Lecture 1.1
Introduction

Who and What is Your Instructor?

- Family Man
  - Ph.D. = Doctor of Philosophy, therefore, a philosopher?
- Researcher?
- Science & Agricultural Policy Expert?
- Teacher?

What is a Scientist?

- publish scientific papers
- belong to a scientific society
- are married to a nonscientist
- watch news, documentaries, and movies on TV
- spend 52 hours per week working
- have an affiliation to an organized religion
- play a musical instrument
- spent 4.9 years in postdoc positions
- travel to at least one scientific meeting per year
- prepare a meal at home at least once per week
- spend 10 hours per week lecturing and mentoring students
- read fiction and nonfiction books
- participate in sporting or athletic activities more than once per week
- have lived in another country
- watch a movie more than once per week, with comedies being the most popular genre
- are motivated by innate curiosity
- vote in national elections
- spend at least one hour per day on the Web

Every teacher has a …

Big Problem:

- What to teach?
- How much to teach?

Let me illustrate this problem

Education:

BA - Pre-Med Biology, minor-Chemistry
Trinity College, Deerfield, IL
Bioprocess Development - Abbott Laboratories, North Chicago, IL
Ph.D. - Cell and Molecular Biology - Microbiology, Michigan State University
**Information Overload!**

- I have over 125 credit hours of science classes
- I have read a couple dozen science text books
- I have read about 1800 research papers
  - 3562 in my reference manager
  - Only 230 in my thesis
- I go to scientific seminars >5x more than I go to the video store.
- I am familiar with less than 0.0000001 of the published scientific literature!

**How Much Info is There?**

- Michigan State’s Library (est. 1955)
- Main library and 14 branches
- 4,000,000 volumes
- 28,000 serial subscriptions (in print and electronic form)
- 5,000,000 items in microfilm and microfiche
- 200,000 maps
- 40,000 sound recordings

That’s Nothing!

**The Library of Congress is the largest library in the world, with nearly 119 million items on over 530 miles of bookshelves. The collections include some 18 million books, 2 million recordings, 12 million photographs, 4 million maps, and 53 million manuscripts.**

In 1814 the entire collection was 3,000 books. Today, the Library receives some 22,000 items each working day and adds approximately 10,000 items to the collections daily.

**The Scientific Literature**

![Graph of Volumes of Knowledge over Time with Doubling Rate = 4.2 years!]

**How Does a Science Teacher Present a subject Given Such a Vast Amount of Information?**

- There is no such thing as unbiased teaching!
  - “bias” is choosing which material to teach taught.
- Most Prof’s won’t tell you their slant, bias or where it comes from...some don’t even acknowledge that they are biased.
- It's up to you to figure it out...

**I want to teach you about the most important issues in science and the environment facing you as a citizen of the US and a human on the planet earth...**

**Pledge:** I will make every effort to present a balanced or at least both sides of a controversial arena in science, biology, ecology and the environment. But like every person, I am operating from a certain ‘worldview’ and I believe that you need to know what that worldview is. There is no such thing as “valueless teaching.”
Worldview or Cosmology…
What is the definition????

• Pledge: I will make every effort to present a balanced or at least both sides of a controversial arena in science, biology, ecology and the environment. But like every person, I am operating from a certain ‘worldview’ and I believe that you need to know what that worldview is. There is no such thing as “valueless teaching.”

What do I expect of You?

Be a student! Chinese Proverb: “When the student …”
– Engage biology positively!
– Attend Class & do your assigned readings...
– Ask questions in class...
• Learn and understand the concepts that I teach you.
• Be willing to see both sides of an issue…be open to change!
• Recognize your privileged position in the world…
• Become a ‘critical’ consumer of scientific information and exercise your citizenship.

Lecture 1.2
Science: What is it?

Chapter 1:
First Definition of Science:
Oppeational Science

1st Model we will use to understand what science is…

Lecture 1 Goals:
1. Define Science
2. Understand concepts of induction, deduction, falsification, Kuhn’s scientific revolution, objectivism, subjectivism, & Scientific Programs
3. Relate these definitions of science throughout the course
to the different areas we will explore this semester.

