speaking: practice speaking and listening to others in large & small groups.
   2) Reading: practice careful and critical reading of text, identification of important points & ideas, as well as slow deliberate reading and interpretation of figures and graphs.
   3) Writing: practice composition of text, writing manuscripts, building figures and graphs.
   4) Thinking: practice identifying data and evaluating author's evidence-based arguments.
5. **Reflect**: Develop personal learning goals and reflect on your progress throughout the semester. (e.g. regularly consider "OK, what I am supposed to be learning here? Have I mastered that topic? What next?)

Our "content" learning goals are for you to understand, describe, and provide examples of how:

(Topics categorized as Organismal Biology)

1. The reproduction of cells, chromosomes, genes, and individuals leads to variation of traits among individuals. (e.g., How beach mice have light colored fur because a mutation in the melanocortin receptor gene makes it difficult for them to make dark hair pigment)
2. Interactions among organisms and the environment determine individual survival and reproduction. (e.g., How and why do Anolis lizards choose their mates?)
3. Selection (and other mechanisms) acts on individuals and leads to the evolution of populations. (e.g., Why can human misuse of antibiotics result in new species of bacteria?)
4. The interaction of the processes underlying heredity (genetics) with the surrounding environment (ecology) leads to evolution and the diversity of biological communities observed on this planet. (e.g., what processes and environments led to the diversification of animals?)
5. The persistence of an allele in a population is dependent on natural selection and other evolutionary processes. (e.g., why do alleles causing cystic fibrosis and sickle cell remain in the human population?)

(Topics categorized as Cell and Molecular Biology)

1. Information in DNA -> becomes (transcribed) information as RNA -> becomes (translated) information in the proteins that determine structure. (e.g. How does a cell make insulin? Transcription make mRNA?)
2. The 3D structure of a molecule determines its function (and influence its evolution). (e.g. the CFTR protein looks like a roll of toilet paper in the cell membrane, turns out it's an ion channel)
3. Changes in DNA (mutations that lead to new alleles) result in changed RNA that may lead to changed protein (structure) that lead to changed function. (e.g. What DNA change leads to sickle cell anemia? or How does a three base deletion result in the disease cystic fibrosis?)
4. Some cells can capture CO2 and transform photonic* energy into chemical energy (e.g. ATP) to drive cellular processes and build cellular polymers. (e.g. How does photosynthesis work? How does a chlorophyll pigment molecule capture light energy?)
5. Small organic molecules (nucleotides, amino acids, lipids, carbohydrates) when built into polymers can associate to create large cellular surfaces and compartments with which to perform biochemical processes (called life). (e.g. What is a lipid and how is it used to create a cell membrane? When proteins join a membrane that makes intelligence!)
BioCore (Integrating Concepts in Biology): What is so insanely great about this textbook?

Over the past 50 years, research in biology has become more quantitative and interdisciplinary, relying more heavily on other sciences. To understand large, rapidly changing ecosystems, or to make sense of massive amounts of data from the Human Genome Project, today's biologists must be able to use modern mathematical, statistical, computational, and technological tools.

Biology instruction has not kept pace with research into how people learn. Studies on learning reveal that: students learn best if they are actively engaged working both individually and in groups together constructing their own knowledge [this is also how scientists work]. The textbook Integrating Concepts in Biology takes advantage of these insights and enables you to better achieve your full learning potential by directly involving you in your own learning¹.

You will be asked to construct your own knowledge by analyzing and interpreting published data. As you gain knowledge, you will find you can learn more and retain new information more easily. Our classroom discussions will help you learn how to read text and scientific figures. The case study (scientific stories) approach in the textbook provides a context in which you can connect new information. You will be able to learn major concepts by reading about several examples in more depth. The textbook readings, online homework and in class discussions will guide you in interpretation and analysis, and will help you build your new skills and knowledge.

The textbook does five things that experts² have always said “should be done” in biology textbooks:

1. **Historical (HPS) data**: You are presented with questions and the published historical research data used to answer the questions. You interpret historical data that were analyzed by biologists in the context of answering each framing question.

2. **Hierarchy/Scale**: BIG biology (organismal) and little biology (molecular/cellular) is addressed together, integrated. The text integrates across the biological size hierarchy and scale.

