Biological Science 10: Principles of Biology
Monday and Wednesday 14:30-16:00 SS214
Instructor: John Crocker
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Office: LS117
Office Hours: Monday 13:30-14:30 or by appointment

Required Texts:
Audesirk, Audesirk & Byers *Life On Earth*
Pearson Custom Publishing-Gavilan College.

*Laboratory Manual for Biological Science 10*
Gavilan College. (hhh.gavilan.edu/jcrocker)
Course Goals:

1. Think critically about facts and issues in science.
2. Describe key characteristics of all living things.
3. Describe essential biological structures and processes that occur at the molecular, cellular, and organismal levels that enable life.
4. Explain gene function and the role of genes in inheritance and evolution.
5. Explain and practice the scientific method of inquiry.
6. Describe ecological interactions that occur within ecosystems, communities, and populations.
7. Recognize biological processes in your daily life.
8. Effectively organize and present information to a group.
**Grading Policy:**

Lecture (70%):  
- 3 exams at 100 points each (drop 1) 55%
- Homework/Quizzes 10%
- Final Exam 35%

Laboratory (30%):  
- Lab reports/ presentations 60%
- Lab Quizzes 40%

**Grading Scale:**  
- A= 90% and up (A-=89.5)
- B= 80-89% (B+88; B-79.5)
- C= 70-79% (C+=78)
- D= 60-69%
- F= less than 60%

- NRS= withdrawal during weeks 1-5
- W= withdrawal during weeks 6-14
- F= failure to notify instructor of withdrawal or withdrawal after week 14
- I= incomplete (for unforeseen and justifiable reasons, or emergency; may be granted only after week 14)

-Please note that this point system is tentative and may change slightly.

-As per college policy, students missing one more class hour than the unit value of the course may be dropped. (However, it is your responsibility to drop the class (either through admissions, in person or by telephone.) You are responsible for all material covered in class. If you foresee missing more than one or two days of class, please inform me.

-Students requiring special services or arrangements because of hearing, visual, or other disability should contact their instructor, counselor, or the Disability Resource Center

-Students are expected to exercise academic honesty and integrity. Violations such as cheating and plagiarism will result in disciplinary action which may include recommendation for dismissal. This further discussed in the Student Handbook. Expected conduct during examinations is discussed in the last page of this handout.
Please take out pen or pencil and paper
1. Define the term Biology.

2. What is the scientific method?

3. List the steps of the scientific method.

4. Define the term hypothesis.

5. Define the term theory.


7. What are the common characteristics of all living things?

8. List the levels of organization of life beginning with the smallest and progressing up in complexity to communities of multiple species.

9. What is DNA?

10. What is a species?

11. How are species classified?

12. The pictured organism is most closely related to
   a) Sponges
   b) Corals
   c) Humans
   d) Grey aliens
   e) Nothing, I made it in Photoshop
Chapter 1

An Introduction to Life on Earth

Lectures by Gregory Ahearn
University of North Florida
Modified by John Crocker
Why Study Biology?

- Biology helps you understand your body.
- Biology helps you become an informed citizen.
- Biology can open career opportunities.
- Biology can enrich your appreciation of the world.
Scientific Principles

- Biology is a scientific discipline
- All scientific inquiry is based on a small set of assumptions or principles
  - Natural causality
  - Uniformity in space and time
  - Similar perception
Natural Causality

- Historical approaches to studying life
  1. Belief that some events happen through supernatural forces (e.g. the actions of Greek gods)
  2. Belief that all events can be traced to natural causes that we can comprehend (natural causality)
    - Corollary: Evidence gathered from nature has not been deliberately distorted to fool us
Uniformity in Space and Time

- Natural laws are uniform in space and time.
- This principle is key understanding biological events (e.g. evolution) that occurred before humans recorded them.
- Creationism is contrary to the principle of uniformity-in-time and natural causality.
  - Creationists hold that different species were created one at a time by the direct intervention of a supernatural being.
Similar Perceptions

- Assumption that all human beings perceive natural events in fundamentally the same way
- Common perception allows us to accept observations of other humans as reliable
- Common perception is usually not found in appreciation of art, poetry, and music, nor between cultures or religious beliefs
  - Value systems are subjective
  - Science requires objectively gathered data
The Scientific Method

- Scientific inquiry is a rigorous method for making observations
- The Scientific Method for inquiry follows 4 steps...
The Scientific Method