Assignment:
1. Read: Introduction in Textbook
2. Websites: FYI & E
   http://www.geog.umd.edu/homepage/courses/500/week1/group2/ind001.htm
   http://home.earthlink.net/~imaginationworks/lyrics/mike.htm
   http://www.drpac.org/phil/ron/events/31/2001/deductive.htm
   http://www.aynrand.org/objectivism/

Operational Science

• Empirical Science
  – Observational, descriptive Science
  – Detecting patterns, or departures from patterns

• Theoretical Science
  – Generating and testing models (hypothesis testing)
  – Concerned with explaining observations and making predictions

• Technological Science
  – Generating new methods and processes
  – Troubleshooting
Operational Science

Basic Assumptions/ Beliefs

- **Materialism and Naturalism**
  1. Operate in a closed system
  2. Nothing interferes with the system
  3. All events are totally dependent on the whole system
  4. Natural explanation for all phenomena

- **Knowledge is based on methodology**
  - Observation
  - Hypothesis
  - Experimentation
  - Dynamic, not static

Scientific Reasoning

(Propositional Logic)

**Inductive Logic**
- Reasoning from Experiences
- Knowledge Expanding
  - Contains more information than premise

**Deductive Logic**
- Start with general knowledge and predict a specific observation
- Truth preserving
  - Contains less information than premises

Terms

- Postulate- Premise, Fundamental Assumption
- Principle
- Theory
- Hypothesis
- Test

Principle of Inductivism

- The number of observations forming the basis of a generalization must be large
- Observations must be repeated under a variety of conditions
- No observations should conflict with universal laws, principles, or theories

Example of Induction

- A large number of adult moths have been observed to have wings
- All observed adult moths have wings, regardless of the environmental circumstances
- All adult moths have wings.

Problems with Inductivism

- Appeals to logic
- Appeals to experience
- How many observations are required?
- What constitues significant variation
- Must retreat to probability
- Theory: dependent on inductivism
- Inductivism fails to throw new light on science
**Example of Induction**

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**Scientific Reasoning**

*(Propositional Logic)*

**Inductive Logic**
- Reasoning from experiences
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**Deductive Logic**
- Start with general knowledge and predict a specific observation
- Truth preserving
  - Contains less information than premises

**Example of Deduction**

- Many lectures on the philosophy of science are boring.
  - This is a lecture on the philosophy of science.
  - Therefore, this class is boring.

**Deductive Science**

**Process**
1. Statement of problem
2. Hypothesis as to the cause of the problem
3. Experimental tests for each hypothesis
4. Predict results (how to accept or reject the hypothesis)
5. Observe results
6. Draw conclusions from the results (accept or reject the hypothesis)

**Example**

- Problem: Class is too large
- Hypothesis: If I make this confusing, then some students will drop
  - Deliver miserable lecture about logic
  - Some people will get confused and drop
- Observation: No Drops
- Conclusion: Accept

**Example**

- Observation: Loads-0-Drops
- No Drops
- Reject
- Accept

**Was This a Good Example?**
Deduction
Premis, Fundamental Assumptions
Must be both valid and true
Good tests
Prediction is logically deducible
Prediction is improbable
Prediction is verifiable

Principle of Deduction
• Start with inductively derived laws and theories
• Define initial conditions
• Make predictions and explanations

Deductive Falsification
(Conjectures and Refutations)
• Positivist-
  – Only has supporting evidence
  – Ignores evidence against

Hypothetico-Deductive Method
Laws and theories
Induction
Prediction is logically deducible
Prediction is improbable
Prediction is verifiable

Deduction
Prediction is verifiable
Predictions and explanations

Chapter 3: Science as Falsification
And model we will use to understand what Science is…

Science: The Process of Popperian Falsification
Falsification science: the process of developing a set of hypotheses, tentatively proposed, to as accurately as possible describe an aspect of the natural world.

