Week two: Environment and scientific method

- summarize your cause and effect projects for presentation in day 2 of the week
- begin exploration of cause and effect
- begin readings from fr text chapter 1 (link below)

FR3e chapter 1

https://elab.hpa.edu/apes/texts/fr3e/fr3e_ch1.pdf

Key concept:

energy->water->food->culture

1. With energy you can move/purify water
2. With water you can grow food
3. With food you can maintain a culture

What is the "environment"?

- Front of ship fell off-https://www.youtube.com/watch?v=3m5qxZm_JqM
- "we towed it out into the environment"..."you mean into another environment"

Environment: Everything around us, including us

Climate change map-try this out:

https://impactlab.org/map/#usmeas=absolute&usyear=2080-2099&gmeas=absolute&gyear=1986-2005&usyear=1986-2005&gmeas=absolute&gyear=1986-2005

Nebraska->Alberta by 2050

Module 1 ----------

Fracking-know what it is? Why is it controversial? How has it changed how we generate electricity in our country? At what cost? Why is this politically important? Why are the solvents they use secret? What is the impact of these solvents on water?

Bio=life, so biotic means living, abiotic means not living (druids had a neat view on this)

How systems are defined enables us to create models of cause and effect (favorite topic of physicists and historians as well)

Module 2 ----------

Environmental indicators: what we know and can observe that indicate the condition of a system

- Biodiversity
- Food production
- Global warming
- Human Population
- Resource depletion

TABLE 2.2 Five key global indicators

Indicator	Recent trend	Outlook for the future	Overall impact on environmental quality
Biological diversity	Large number of extinctions, extinction rate increasing	Extinctions will continue	Negative
Food production	Per capita production possibly leveling off	Unclear	May affect the number of people Earth can support
Average global surface temperature and CO_2 concentration	CO_2 concentrations and temperatures increasing	Probably will continue to increase, at least in the short term	Effects are uncertain and varied but probably detrimental
Human population	Still increasing, but growth rate slowing	Population leveling off; resource consumption rates also a factor	Negative
Resource depletion	Many resources being depleted at rapid rate, but human ingenuity develops "new" resources, and efficiency of resource use is increasing in many cases	Unknown	Increased use of most resources has negative effects

Ecosystem services: can be economic, direct or cascading (fishing in the Gulf of Mexico impacted by offshore oil spills)

TABLE 2.1 Some common environmental indicators

Environmental indicator	Unit of measure	Chapter
Human population	Individuals	7
Ecological footprint	Hectares of land	1
Total food production	Metric tons of grain	11
Food production per unit area	Kilograms of grain per hectare of land	11
Per capita food production	Kilograms of grain per person	11
Carbon dioxide	Concentration in air (parts per million)	19
Average global surface temperature	Degrees centigrade	19
Sea level change	Millimeters	19
Annual precipitation	Millimeters	4
Species diversity	Number of species	5, 18
Fish consumption advisories	Present or absent; number of fish allowed per week	17
Water quality (toxic chemicals)	Concentration	14
Water quality (conventional pollutants)	Concentration; presence or absence of bacteria	14
Deposition rates of atmospheric compounds	Milligrams per square meter per year	15
Fish catch or harvest	Kilograms of fish per year or weight of fish per effort extended	11
Extinction rate	Number of species per year	5
Habitat loss rate	Hectares of land cleared or "lost" per year	18
Infant mortality rate	Number of deaths of infants under age 1 per 1,000 live births	7
Life expectancy	Average number of years an infant born today can be expected to live under current conditions	7

1. Biodiversity: biological diversity (more about this later)
   - Robust systems (can be biological, racial, technological) all have strong diversity
   - Genetic Diversity: genetic variation within a population (corn for example)
   - Species: ducks vs. dogs
   - Species diversity: variation of species in an ecosystem
   - Speciation (more) vs. extinction (less)
   - Background speciation rate (cosmic rays)
   - Background extinction rate (before humans, much higher in the anthropocene era)

Speciation: an adaptation based on stress (evolution)

