Élie Metchnikoff, father of phagocytosis

The last decades of the 19th century saw an explosion of discoveries in the new science of bacteriology. This was led, in great part, by the rival schools in Germany and France, led by Robert Koch in Berlin and Paul Ehrlich in Frankfurt, and by Louis Pasteur in Paris. It was with Pasteur while he was assistant director of the Pasteur Institute that Élie Metchnikoff did his principal work, the description of the ingestion of bacteria by white cells, which he named phagocytosis. This year we celebrate the 100th anniversary of his death, in 1916.

Metchnikoff, or to give him his Russian name, Elias Mecznokow, was born in 1845 in Kharkov. His father was an army officer, in the Imperial Guard, who retired with the rank of major general. He studied biology at the University of Kharkov, then successively at Gnessen, Gottingen, Munich and Naples (with its famous marine biology laboratory). He returned to Russia in 1867, where he taught zoology, first in Odessa and then in Petrograd – now St. Petersburg.

In 1868, aged 23 years, he married a beautiful young girl, Ludmilla Feodorovitch, a consumptive, who was carried to the wedding ceremony in an invalid's chair and who died shortly afterwards.

At the age of 25 years, in 1870, he was appointed Professor of Zoology and Comparative Anatomy at Odessa, also spending some time working at Messina. At this stage, Metchnikoff's principal interests were in the biology of green flies, sponges, worms and the scorpion. He now remarried.

In 1883, while working in the marine laboratory at Messina, Metchnikoff changed, he said, 'from a naturalist to a microbiologist'. He noticed, in the transparent larvae of the starfish, the ingestion of carmine particles and rose thorns and wondered if these cells could also ingest microbes. He then went on to observe transparent water fleas ingesting yeasts. He wrote in his diary that 'I suddenly became a pathologist'. Metchnikoff named this process 'phagocytosis', deriving the name from the Greek. Returning to Odessa, he lectured on 'the curative forces of the organism', having, at this stage, not seen a single example of a phagocytosed microbe!

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In 1886, Metchnikoff was appointed Scientific Director of the newly-opened Research Institute in Odessa. That same year he was what we now call 'head-hunted' by Louis Pasteur himself to join him at the Pasteur Institute in Paris as sub-director. Metchnikoff accepted, and remained there for the rest of his life.

His further studies now showed that phagocytosed cholera vibrios were still living and active, thus demonstrating that phagocytosis was not merely the ingestion of dead organisms.

In Paris, Metchnikoff and his assistants tried unsuccessfully to isolate the causative organism of syphilis. It remained for Schaudinn and Hoffmann in Berlin to demonstrate the spirochaete pallida in 1905. In that same year, Metchnikoff and his co-worker Emil Roux were able to transmit syphilis consistently to the ape.

It is interesting that the French school of bacteriologists favoured phagocytosis as the body's defence against bacterial invasion, while the German school, led by Paul Ehrlich, supported the humoral defence mechanism effected by the production of antibodies. No doubt this antagonism was engendered by the bitterness between the two countries fired by the sufferings of the Franco-Prussian war of 1870 and its aftermath. Of course, by the early years of the 20th century it was realized that, like so many biological processes, both phenomena are important parts of the defence mechanisms of the body.

Metchnikoff had a striking appearance – an impressive beard, long hair and broad head and forehead. In his later years he became interested in the biology of aging, which he postulated was caused by poisons produced by the gut bacteria. Impressed by what he believed (without hard evidence) to be the longevity of the Bulgarian peasants, he attributed this to their ingestion of large amounts of yoghurt. He therefore advised the ingestion of large quantities of this foodstuff, together with pure cultures of *Bacillus bulgaricus*, which he cultured from yoghurt.

He published his views in book form in 1903, with an English edition the same year, stating that yoghurt would prolong life beyond a century. He hardly helped his hypothesis by dying at the age of 71 years!

Metchnikoff was showered with honours from many parts of the world. He was elected a foreign member of the Royal Society in 1906, together with the award of its Copley medal. In 1908 he shared the Nobel Prize for Medicine with Paul Ehrlich, who one might regard as his rival theorist.

In Metchnikoff's book *The Nature of Man*, which was translated into English, his closing words are:

> **'If there can be formed an ideal to unite men in a kind of religion in the future, the ideal man must be based on scientific principles, and if it be true that man can live by faith alone, the faith must be in the power of science'.**

A remarkable scientist, the like of which, for breadth of interest, we are unlikely to see again. **BJHM**

Conflict of interest: none.

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