1. Observation of a phenomenon
   - Subsequent development of questions

2. Formulation of a hypothesis
   - A supposition that explains an observed phenomenon and leads to testable predictions

3. Testing through experimentation
   - Additional controlled observations

4. Development of a conclusion
   - Evaluation of hypothesis in light of experimental data
Observation

Question

Hypothesis

Prediction

Experiment or Observation

**Hypothesis not supported—pose new hypothesis.**

**Conclusion**

**Hypothesis supported—make more predictions.**
The Scientific Method

- Scientific experimentation tests the assertion that a single \textit{variable} causes a particular observation.
- The experiment must rule out the influence of other possible variables on the recorded observations.
- \textbf{Controls} are incorporated into experiments.
- Controls keep untested variables constant.
- Scientific method is illustrated by Francesco Redi’s experiment.
Observation: Flies swarm around meat left in the open; maggots appear on meat.

Question: Where do maggots on meat come from?

Hypothesis: Flies produce the maggots.

Prediction: IF the hypothesis is correct, THEN keeping the flies away from the meat will prevent the appearance of maggots.

Experiment

Obtain identical pieces of meat and two identical jars.
Place meat in each jar.

Control situation

Leave jar uncovered.
Leave exposed for several days.
Flies swarm around and maggots appear.

Experimental situation

Experimental variable: gauze prevents entry of flies
Controlled variables: time, temperature, place

Cover jar with gauze.
Leave covered for several days.
Flies kept from meat; no maggots appear.

Results

Conclusion: The experiment supports the hypothesis that flies are the source of maggots and that spontaneous generation of maggots does not occur.

Figure E1-1  Biology: Life on Earth, 8/e  © 2008 Pearson Prentice Hall, Inc.
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Controlled variables: time, temperature, place

Results

Conclusion: The experiment supports the hypothesis that flies are the source of maggots and that spontaneous generation of maggots does not occur.
Application to Everyday Problems

- Assume you are late for an appointment and hurriedly try to start your car

1. **Observation**: The car won’t start
Observation

Car won’t start.

Question

Why won’t the car start?

Figure 1-4b part 1  Biology: Life on Earth, 8/e
© 2008 Pearson Prentice Hall, Inc.
Application to Everyday Problems

2. **Hypothesis**: the battery is dead
Why won’t the car start?

The car won’t start because the battery is dead.
3. **Experimental design**: Replace your battery with another and restart the car
The car won’t start because the battery is dead.

IF the hypothesis is correct, THEN the car will start if the battery is replaced.
4. Premature conclusion:
   • The problem was a dead battery because the car starts when replaced with a different one.
5. Recognition of inadequate controls

- Did you attempt to start the car more than once?
- Was the battery cable on my original battery loose?
6. Establishing a control

a. Reinstall your old battery, check for tight cables, *now* try to start the car

b. If car *still* fails to start on old battery, the **only variable** in this investigation now is the effectiveness of the battery
IF the hypothesis is correct, THEN the car will start if the battery is replaced.

Replace the battery.
Application to Everyday Problems

7. Making a better conclusion, based on controlled experiments
   • Your battery was probably dead
Experiment or Observation

Replace the battery.

Conclusion

The dead battery hypothesis is supported.
Observation: Car won’t start.

Question: Why won’t the car start?

Hypothesis: The car won’t start because the battery is dead.

Prediction: IF the hypothesis is correct, THEN the car will start if the battery is replaced.

Experiment or Observation: Replace the battery.

Conclusion: The dead battery hypothesis is supported.
Question: Have all other variables been eliminated?
  • Example: loose battery cables
  • Example: broken electrical wires

Solution: Control for other variables
  • Make sure cables are tight.
  • Make sure electrical wires are in good condition.
Limitations of the Scientific Method

- Can never be sure *all* untested variables are controlled
- Conclusions based on the experimental data must remain tentative
- Results of experimentation must be communicated thoroughly and accurately to other scientists for repetition
- Repetition by other scientists add verification that findings can be used as the basis for further studies
Science Is a Human Endeavor

- Human personality traits are part of “real science”
- Scientists, like other people may be driven by pride, ambition, or fear
- Scientists sometimes make mistakes
- Accidents, lucky guesses, intellectual powers, and controversies with others contribute strongly to scientific advances
Science Is a Human Endeavor