Evolution needs three things:

1. some form of genetic variation
2. some stress that favors this variation
3. survivors have to reproduce and carry on the variation

Think of giraffes as an example:

1. longer necks in some animals

2. drought that kills all short neck creatures (just like in land before time)
3. long neck animals survive to reproduce and carry on the variation

Cool stuff:

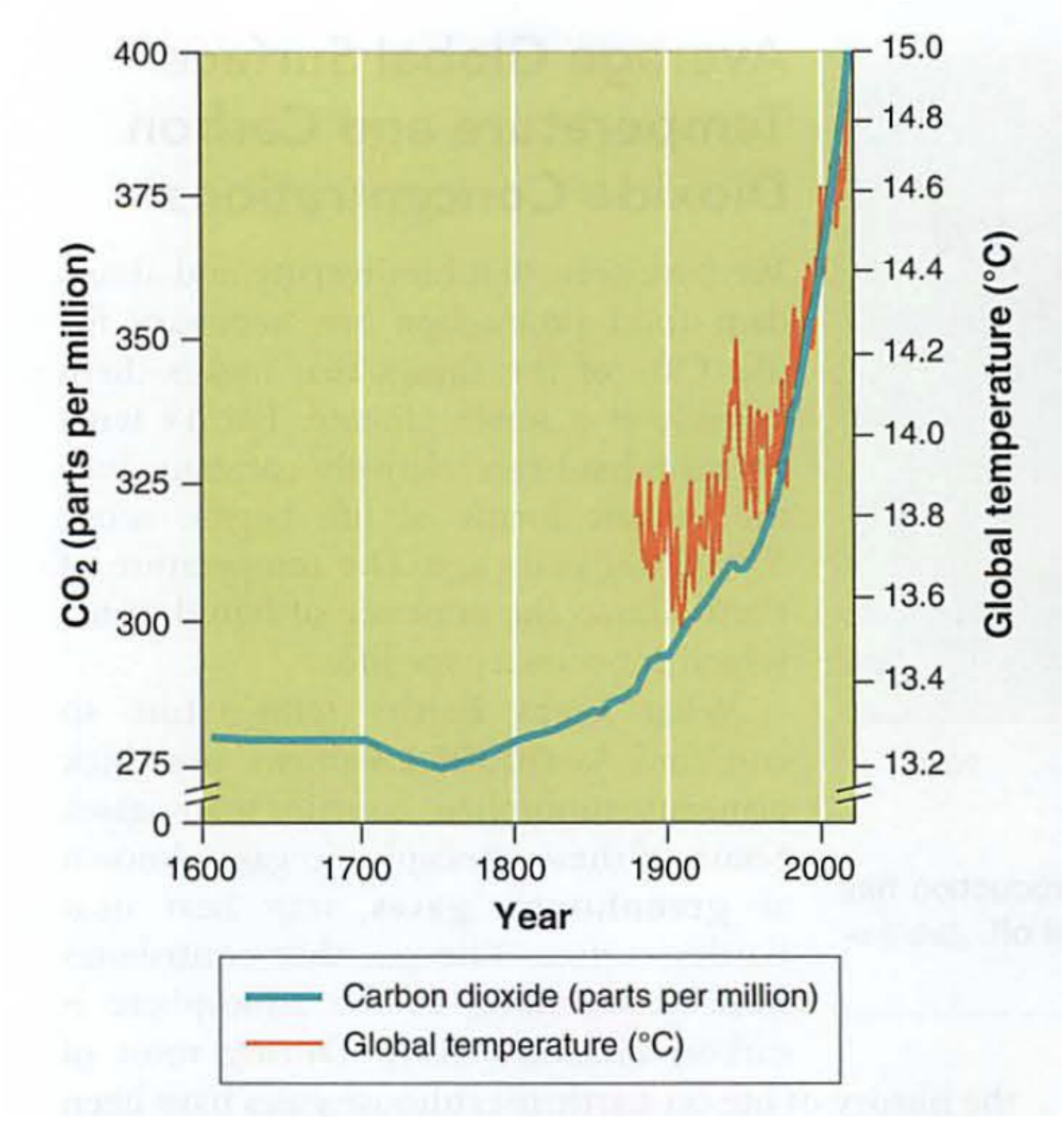
- There is a theory that the background rate of mutation/speciation was much higher long ago because our atmosphere was thinner, and enabled more cosmic rays to penetrate, causing much higher rates of mutation/speciation.
- In England, butterflies have adapted since 1850 to look more like soot from coal fires.
- In NYC, a species of "subway mosquitoes" have been found that feed on humans in a dark, cool place
- Huh.

