"On the Induction of Embryonic Primordia by Implantation of Organizers from Different Species" (1924), Hilde Mangold's Dissertation [1]


Hilde Pröscholdt Mangold was a doctoral student at the Zoological Institute at the University of Freiburg [8] in Freiburg, Germany, from 1920 to 1923. Mangold conducted research for her dissertation “On the Induction of Embryonic Primordia by Implantation of Organizers from Different Species” (“Über Induktion von Embryonanlagen durch Implantation artfremder Organisatoren”), with the guidance of Hans Spemann [9], a professor of zoology at the University of Freiburg [8]. The dissertation was the culmination of five experiments on three species of newt embryos of the genus Triton (presently Triturus [10]), performed during the summers of 1921 and 1922, experiments that confirmed Spemann’s organizer [11] concept. Spemann and Mangold published the dissertation in a 1924 edition of Roux’s Archives for Microscopic Anatomy and Developmental Mechanics (Roux’s Archiv für Mikroskopische Anatomie und Entwicklungsmechanik [12]).

Mangold’s experiments arose from issues raised in Spemann’s 1918 article “On the Determination of the First Organ Systems of the Amphibian Embryo” (“Über die Determination der ersten Organanlagen des Amphibiienembryo I-IV”). In this 1918 article, Spemann found that by transplanting a piece of the blastopore [13] lip of a newt embryo into the embryo of a second newt, a second nervous system structure (a neural tube [14]) formed in the host. Spemann’s results suggested that the blastopore [13] lip acquired its fate before adjacent areas, and could then exert its influence on the development of surrounding tissues. This result became the basis of the organizer [11] concept; that is, the idea that certain regions of the embryo become specified before others, and that these specified regions influence the development of surrounding tissues. While Spemann’s 1918 article hinted at the role of the blastopore [13] lip as an organization center [19], he could not discern which part of the secondary neural tube [14] derived from the implant, and which part derived from the host.

In 1920, Mangold entered Spemann’s laboratory to conduct her doctoral research. After a failed series of attempts to recreate Abraham Trembley’s experiments in which a Hydra [16] is turned inside-out, Spemann assigned Mangold the problem of transplanting the blastopore [13] lip between species. Using mainly two species of newt, the crested newt [17], Triton cristatus and the smooth newt [18], Triton taeniatus, Mangold proceeded where Spemann’s 1918 article left off; by tracking the formation of neural structures through the transplantation of the blastopore [13] lip between embryos.

In the spring of 1921, Mangold began her experimental work by excising a section of the upper lip of the blastopore [13] from a cristatus embryo and implanting it into undifferentiated tissue in the taeniatus embryo. The natural cell pigmentation differences between the two species allowed Mangold to easily differentiate the implanted and transparent cristatus dorsal lip tissue from the colored taeniatus cells. These pigmentation differences lasted throughout the course of development, enabling Mangold to observe the contributions that the transplants made to the growth of secondary neural structures.

Mangold allowed the host taeniatus embryo to develop to the point where both of the neural tubes had closed. After halting the embryo’s development at this stage, Mangold cut it into sections as close to perpendicular to the neural tubes as possible so that she could further investigate the cell arrangements surrounding these structures. When Mangold looked at the cross sections, she saw that the overwhelming mass of the secondary neural tube [14] was made of the host taeniatus cells. Despite the majority of taeniatus cells, intercalated within a section of the neural tube [14], and underlying its length, there was a narrow mass of unpigmented cells from the cristatus transplant. The cristatus cells had folded inside of the embryo, through a process called invagination, and had resisted the influences of the surrounding taeniatus cells to develop as they would have in their original cristatus embryo. To Mangold, these results indicated that the cristatus dorsal blastopore [13] lip induced the surrounding host taeniatus tissue to form the secondary neural tube [14].

In the spring following her first experiment, Mangold performed four more experiments which further investigated the organizing power of the dorsal blastopore [13] lip. In her first experiment in 1922, Mangold excised a piece of upper blastopore [13] lip from a cristatus embryo at an early stage of gastrulation [19], and she implanted it into the midline of a taeniatus gastrula [20] of the same stage. In contrast to her first experiment, the implanted cristatus organizer [11] formed a unified mass of cells, not separated by a
Sources

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