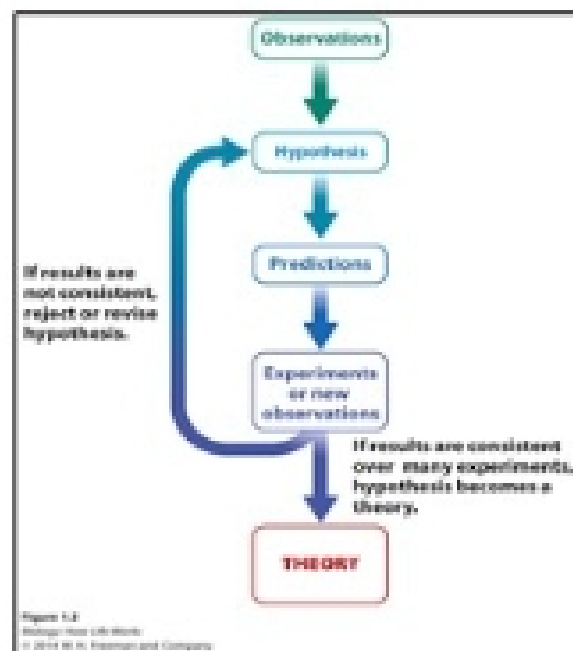


Life: Chemical, Cellular and Evolutionary Foundations

- I. What is biology?
 - A. The science of how life and the body works.
 1. Science is about making observations based on knowledge.

II. The Scientific Method

A.



1. **Observation:** the act of viewing the world around us.
2. **Hypothesis:** a tentative explanation for one or more observations.
 - a. "educated guess"
 - b. Not typically based on a lot of knowledge.
 - c. A good hypothesis makes predictions about observations not yet made or experiments not yet run.
 - d. These predictions can be tested.
3. **Predictions:** what do you think is going to happen next?
4. **Experimentation:** a disciplined and controlled way of asking and answering questions about the world in an unbiased manner.
 - a. Needs to be *unbiased*.
5. **Theory:**
 - a. Once a hypothesis has been supported by a large body of experiments and observations, it can become a theory.
 - b. Theory is only possible if results are consistent over many experiments.
 - c. Note that, in general conversation, the term theory is often synonymous with hypothesis.
 - d. But in science, a theory is **fact**.

III. A Case Study on the Scientific Method (partner activity over what causes stomach ulcers)

IV. Types of Experiments (2)

A. Comparative

1. Look at trends in data to make predictions.

B. Controlled

1. Only one variable is looked at, all other are kept controlled.
2. Dependent variable is the only one manipulated.

V. What do you think causes ulcers?

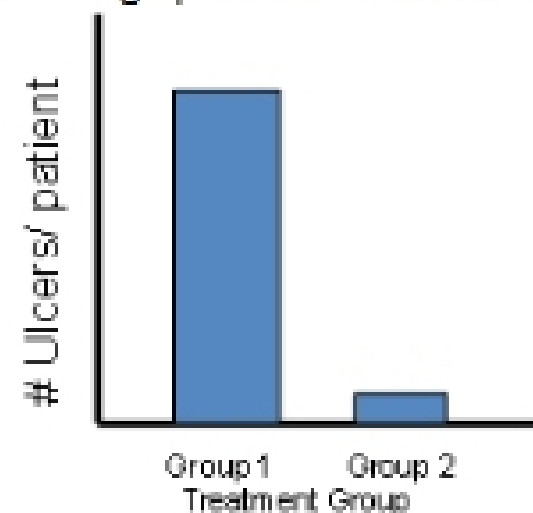
- A. Stress
- B. Excessive stomach acid**
- C. A bad diet
- D. Being overweight
- E. Drinking excessive alcohol

VI. What Causes Ulcers?

- A. Design an experiment to test if the “*excess acid hypothesis*” is true.
- B. In small groups: design the experiment - be specific about how you would treat your groups and what you would measure.

