Anthropology and the scientific method

What archaeologists and biological anthropologists do is a SCIENCE

xkcd.com

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!

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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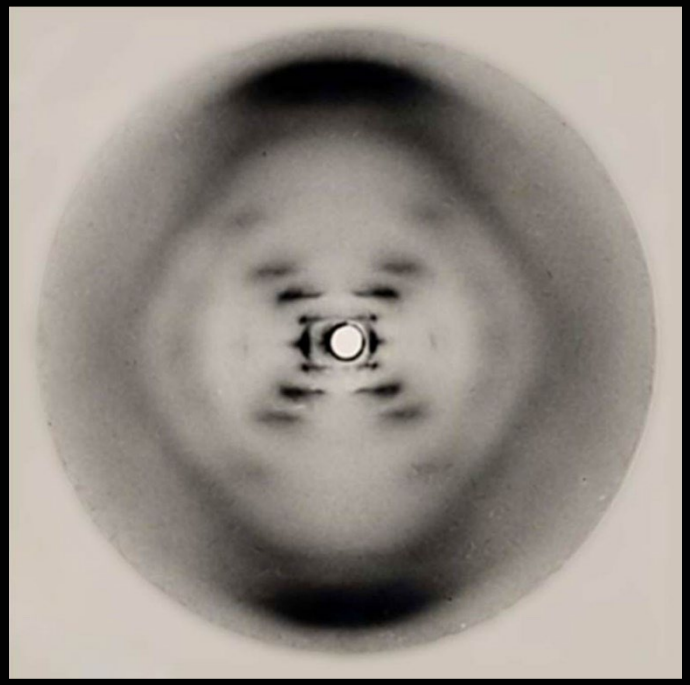

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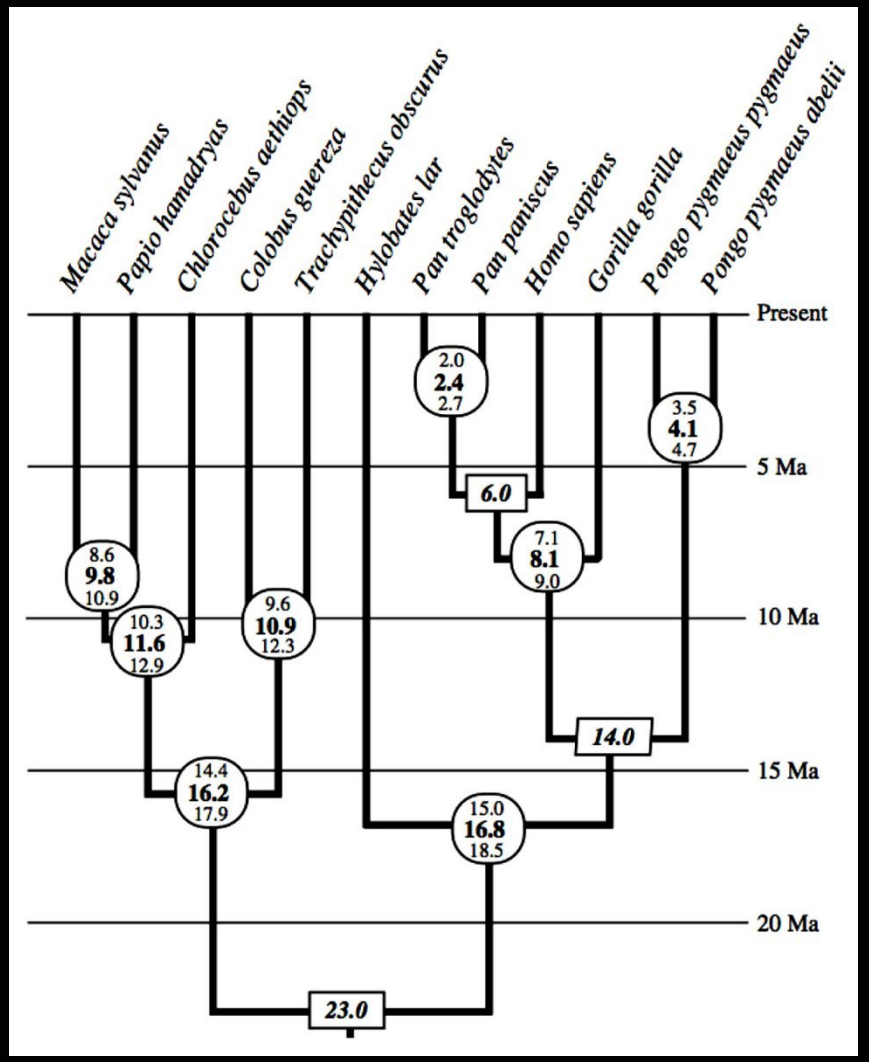


