

Koch and tuberculosis

Introduction

This account describes Koch's discovery of the TB bacillus and introduces Koch's postulates. It provides another example of the use of experiments to extend understanding of germ theory. The comprehension questions could be used as homework, review or revision.

The activity

- (a) Why did Koch feel that the evidence described in paragraph 3 was not enough to show that the bacilli actually caused TB? Could his observation have been explained in some other way?

The observed bacteria might have been a product not a cause of disease.

Both could have been caused by some other unknown factor.

- (b) The sequence of experiments needed to show the cause of an infectious disease is now known as Koch's postulates
- (i) Three of the four postulates are described in the account of the discovery of the TB bacterium. Note the paragraph in which each are described.

- The bacteria must be present in every case of the disease. *paragraph 3*
- The bacteria must be isolated from the host with the disease and grown in pure culture. *paragraph 5*
- The specific disease must be reproduced when a pure culture of the bacteria is inoculated into a healthy susceptible host. *paragraph 6*

- (ii) Which one is not described? Write another paragraph describing what Koch might have done to meet this requirement.

The bacteria must be recoverable from the experimentally infected host.

The characteristic bacteria were always found in the diseased organs of the animals that became ill after injection of the cultured bacteria

- (c) The account says that Koch had a strong belief that TB was caused by bacteria long before such bacteria were found. At what points might a scientist with less belief or less skill have given up? *Paragraphs 2 and 4*

- (d) The article in the Times ends by discussing the use of animals in this research. "However noisy the fanaticism of the moment may be, the common sense of England will not in the long run permit it to enact cruelty in the name of tenderness ...[to prevent] such investigations." There was clearly an animal rights movement in 1882.

How Science Works

Bd To investigate the relationship between a factor and an outcome, it is important to control all other factors that might affect the outcome. Then changes in the outcome can be attributed to the factor that is being changed.

Bj We are more likely to accept that there is a correlation between a factor and an outcome – and much more likely to believe that the factor is a cause of the outcome – if we can identify a plausible mechanism that would link them.

Cd Scientists test an explanation by seeing if specific predictions based upon it are in agreement with data from observation or from an experiment (a deliberate intervention to generate data)

Ea The topics, questions and problems that scientists choose to work on, and the methods and approaches they use, are strongly influenced by the previous work and publications of other scientists, and by established traditions and practices in that field of research.

How might Koch have justified his use of animals and explained that failure to do the experiments would have been 'cruelty'?

The information in paragraph 1 stresses the high cost of the disease and the need to find out more about it in order to prevent it.

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Koch and tuberculosis

In March 1882 Robert Koch gave a lecture in Berlin at which he announced the discovery of the cause of tuberculosis. The account below is adapted mainly from a report of the lecture in the Times newspaper a few weeks later.

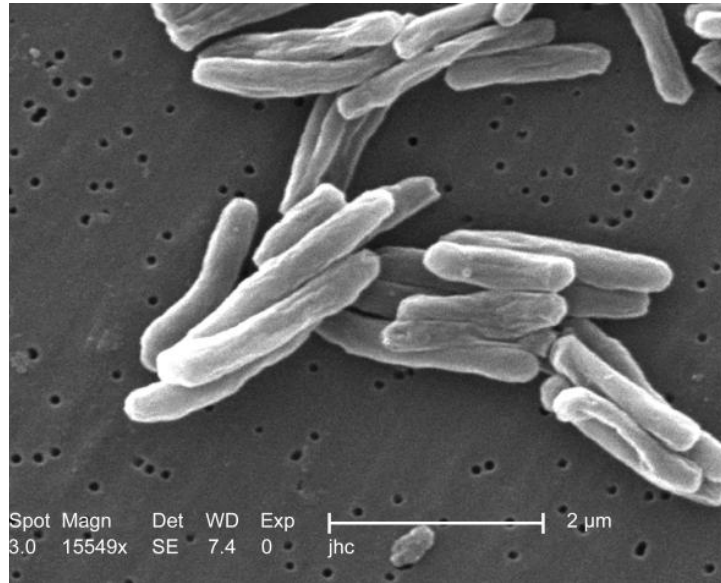
1. Koch started by talking about the impact of TB. "One-seventh of the deaths of the human race are due to tubercular disease.....Fully one-third of all those who die in active middle age are carried off by the same cause."
2. Koch and other scientists found that when diseased organs from TB patients were injected into animals the animals too became ill with tuberculosis. Koch developed the strong belief that TB was caused by a living bacterium, that was passed from one patient to another, despite the fact that no such microbe had ever been seen, even with a microscope.
3. Koch developed a new way of staining samples with dyes before looking through the microscope. Using this technique on samples from diseased organs, he always saw the same minute organisms with a characteristic rod shape and a characteristic reaction to the different dyes used.

Robert Koch and an impression of the bacteria he saw in his microscope



4. However he needed to do more, to show that these bacteria really caused TB. He decided to grow them outside the human body and see if the purified bacteria would still cause disease. This proved very difficult, because the temperature had to be just right, and they grew slowly taking a week or more for groups (colonies) to become visible to the naked eye.
5. When he had found the right conditions Koch was able to take a speck of matter from a tuberculous human lung and spread it on special nutrients to grow the bacteria in culture. Those that grew were transferred to fresh nutrient. This was repeated several times, over as long as 6 months.

TB bacteria seen through a modern electron microscope



CDC/ Dr. Ray Butler; Janice Carr

6. The purified bacteria from the culture were then injected into 4 guinea pigs. Two more similar guinea pigs were not injected. All the 4 injected guinea pigs developed TB, the other 2 did not. This experiment was repeated several times in other animals.
7. Koch found these same bacteria in the sputum coughed up by people with TB. This was still able to infect animals even after being kept dry for several weeks.

Questions

- (a) Why did Koch feel that the evidence described in paragraph 3 was not enough to show that the bacilli actually caused TB? Could his observation have been explained in some other way?
- (b) The sequence of experiments needed to show the cause of an infectious disease is now known as Koch's postulates
 - The bacteria must be present in every case of the disease.
 - The bacteria must be isolated from the host with the disease, (the patient), and grown in pure culture.
 - The specific disease must be reproduced when a pure culture of the bacteria is inoculated into a healthy susceptible host.
 - The bacteria must be recoverable from the experimentally infected host.
- (i) Three of the four postulates are described in the account of the discovery of the TB bacterium. Note the paragraph in which each are described.
- (ii) Which one is not described? Write another paragraph describing what Koch might have done to meet this requirement.

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- (c) The account says that Koch had a strong belief that TB was caused by bacteria long before such bacteria were found. At what points might a scientist with less belief or less skill have given up?
- (d) The article in the Times ends by discussing the use of animals in this research. “However noisy the fanaticism of the moment may be, the common sense of England will not in the long run permit it to enact cruelty in the name of tenderness ...[to prevent] such investigations.” There was clearly an animal rights movement in 1882.

In modern English we might say; “Despite the protests of animal rights activists on behalf of the animals, in the long run it would be cruel not to do these experiments.”

How might Koch have justified his use of animals and explained that failure to do the experiments would have been ‘cruelty’?