Extinction is the opposite of speciation, where species die off (except in the film Jurassic Park)
There is such a thing as a "background rate of extinction", which we have surpassed by many times
Diversity is good: think of monoculture food crops: one pest kills everything

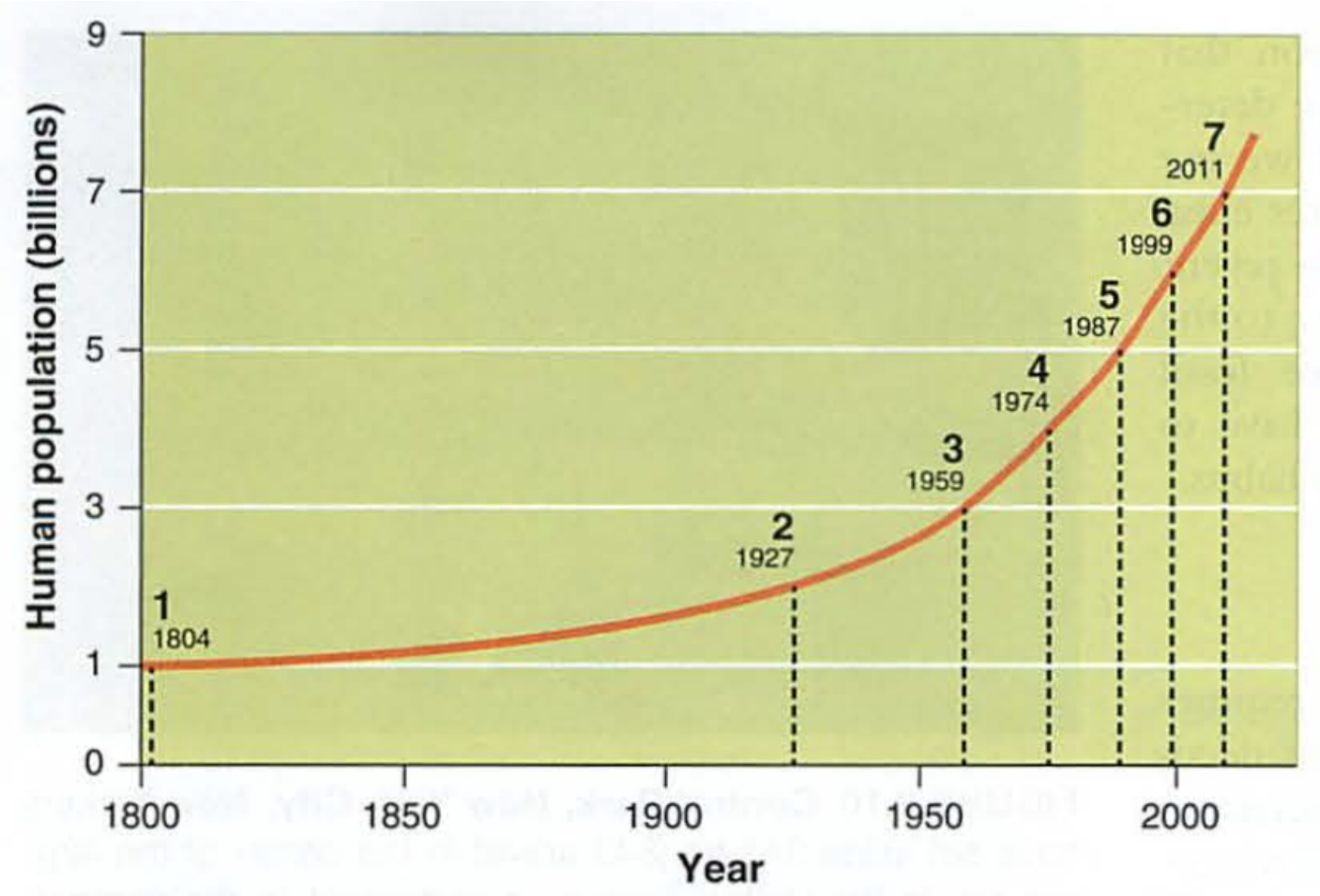
2. Food production: see Malthus and Norman Borlaug, e.g. Mexico famine