What is science?

- 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.

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.

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*.

The scientific method

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

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.

Step 2: Hypothesis

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

What makes a good/valid hypothesis?

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

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!

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.

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.

What is a theory?

- In colloquial use, a theory is just a guess or a tentative suggestion ("*just a theory*")

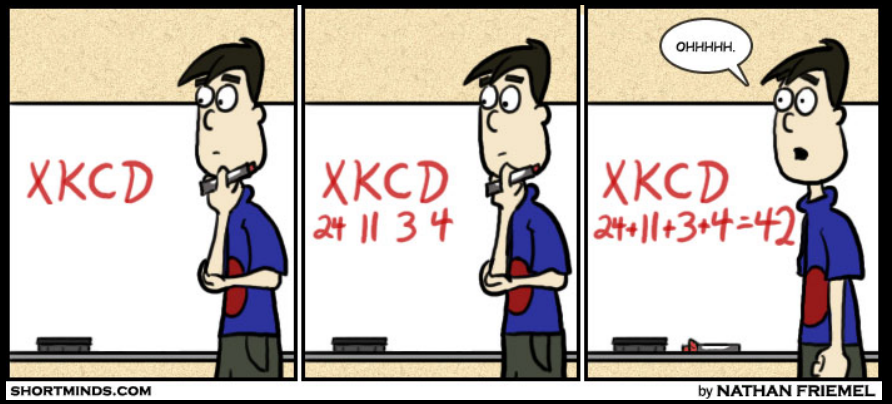
- In SCIENCE, a theory is a collection of mutually consistent hypotheses that have withstood repeated attempts at rejection (e.g., theory of gravity)

What is a “scientific law”?

- Law ≠ 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.

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



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).

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

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.

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.

Step 5: Report Results

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

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.

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.

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.

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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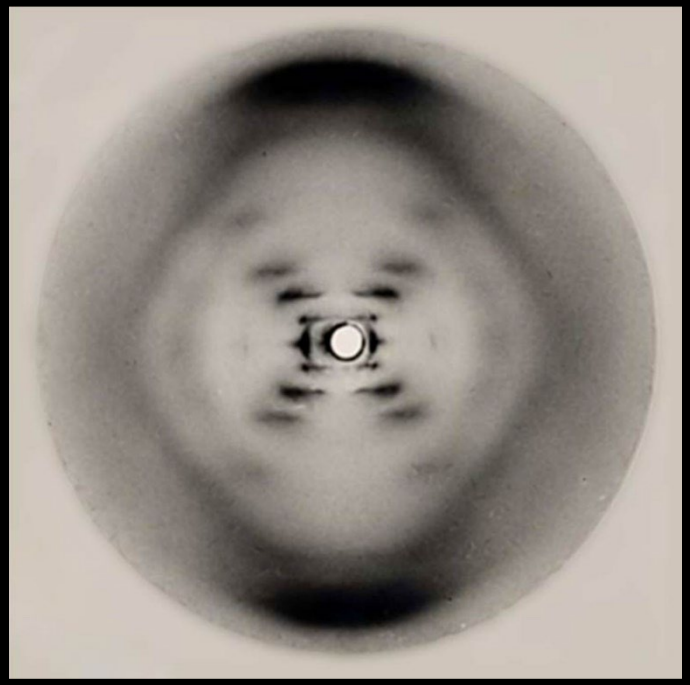

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