Endoderm [1]

By: MacCod, Keywords: endoderm [2]

Endoderm is one of the germ layers—aggregates of cells that organize during early embryonic life and from which all organs and tissues develop. All animals, with the exception of sponges, form either two or three germ layers through a process known as gastrulation [3]. During gastrulation [4], a ball of cells transforms into a two-layered embryo made of an inner layer endoderm [5] and an outer layer ectoderm [6]. In more complex organisms, like vertebrates, these two primary germ layers interact to give rise to a third germ layer, called mesoderm [7]. Regardless of the presence of two or three layers, endoderm [8] is always the inner-most layer. Endoderm forms the epithelium—a type of tissue in which the cells are tightly linked together to form sheets—that lines the primitive gut. From this epithelial lining of the primitive gut, organs that develop into the tracts, liver, pancreas, and lungs develop.

Throughout the early stages of gastrulation [9], a group of cells called mesendoderm expresses sets of both endoderm [10] and mesoderm [11]—specific genes [12]. Cells in the mesendoderm have the ability to differentiate into either endoderm [13] or ectoderm [14], depending upon their position among surrounding cells. Scientists have found mesendoderm is widespread among invertebrates, including the nematode Caenorhabditis elegans [15], and the purple sea urchin [16]. Strongly/cis-dominant purpuratus [17]. Within vertebrates, mesendoderm has been found in the zebrafish Danio rerio [18], and has been indicated in mice, Mus musculus [19].

Endoderm, along with the other two germ layers [20], was discovered in 1817 by Christian Pander, a doctoral student at the University of Würzburg [21], in Würzburg, Germany. In his dissertation Beiträge zur Entwicklungs geschichte des Thieres [22] (Contributions to the Developmental History of the Thiere), Pander described how two layers give rise to a third in chick [23] (Gallus gallus) embryos. Pander described the formation of these layers for the first time and, as a result of his work, he described and named the germ layers. In 1905, Hans Driesch, at the University of Königsberg, in Königsberg, Prussia (later Poland), found evidence in a developing Ascidian Egg [24].

Early twentieth-century scientists sought to explain the phylogeny [25] of cells he saw in the adult jellyfish related to each other the same way as the Ascidian Egg [26]. By: Edwin Grant Conklin [27] at the University of Pennsylvania [28], in Philadelphia, Pennsylvania, was one of the first to trace cell lineages from the single-cell stage. In his 1905 text The Organization and Cell-lineage of the Ascidian Egg, Conklin mapped the divisions and subsequent differentiation of cells in the egg of an ascidian, or sea squirt, and a particular type of invertebrate that develops a tough outer layer and clings to the sea floor. By creating a plot, or fate map, of the developmental route of each of the cells, Conklin located the precursor cells, traced the formation of each of the germ layers [29], and showed that even at very early stages of development, the ability of some cells to differentiate becomes restricted.

Conklin’s fate mapping [30] experiments, along with questions about the capacity of the cells to differentiate, influenced scientists like Robert Briggs, abridiana University [31] in Bloomington, Indiana, and his collaborator, Thomas King, at the Institute for Cancer Research [32] in Philadelphia, Pennsylvania. In the 1950s Briggs and King began a series of experiments to list the developmental capacity of cells and embryos. In 1957 Briggs and King transplanted nuclei from the presumptive endoderm [33] of the northern leopard frog [34], Rana pipiens [35], into eggs from which they had removed the nuclei. This technique, which Briggs and King later developed, created, called nuclear transplantation [36], allowed them to explore the timing of cellular differentiation [37], and the technique became a basis for future experiments including [38]. From their nuclear transplantation [39] experiments, Briggs and King found that during endodermal differentiation [40], the ability of the nucleus [41] to help cells specialize becomes progressively restricted. That result was supported in 1960 by the work of John Gurdon [42], at Oxford University in Oxford, England. Gurdon recreated Briggs and King’s experiments using the African clawed Xenopus laevis [43], Xenopus laevis [44], and Gurdon found that there are significant differences between species in the rate and timing of onset of these endodermal restrictions.

While Briggs, King, and Gurdon worked to understand the restriction of endodermal cell fates, other scientists, like Pieter Nieuwkoop, at the Royal Netherlands Academy of Arts and Science, in Utrecht, Holland, investigated the formation of the germ layers [45]. In 1969 Nieuwkoop published an article, “The Formation of the Mesoderm in Urodelean Amphibians. I. Induction by the Endoderm,” in which he examined the interactions of the endoderm [46] and ectoderm [47]. Nieuwkoop divided embryos of the chick [48], Ambystoma mexicanum [49], into regions of presumptive endoderm [50] and presumptive ectoderm [51], when left to develop in isolation, did not form. But when he recombined the two tissues, endoderm [52] induced the formation of mesoderm [53], in adjacent regions of the chick [54].

Although scientists had traced the fate of the endoderm [55], investigated the capacity of endodermal cell to differentiate, and had examined the endoderm [56] potential of said cells, they did not investigate the molecular pathways that specify and pattern the endoderm [57] until the 1990s. From these studies emerged the theory that maternal signals, or developmental effects that the mother contributes to the embryo, interact to give rise to a third germ layer, called mesoderm [58]. These signals are proteins β-catenin, Vg1, T, and Otx. The molecular pathways involved in later stages of endoderm [59], and mesoderm [60] are necessary for Gene expression that is necessary for the endoderm [61] to differentiate. While there are some genetic elements conserved across the animal kingdom, like β-catenin, some portions of the endoderm [62] pathway, especially signals like the proteins Nodal and Vnt, are vertebrate-specific. In 2000 Eric Davidson [63] and his colleagues at California Institute of Technology [64] in Pasadena, California, announced the full network genes that regulate the specification of endoderm [65] and mesoderm [66] in sea urchins in their paper, “A Genomic Regulatory Network for Development.” Davidson confirmed that network of genes in a co-authored article published in 2012.

Sources

14. Huis, Wilhelm. Untersuchungen über die erste Anlage des Wirbelthierkörpers: Die erste Entwicklung des Hühnchens im Ei [Studies on the first system of the vertebrate body: The first development of the
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Subject


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Endoderm is a tissue that forms in the digestive system from the innermost layer of the embryo. It develops from cells that migrate to the center of the embryo and differentiate into epithelial cells that line the gut. Endoderm plays a crucial role in the development of the digestive tract, liver, pancreas, and lungs. It is one of the germ layers that form early in embryonic development and gives rise to organs such as the lungs, pancreas, and liver. Endoderm is distinct from other germ layers such as ectoderm and mesoderm.

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Last Modified

Wednesday, July 4, 2018 - 04:40

DC Date Accessed

Sunday, November 17, 2013 - 17:47

DC Date Available

Sunday, November 17, 2013 - 17:47

DC Date Created

2013-11-17

Topic

Processes [104]

Publisher

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

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