3. **Big Ideas**: The text focuses on five big ideas, so that you learn that these big ideas of biology and levels do not exist in isolation.
   - 1) **INFORMATION**: Living system's mechanisms to store, retrieve, and transmit information.
   - 2) **EVOLUTION**: The diversity and unity of life can be explained by the process of evolution.
   - 3) **CELLS**: Cells are a fundamental structural and functional unit of life.
   - 4) **EMERGENT PROPERTIES**: Interdependent relationships give rise to emergent properties.
   - 5) **HOMESTASIS**: Biological systems maintain energy and matter homeostasis.

4. **Math**: Mathematics is used as an important tool and is intimately associated with each case. Self-contained Bio-Math Explorations (BMEs) help you understand how math is applied to answer questions and improve comprehension of biology. The math is readily accessible, ranging from simple arithmetic, algebra, and geometry, to more challenging examples in probability, statistics and modeling.

5. **HPS ethics**: Finally, the text raises your awareness about ELSI (ethical, legal, and social implications) topics your HPS instructors and Lyman Briggs College want you to consider. You engage with case studies of ethics and real-world implications of the biology you are learning.

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THE LECTURE
ASSIGNMENT SCHEDULE

SHORT READINGS, QUIZZES & MISCELLANEOUS EXERCISES:
Researchers have found increased structure and active learning increase everyone's ability to learn in introductory biology courses. In addition, every student in our course really does want to slowly carefully read the textbook, learn new information and enjoy mastering topics in biology. Traditional university science courses often require students to read numerous pages in the textbook before each lecture. But since people are busy the reading occurs at the very last minute, and it's not effective to learn material by reading 20+ pages of a science textbook in one sitting. Given we believe the textbook we are using in BioCore is outstanding, we are structuring short readings in the course so you have more time to carefully read each section and reflect upon it.

In addition, a quiz or graded exercise may be given each lecture. These quizzes/exercises are designed to help you assess your own learning before and between exams. They provide you with regular feedback as to how well you are mastering each topic. Quizzes may be written multiple choice or essay-style. You will write answers in your carbonless paper notebook so you can turn in your answer and keep a copy. Take-home written exercises may be given as a homework assignment. They are designed to improve your skills and test your ability to apply new concepts.

ATTENDANCE AND PARTICIPATION:
It is essential that you not only come to class but also participate in order to construct your own knowledge. While attendance is being present in lecture and lab, participation includes reading and preparing well for class and will often be assessed by in-class clicker questions.

EXAMS:
There will be three midterm exams and a final exam (100 points each) in the course, each will be comprehensive of all prior material. Midterm exams may be traditional multiple-choice format, or may be essay-style (even take-home exams). Answers to take home exams must be submitted online to http://turnitin.com/ and as a hard copy at the start of lecture. During final exam week, the written final exam will be comprehensive. Because MSU requires final course grades to be submitted 48 hrs after the final exam, on the final exam we often use a multiple-choice format.

Assignments (pts):

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<tr>
<td>4</td>
<td>Exam I (Multiple choice or Essay)</td>
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<td>Exam III (Multiple choice or Essay)</td>
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<td>100</td>
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<tr>
<td>16</td>
<td>Final Exam (Multiple choice)</td>
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Total 500 pts

