

Hensen's Node ^[1]

By: Doty, Maria DeRuiter, Corinne Keywords: [Chicks](#) ^[2] [Gastrulation](#) ^[3]

A node, or primitive knot, is an enlarged group of cells located in the anterior portion of the [primitive streak](#) ^[4] in a developing [gastrula](#) ^[5]. The node is the site where [gastrulation](#) ^[6], the formation of the three [germ layers](#) ^[7], first begins. The node determines and patterns the [anterior-posterior axis](#) ^[8] of the embryo by directing the development of the chordamesoderm. The chordamesoderm is a specific type of [mesoderm](#) ^[9] that will differentiate into the [notochord](#) ^[10], [somites](#) ^[11], and [neural tube](#) ^[12]. Those structures will later form the [vertebral column](#) ^[13]. In the [chick](#) ^[14] embryo, the node is called Hensen's node because of its discoverer, Viktor Hensen, who first described the node in 1875. The discovery of Hensen's node has helped to explain axis formation and has allowed experimental embryologists to further investigate vertebrate embryonic development.

Hensen's research focused on the embryonic development of guinea pigs and rabbits. While studying those organisms he noticed something previously undiscovered—an enlarged area above the [primitive streak](#) ^[4]. He referred to that area as the node in his article, "Beobachtungen über die Befruchtung und Entwicklung des Kaninchens und Meerschweinchens" (Observations on the fertilization and development of the rabbit and [guinea pig](#) ^[15]). Hensen's article was meant to describe development and encourage other researchers to further investigate the node. After the article, people researched nodes, and in 1924 [Hans Spemann](#) ^[16] and [Hilde Mangold](#) ^[17] published their work on the node in African clawed frogs ([Xenopus laevis](#) ^[18]), for which they called the node the [organizer](#) ^[19]. Hensen's node and the [organizer](#) ^[19] have nearly the same characteristics—in both [chick](#) ^[14] and [frog](#) ^[20] embryos they become the head processes. Kupffer's vesicle which was later discovered in [fish](#) ^[21] is also similar to the [organizer](#) ^[19] and Hensen's node

In the 1930s [Conrad Hal Waddington](#) ^[22] invented a way to cultivate [chick](#) ^[14] embryos on plasma clots, consisting of the organism's plasma. With this new technique, Waddington was able to remove Hensen's node and observe the effects when it was placed in another area of the [chick](#) ^[14]. The [notochord](#) ^[10], [somites](#) ^[11], and [neural tube](#) ^[12] began to form in the new location suggesting that Hensen's node controlled axis formation and the development of those subsequent structures.

Experiments such as Waddington's initiated further investigations into the node's mechanistic properties, such as gene expression. Those experiments found that two sets of gene expression occur in the region of Hensen's node. The first set of [genes](#) ^[23] includes those that are expressed in the posterior part of Koller's sickle and later appear throughout the entire length of the [primitive streak](#) ^[4]. Koller's sickle is another area of thickened cells which acts as a margin separating the [blastoderm](#) ^[24] from the hypoblast layer during migration of the [primitive streak](#) ^[4]. Those [genes](#) ^[23] are *Vg1* and *Nodal*. The gene *Vg1* plays a crucial role in forming the [primitive streak](#) ^[4]. When *Vg1* is expressed in the anterior marginal zone of the [blastoderm](#) ^[24], *Nodal* will be subsequently expressed and an [anterior-posterior axis](#) ^[8] will form. The second set of [genes](#) ^[23] are those whose expression is only in the anterior part of the [primitive streak](#) ^[4] and includes [chordin](#) ^[25] and [sonic hedgehog](#) ^[26] (*shh*). Expression of [chordin](#) ^[25] and *shh* is later found in Hensen's node.

In chicks and all other vertebrates, dorsal [mesoderm](#) ^[9] induces overlying [ectoderm](#) ^[27] to become the precursor population of the [central nervous system](#) ^[28] and [notochord](#) ^[10]. In chicks, cells of Hensen's node secrete proteins that dorsalize the [ectoderm](#) ^[27] and [mesoderm](#) ^[9]. The proteins secreted are [chordin](#) ^[25], Noggin, and Nodal, all of which repress bone morphogenetic proteins (BMPs). Fibroblast Growth Factors (FGFs) are also critical for [induction](#) ^[29] of [mesoderm](#) ^[9], for BMP repression, and for signaling the beginning of [neurulation](#) ^[30]. FGFs and Nodal are responsible for activating the [genes](#) ^[23] *Brachyury* and *Tbx6* in cells going through the [primitive streak](#) ^[4]. FGFs signal for [mesoderm](#) ^[9] ingress to cease and for stabilization of the [epiblast](#) ^[31] in preparation for [neurulation](#) ^[30].

Hensen's node is homologous to Kupffer's vesicle in [fish](#) ^[21] and the Spemann-Mangold [organizer](#) ^[19] in [amphibians](#) ^[32]. Though there is current research to understand the mechanism for the formation and regression of Hensen's node, much is still unknown. Hensen's node continues to be a source for new information regarding axis specification and [notochord](#) ^[10] development.

Sources

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Subject

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Topic

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- The Embryo Project at Arizona State University, 1711 South Rural Road, Tempe Arizona 85287, United States

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