

Biological Diversity (w/ Dr. Mark Kershner)

Science, Scientific Method and Misused Terms

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To even understand biological diversity, we need a working definition of science itself that will be used comprehensively throughout the class.

What is science?

- Most people respond with “a description or explanation, a purpose or goal”

Therefore we ask, what is the purpose of science?

- To seek an increasingly accurate explanation of the natural world (this explanation is always building/changing)
- We also assume that, in science...
 - a. Natural phenomena have natural explanations, which follow natural rules/patterns
 - b. Nat. rules/patterns are unchanging across space and time (i.e. gravity is true across the planet)
 - c. We can understand these explanations and patterns with the scientific method

So, we will define science as...

- An organized body of knowledge describing the nat. world (this is the description part)
- With a systematic process of acquiring, organizing, and communicating this knowledge (this is the purpose/goal part)

For this to work, a few conditions must be met:

Science must be...

- a. Based upon the best available evidence
 - b. Objective and unbiased, so therefore trustworthy
 - c. Verifiable, testable, repeatable
 - d. Acquired using the scientific method
 - Observation (data pool)
 - Questions
 - Hypothesis
 - Experiment
 - Use reasoning to interpret
- i.e. Why are there so many worms on campus when it rains?

1. **Observation:** single/multiple observations
 - "data"
 - Objective, unbiased, impartial
 - Restricted to our senses (sight, smell, touch, etc.)
 - ◆ Improved with devices/instruments like microscopes
2. **Question:** framed/generated based on the observation/data
3. **Hypothesis:** tentative explanation of observation/data
 - NOT a random guess
 - Based on inductive or deductive reasoning
 - ◆ Inductive- uses specific observation/data to generate a more general idea
i.e. Daisy the dog has hair, a lot of other dogs have hair, 5 dogs have hair, so ALL dogs must have hair.
 - ◆ Deductive- applies a general principle to predict specific results
i.e. Principle: every dog has hair. So, if it is a dog, **then** it must have hair.
 - Clear, focused prediction (very specific, not vague or too general)
 - Must also be testable (be able to make further observations, surveys, experiments to test this hypothesis)
4. **Experiment:** manipulation of some variable or factor
 - There is a suspected CAUSE (explanation) and a measurement of the EFFECT of the manipulation
 - You must account for most/all other variables that influence the EFFECT you measure (must have controls)
 - Must be repeatable, for consistency of results
- Interpretation of the experiment... Experimental Outcome
 - ◆ Compare outcome to hypothesis
 - ◆ If the outcome supports the hypothesis...
 - We would say we "accept" it
 - To proceed, one could redo or redesign the experiment, stop, or design a new experiment to obtain further support
 - ◆ If the outcome doesn't support the hypothesis...
 - We would say we "reject" it
 - To proceed, one could redesign the experiment, revise the hypothesis, redo the experiment, or stop/abandon the experiment altogether
- The word "reject" is very definite
- The word "accept" does NOT mean "to prove" and does NOT mean "find to be true"
 - Science does NOT prove anything or determine truth
 - All results could change with new data; it is simply based on the current understanding of the best available evidence

Important/Often Misused Terms

FACT: well confirmed observation

- There is a lot of independent evidence to support
- Unlikely to be overturned
- NOT proof or truth

LAW: general statement describing some aspect of the natural world and how it behaves

- NOT KNOWN TO VARY
i.e. laws of gravity, thermodynamics

HYPOTHESIS: possible/tentative explanation of an observation

- May be weakly supported, strongly supported, or not supported at all

THEORY: a very well supported explanation that uses tested hypotheses, facts, and laws

- Supported by ample amount of data/observations
- Multiple lines of independent evidence
- NO scientist would ever say, "It's *just* a theory"

→ **FACTS AND LAWS:** *require* explanations

→ **HYPOTHESES AND THEORIES:** *provide* explanations