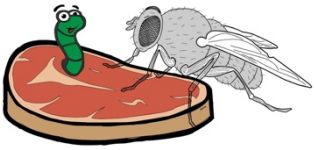
The cell theory: A 2000-year long process

In 1839, German scientists Matthias Jakob Schleiden and Theodor Schwan came up with 3 principles traditionally accepted as being the governing principles of life:

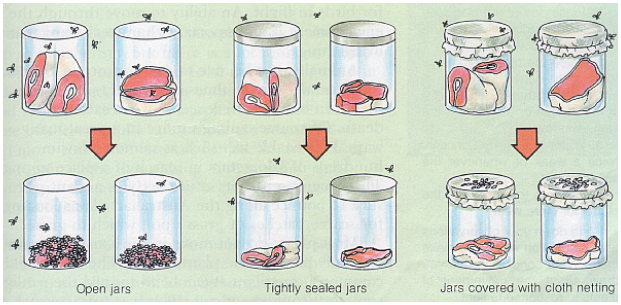
1. **All organisms are made of cells**
2. **Cells are the basic units of life**
3. **All cells come from previous cells**

If these principles sound simple, they are issued from a long process spanning over more than 2 millennials.

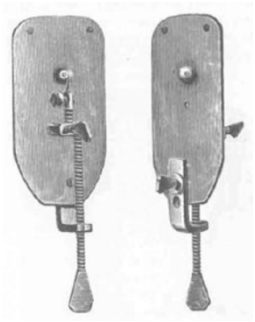


- **4th century BC: Aristotle** considers that life appeared spontaneously, as a result of chance events => Spontaneous generation

- **1668: Francesco Redi** disproves spontaneous generation through an experiment with meat and flies.



Without contact between the flies and meat, no maggots (larvae of flies) appear on rotting meat



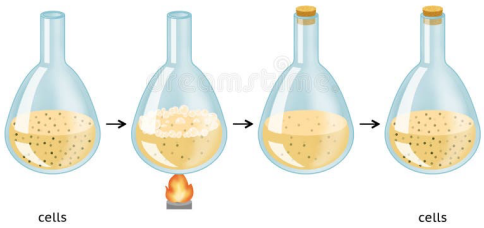
- **1674: Antoni van Leeuwenhoek** publishes his first microscopic observations of living cells (algea).

Note: Van Leeuwenhoek wasn't the first to identify cells. The name "cell" has first been used by Robert Hooke in 1655, while he was observing cork through one of his microscopes. However, these were dead plant cells.

Every single observation since then leads to the first 2 points of the cell theory:

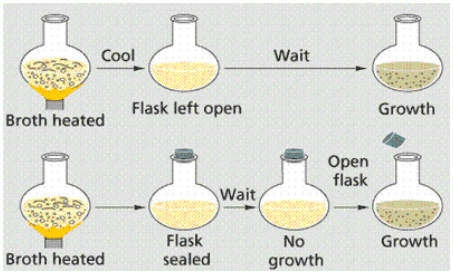
1. **All organisms are made of cells**
2. **Cells are the basic units of life**

- **1745: John Turberville Needham**, a Scottish Biologist and Priest, performs an experiment to confirm his belief that spontaneous generation is possible.



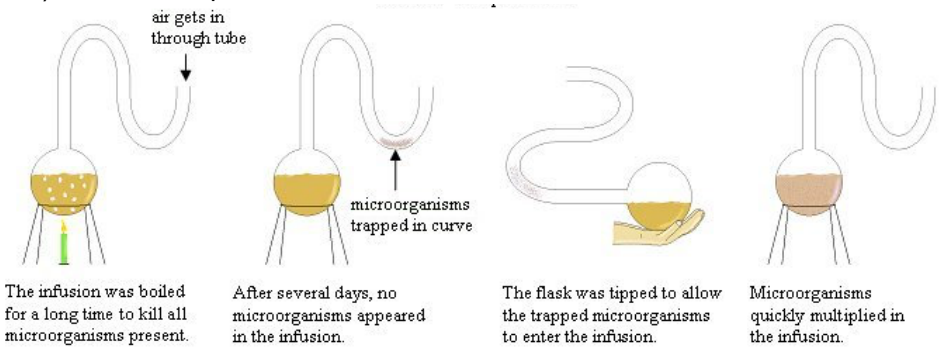
His results confirm his beliefs: after having killed all cells initially present in the broth, new cells appeared via spontaneous generation.
If his experiment makes sense, there are several flaws in his experiment, the foremost being that he is biased by his own beliefs. With a more objective approach, he would probably have recognized that his broth could have been contaminated through the loose cork while cooling down.

- **1768: Lazzaro Spallanzani** performs the same experiment than Needham a few years earlier. However, he has a more rigorous approach of the experimental conditions.



A comparaison between the 2 flasks showed a difference. As long as the second flask remained sealed, no growth of bacteria could be seen. It is through the contact with air (1st flask, and 2nd flask after having been opened) that bacteria appear.
This disproves spontaneous generation of life.

- **1862: Louis Pasteur** uses an even more sophisticated device (a tube called a Swan's neck) to confirm Spallanzani's results.



As long as there is no contact with the environment, no microorganisms appear. It is only once it has been contaminated by the exterior air that microorganisms will appear and their population will grow rapidely.

Note: Pasteur also sealed some of his flasks, insuring no contamination on a long term. Some flasks still remain over 100 years later, and still don't show any presence of life.

This was the last and final blow against the "spontaneous generation" hypothesis, and a confirmation of the last point of the cell theory:

3. All cells come from previous cells