Ilya Ilyich Mechnikov (Élie Metchnikoff) (1845-1916) [1]

By: Racine, Valerie Keywords: Elie Metchnikoff [2] Ilya Mechnikov [3] Phagocytosis [4] Immunology [5]

Ilya Ilyich Mechnikov studied phagocytes, immune function, and starfish [6] embryos in Europe during the late nineteenth and early twentieth centuries. Mechnikov adopted the French form of his name, Élie Metchnikoff, in the last twenty-five years of his life. In 1908, he won the Nobel Prize in Physiology or Medicine [7] with Paul Ehrlich for their contributions to immunology. Mechnikov discovered phagocytes, immune cells that protect organisms by ingesting foreign particles or microorganisms, by conducting experiments on starfish [6] larvae. He then developed a theory of the cellular process involving phagocytes, known as phagocytosis, to explain how inflammation is a part of the self defense system found in both vertebrates and invertebrates. His experimental work was part of the tradition of evolutionary embryology [8], which emerged in the decades following the publication of Charles Darwin [9]'s *On the Origin of Species* in 1859, and was influenced by Ernst Haeckel [10]'s concept of the biogenetic law [11].

Mechnikov was born on 16 May 1845 to Emilia Nevahovna and Ilya Ivanovitch Mechnikov in the village of Ivanovka, near Kharkov, later part of Ukraine, but then was part of the former Russian Empire. He was the youngest of five children. His father, Ilya Ivanovitch Mechnikov, a Russian Imperial guardsman, was absent for most of Mechnikov's early childhood and education. Mechnikov's mother, Emilia Nevahovna, encouraged her son to pursue a scientific career in the life sciences. A tutor to the family motivated Mechnikov to study natural history [12], especially botany and geology. Mechnikov gave lectures on these subjects to his siblings and other children when he was six years old. When Mechnikov turned eleven, he enrolled at the Lycée Kharkov in 1856 where he first encountered microscopes when he was fifteen years old. He then studied cells and took private lessons in histology [13], the study of the microscopic structure of tissues. During this time, Mechnikov read Henry Thomas Buckle's *History of Civilization in England*, and he adopted its main tenet; that the progress of civilization depends on the advancement of science. He also developed interest in the ideas of socialism, materialism [14], and atheism during his time at the Lycée Kharkov.

In 1862, Mechnikov graduated from the Lycée. Mechnikov's mother persuaded him to pursue his studies in biology. She also convinced her son that he would be more suited to study biology than medicine because of his overly-sensitive disposition. Mechnikov concurred, and enrolled in the university in Kharkov in 1863. During this time, Mechnikov published his first scientific paper on the histology [13] of *Vorticella* [15], a genus of protozoa [16]. He completed his university courses at Kharkov in two years and then moved to Giessen, Germany, in 1865 to work with Rudolph Leuckart, a taxonomist and parasitologist. In Giessen, Mechnikov made his first scientific discovery on the intra-cellular digestion of flatworms. Mechnikov denounced Leuckart for publishing the discovery without any acknowledgement of Mechnikov's contribution. After this experience in 1865, Mechnikov left Germany to research in Naples, Italy.

In Naples, Mechnikov experimented on marine invertebrate embryos with zoologist, Aleksandr Kovalevsky. Before arriving in Naples, Mechnikov read Fritz Müller's *Für Darwin* (For Darwin) in Giessen. This book conveyed an enthusiasm in Germany for Darwin's theory of evolution [17] by natural selection [18], and it provided a defense of Haeckel's biogenetic law [11], the theory that the developmental stages [19] of animals replay the adult stages of their evolutionary ancestors. Mechnikov adopted the theory and chose to study the development of germ layers [20], the group of cells in early embryonic development that later form organs and tissues, in invertebrate embryos. He compared the development of the germ layers [20] in vertebrate embryos to germ layers [20] in invertebrate embryos. He aimed to establish a common link in the evolution [17] of vertebrates and invertebrates by comparing their embryonic development, and thus, to confirm Darwin's theory that all animal species evolved from a common ancestor.

Mechnikov and Kovalevsky left Naples in the fall of 1865 because of a cholera outbreak, and they traveled to St. Petersburg, Russia, to finish their doctoral studies. In 1867, Mechnikov earned his doctorate for his work on the embryological development of the cuttle-fish [21] *Sepiola* [22] and the crustacean *Nelalia*. That year, Mechnikov and Kovalevsky shared the first Karl Ernst von Baer [23] Prize for their work on germ layers [20] in invertebrate embryos, and Mechnikov became a professor of zoology and comparative anatomy at the University of Odessa in Odessa, Ukraine, at the age of twenty-two. However, Mechnikov quarreled with his colleagues and he soon left Odessa to return to work at the university in St. Petersburg. Mechnikov lived in poverty and solitude, while his vision and mental health deteriorated. He met Ludmilla Federovna, and when they were married in 1869, Federovna had to be carried into the church as she had tuberculosis. In 1873, she died from the disease, and Mechnikov attempted suicide by ingesting a large dose of morphine.