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**BIOCORE: CELL AND ORGANISMAL BIOLOGY (LECTURE), FALL 2014**

**SCHEDULE:** Lecture meets Tuesday & Thursdays 10:20-11:40am in C-106 Holmes Hall

<table>
<thead>
<tr>
<th>Date</th>
<th>Lecture Topic</th>
<th>Readings in lecture (emphasis pages)</th>
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<tr>
<td>Aug.</td>
<td>Th, 28 The course, Information at Molecular Level</td>
<td>Chapter 1 (sections 1.1, 1.2)</td>
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<td>Sep. T, 2 Information at Molecular Level</td>
<td>Chapter 1 (sections 1.3, 1.4)</td>
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<td>Th, 4 Information at Molecular Level</td>
<td>Chapter 1 (sections 1.5, 1.6)</td>
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<td></td>
<td>Th, 9 Information at Cellular Level</td>
<td>Chapter 2 (section 2.1)</td>
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<td></td>
<td>Th, 11 Information at Cellular Level</td>
<td>Chapter 2 (section 2.2)</td>
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<td>T, 16 Information at Cellular Level</td>
<td>Chapter 2 (sections 2.3, 2.4)</td>
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<tr>
<td>Th, 18</td>
<td><strong>EXAM I</strong></td>
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<td>T, 23 Information at Organismal Level</td>
<td>Chapter 3 (sections 3.1, 3.2)</td>
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<td>Th, 25 Information at Organismal Level</td>
<td>Chapter 3 (sections 3.3, 3.4)</td>
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<td>Th, 2 Information at Population Level</td>
<td>Chapter 4 (sections 4.1, 4.2)</td>
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<td>T, 7 Information at Population Level</td>
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<td></td>
<td>Th, 9 Information at Population Level</td>
<td>Chapter 4 (sections 4.4, 4.5)</td>
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<td>T, 14</td>
<td><strong>EXAM II (comprehensive)</strong></td>
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<td>Th, 16 Information at Ecological System Level</td>
<td>Chapter 5 (section 5.1)</td>
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<td>T, 21 Information at Ecological System Level</td>
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<td>Th, 30 Evolution at Molecular Level</td>
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<td>Chapter 6 (sections 6.4, 6.5)</td>
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<td>Th, 6</td>
<td><strong>EXAM III (comprehensive)</strong></td>
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<td>Th, 13 Evolution at Cellular Level</td>
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<td>Chapter 8 (sections 8.2, 8.3)</td>
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<td>Chapter 8 (section 8.4)</td>
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<td>W, 10</td>
<td><strong>FINAL EXAM (comprehensive)</strong> finals week, 7:45-9:45am, C-106 Holmes Hall</td>
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<tr>
<td>Sep-May</td>
<td>Your research in the BioCore I &amp; II laboratories$^4$</td>
<td>Chapters 9 (Spring) &amp; 10 (Fall)</td>
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</tbody>
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$^4$ Through your BioCore laboratory research you will experience for yourself the ideas promoted in Chapters 9 & 10, and, conversely, your research in the BioCore laboratory will be aided by reading Chapters 9 & 10 on your own. For example, the Spring BioCore laboratory will use RAPDs as discussed in Ch. 9.
Integrating Concepts in Biology
By A. Malcolm Campbell, Laurie J. Heyer, and Christopher J. Paradise

Table of Contents
Each of the five units focuses on one of the Big Ideas of biology. Each chapter in a unit focuses on a particular level of the biological hierarchy. In the TOC below we have listed the questions posed and answered in each chapter. Answers to the questions often require multiple cases but these will be as limited as possible.

Big Idea 1: Information
Living systems have multiple mechanisms to store, retrieve, and transmit information.
Main ideas to integrate throughout the Big Idea
6. Heritable information provides for continuity of life.
7. Imperfect information transfer produces variation.
8. Information can be expressed and regulated without loss of content.
9. Non-heritable information is transmitted within and between biological systems.

Chapter 1: Information at the Molecular Level (Heritable Material: History, DNA, code)

In Chapter 1, you will explore and interpret the original data from experiments that led to our current understanding of DNA as heritable information. Questions posed include: What is biological information? What defines a human being, what is life, science is a process not a compilation of facts, information is, an emergent property. What is the heritable material?
Case studies presented are: (i) Griffith and Pseudomonas bacteria story, then (ii) Oswald Avery's data and story, (iii) Alfred Hershey and Martha Chase use of radioactive isotopes and viruses. ELSI Who owns your DNA? DNA evidence used in criminal trials, eugenics history.
Then (iv) Watson, Crick story with Franklin and Wilkins; and then (v) data and work by Matthew Meselson and Franklin Stahl, on ways DNA could replicate. A discussion of methylation of DNA sequences reduces expression, methylation protects DNA from enzymes, epigenetics, sickle cell mutations in hemoglobin. Last: (vi) How do genetic diseases arise? David Baltimore and Donna Smoler study DNA replication and polymerases (DNA polymerase activity) effects of magnesium and other metals on DNA polymerase activity and error rate.

