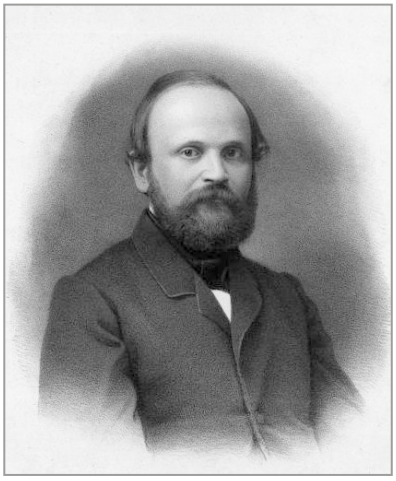
The work of Remak, Virchow and Pasteur

Sheet 6

Robert Remak and Rudolph Virchow



Lithographie von Georg Engelbach, *Robert Remak*
https://commons.wikimedia.org/wiki/File:Robert_Remak.jpg

Robert Remak (1815–1865) was a Polish physician and microscopist who set out to demonstrate that cells originate from the division of pre-existing cells by staining the cell membrane so he could see the cell divide.

Remak's evidence came from examination of red blood cell formation in chicken embryos, muscle development in tadpoles and the examination and mapping of tissue formation in chicken and dog embryos from their origin as a fertilised ovum. Through his research he was able to substantiate the existence of the cell membrane and provide evidence that (in at least some cases) new cells arise from pre-existing cells through cell division.

Remak summarised his findings in a paper written in 1852;

'Since the publication of the cell theory, it has seemed to me that the extracellular creation of animal cells is as unlikely as the *generatio aequivoca* (spontaneous generation). These doubts have led to my observations on the multiplication of blood cells by division in bird and mammalian embryos … and the division of muscle bundles in frog larvae; then finally in the spring of 1851, I succeeded in finding that all embryonic cells multiply by division.'

He concluded, 'These results are just as closely related to pathology as they are to physiology … I venture to suggest that pathological tissues are, like normal ones, formed not in an extracellular cytoblastem but are the descendants or products of normal tissues of the organism.'

Source: Remak quoted in Lagunoff, D. 2004, 'Cell theory and neoplasia' in *Milestones in Investigative Pathology*, p. 14 (American Society for Investigative Pathology)
http://www.asip.org/publications/milestones/Milestones_Compendia/2004/Cell_Theory_and_Neoplasia.pdf

Unfortunately, Remak's research was rejected by the scientific community because of his Jewish heritage and because it went against the widely accepted theory of 'spontaneous generation'. The long-held view that living organisms arose from non-living objects aligned with people's everyday observations and their religious beliefs about the origins of life.



Unknown, *Rudolf Virchow*
https://commons.wikimedia.org/wiki/File:Rudolf_Virchow_NLM3.jpg

It wasn't until German doctor and pathologist, Rudolph Virchow (1821–1902) published Remak's theory as his own that the belief in cell division as the sole origin of all cells was widely accepted. For a long time Virchow had believed in the concept of 'spontaneous generation'. However, in an editorial written in 1855, Virchow coined the famous phrase *omnis cellulae cellula* (every cell stems from another cell), in relation to pathological changes. He made no reference to Remak's work or anyone else's.

Despite later acknowledgement of Remak's work, Virchow's writings would go down in history as the primary push behind the change in understanding of cell origins. It was Remak's research however, that provided the evidence for this important change.

Sheet 6

Spontaneous generation and Louis Pasteur

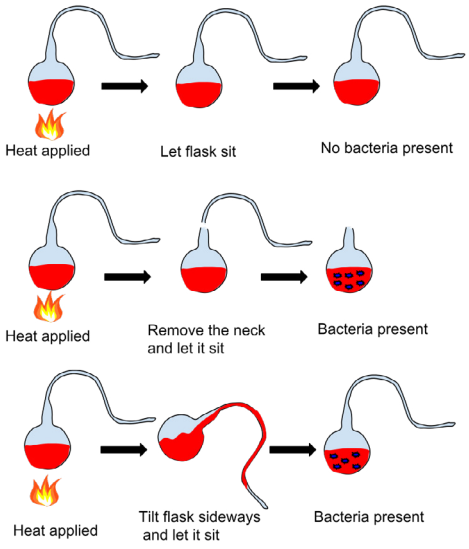
One of the earliest experiments to test the theory of 'spontaneous generation' was conducted by Francesco Redi (1626–1697), an Italian physician, naturalist and biologist with an interest in experimental biology and parasitology. He set up a series of uncovered and covered jars containing organic material. After a period of time he found that fly maggots formed in the uncovered jars that flies had access to. This investigation gave support to the idea that new organisms come from pre-existing organisms. However, this was before the discovery of microscopic organisms by Anton van Leewenhoek, which subsequently reignited discussion of 'spontaneous generation'.

In 1745, John Needham (1713–1781), an English biologist, observed that boiled soup mixture left in open containers to cool and then sealed would contain microorganisms a few days later. He theorised that inorganic air trapped in the sealed containers was the source of a 'life force' that could spontaneously generate new life. This idea was challenged in 1768 by Lazzaro Spallanzani (1729–1799), an Italian biologist and physiologist, who found that boiling the soup mixture for longer and sealing it in air-tight containers prevented the development of microorganisms. He suggested that pre-existing microorganisms are present in the air and they could be killed by boiling. Needham counteracted by stating that the 'life force' was destroyed by experiments.

The concept of 'spontaneous generation' as the origin of cells and living organisms remained for almost another hundred years, until, shortly after the work of Remak and Virchow, French chemist and microbiologist, Louis Pasteur (1822–1895) conducted his own version of the soup experiment.



Nadar, *Louis Pasteur*
https://commons.wikimedia.org/wiki/File:Louis_Pasteur,_foto_av_F%C3%A9lix_Nadar_Crisco_edit.jpg



Kgerow16, *Louis Pasteur's pasteurization experiment*, (modified to grey scale)
https://commons.wikimedia.org/wiki/File:Louis_Pasteur_Experiment.svg,
CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0/deed.en

Pasteur made a broth and placed it into two different flasks: one that was open at the top and another that was open but had an s-shaped neck. He boiled the two flasks and allowed them to sit for several weeks. Over time the one with the opening at the top began to become discoloured and cloudy, while the other didn't change.

Pasteur reasoned that if 'spontaneous generation' were a real phenomenon then both would have seen changes in their appearance. He concluded that the flask with the open top was exposed to 'germs' that could easily drop into the broth and multiply, while the germs were unable to get to the broth in the other flask and got stuck in the s-shaped neck.

Pasteur's experiment confirmed the idea of cell division proposed by Remak and provided further evidence against the theory of spontaneous generation.

Pasteur's many experiments showed that the growth of microorganisms was responsible for spoiling beer, wine and milk and he is best known for the invention of the 'pasteurisation' method still used today for sterilising beer and milk.

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