When he recovered, Mechnikov returned to his position at the University in Odessa. In 1875, he married Olga Belokopitova, a student living in the apartment above him. She contracted typhoid fever in 1880. At the same time, political strife and student unrest added to the pressures Mechnikov faced with his wife's illness. He attempted suicide again in 1880. This time, because he wanted to spare his wife and his family embarrassment, he decided to inoculate himself with relapsing fever, a bacterial

infection transmitted by lice or ticks, in an attempt to show whether it could be transmissible by blood. Mechnikov survived, although he became seriously ill and needed a long recovery.

In 1882, Mechnikov once again left Odessa with his wife—this time because of increasing political unrest in Russia—to start a private research lab in Messina, Italy. In Messina, Mechnikov formed his theory of phagocytosis from observation of the moving cells surrounding foreign material in transparent starfish [6] larvae. Mechnikov noted that the process was similar to the inflammatory response found in animals with vascular systems. He hypothesized that the mobile cells in starfish [6] larvae, or phagocytes, were the evolutionary ancestors of the mesodermal cells in higher animals, which have a primitive digestive function as a defense against foreign organisms.

Mechnikov was not the first to observe the process of phagocytosis. Haeckel had observed white blood cells digesting dye particles in 1862 at the University of Jena [24] in Jena, Germany. However, Mechnikov was the first to posit that the process of phagocytosis served as a natural immune system. Mechnikov's theory of phagocytosis conflicted with a theory of immunity at the time, called the humoral theory. The adherents of the humoral theory claimed that an organism's blood serum, or components of the bloodstream, defended the organism against foreign bacteria. Mechnikov's theory challenged the humoral theory for two reasons. First, Mechnikov found that the process of inflammation in the tissues of vertebrates was similar to the action of the cells digesting foreign particles in the starfish [6] larva, an organism lacking a vascular system. Second, he established that there was a similar developmental process of the mesodermal cells in various organisms, including vertebrates and invertebrates, a system that generated the process of phagocytosis. Moreover, the dominant humoral theory claimed that, contrary to Mechnikov's hypothesis, the cells that exhibited a digestive function, the phagocytes, caused the spread of disease in the body and thus would harm the host, rather than defend it, against bacterial invasion. Mechnikov devoted much of his subsequent scientific work to the development and defense of his theory of phagocytosis in natural immunity, including his treatise *L'immunité dans les Maladies Infectieuses (Immunity in Infectious Diseases)* published in 1901.

In 1885, Mechnikov returned to Odessa to head a bacteriological station designed to vaccinate people from rabies, based on Louis Pasteur's vaccine initiatives in France. Mechnikov resigned from this post one year later because he encountered hostility from his colleagues, who argued that Mechnikov lacked medical training and competence [25]. In 1888, Mechnikov and his wife moved to Paris, France, to work at the Pasteur Institute.

During his years at the Pasteur Institute, Mechnikov authored treatises on the topics of senescence [26], disease, and death. In his 1903 *Études sur la nature humaine: Essai de philosophie optimiste (The Nature of Man: Studies in Optimistic Philosophy)* he argued that science, rather than religion or philosophy, can lead to meaningful optimism, despite the apparent disharmony between humans [27] and their environment. According to Mechnikov, science could, and would continue to, suppress disease and regulate proper hygiene, thereby contributing to the progress of civilization. Death, he claimed, would no longer be seen as a terror, but as a natural end. He won the Nobel Prize in Physiology or Medicine [7] for his contributions to immunology in 1908.

In addition to the 1908 Nobel Prize, Mechnikov received an honorary degree from the University of Cambridge in Cambridge, UK, and the Copley Medal of the Royal Society. He had honorary memberships in the Academy of Medicine in Paris and the Academy of Sciences and Medicine in St. Petersburg. Despite the optimistic philosophy he developed later in life, Mechnikov said that he was horrified and saddened by the outbreak of the First World War in 1914 and that it shook his profound belief in the power of science to remedy society's ills, and to contribute to the moral progress of civilization. In 1916, Mechnikov moved from his country house outside of Paris to the rooms at the Pasteur Institute where Pasteur had stayed during his final days. Mechnikov died at the Pasteur Institute on 15 July 1916 of cardiac failure. Historians have described Mechnikov as a tall, but stooping figure, with long unkempt hair and pockets overflowing with scientific notes and papers.

