Rita Levi-Montalcini (1909-2012) [1]

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Rita Levi-Montalcini [4] is a Nobel Laureate recognized for her work in the discovery and characterization of nerve growth factor [5]. Nerve growth factor (NGF) promotes the growth and maintenance of the nervous system in a developing system. The majority of her career has been devoted to investigating the many aspects of NGF.

Levi-Montalcini and her twin sister Paola were born on 22 April 1909 in Turin, Italy, to her father, Adamo Levi, an electrical engineer and mathematician, and mother, Adele Montalcini. In her autobiography she describes her family atmosphere as wonderful, loving, and with reciprocal devotion. Her father was a very traditional man and his daughters were not allowed to pursue a professional career, which would have interfered with their future roles as wife and mother. At the age of twenty, with the feeling she could not fit into her prescribed traditional female role, Levi-Montalcini asked her father?s permission to pursue a professional career. She filled in her required high school courses and enrolled at the University of Turin [6] Medical School.

Levi-Montalcini?s university class contained three future Nobel laureates: Salvadore Luria, Renalto Dulbecco, and herself. She attributed much of the brilliance of this class to the instructive talents of Giuseppe Levi [7], an Italian histologist. In 1938 she graduated *summa cum laude* from the University of Turin [6] Medical School with a degree in medicine and surgery. Later that year Benito Mussolini signed the ?Manifesto per la Difesa della Razza? (The Defense of the Race), which persecuted Jewish Italians among other groups. As a Jew with professional aspirations, Levi-Montalcini was forced to flee to Brussels, Belgium, where she studied as the guest of the neurological institute.

In the spring of 1940 Belgium was near invasion by Nazi forces, and Levi-Montalcini was again forced to flee prejudice stemming from World War II. Instead of immigrating to the United States, Levi-Montalcini returned to her home and family. To continue her studies on the neurological development of chicks, she developed a small laboratory in her bedroom with only an incubator, microscope [8], and microtome [9]. In these cramped settings, she began a project inspired by Viktor Hamburger?s research on the effects of limb excision on nerve generation. Although her results matched Hamburger?s, her conclusion was different. She saw later nervous system development as a degenerative process, and Hamburger saw it as a targeted process. In 1941 Allied bombing forced her to flee with her mini-laboratory to Piemonte, in Italy?s countryside. Conditions were harsh?the same eggs used for research were also eaten by the family. In 1943, after the fall of Mussolini, the Nazis invaded Italy and Levi-Montalcini fled to Florence, where she was forced to live anonymously for the duration of the war. After the war ended, she returned to Turin and began work as a postgraduate under her former instructor Giuseppe Levi [7] at the University of Turin [6].

Viktor Hamburger [10] sent a letter to Levi-Montalcini in 1947 inquiring about their conflicting results. He offered her one year of study in his lab at Washington University [11] in St. Louis. She accepted and ended up staying for more than 20 years. She found this period one of the

happiest and most productive of her life. In St. Louis, Levi-Montalcini?s research in her mini-laboratory was vindicated. Her conclusion that neural differentiation [12] is related to normal degeneration of the central nervous system [13], rather than the destination of nerves, was shown to be correct.

Levi-Montalcini?s career was devoted almost completely to the study of NGF. Hamburger introduced Levi-Montalcini to work done by Elmer Bueker [14] on a tumor abnormally invaded by nervous tissue. Levi-Montalcini obtained the tumor and over the course of many successive experiments determined that the tumor was emitting some substance causing increased growth and differentiation [12] of the nervous tissue. She confirmed these results using a tissue culture at the University of Brazil [15] with Hertha Meyer [16], a friend from her time at the University of Turin [6]. When Stanley Cohen [17], a biochemist who shared the 1986 Nobel Prize with Levi-Montalcini, joined the lab in 1953, he began work to characterize NGF. NGF was determined to be a protein required for the development of the nervous system, the immune system, and was implicated in stress management.

In 1956 Levi-Montalcini became an associate professor at Washington University [11]. She was promoted to full professor in 1958 and left in 1962 to establish the European Brain Research Institute [18] in Rome. From 1969 to 1978 she was the Director of the Institute of Cell Biology of the Italian National Council of Research in Rome. In 1977 she retired and was named guest professor at the Institute of Cell Biology.

Her numerous and varied awards include: the 1969 Feltrinelli Medical Award [19] of the Accademia Nazionale die Lincei, the 1974 William Thomson Wakeman Award [20] of the National Paraplegia Foundation, the Lewis S. Rosentiel Award for Distinguished Work in Basic Medical Research [21] in 1982, and the 1983 Louisa Gross Horwitz Prize [22] of Columbia University [23]. In 1986 she won both the Albert Lasker Basic Medical Research Award [24] and shared the Nobel Prize in Physiology or Medicine [25] with Stanley Cohen [17]. She was named one of the first four ambassadors of the Food and Agriculture Organization of the United Nations in the campaign against world hunger. She is a member of the American National Academy of Sciences [26], the Italian Academy of Lincei, and the first female inductee of the Pontifical Academy of Sciences [27].

Rita Levi-Montalcini [4] has published more than 200 manuscripts and remains a Senator for Life in the Italian Parliament.