1.1 What is biological information? What defines a human being, what is life, science is...
1.2 What is the heritable material? Griffith and Pseudomonas bacteria
BME 1.1: Why do amino acids make a better code than nucleotides?
1.3 Can you prove protein is NOT the heritable material? Alfred Hershey and Martha Chase
ELSI Box 1.1: Who owns your DNA? DNA evidence used in criminal trials, eugenics
1.4 How does DNA’s shape affect its function? Linus Pauling, Watson, Crick
BME 1.2: How much DNA in each band?
BME 1.3: How are generations measured on a log scale?
1.5 Is all genetic information encoded linearly in the DNA sequence? Methylation of DNA
1.6 How do genetic diseases arise? David Baltimore and Donna Smoler study DNA polymerases effects of magnesium and other metals on activity and error rate. Chapter reading ends Page 40.
Chapter 2: Information at the Cellular Level (Central Dogma: Transcription, Translation)

In this chapter, you will follow the path of researchers who made many ground-breaking discoveries about how cells produce proteins. Chapter 2 focuses on central dogma (transcription, translation) -"how does DNA communicate information to the cell": author discusses Gel electrophoresis, transcription, translation, codon tables, ribosomes, lac operon, promoters, DNA sequence RNA sequence 5' 3' etc, RNA types, DNA sequence analysis comparing sequences BLAST-style, and ends chapter with post translational processing and the example of how to make insulin.

2.1 How does DNA communicate information to the cell?
ELSI Box 2.1: Choose your words carefully
BME 2.1: How measure the strength and speed of gene induction? (Lac operon) (6 BME IQs)
2.2 What regulates gene activation and repression? (Lac operon)
BME2.2: How can you quantify a sequence pattern? (Position weight matrix) (4 BME IQs)
2.3 How do cells make proteins? pribnow, promoters TATA boxes, DNA sequences
2.4 Can cells pick and choose information? RNA splicing
ELSI Box 2.2: Is science possible if you are uncertain about what is true?

Chapter 3: Information at the Organismal Level (Mitosis-Meiosis, Variation-Pop Genetics)

In this chapter, you will learn how to predict patterns of inheritance and how organisms passed their genetic information to future generations. Chapter 3 discusses how prokaryotes (E. coli) reproduce through cellular fission, how eukaryotes use mitosis for division (detailed step-by-step), phases of the cell cycle, the process of meiosis (detailed step-by-step) and it’s genetic outcomes (gametes ploidy recombination), the laws discovered by Gregor Mendel (detailed information and steps, crosses Punnet squares peas) analysis of genetic data to find patterns in inheritance, examine viral mechanisms.

3.1 How do prokaryotes communicate their identity to the next generation?
BME 3.1: A mathematical model of cell growth (E. coli growth rates and graphs)
3.2 Do eukaryotes produce new cells the same way as bacteria?
3.3 How can two parents produce non-identical offspring?
ELSI Box 3.1: Should we engineer better babies? (Cystic fibrosis, GATTACA, Van Gogh)
3.4 How can traits disappear and later reappear? (Gregor Mendel)
BME 3.2: Probability rules for genetics
ELSI Box 3.2: ‘Was that totally random?’
3.5 Non-Mendelian genetics: Why do we need annual flu vaccines? Influenza pandemic H1N1
Chapter 4: Information at the Population Level (Behavior: Communication<->individuals)

Chapter 4 discusses communication and information transfer between organisms. How animals communicate and find each other through signals, signaling using light or sound playback experiments to decode messages, communication used by animals that live in groups, comparative research approaches, how female reproductive structures and plants recognize pollen, compare contrast animal plant and microbial communication, discuss bacteria using luminescence. Case study stories include: (i) fireflies, with detailed analysis of a great amount of data then (ii) a story about bird communication, storm petrels, chi-squared test, (iii) then a story about meerkats or the mongoose living alone or in groups, designing experiments to compare, next (iv) how do plants communicate? The anatomy of a plant and how pollen is recognized by the same species, and (v) the Hawaiian bobtail squid and the bioluminescent organisms inside it.