Sources

1. Brieger, Gert H. "Metchnikoff, Élie." *Dictionary of Scientific Biography* 9 (2008): 331–335.
2. Buckle, Henry Thomas. *History of Civilization in England.* New York City: D. Appleton and cCmpany, 1884. http://www.archive.org/details/historyciviliza03buckgoog [28](Accessed March 5, 2014).
3. Darwin, Charles R. *On the Origin of Species by Means of Natural Selection, or the Preservation Of Favoured Races in the Struggle for Life.* London: John Murray Publishing House, 1859. http://darwin-online.org.uk/content/frameset?pageseq=1&itemID=F373&viewtype=text [29] (Accessed December 3, 2013).
4. Gordon, Siamon. "Élie Metchnikoff: Father of Natural Immunity." *European Journal of Immunology* 38 (2008): 3257–3264. http://onlinelibrary.wiley.com/doi/10.1002/eji.200838855/full [30] (Accessed July 3, 2014).
5. Haeckel, Ernst. *Generelle morphologie der organismen* [General Morphology of the Organism]. Berlin: G. Reimer, 1866. http://www.biodiversitylibrary.org/item/22319#page/11/mode/1up [31] (Accessed December 3, 2013).
6. Haeckel, Ernst. *Anthropogenie; oder, Entwickelungsgeschichte des Menschen. Keimes- und Stammesgeschichte* [Anthropogeny, or the Evolutionary History of Humans]. vol. 1. Leibzig: Engelmann, 1877. http://biodiversitylibrary.org/page/3146520 [32] (Accessed December 13, 2013).
7. MacLennan, S.F. "The Nature of Man: Studies in Optimistic Philosophy by Élie Metchnikoff." *Philosophical Review* 13 (1904): 381–383.

8. "Metchnikoff, Élie (1845–1916)." *World of Microbiology and Immunology*. Eds. Brenda Wilmoth Lerner and K. Lee Lerner. Vol. 2. Detroit: Gale, 2003, 377–378.
9. Mecznikow, Elias. "Nachträgliche Bemerkungen über den Stiel der Vorticellinen." (Further observations on the stem of the Vorticellinen). *Archiv für Anatomie, Physiologie und Wissenschaftliche Medicin* (Archive for Anatomy, Physiology, and Scientific Medicine). 1863 (1864): 291–302. http://www.biodiversitylibrary.org/item/109677#page/299/mode/1up [33] (Accessed July 3, 2014).
10. Metschnikoff, Élie. *Studien über die Entwicklung der Echinodermen und Nemertinen* (Studies on the Development of Echinoderms and Nemertea). St. Petersberg: The Imperial Academy of Sciences, 1869. http://books.google.com/books?id=Z5ZFAAAAcAAJ&dq=%22e+Metschnikoff%22&lr=&source=gbs_navlinks_s [34] (Accessed July 3, 2014).
11. Metschnikoff, Élie. 1884. "Über eine Sprosspilzkrank heit der Daphnien. Beitrag zur Lehre iiber den Kampf der E hagocyten gegen Krankheitserreger." (A Disease of Daphnia caused by a Yeast. A contribution to the theory of phagocytes as agents for attack on disease-causing organisms). *Virchows Archiv* [35] (Virchow's Archive) 96 (1884): 177–195.
12. Metschnikoff, Élas. "Über die phagocytäre Rolle der Tuberkelriesenzellen." (About the Phagocytic Role of the Large Tubercle Cells) *Virchows Archiv* [35] (Virchow's Archive) 113 (1888): 63–94. http://hal.archives-ouvertes.fr/docs/00/72/40/23/PDF/metzol22.pdf [36] (Accessed July 3, 2014).
13. Metschnikoff, Élias. "Lecture on Phagocytosis and Immunity." *British Medical Journal* 1 (1891): 213–17. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2197023/ [37] (Accessed July 3, 2014).
14. Metchnikoff, Élie. *Études sur la nature humaine: Essai de philosophie optimiste* Paris: Éditeurs Masson & Cie., 1903. http://babel.hathitrust.org/cgi/pt?id=nyp.33433070253293;seq=13;view=1up;num=ix [38] Translated as *The Nature of Man: Studies in Optimistic Philosophy*. Ed. P. Chalmers Mitchell. New York: G.P. Putnam's Sons. https://archive.org/stream/naturemanstudie01mechgoog#page/n10/mode/2up [39] (Accessed July 3, 2014).
15. Metchnikoff, Élie. *Immunity in Infectious Disease*. Trans. Francis G. Binnie. Cambridge: Cambridge University [40] Press, 1907. http://babel.hathitrust.org/cgi/pt?id=ien.35558005390543;seq=7;view=1up;num=iii [41] (Accessed July 3, 2014).
16. Metchnikoff, Élie. *The Founders of Modern Medicine: Pasteur, Koch, Lister*. New York: Walden Publications, 1935.
17. Metchnikoff, Olga. *Life of Élie Metchnikoff (1845-1916)*. Boston & New York: Houghton Mifflin Company, 1921. http://babel.hathitrust.org/cgi/pt?id=njp.32101071982639;seq=9;view=1up;num=iii [42]
18. Müller, Fritz. *Für Darwin* (For Darwin). Leipzig [43]: Wilhelm Engelmann, 1864. https://archive.org/stream/frdarwin00mlgoog#page/n10/mode/2up [44] (Accessed July 3, 2014).
19. Nobel Foundation. "The Nobel Prize in Physiology or Medicine [7] 1908." http://www.nobelprize.org/nobel_prizes/medicine/laureates/1908/press.html [45] (Accessed March 23, 2013.)
20. Nobel Foundation. "Ilya Ilyich Mechnikov-Biography." http://www.nobelprize.org/nobel_prizes/medicine/laureates/1908/mechnikov-bio.html [46] (Accessed March 23, 2013.)
21. Vaughan, R.B. "The Romantic Rationalist: A Study of Élie Metchnikoff." *Medical History* 9 (1965): 201–215. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1033501/ [47] (Accessed July 3, 2014).
22. Zalkind, Semyon. *Ilya Mechnikov: His Life and Work*. Honolulu, Hawaii: University Press of the Pacific, 2001.

