Hans Spemann (1869-1941) [1]


Hans Spemann [5] was an experimental embryologist best known for his transplantation studies [6] and as the originator of the "organizer" concept. One of his earliest experiments involved constricting the blastomeres of a fertilized salamander [7] egg [8] with a noose of fine baby hair, resulting in a partially double embryo with two heads and one tail. Spemann continued changing variables such as the amount of time the embryo was constricted and the degree of constriction, all of which added more empirical evidence to Hans Driesch's studies showing that embryonic cells could self-regulate to varying degrees. Spemann’s long list of "simple" experiments and significant findings were mainly carried out at his laboratory, the Spemann School [9] at the University of Freiburg [10], Germany, where numerous graduate students collaborated with Spemann to investigate embryonic induction [11].

Spemann was born 27 June 1869 in Stuttgart, Germany to Lisinka and Wilhelm Spemann [12], a publisher. From 1878 to 1888 he attended the Eberhard-Ludwig School at Stuttgart. After one year of business with his father and a year in the military, Spemann decided to study medicine at the University of Heidelberg [13]. Influenced by the works of Johann Goethe, Ernst Haeckel [14], and Carl Gegenbaur [15], Spemann studied embryology [16] along with clinical science.

In 1892 Spemann married Klara Binder and soon after entered the University of Munich [17] for more clinical training. In studying with Gustaf Wolff [18] and Gegenbaur, Spemann’s life-long interest in zoology took hold. During late 1894 Spemann worked with cytologist Théodor Boveri [19], plant physiologist Julius Sachs [20], and physicist Wilhelm Röntgen [21] at the Zoological Institute at the University of Würzburg [22]. In 1895 Spemann was awarded a PhD in zoology, botany, and physics with Boveri serving as his doctoral advisor and chair. In 1896, while recovering from tuberculosis, Spemann read August Weismann’s book Das Keimplasma: Eine Theorie der Vererbung (1892). The rest and reading helped motivate Spemann for a healthy return to the laboratory.

In 1898 Spemann became a Privatdozent at the University of Würzburg [23] and in 1901 he began his intense research productivity with transplantation experiments. That same year he published his first paper in Archiv für Entwicklungsmechanik [24], founded and edited by Wilhelm Roux [25]. Dissatisfied with only watching embryos grow, Spemann began work on separating and rearranging parts of embryos from salamanders, his favorite experimental animal. To Spemann, studying embryos meant disrupting their normal physiological development; much of his laboratory work consisted of taking tissue from one embryo and implanting it into another.

Spemann’s work soon turned to a series of constriction experiments [25]. This involved the intricate process of tying fine hairs around embryos and slowly tightening them until the two regions were constricted into a dumbbell shape. He found that when the hairs were tightened around the embryo and made to cross the blastopore [26] (the slit-like invagination of the gastrula [27] through which cells move to form internal organs), the result was two complete embryos. Such was not the result when he tied the hairs above or below the blastopore [28]; in these cases the region containing the blastopore [29] developed into a complete embryo and the region without formed a soon-to-die undifferentiated Baruchstücker (belly mass). From this Spemann concluded that an embryo’s blastopore [26] region is essential for differentiation [28]. Spemann’s constriction experiments [25] also showed that the formation of duplicate heads or tails could not be replicated if the manipulation was done at the end of gastrulation [29]. Early gastrulation [29] is when the decisive action for axial differentiation [28] occurs.

In 1908 Spemann was appointed Professor of Zoology and Comparative Anatomy at the University of Rostock [30], Germany, and there he further elaborated his work on the development of the vertebrate lens. The concept of embryological induction [31], whereby the development of tissues or a structure is affected by closely situated tissues was first clearly demonstrated by Spemann in 1901 in the development of frog [32] embryo eyes. When embryonic eyes begin to develop, they start as optic vesicles in the mesoderm [33] and bulge outward on each side of the embryo brain. Upon contact with the overlying ectoderm [34], the ectoderm [34] invaginates to form an optic cup and, eventually, the lens of the eye.

Spemann transplanted the eye mesodermal layer (eye anlagen) to other parts of the frog [32] body to see if he could induce lens development [35] in ectodermal layers far removed from the normal eye area. He found that he could induce lens development [35] practically anywhere on the frog [32] using this method. He then removed the local ectoderm [34] of the eye region and replaced it with ectoderm [34] from other parts of the frog [32] body. Again, lens formation occurred. From this Spemann concluded that head ectoderm [34] possesses a predisposition for lens formation. This work first led Spemann to the concept of induction [31] and the "organizer," although he did not use these terms in his report.

In 1914 Spemann was appointed co-director and head of the Division of Developmental Mechanics of the Kaiser Wilhelm
Sources


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