

## Think about it

### Louis Pasteur and the theory of spontaneous generation

#### *A historical account of identifying and controlling variables*

Some people used to think that flies, worms, bacteria, and other unwanted organisms actually came from rotten food, liquid, or other substances. They thought that somehow the food actually turned into these organisms. This idea—that nonliving substances could turn into living organisms—is called *spontaneous generation*. Spontaneous means “to happen suddenly without anyone or anything trying to make it happen”. Generation means “to come into being” or “to be born”.

In the 1860s, the French scientist Louis Pasteur designed and conducted a scientific investigation to test whether the idea of spontaneous generation was true. Pasteur did not think that food or drink could somehow turn into living organisms. Instead, he thought that the organisms came from somewhere else and got into the food from the air or in some other way. He knew it was important to design a fair experiment to test whether spontaneous generation was true or false.



Pasteur decided to concentrate on the problem of bacteria causing certain liquids to spoil. His question to investigate was: *Do bacteria from the air cause food to spoil?*

In designing his experiment, Pasteur decided to use two containers of broth (a clear soup). He knew that he needed to keep everything about these two containers exactly the same except for the one thing he was trying to test. Both needed the same type of broth, both had to be open to the same air, and both needed to be exposed to the same light and temperature. Pasteur had to set up the experiment so that the only difference between the two containers was that bacteria could get into one container but not the other. If the broth spoiled in the container that allowed the bacteria to enter, it had to be the bacteria that caused it. Nothing else could have caused it because everything else about the containers was the same.

Pasteur predicted that the broth in which bacteria could enter from the outside would soon become filled with bacteria and would spoil. He also predicted that the broth that bacteria could not enter would not spontaneously produce bacteria but would remain clear and unspoiled. Pasteur believed that this experiment could show that the idea of spontaneous generation was not true.

Vocabulary
variable
predict
spontaneous generation
pasteurize

## Think about it *(continued)*

### Here's what he needed to do

Pasteur needed to figure out a way to let bacteria get into one container but not into the other. He could not simply leave one open and the other closed because then one container would be getting air and the other would not. This difference between the two containers Pasteur knew would make the experiment unfair. The only difference between them could be that bacteria could get into one but not the other. Pasteur needed to figure out a way to do this while leaving both containers open to the air.

### Here's how he did it

Pasteur got two glass containers for holding the broth. One of the containers had a neck that went straight up and was open at the end. When air passed over the opening, bacteria in the air could fall down into the broth.

The other container had a curved neck that was open at the end. When air passed over this opening, bacteria would fall into the curve in the neck and become trapped, never able to reach the broth. Using this method, Pasteur found a way to expose both samples of broth to the air but allowed bacteria to get into the broth in only one.

Pasteur then put the same kind and same amount of broth into both containers. He heated each container, in the same way, at the same temperature, for the same length of time, to kill any bacteria that may have been in the broth already.

After only a few days, the broth in the straight-necked container, in which bacteria could enter from the outside, was cloudy and spoiled. The broth in the curved-necked container, in which bacteria could not reach, stayed clear. The experiment proved that broth doesn't somehow spontaneously turn into bacteria on its own. Rather, for broth to spoil, bacteria need to get into it from the outside.

### Pasteurization

Louis Pasteur conducted many experiments and solved many problems. One of the techniques he developed was named after him and is still commonly used today—it's *pasteurization*. Look on containers of juice and milk. Many of them say that they are pasteurized. What this means is that the drink was heated to kill bacteria that might make people sick. Then it was cooled quickly so that the flavor would not change much. Since pasteurization kills much of the bacteria in drinks, it also keeps them fresher longer. So, Louis Pasteur's work still affects us today.

**Think about it** (*continued*)

1. What is the main idea of the reading about Louis Pasteur?
  - a. Louis Pasteur wanted to test ideas in a laboratory.
  - b. Louis Pasteur designed and conducted an experiment to test the theory of spontaneous generation.
  - c. Louis Pasteur was the inventor of pasteurization.
  - d. Louis Pasteur was a scientist.
2. The term *spontaneous generation* means:
  - a. to suddenly catch on fire.
  - b. to have a large and complicated family tree.
  - c. a living thing can come from a non-living thing.
  - d. to get power from a generator.
3. Pasteur *predicted* that bacteria from the air caused broth to spoil. What does the word *predicted* mean in this sentence?
  - a. expected
  - b. exposed
  - c. produced
  - d. designed
4. In his experimental design, Pasteur kept everything about the containers the same except bacteria could get in one container but not the other. He designed his experiment this way so that it was a *fair* test.  
In a *fair* test:
  - a. No variables are used.
  - b. There are at least three variables used.
  - c. All variables are kept the same except for the one you are testing.
  - d. Two variables are changed at the same time.
5. In Pasteur's experiment, he used a curved-neck container and a straight-neck container. Why did he use different shaped containers?
  - a. The straight one allowed air to get in.
  - b. The curved one prevented the broth from spoiling.
  - c. They both allowed air in, but the curved one prevented bacteria from getting in.
  - d. He could heat both without the broth boiling over.
6. If you were to come up with a title for this reading, it might be:
  - a. Louis Pasteur solves many problems.
  - b. Louis Pasteur likes milk.
  - c. Louis Pasteur experiments with broth.
  - d. Louis Pasteur tests the theory of spontaneous generation.

**Think about it** *(continued)*



7. In Louis Pasteur's experiment to disprove the theory of spontaneous generation, what were some of the variables that he needed to keep the same so that his experiment was fair?

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8. In Pasteur's experiment, what was the one variable that was different between the two containers?

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9. If Pasteur wanted bacteria to get into one container of broth but not the other, why didn't he just leave one open and put a lid on the other?

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10. In your own words, explain how the careful setup of Pasteur's experiment added evidence to the case that the theory of spontaneous generation is not true.

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