Hilde Mangold (1898-1924) [1]

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Hilde Mangold [6], previously Hilde Proescholdt, was a German embryologist and physiologist who became well known for research completed with Hans Spemann [7] in the 1920s. As a graduate student, Mangold assisted Spemann and together they discovered and coined the term the “organizer”. The organizer [8] discovery was a crucial contribution to embryology [8] that led to further understanding of the pattern of embryo differentiation [10] of amphibians [11]. Mangold’s dissertation was connected to Spemann’s Nobel Prize, but Mangold died early in life, and was unable to witness the impact her research had on experimental embryology [9].

Mangold was born on 20 October 1898 to Gertrude and Ernest Proescholdt in Gotha Thuringia, an east-central German province. She was born to a wealthy family that included one older sister and one younger sister. In 1918 she went to the University of Jena [12], but left in 1919 to attend the University of Frankfurt. While studying in Frankfurt, Mangold attended a lecture held by Hans Spemann [7]. Mangold was so intrigued with Spemann’s research that she decided to follow him to the school where he taught, the Zoological Institute in Freiburg, Germany. Mangold finished her master’s degree in 1920 and began her doctorate in zoology working alongside Spemann. During that time, Mangold was able to work in conjunction with, and befriend, embryologist Viktor Hamburger [13]. According to Hamburger, Mangold was a likeable and exceptional scientist.

Experimental embryologists performed many cell transplantation experiments during the early 1900s. Their early experiments demonstrated that a recipient embryo determined the fate of a donor embryo’s transplanted cells. For example, if a donor’s back (dorsal) cells were transplanted onto a recipient’s stomach (ventral), the dorsal cells would integrate with and become stomach cells. However, the region failed to become the neural tube [14], which ultimately forms the brain and spinal cord, did not incorporate. Spemann and Mangold discovered that if the progenitor cells from the neural tube [14] region were transplanted from a donor embryo to a recipient embryo, a neural tube [14] would always develop regardless of the cell’s placement.

Spemann suggested Mangold’s doctoral dissertation include a series of experiments with embryos of two species of newts, dark colored newt (Triturus cristatus [15]) and light colored newt (Triturus taeniatus). In the spring of 1921 Mangold began her experiments which consisted of transplanting cells of the dark colored newt embryo onto the light colored newt embryo. Because the two species of Newt had different colored cells, Mangold would be able to create a fate map and trace the cell migrations of the donor tissue.

The transplantation technique used by Mangold was difficult and tedious. Using glass needles [16] made by Spemann, small portions of donor embryos were cut out and transplanted onto recipient embryos. Specifically, Mangold transplanted the upper region of the blastopore [17] lip (where gastrulation [18] starts in amphibians [11]) of the gastrula [19] from the dark colored newt onto the opposite side of a light colored newt gastrula [19]. After the procedures, the recipient embryos developed in their natural environment, pond water. Because pond water is not sterile, it was nearly impossible to prevent bacteria from infecting the embryos. Mortality from bacterial infections was high and because of the sensitivity of the experiment, Mangold was unable to get many results in one breeding season. Out of the hundreds of manipulations done, only six embryos were viable [20] enough to yield data. The resulting recipient embryos had formed second neural tubes and subsequently second head, brains, and spinal cords.

Those results highlighted Mangold’s dissertation, On the Induction of Embryonic Anlagen by Implantation of Organizers from Different Species (Über die Induktion von Embryonalanlagen durch Implantation artfremder Organisatoren). In February 1923, Mangold received her doctorate in zoology and although she objected, Spemann added his name as an author to her dissertation.

During her 1921 experiments, Mangold met and married Otto Mangold [21], Spemann’s chief advisor. By 1924, the Mangolds’ had a son and moved from Freiburg to Berlin, where Otto had obtained a director position at the Kaiser Wilhelm Institute [22] for Biology. That same year Mangold’s dissertation work appeared in one of the most prominent embryology [8] journals, Wilhelm Roux’s Archiv für Entwicklungsmechanik der Organismen [23]. On 4 September 1924, Mangold died of severe burns caused from a kitchen explosion in her apartment.

In 1935, Spemann received the Nobel Prize in Physiology or Medicine [24] for discovering the Organizer. Though Spemann gave credit to Mangold in his acceptance speech, many believe that he would have shared the prize with her if she had not died. Mangold performed the manipulations and authored the dissertation that led to Spemann’s Nobel Prize. Although she did not receive any awards, her work with newt embryos provided a foundation for the field of experimental embryology [9].
Hilde Mangold, previously Hilde Proescholdt, was a German embryologist and physiologist who became well known for research completed with Hans Spemann in the 1920s. As a graduate student, Mangold assisted Spemann and together they discovered and coined the term the “organizer.” The organizer discovery was a crucial contribution to embryology that led to further understanding of the pattern of embryo differentiation of amphibians. Mangold's dissertation was connected to Spemann's Nobel Prize, but Mangold died early in life and was unable to witness the impact her research had on experimental embryology.

**Sources**