4.1 How is information transmitted between members of animal species?
BME 4.1: How can observations be adjusted for varying conditions?
BME 4.2: Are two situations significantly different?
ELSI Box 4.1: What causes love at first sight, and are there ethical and social consequences?
4.2 Does group living require more derived mechanisms of information transfer?
BME 4.3: What can you learn from a boxplot?
4.3 How do plants of the same species recognize one another?
4.4 How do single-celled organisms communicate with one another?

Chapter 5: Information in Ecological Systems (Information in the Environment)

Chapter 5 discusses commonalities in communication within a species and between species, how information is used by organisms to find and exploit other species. Case studies include: (i) mole crickets laying larvae versus parasites, then (ii) frog choruses and predators (opossums and bats), then (iii) foraging behavior of lizards (how much time to stay in any one nest of ants), then (iv) how plants assess the presence of nutrients (plant plot experiments with nitrate), (v) where egg-laying moths decide to have their larvae (based on the food present for the larvae), (vi) where corals decide to grow, tadpoles in lakes.

5.1 Have organisms evolved to exploit communication between individuals of other species?
5.2 How do organisms assess their environment when searching for resources?
BME 5.1: How do you predict foraging results?
BME 5.2: Is this the perfect time to leave?
5.3 Is chemical communication used to block competition or defend self?
5.4 How does change in number of species affect information content of an ecological system?
BME 5.3: How do you measure biodiversity?
ELSI Box 5.1: Do we have an obligation to preserve biodiversity?
Big Idea 2: Evolution

The diversity and unity of life can be explained by the process of evolution.

Main ideas to integrate throughout the Big Idea
2. The origin of living systems occurred by natural processes, and life continues to evolve within a changing environment.
3. Organisms can be linked by lines of descent from common ancestry.
4. Natural selection is a mechanism of evolution that accounts for adaptation.
5. Human activity can alter the course of evolution.

Chapter 6: Evolution at the Molecular Level (Origin of Cells/Life on Earth)

In Chapter 6, you will analyze data that illuminate the origin of eukaryotic cells from prokaryotic ancestors as well as the origins of chloroplasts and mitochondria which are DNA-containing organelles. Chapter 6 discusses the four mechanisms of evolution (Darwin, natural selection, mutation gene flow genetic drift), the evidence that supports life evolved from abiotic stuff (structures of basic macromolecules, Stanley Miller experiment), the three fundamental properties of living systems, how RNA molecules can act like enzymes (the RNA world hypothesis), how vesicles can grow (structure of lipids), compete and store energy, how these abiotic structures exhibit dynamic and competitive behaviors learn about how eukaryotes inherited genes from bacteria and archea, the evolutionary origin of the nucleus mitochondria and chloroplasts. Other tidbits discussed: pH, chemical potential, gradients, and religion versus science, chance events, belief versus acceptance of evolution.

6.1 What is evolution? definition and mechanisms
ELSI 6.1: Are evolution and religion compatible? science (the Dover Pennsylvania legal ruling)
6.2 Could abiotic molecules produce the first cells?
BME 6.1 How many mutations do you expect?
BME 6.2 Are you sure this is the best possible sequence?
BME 6.3 What is the probability of a highly conserved base-pairing?
6.3 Can non-living objects compete and grow?
BME 6.4 How fast is the vesicle size changing?
6.4 Can non-living objects harvest and store energy?
BME 6.5 Logarithms: The power of pH
6.5 How did the first nucleus come into being?

Chapter 7: Evolution at the Cellular Level (Evolution Applied)

Evolution can happen when populations of cells change their genotypes over time. The DNA content of any population varies due to the inherent potential for DNA polymerases to make mistakes and DNA is subject to many more changes than just DNA polymerase errors. Chapter 7 describe the
different genome changes/mutations that can lead to speciation (the LE mutation of the gibberellin gene in pea plants is discussed, gene duplication, genetic drift GC content, viral DNA inserted into a genome, cancer, mitosis pathogenic strains of E. coli), students analyze DNA and protein sequences to elucidate evolutionary relationships, discusses how the immune system involves in a short period of time, allergies antigens, B cells, stem cells, details the steps involved in producing a more robust anti-body response over time, presents current models that explain coral bleaching comparison contrast three coral bleaching models and discuss implications (climate change). The math exercises include dot plots as well as extrapolating outside the range of observed data to make predictions. Two ELSI exercises; one which requires the student to talk about GMO's, another about the use of peanut butter being banned in a school.