Hypotheses ($H_0$) must be falsifiable: one develops logically possible observations which, if established, would falsify the $H_0$. 
Many lectures on the philosophy of science are boring

This is a lecture on the philosophy of science

Therefore, this class is boring

What is the experiment that would falsify or disprove our hypothesis?

Theory underlying $H_0$ may be false.

The premise behind $H_0$ is false.

Complexity of any realistic test of most modern theories is often extremely difficult.

Example of Falsification from Induction

• Many lectures on the philosophy of science are boring

• This is a lecture on the philosophy of science

• Therefore, this class is boring

What is the experiment that would falsify or disprove our hypothesis?

Judging $H_0$’s

• Degree of falsifiability

• Clarity

• Precision

• Boldness

• Novelty

Chapter 2: Science: Objectivism vs. Subjectivism

Understanding whether science and scientists are objective or subjective is important in understanding what science is. These are not models but definitions of how science is practiced.

Science Values

Here is a cutting edge concept in a Postmodern world!

Scientific Knowledge is not good or bad...

Its Goodness or Badness depends on how it’s used and by what standard you grade it.

Objectivism Vs Subjectivism

Is science and are scientists objective?

Objectivism is the belief that man can be removed from dependent of his surroundings, training and experiences while making observations.

Subjectivism holds that man is not objective, but subjected to his surroundings, training and experiences while making observations.
Objectivism and Subjectivism result in at least three concurrent views of science...

1- Scientific Imperialism

- Science is the Truth Arbiter
  - Therefore, anything goes if scientists say so.

Objectivism is the belief that a scientist can be removed from or independent of his surroundings and experiences while making observations, conclusions and recommendations.

2- Postmodern Relativism

- Plurality of Truths
  - Science is only one form of Subjective Truth
  - Science has made errors in the past.
    Therefore, science and scientists should be:
    - Questioned...
    - Evaluated...
    - Regulated...

Subjectivism holds that science and scientists are not objective, but antecedents to surroundings, training, personal experience, etc.

Michael Polanyi -- (1891-1976)
Eminent Nobel Chemist
Worried about what subjectivism would do to Science -- “tacit knowledge” “we know more than what we can tell”. Like riding a bicycle...

Paul Feyerabend
Postmodern philosopher
Science is not intrinsically superior to other forms of knowledge

3- Godisms

- Mankind is created and ultimately Truth is God Revealed.
  - Science is a product of mankind, therefore science must be carefully evaluated for its potential good and/or bad outcomes.
Scientific Imperialism:
- Based on the Enlightenment < 5%

Post Modern Relativism
- Fastest growing > 14%

Godisms:
- Largest > 80%

Scientific Imperialism:
- Based on the Enlightenment < 5%

Chapter 5: Science as Research Programs

The 3rd model we will use to understand what Science is…

Science: Research programs
- Hard core theory, often not easily challenged
- Generates lots of Hypotheses

Progress
Degenerate

Problems: 1) Politically influenced, 2) Special interest influenced, 3) Dictate large expenditures of public funds, 4) Redirect or sometimes misdirect science thrusts and 5) Often ideologically driven or oriented.

Examples: Genomics, NASA, Aids Research, Human Genome Project, etc.

Chapter 6: Science as a Revolution

The 4th model we will use to understand what Science is…

Kuhn’s Scientific Revolution

A Scientific Theory is like a pitcher of water.

When one Theory fails its components often flow into another Theory.
**Assignment: Learn the Presuppositions of Science**

**Lecture 1 Science: What is it wrap-up**

- Human endeavor dependent on the scientific community and society.
- Not infallible, often guided by scientific fads, yet the best we have.
- There are at least 4 ways of describing Science: Naive Inductivism, Falsification, Science Programs & Kuhnian Revolutions.
- Based on presuppositions about how the world is, & many if not all of these presuppositions are not scientifically testable.

“Science is simply common sense at its best… rigidly accurate in observation, and merciless to fallacy in logic.”

Thomas Henry Huxley (1825-1895) English biologist and “Darwin’s bulldog”.