- grain variation and monoculture
- regional grain production (e.g. Pearl river delta)
- vegetarian vs. carnivores

3. Global Warming
Man made, from burning fossil fuels (anything that was living, decayed capturing atmospheric carbon)
carbon dioxide was in the air, then captured as plants and animals
we burn their carbon with oxygen to make carbon dioxide
greenhouse gases: trap infrared radiation, warming the planet (cause and effect)
Not too many people know we need some CO2 to keep water above freezing-think of this as we search for exoplanets...



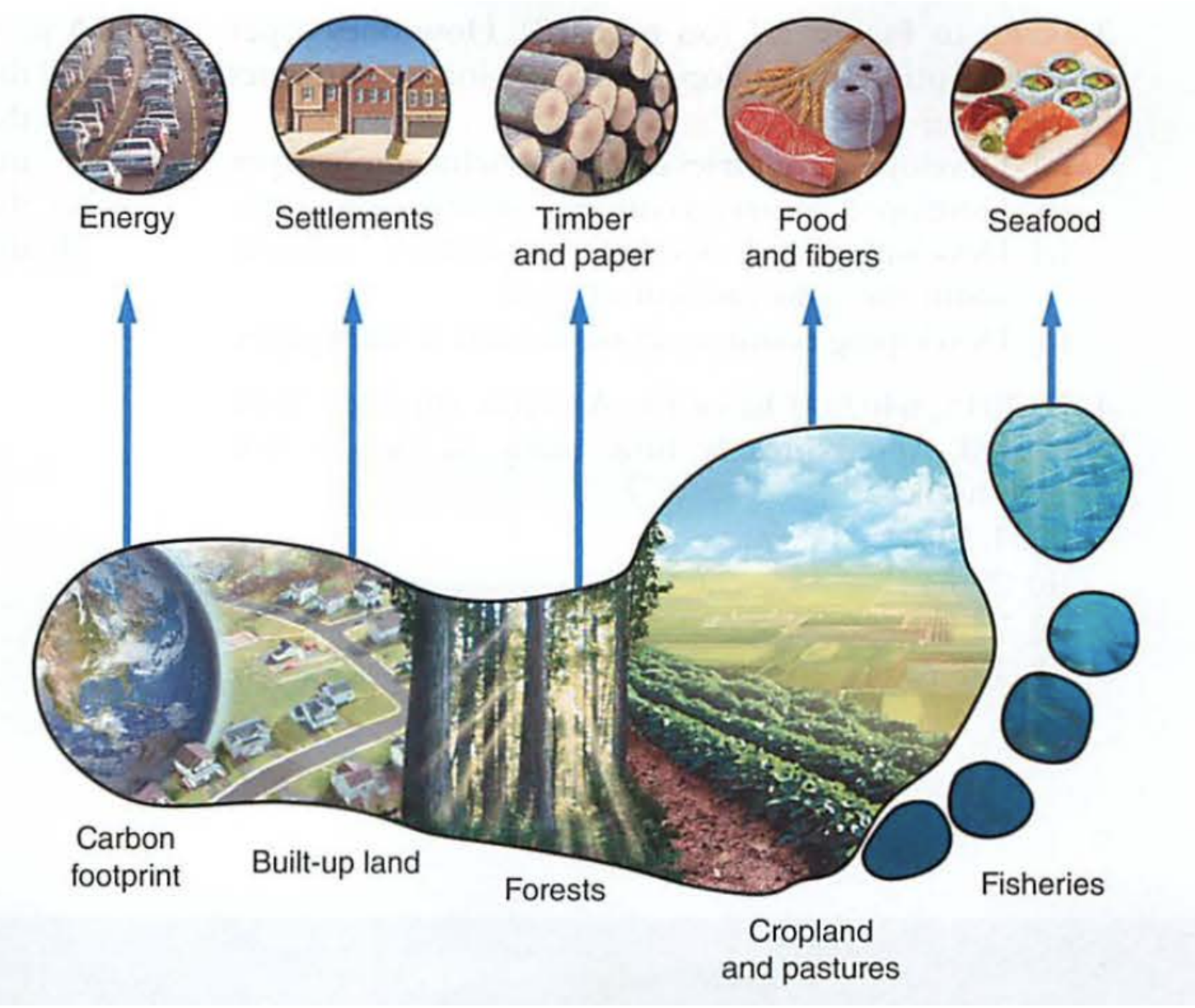
4. Human population
   - growth rates
   - dispersion
   - access to water
   - Why was China's one child policy eventually a problem for China?
   - education, reproductive rights and religion



