

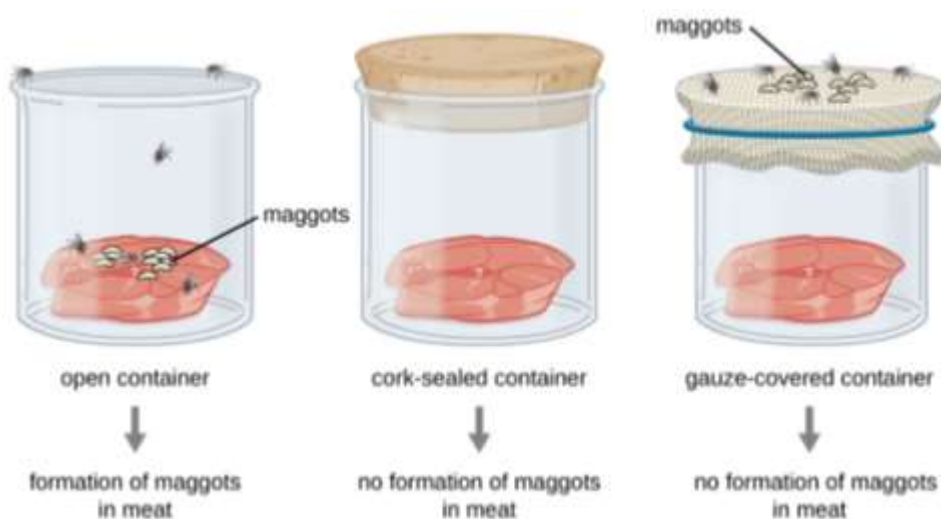
## 03- Microorganisms & Spontaneous Generation (Instructor: Şeref Tağı)

Humans have been asking for millennia: **Where does new life come from?** Religion, philosophy, and science have all wrestled with this question. One of the oldest explanations was the theory of spontaneous generation, which can be traced back to the ancient Greeks and was widely accepted through the Middle Ages.

After Leeuwenhoek died, the study of microbiology did not progress rapidly because microscopes were rare and interest in microorganisms was not high. In those years, scientists debated the theory of spontaneous generation, the doctrine stating that living things including microorganisms arise from lifeless matter such as beef broth that is, where there was putrefaction and decay. In the early 1600s, most naturalists were “vitalists,” individuals who thought life depended on a mysterious “vital force” that pervaded all organisms. This force provided the basis for the doctrine of spontaneous generation.

### **Debunking Spontaneous Generation**

Earlier, in the 1600s, an investigator Italian physician named Francesco Redi (1626–1697), showed that maggots would not arise from decaying meat (as others believed) if the meat were covered to prevent the entry of flies, as shown.



Francesco Redi's experimental setup consisted of an open container, a container sealed with a cork top, and a container covered in mesh that let in air but not flies. Maggots only appeared on the meat in the open container. However, maggots were also found on the gauze of the gauze-covered container.

Years later, in 1745, an English cleric named John Needham (1713–1781) advanced the theory of spontaneous generation by showing that microorganisms appear spontaneously in beef broth infused with plant or animal matters, hoping to kill all preexisting microbes. He then sealed the flasks. After a few days, Needham observed that the broth had become cloudy and a single drop contained numerous microscopic creatures. He argued that the new microbes must have risen spontaneously. In reality, however, he likely did not boil the broth enough to kill all preexisting microbes.

