

Anthropology and the scientific method



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Why do we care?

- Science is a way of understanding the world around us
- Many different disciplines of science! Some are done in the field, some in the lab, some entirely on a computer, or all/none of the above!
- No one is inherently “good” or “bad” at “science” – we all have our strengths and weaknesses, and science(s) benefit from different ways of thinking!
- Lots of misunderstanding and/or hesitancy around science– we’re here to dispel at least some of those concerns!

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Biological anthropology

- The scientific study of physical characteristics, variability & evolution of the human organism
- Subfields of biological anthropology:
 - **Evolutionary morphology & systematics** (paleoanthropology, osteology, paleopathology, forensic anthropology, human biology, adaptation & variation)
 - **Behavioral ecology** (humans and non-human primates)
 - **Molecular (genetic) anthropology** (DNA, hormones, host-parasite interactions, etc.)

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What can *bones/fossils* tell us about human evolution?



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What can *primate behavior* tell us about human evolution?

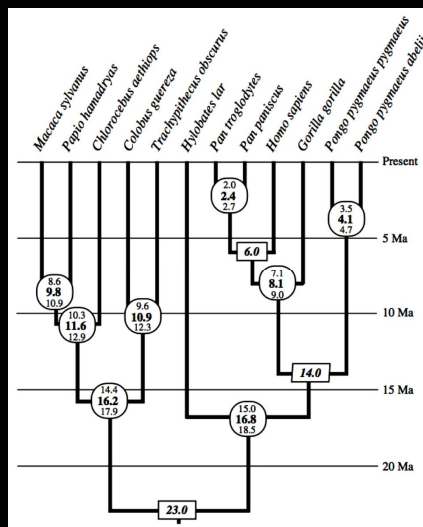


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What can *DNA* tell us about human evolution?



Photo 51 by
Rosalind Franklin



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What archaeologists and
biological anthropologists do is a
SCIENCE

STAND BACK



I'M GOING TO TRY
SCIENCE

xkcd.com

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What is science?

- Science is a process of understanding phenomena through **observation**, **generalization & falsification**.
- The general goal of science is to **produce knowledge about the observable world**. It is one of the ways people go about doing so.
- A process.
- A **method**, or set of methods.

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Science is empirical

This means that:

- Science relies on **experimentation or observation** of observable phenomena.
- Scientific data are **evidence** from which **interpretations** can be made & **conclusions** can be drawn.

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Facts

- In common usage, a **fact** is true knowledge.
- In science, the word isn't used very much.
 - Data are more or less **reliable**.
 - Ideas are more or less well **established**.

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The scientific method

- Observation & deduction
- Constructing a hypothesis
- Experimentation or analysis (testing)
- Interpretation of results
- Reporting results

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Step 1: Observation & deduction

- **Observation** is the gathering of scientific information (data) by watching a phenomenon.
- **Deduction** is a conclusion that follows logically from a set of observations.

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Step 2: Hypothesis

- A hypothesis **attempts to explain data**.
- A preliminary explanation of a phenomenon.
- An educated guess.

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What makes a good/valid hypothesis?

- Logical.
- Actually explains the data.
- **Falsifiable!**
- Simple.
- Consistent with other knowledge/hypotheses.

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What does *falsifiable* mean?

- There is an observation or experiment that, if made, would reject the explanation given by a hypothesis.
- **Falsifiable:**
 - “All swans are white.”
- **Not falsifiable:**
 - “All swans are either white or not white.”
- **Unclear/subjective criterion**
 - “Dogs are cooler than cats”.

Science is self-correcting!

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Why should hypotheses be simple?

- For any set of observations, there is an infinite number of potential explanations.
- Whether or not the world is actually simple, *simpler explanations are easier to test.*
- **Occam's Razor:** one should not increase, beyond what is necessary, the number of entities required to explain anything.
- **Parsimony:** choose the explanation that requires the fewest leaps of logic.

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Why should hypotheses be consistent?

- So they can form **a theory**.
- A new hypothesis that is not consistent with what is already “known” must be well tested. Often starts a new area of research.

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What is a theory?

- In colloquial use, a theory is just a guess or a tentative suggestion (“*just a theory*”)
- In SCIENCE, **a theory is a collection of mutually consistent hypotheses that have withstood repeated attempts at rejection** (e.g., theory of gravity)

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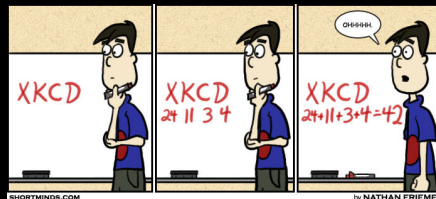
What is a “scientific law”?

- Law $\neq$ theory!
- An observation (not explanation!) valid under specific circumstances
- A hypothesis tested countless times
- For many “laws” there are **known conditions under which they do not apply**, or have been falsified altogether.

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Theory of evolution

- A collection of **mutually consistent hypotheses** that have withstood repeated attempts at rejection
- Current best explanation for the diversity of life forms (extant and extinct)
- NOT about the meaning of life, the universe and everything



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Step 3: Experimentation or analysis (testing)

- The procedure by which hypotheses & theories are falsified or modified.
- Experimentation or analysis is done to test a hypothesis.
- **Try to falsify the hypothesis.** If falsified, it is rejected in its present form (can be modified and re-tested in the future). If it cannot be falsified, then it MAY be 'true' (aka robust hypothesis).

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Observable/measurable data

- Time of sunrise
- Height
- Date of a particular volcanic eruption.
- How many people are in this room
- Presence/absence of a viral infection
- Average birth rate in a population

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Quantitative vs. qualitative data

- **Quantitative (measurable)**
 - I am 1.69 m tall.
 - This laser pointer cost me \$15.
 - Humidity today is 65%.
- **Qualitative (observable)**
 - I am taller than you are.
 - The color of the sky is blue.
 - Someone outside is riding a bike.

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Not data

- The feel of the lavender haze.
- The world population of leprechauns.
- The length of the average unicorn's horn.
- What the tooth fairy does with your teeth.

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Step 4: Interpretation

- Can the hypothesis be rejected?
- If so, or if not, what **inferences** can be made from this? (Inference = The act of deriving logical conclusions from factual knowledge or evidence.)
- Conclusions summarize how well data fits the original hypotheses.

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Step 5: Report Results

- **Presentations** at professional conferences
- **Publications** in peer-reviewed journals (findings are critiqued by other scientists prior to publication)

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Peer review in science

- Validation of research.
- The funding and presentation of modern science is “refereed”.
 - **Funding** is dependent on convincing your peers (other scientists) that what you are doing is worthwhile.
 - **Publication** is dependent on convincing your peers that what you have found (and written up) is worth reading.

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Scientific publications

Two main categories:

- **Research Article**
 - The results of primary research are presented.
 - New data is related to current hypotheses.
 - New hypotheses may be introduced.
- **Review Article**
 - Summarizes the results from many research articles.
 - *May* take sides.
 - *May* introduce new hypotheses.

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Issues in science

- Self-correcting, but far from perfect!
- Done by people and thus can be influenced by individual and systemic biases in approach, execution and interpretation
 - Lack of diversity among researchers and research participants/samples
 - Bias towards Western traditions and schools of thought
 - sexism, racism, elitism, etc.

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Issues in science

- Initiatives aimed at increasing diversity among scientists and in scientific research
- Better policies
- Incorporating practices shown to minimize the effects and influence of bias (e.g., double-blind peer review)
- Anti-racist and anti-colonialist approaches

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