5. Resource depletion

- water is first
- Resource depletion is hard to grasp, but resource constraints are easier:
- If we had a major tsunami here that closed airports (all near the shore) and ports, how long would we have electricity?
- water? (pumped by electricity)
- food?

Sustainability: ability to sustain present conditions forever (not likely)
Ecological footprint: what you calculated



Module 3: Scientific method

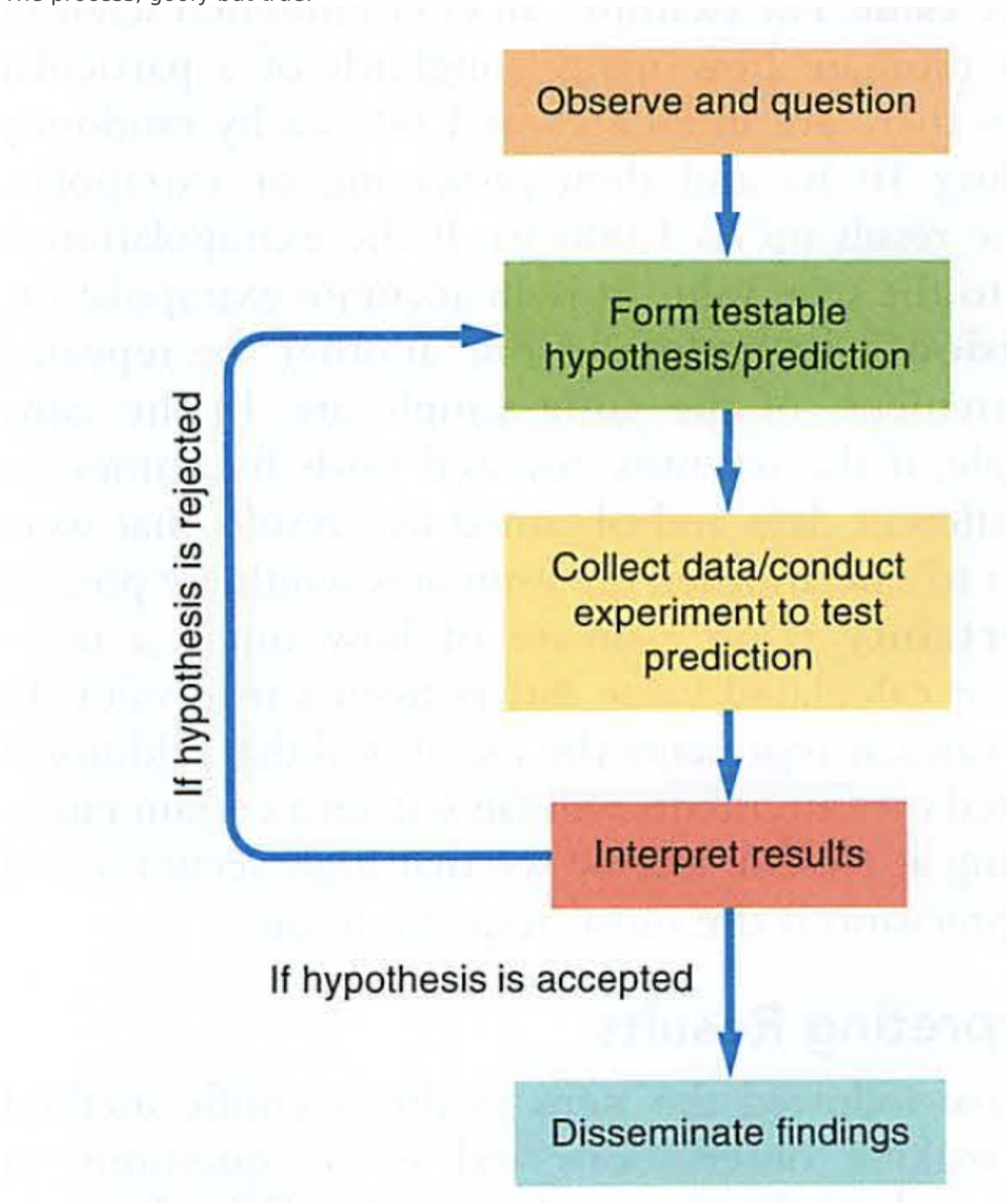
Watch this: Monty Python Witch scene: https://www.youtube.com/watch?v=Ii68tPIiZOo