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Publisher

Arizona State University. School of Life Sciences. Center for Biology and Society. Embryo Project Encyclopedia.

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Last Modified

Sunday, June 20, 2021 - 19:17

DC Date Accessioned
Saturday, July 5, 2014 - 19:12

DC Date Available
Saturday, July 5, 2014 - 19:12

DC Date Created
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[28] http://www.archive.org/details/historyciviliza03buckgoog
[29] http://darwin-online.org.uk/content/frameset?pageseq=1&itemID=F373&viewtype=text
[30] http://onlinelibrary.wiley.com/doi/10.1002/eji.200838855/full
[31] http://www.biodiversitylibrary.org/item/22319#page/11/mode/1up
[32] http://biodiversitylibrary.org/page/3146520
[33] http://www.biodiversitylibrary.org/item/109677#page/299/mode/1up
[34] http://books.google.com/books?
id=Z5ZFAAAAcAAJ&dq=%22e+Metschnikoff%22&lr=&source=gbs_navlinks_s
[35] https://embryo.asu.edu/search?text=Virchows%20Archiv
[36] http://hal.archives-ouvertes.fr/docs/00/72/40/23/PDF/metzol22.pdf
[37] http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2197023/
[38] http://babel.hathitrust.org/cgi/pt?id=nyp.33433070253293;seq=13;view=1up;num=ix
[39] https://archive.org/stream/naturemanstudie01mechgoog#page/n10/mode/2up
[40] https://embryo.asu.edu/search?text=Cambridge%20University
[41] http://babel.hathitrust.org/cgi/pt?id=ien.35558005390543;seq=7;view=1up;num=iii
[42] http://babel.hathitrust.org/cgi/pt?id=njp.32101071982639;seq=9;view=1up;num=iii

[43] https://embryo.asu.edu/search?text=Leipzig
[44] https://archive.org/stream/frdarwin00mlgoog#page/n10/mode/2up
[45] http://www.nobelprize.org/nobel_prizes/medicine/laureates/1908/press.html
[46] http://www.nobelprize.org/nobel_prizes/medicine/laureates/1908/mechnikov-bio.html
[47] http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1033501/
[48] https://embryo.asu.edu/library-congress-subject-headings/metchnikoff-elie-1845-1916
[49] https://embryo.asu.edu/library-congress-subject-headings/phagocytes
[50] https://embryo.asu.edu/library-congress-subject-headings/embryology-experimental
[51] https://embryo.asu.edu/medical-subject-headings/phagocytosis
[52] https://embryo.asu.edu/medical-subject-headings/embryology
[53] https://embryo.asu.edu/topics/people
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