7.1: How are new species formed?
BME 7.1: What biological information is in a dot plot?
ELSI 7.1: Are GMOs safe?
7.2 Why do my allergies get worse each year?
ELSI 7.2: Banning PB&J: How far should a society go to protect the rights of an individual?
7.3 Why are corals dying around the world? symbiosis
BME 7.2: Can you predict future coral bleaching?

Chapter 8: Evolution at the Organismal Level (Mechanisms, Evolution of Eukaryotes)

In this Chapter, you will analyze data that reveals how the first nucleus evolved, learn how DNA is wrapped up to facilitate mitosis and about mitochondrial and chloroplast genomes. Chapter 8 discusses how the five tents of evolution influence individual organisms, evaluates the processes by which variation is generated in organisms and how this affects natural selection, differentiates between independent assortment and crossing over, discusses cost-benefit analysis of behaviors and how they relate to natural selection, explains what evolutionary trees are, evaluate the evidence for evolutionary adaptive radiation's orchids and bass, compares pesticide resistance and insects to herbicide resistance and weeds and antibiotic resistance and bacteria. The math exercises discussed linear aggression use, p-values, and maximum parsimony. The ELSI exercises discuss antibiotic resistance.

8.1 What causes individual variation?
8.2 How does selection act on individuals with variable characteristics?
BME 8.1: How does linear regression work?
BME 8.2: Do females really prefer bold males?
8.3 Can you observe descent with modification in orchids?
BME 8.3: How do you build an evolutionary tree?
8.4 How did wings evolve in bats?
8.5 Can you observe evolution in your lifetime?
ELSI 8.1: When is there too much of a good thing? Overuse of chemicals.
Chapter 9: Evolution of Populations (Evolutionary History)

Chapter 9 evaluates gene flow and genetic drift in terms of their evolutionary effects on population. How the structure of a population affects its evolution, how non-adaptive evolution such as genetic drift works, how speciation requires time and isolation, analyzes the evolution of the human family tree, adaptation of plants living in low light, behavioral adaptations animals have evolved to use environmental cues to initiate migration. The math exercises teach the student to quantify genetic distance between populations, estimate the median and mean flight, and use of confidence interval. The ELSI exercises have students evaluate eugenics, evaluate prejudice, and evaluate the concept that humans are still evolving.

BME 9.1: How genetically different are two populations?
BME 9.2: What information is in a relative frequency distribution?
9.2 Do populations evolve in the absence of natural selection? genetic drift
BME 9.3: How confident can you be in your observations?
9.3 Where, when, and from what ancestors did humans evolve?
ELSI 9.1 What is prejudice vs. good science? Eugenics yesterday and today
ELSI 9.2 Has evolution reached its peak? Are humans still evolving?
9.4 How does the amount of light affect the distribution of photosynthesizing organisms?
9.5 Why do animals migrate and how do they know when to

Chapter 10: Evolution at the Ecological System Level (Interactions in Communities)

In Chapter 10 the author discusses co-evolution with two of its types (pairwise and diffuse), mutualism between species, the challenges/differences faced when aquatic plants descended into terrestrial plants, disturbances in ecological systems, and global climate change’s effect on the evolution of population. The bio math exercises teach students to break down complicated equations, interpret a cumulative frequency distribution, and use graphs to estimate growth rates. ELSI discusses management of disturbances (fire) may lead to unintended consequences, and critique how science is used and misused making policy decisions about global climate change.

10.1 How have species evolved as a consequence of their interactions with other species?
BME 10.1: What does that equation mean? (And is it really necessary?)
10.2 When and how did plants colonize land?
10.3 How have ecological communities adapted to disturbance?
BME 10.2: How fast did the trees grow?
ELSI 10.1: Should we act to prevent forest fires?
10.4 How will communities respond to climate change?
ELSI 10.2: When do we have enough data to act and formulate policy?
A syllabus is a form of contract between the instructor and the students. If you, the student, complete tasks with a specific score a predefined grade is awarded. Read the announcements below and the syllabus in full before signing and submitting this page.