1. Can you follow cause and effect?
2. What is their logical path?
3. Why do folks associate fossil fuels with global heating?
4. Who might be against this line of reasoning and why?
5. Fact: in ancient times, women were thrown into ponds to determine if they were witches. If the water "rejected them" they were possessed by the devil and therefore witches. If not, they just drowned. It is a wonder we made it this far.
6. Another example: cold fusion (look this up) Ponds and Fleishmann claimed they could replicate the processes in the sun (1 million degrees C) in a cooler on a table.
7. Science is built on replication: if a process cannot be replicated, it cannot become part of the scientific "pyramid" of understanding. No bad blocks allowed.
8. Also key is taking notes (must be in pen, not pencil). Alfred Nobel invented dynamite. His brother's last words in his lab notebook, in pen were "I'm now going to compress the

dynamite"

9. Why is there no Nobel prize for Mathematics?

The process, goofy but true:



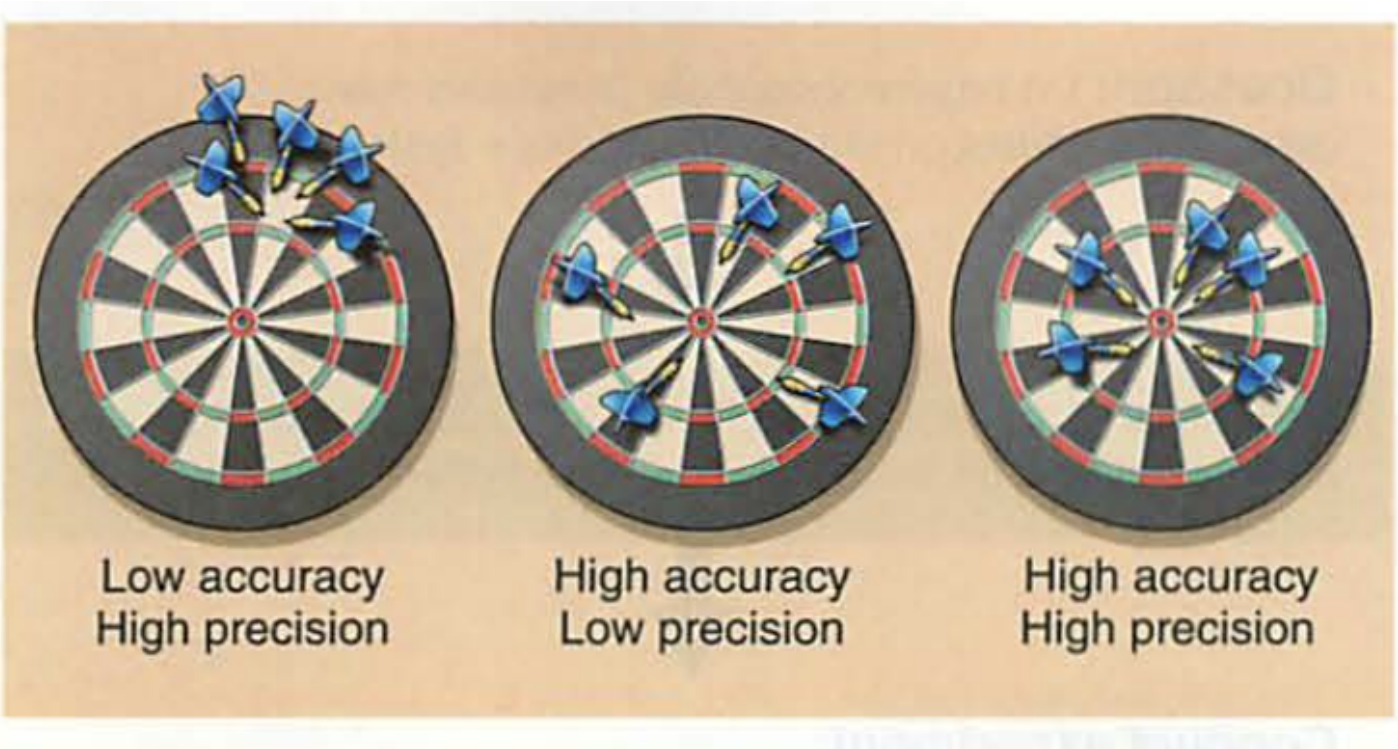
Replication is key: if you have magic beans, and nobody can replicate your results, you are in trouble.

See also Korean claims of cloning humans (not sheep, we already did that-her name was Dolly)

Key idea: even wrong experiments are valuable: Edison: "I learned 800 ways not to make a light bulb"

Important terms (yes, these actually show up on the AP exam):

- Variable: any difference, in a planned or "natural" experiment
- Independent variable: the part that does not change (like x in a graph)
- Dependent variable: the part that changes-or not
- Null hypothesis: proving something is NOT cause and effect (can sheep's bladders be used to predict earthquakes)