VII. A Possible Study Design

- A. Doctors divide patients into two groups:
 - 1. Group 1 received antacids and were instructed to take them 3x/day.
 - 2. Group 2 received sugar pills and were instructed to take them 3x/day.
- B. After 3 months, the number of ulcers per patient is assessed.
- C. Predict what the results would look like if the excess acid theory was supported.
 - 1. The graph should look a bit like this.



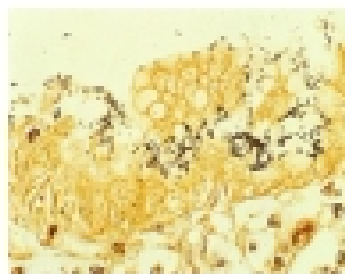
- D. Initially, this type of experiment was not performed.
- E. Patients who took antacids had decreased ulcer symptoms.
- F. Symptoms returned in patients that stopped taking the antacids.

VIII. Dr. J. Robin Warren: (pathologist)

- A. Examines stomach biopsies
- B. Used higher power magnification to look at the slides

IX. Dr. Warren thought he saw:

- A. *Helicobacter pylori* (a new species of bacteria)



- 1. (The black squiggly spots on the slide are bacteria that Dr. Warren observed in his biopsy slides.)
- B. But no one else believed him!
- C. He used a special stain that highlights bacteria on his slides.

D. This convinced his colleagues that the bacteria were there.

X. Dr. Warren thinks *H. pylori* causes ulcers.

A. What is another hypothesis to explain why Dr. Warren was finding bacteria on his slides? (there are *at least three* alternative hypotheses...)

1. Alternative explanations (hypotheses):

a. Contamination happened AFTER.

b. The bacteria lives in the stomach, but does no damage.

c. Bacteria are opportunistic, and arrive after ulcers have already weakened the stomach's defenses.

XI. Dr. Barry J. Marshall Joins Dr. Warren's Research

A. Their first survey study:

1. 100 stomach ulcer patients surveyed (biopsy taken).

2. 100% had *H. pylori* present.

a. This supported Warren's original hypothesis.

b. The real experiment is missing control.

B. Hypothesis: Bacteria **CAUSE** stomach ulcers.

C. What experiment would you design if you wanted to test this hypothesis?

D. Based on this they performed an experiment in which all the patients were treated with antibiotics to see if this would cure the ulcers.

1. What is missing from this experiment?

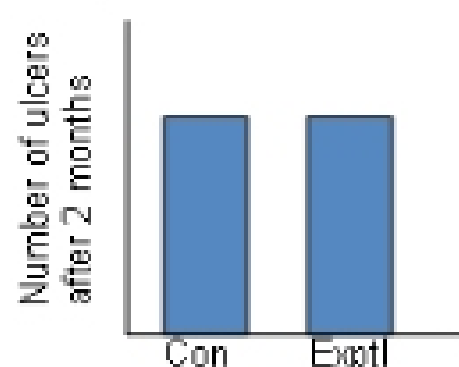
a. **CONTROL.**

XII. Prediction of Results

A. If they set up their antibiotic with a treatment group (Exptl) who received antibiotics and a control group (Con) who received a placebo (no antibiotics)

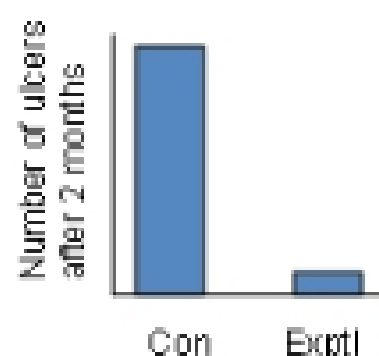
what results would expect if the original "**excess acid hypothesis**" was supported?

1. Results Expected:



B. What results would you expect if the "**bacteria cause ulcers hypothesis**" was supported?

1. Results Expected:



XIII. Actual Results of Warren & Marshall's Study

A. When treated with antibiotics, 80% of patients were permanently cured of their ulcers.