1. **WORKLOAD** As the Undersigned student, I am aware the lecture & lab course is worth 4 credit and will require me to work outside of class 8-16 hours each week. Some weeks will require less, and some weeks will require more effort. If I prepare poorly for class, learning will take longer.

2. **TOURISM** I am aware that I will work with a group of students that sit together in lecture, work together as a research team in lab, meet and study together outside of class at night and on weekends. This course is designed for full-time residential LBC students and if I need to travel off-campus frequently (go home every weekend, like you’re just a tourist at college), I should realize my group members may become very unhappy, and I should discuss this with them or the prof.

3. **DAILY SHORT READINGS** As the Undersigned student, I am aware that I will have many required daily short reading assignments each week, and unless I read the assigned pages, answer questions, take notes and study them prior to class, it’s likely I will become lost in lecture.

4. **QUIZZES** As the Undersigned student, I am aware that I will have a quiz or graded exercise each week and unless I read the assigned pages in the reading, take notes and study them prior to the quiz, it’s likely I will get a low score on said quiz or exercise.

5. **EXAMS** As the Undersigned student, I am aware midterm exams may be purely essay style and provided in advance, and in this case I should work with my group studying the questions and developing excellent answers in the time prior to the test. If I just “cram” my studies and work into 48 hours prior to the exam, it’s likely I will get a low score on said midterm.

6. **GROUP GRADES** I am aware that I, with the help of other students in my research group, will be authoring one research paper in lab (with a number of drafts) and my grade will include both the score of my section of the manuscript as well as the score for the manuscript as a whole. I realize I will be expected to review the entire manuscript before submission. If this doesn’t work well for me, I should discuss it with my group or the prof immediately.

7. **HONOR CODE** In the authoring of assignments, I accept that any draft may be submitted to http://turnitin.com for screening. I am also aware that if the sections authored by me are found to be plagiarized, I will be given a zero for the LB144 course grade.

I have read the above announcements and syllabus. I understand the expectations are high but I’m up to the challenge. I agree to the tenets of this contract.

__________________________________
Printed Name                       Signature                          Date
The "Honors Option" for BioCore (LB144, optional)

*Note: The Honors Option for BioCore (LB144) this semester is presenting your group’s Fall Semester research findings as a talk at the UURAF (see below) during the Spring Semester. This is an individual assignment (you give the talk solo) if you seek individual credit for your Honors Option. Be aware the UURAF application deadline(s) are in January.

FYI: All students who find themselves interested in research as a potential career path can take advantage of the REU programs (http://www.nsf.gov/crssprgm/reu/) mentioned in class and listed online, as well as these opportunities (below).

Check out this info and ask Drs. Luckie and Cheruvell and TAs for more information on these topics if they are of interest to you.

1. UNDERGRADUATE RESEARCH WORKSHOPS
   Workshops with topics that usually include strategies for pursuing research opportunities on campus, preparing oral and poster presentations, abstract writing, and graduate school. Visit urca.msu.edu/event for an up to date listing.

2. RESEARCH SEMINARS
   Every week a variety of research seminars occur on campus on cutting edge topics (viruses, stem cells, climate change, gene mapping, diseases caused by mutant genes etc).

3. UNIVERSITY UNDERGRADUATE RESEARCH AND ARTS FORUM (UURAF)
   UURAF provides MSU undergraduates with an opportunity to showcase their scholarship and creative activity. UURAF brings together an intellectual community of highly motivated students to share their work with faculty, peers, and external audiences. Registration opens in January and closes mid-February. For more information, visit http://urca.msu.edu/uuraf.

4. LYMAN BRIGGS RESEARCH SYMPOSIUM
   Every Spring Semester Lyman Briggs College holds a research forum of it's own.

5. FUNDING FOR STUDENT CONFERENCE TRAVEL
   The MSU undergraduate research office can provide additional funding to support students who are presenting research at a conference or meeting. Visit urca.msu.edu/faculty/funding for details on how to apply for this money. Funds are also available from Lyman Briggs.