- Replication: everybody must be able to get the same results, using the same materials
- Sample size (n): must be large enough to be accurate
- Accuracy: close to truth or true value
- Precision: how close your results are to each other (gas pump is in 0.01liters, but your odometer is only in miles)
- Control group: those you DON'T mess with in the experiment (think of some drug test)



Natural experiment: variation not planned (Lahaina, COVID, Mount Pinatubo and cooling of the planet, etc.)

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Ozone hole example: compare and contrast with anthropogenic climate change-why different?

Renewable vs. non-renewable resources (one politician recently tried to get nuclear energy classified as a renewable resource-it takes billions of years)

Renewable can be a forest, if used at a sustainable rate, otherwise not

Malthus again, Norman Borlaug again, and a new name: Paul Erlich (1968) "The Population Bomb"

In short: famine and conflict will arise from population growth.
In reality, it is much more complex, involving politics (e.g. Syria), economics (e.g. refugees from sub-Saharan Africa) and water rights (e.g. Palestine).
Jurgen Randers told me during the Elab opening that he thought in the next 50 years, China would invade Mongolia to the north, stating as a cause "religious instability" but the real cause would be access to water there.
If the Himalayan snowpack ceases to be a seasonal flow for the rivers of Asia, most of Western China would be in a drought, unable to produce food.

Ecological Footprint again:
Tragedy of the Commons:
Garrett Hardin, UCSB (look this up)

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