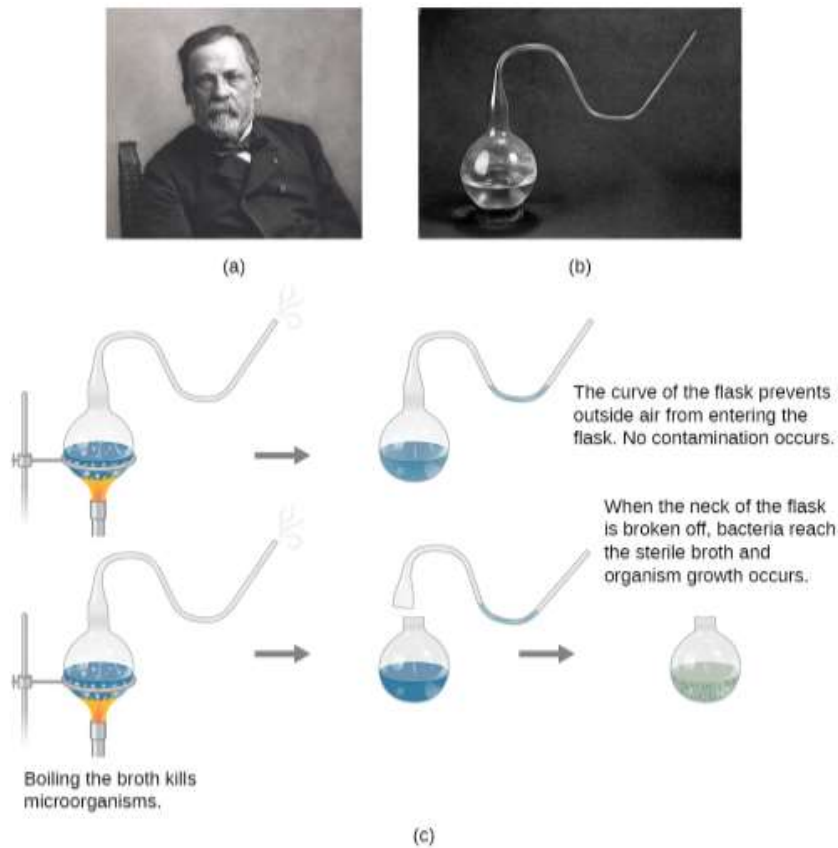
But a scientist named Lazzaro Spallanzani disputed the theory by showing that boiled broth would not give rise to microscopic forms of life. He suggested that the duration of heating might not have been long enough. In 1765, he repeated Needham's experiments by boiling the tubes for longer periods. As control experiments, he left some tubes open to the air and stoppered others loosely with corks.

After two days, the open tubes were swarming with animalcules, but the stoppered ones had many fewer—and the sealed ones contained none. Spallanzani proclaimed, "the number of animalcula developed is proportional to the communication with the external air."

### **Pasteur's Experiments**

Pasteur set up a series of experiments to test the hypothesis that "Life only arises from other life" (see facing page). Experiment 1A and 1B: Pasteur sterilized a meat broth in glass flasks by heating. He then either left the neck open to the air (A) or sealed the glass neck (B). Organisms only appeared (turned the broth cloudy) in the open flask. Experiment 2A and 2B: Pasteur sterilized a meat broth in swan-neck flasks (A), so named because their S-shaped necks resembled a swan's neck. No organisms appeared, even after many days. However, if the neck was snapped off or the broth tipped to come in contact with the neck (B), organisms (cloudy broth) soon appeared.

Although Pasteur's experiments generated considerable debate for several years, his exacting and carefully designed experiments marked the end of the long and tenacious clashes over spontaneous generation that had begun two centuries earlier.



(a) French scientist Louis Pasteur, who definitively refuted the long-disputed theory of spontaneous generation. (b) The unique swan-neck feature of the flasks used in Pasteur's experiment allowed air to enter the flask but prevented the entry of bacterial and fungal spores. (c) Pasteur's experiment consisted of two parts. In the first part, the broth in the flask was boiled to sterilize it. When this broth was cooled, it remained free of contamination. In the second part of the experiment, the flask was boiled and then the neck was broken off. The broth in this flask became contaminated. (credit b: modification of work by "Wellcome Images"/Wikimedia Commons) "Download for free at <https://openstax.org/details/books/microbiology>."

#### References:

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- 4- "Download for free at <https://openstax.org/details/books/microbiology>."