1. In the 1920s, bacteriologist Alexander Fleming grew bacteria in cultures.
2. One of the bacterial cultures became contaminated with a mold.
3. Fleming nearly destroyed the culture when he noticed the mold (*Penicillium*) inhibited bacterial growth in the culture.
4. Fleming hypothesized that the mold produced an antibacterial substance.
Science Is a Human Endeavor

- Penicillin kills bacteria.
Science is a Human Endeavor

5. Further tests using broth from pure *Penicillium* cultures lead to the discovery of the first antibiotic, penicillin.

6. Fleming continued beyond a lucky “accident” with further scientific investigation to a great discovery.

7. “Chance favors the prepared mind” (Louis Pasteur)
Scientific Theory

- A scientific theory differs in definition from that of everyday usage
  - Many people use the word theory to mean hypothesis, and “educated guess”
A scientific theory is a general explanation for important natural phenomena

- It is extensively and reproducibly tested
- It is more like a principle or natural law (e.g. the atomic, gravitational, and cell theories)
- If compelling evidence arises, a theory may be modified
Scientific Theory

- New scientific evidence may prompt radical revision of existing theory
- Example: the discovery of prions…
Before 1980, all known infectious diseases contained DNA or RNA.

In 1982, Stanley Prusiner showed that the infectious sheep disease *scrapie* is caused by a protein (a “protein infectious particle” or *prion*).
Prions have since been shown to cause “mad cow disease” and diseases in humans.

The willingness of scientists to revise accepted belief in light of new data was critical to understanding and expanding the study of prions.
Science Is Based on Reasoning

- Inductive Reasoning
  - A *generalization* is created from many observations
  - Used in the development of scientific theories
  - e.g., the cell theory (all living things are made of one or more cells) arises from many observations that all indicate a cellular basis for life
Science Is Based on Reasoning

- Deductive Reasoning
  - Generating *hypotheses* based on a well-supported generalization (such as a theory)
  - e.g., based on the cell theory, any newly discovered organism would be expected to be composed of cells
1.2 How Do Biologists Study Life?

- Life can be studied at different levels of organization.

![Diagram showing the levels of organization in biology from cell to community](image)
1.3 What Is Life?

- Characteristics of living things
  - Living things are organized.
1.3 What Is Life?

- Characteristics of living things
  - Living things are complex
1.3 What Is Life?

- Characteristics of living things
  - Living things are organized and complex.

(c) Organized and complex
1.3 What Is Life?

- Characteristics of living things
  - Living things grow and reproduce.
1.3 What Is Life?

- Characteristics of living things
  - Living things respond to stimuli
    - Light
    - Sound
    - Chemicals
    - Hunger
    - Pain
    - Touch
    - Heat
    - Cold
    - Motion
    - Gravity
1.3 What Is Life?

- Characteristics of living things
  - Living things acquire and use material and energy.
1.3 What Is Life?

- Characteristics of living things
  - Living things use DNA to store information.
1.4 Why Is Life So Diverse?

- DNA: The universal molecule of life
  - DNA is found in the bodies of all organisms, from bacteria to whales.
  - Its universal presence suggests that all organisms have descended from a common ancestor having the same molecule.
  - DNA is passed from generation to generation during periods of reproduction.
  - Organism diversity results from small changes in DNA accumulating over billions of years of evolution.
1.4 Why Is Life So Diverse?

- Life’s unity and diversity is a result of evolution.
  - Life changes over long periods of time.
  - Groups of organisms change from generation to generation.
  - The changes that accumulate in populations of organisms over time is called evolution.
  - Life’s unity arises from the fact that diverse descendents arise from single ancestors.
  - The unifying principle of biology is that all of life’s features in today’s organisms arose through evolution.
1.4 Why Is Life So Diverse?

- Natural selection is the basis of evolutionary change.
  - Characteristics of individuals in a group vary.
  - Some characteristics help individuals survive and reproduce.
  - Those that reproduce pass on these traits to future generations.
  - The favored traits are accumulated in populations over time, changing the individuals within the group.
  - Example: Big teeth in beavers favor survival and are passed on to future generations.
1.4 Why Is Life So Diverse?

- Biodiversity is threatened by human activities.
  - Biodiversity is the wealth of species in the world and the interrelationships that sustain them.
  - Human expansion in the world has severely reduced habitats for these interrelationships to flourish.
  - Extinction of many organisms have followed from the growth of human populations on all the world’s continents.
  - Pollution and chemical wastes kill aquatic organisms.