

### ***Scientific Method in Vaccine History***

1. Why is there no single model of the scientific method?

The scientific method is a way of asking questions. Different kinds of investigations need different steps, but some steps apply to all investigations.

2. Do scientists try to prove their ideas by using the scientific method? Explain.

Answers will vary, but may include something like: No. They use the scientific method to gain knowledge by careful observation.

3. What are the four main steps of the scientific method?

- a. observation
- b. hypothesis
- c. testing
- d. conclusion

4. What are the qualities of a good hypothesis?

- a. It stems from existing knowledge
- b. It involves a single problem and solution
- c. It is testable
- d. It is falsifiable

5. What are three types of scientific studies?

- a. a test (experiment) with a control group and an experimental group
- b. modeling
- c. research and data analysis

6. What is the difference between the experimental group and the control group in an investigation?

The experimental group is subjected to a variable. The control group is not.

7. How did Edward Jenner test the observation of a milkmaid that having cowpox protected a person from the deadly disease smallpox?

First, Jenner scratched material from a cowpox sore on a milkmaid into the arm of an 8-year-old boy, who became ill with a mild case of cowpox. Later, Jenner scratched some material from a human smallpox sore into the boy's arm to see if he would get ill with smallpox.

8. What was Robert Koch's method of identifying the cause of a disease?

He had a four-step process, which is called Koch's postulates.

- 1.) A particular microbe must be found in each case of the disease
- 2.) The microbe can be taken from a host and grown independently.
- 3.) The disease can be produced by infecting a healthy host with a pure culture of the microbe.
- 4.) The microbe can be isolated from the newly infected host and identified.

9. What was Pearl Kendrick's contribution to the development of a scientific method for testing vaccines?

She had a control group, which was not given the vaccine, and an experimental group that was given the vaccine.

10. How did Jonas Salk's method of testing his polio vaccine improve the way new vaccines are tested?

He used a very large number of subjects, randomly placed subjects into experimental and control groups that both got injections, and used double-blinding so that neither the subject nor the physician giving the vaccine knew whether each subject received the vaccine or the placebo (no vaccine in the injection).

## The Scientific Method Activity

### Overview

1. What problem will you be investigating with the scientific method?

the cause of an illness that has killed several people

2. What can cause the data an investigator collects to be compromised, or invalid?

flawed testing procedures or errors in record or reporting data

### Observation

3. Which of the four reports describe an illness that could be traced to a probable cause? Explain.

Report C; because everyone who became ill had eaten chili dogs the previous day

4. What were some similarities in the information contained in the other three reports?

All involved illnesses with symptoms of a respiratory condition (dry cough, runny nose, fever)

Many people ill and disease spreading

No known cause yet identified

5. What three steps did you take in gathering information about each case?

a. confirm the symptoms of the ill in each of the cases

b. define where (the areas) the disease is occurring

c. establish timelines of the onset of symptoms/activities for each group

6. Why did the expert recommend the use of the fastest methods for investigating the three cases?

Deaths and severe pneumonia had already occurred in two of the three groups.

7. What patterns were uncovered in the initial investigation?

- The outbreak of disease occurred only in the three reported area.
- All of the ill soldiers lived in the barracks for new recruits.
- Most incidences of illness at the school were among 12th graders.
- The soldiers began getting sick a week before the students and the seniors.
- Recruits from the base visited the school and the senior center just before individuals began to get sick.

### ***Hypothesis***

8. What qualities did the expert say that good hypotheses for this investigation should have?

- identify a cause that accounts for the symptoms
- identify the source of the outbreak
- explain the spread of the disease and the groups affected
- be testable
- conform with existing knowledge

9. What two possible causes of the outbreak did you choose to explore?

a possible viral infection of the respiratory tract

a possible bacterial infection of the respiratory tract

10. Why were the other two proposed diseases discarded as possible causes? Why?

common cold; because symptoms did not match

malaria; because malaria-carrying mosquitoes are not found in the city

11. Which hypothesis did you decide to investigate first? Why?

the hypothesis that a viral infection is causing the outbreak; because symptoms match this possibility most closely and it would have the greatest public health consequences

### **Testing & Experimentation**

12. What laboratory tests are used to identify the pathogen in a disease outbreak?

- growing cultures of the virus or bacterium using samples from patients
- blood cultures
- rapid PCR to identify viral or bacterial RNA or DNA
- blood tests for antibodies to viruses and bacteria

13. Which test was chosen as the best one to use? Why?

rapid PCR; because it would give the quickest and most reliable results

14. What is the name for the study of how a disease spreads?

epidemiology

15. What are the two main methods used to study how a disease spreads?

- descriptive epidemiology, which develops a detailed case definition of the disease being studied
- analytic epidemiology, which uses case-control studies and longitudinal studies

16. Which method of epidemiology uses case histories of a control group, as well?

case-control studies

17. What were the results of the tests conducted?

- The rapid PCR tests identified a new strain of adenovirus 14 as the cause of the illnesses at the military base and the senior center.
- All the cases of the illness at the military base and the senior center tested positive for AD14.

18. In which group were case histories and rapid PCR tests not performed? How are these cases being treated?

the high-school students; as suspected cases

19. What was causing the illness among recruits and at the senior center?

adenovirus 14

### ***Analysis & Conclusions***

20. What did the odds ratios show about the spread of the disease among the affected groups?

There was a high correlation between direct contact with a military recruit and cases of the disease at the senior center but not at the high school.

21. What was the “unexpected finding” in the data?

the very low association between contact with a military recruit and the suspected cases at the high school

22. What should you look for when you have an unexpected finding?

bias and other kinds of errors, such as underreporting, overreporting, and contamination of samples

23. What was the cause of error in this investigation?

overreporting of illness due to students feigning illness