

## Gastrulation in *Gallus gallus* (Domestic Chicken) <sup>[1]</sup>

By: DeRuiter, Corinne Doty, Maria Keywords: Chicks <sup>[2]</sup> Gastrulation <sup>[3]</sup>

Gastrulation is an early stage in embryo development in which the [blastula](#) <sup>[4]</sup> reorganizes into the three [germ layers](#) <sup>[5]</sup>: the [ectoderm](#) <sup>[6]</sup>, the [mesoderm](#) <sup>[7]</sup>, and the [endoderm](#) <sup>[8]</sup>. Gastrulation occurs after cleavage but before [neurulation](#) <sup>[9]</sup> and [organogenesis](#) <sup>[10]</sup>. [Ernst Haeckel](#) <sup>[11]</sup> coined the term; 'gaster', meaning stomach in Latin, is the root for '[gastrulation](#) <sup>[12]</sup>', as the gut is one of the most unique creations of the [gastrula](#) <sup>[13]</sup>.

*Gallus gallus* (domestic [chicken](#) <sup>[14]</sup>) is a major model system in [embryology](#) <sup>[15]</sup>. It was one of the first organisms used for developmental research in the nineteenth century because the [egg](#) <sup>[16]</sup> could be opened and the development of the embryo inside could be seen without the use of a powerful [microscope](#) <sup>[17]</sup>. The embryo's large size and the ability to survive under surgical manipulation gave the [chick](#) <sup>[18]</sup> an advantage over other model systems such as [Xenopus laevis](#) <sup>[19]</sup> (African clawed [frog](#) <sup>[20]</sup>) and *Mus musculus* (house [mouse](#) <sup>[21]</sup>).

In the 1850s, [gastrulation](#) <sup>[12]</sup> of the [chick](#) <sup>[18]</sup> was not well understood or documented. There were two suggested explanations of [chick](#) <sup>[18]</sup> [gastrulation](#) <sup>[12]</sup>. The first suggested that the [mesoderm](#) <sup>[7]</sup> formed from the [epiblast](#) <sup>[22]</sup>, the early stage totipotent layer of cells, and the [mesoderm](#) <sup>[7]</sup> then differentiated into the [endoderm](#) <sup>[8]</sup>. The other suggestion was that the [epiblast](#) <sup>[22]</sup> and [endoderm](#) <sup>[8]</sup> developed together first, followed by the [mesoderm](#) <sup>[7]</sup>. It wasn't until August Rauber discovered that the two-layered [chick](#) <sup>[18]</sup> embryo is a [blastoderm](#) <sup>[23]</sup>, a flat layer of embryonic cells that folds several times to become the later stages of an embryo, that [gastrulation](#) <sup>[12]</sup> began to be understood. Rauber emphasized that the [mesoderm](#) <sup>[7]</sup> initiates the [ectoderm](#) <sup>[6]</sup> and [endoderm](#) <sup>[8]</sup> to differentiate and that the [blastoderm](#) <sup>[23]</sup> was essentially the canvas for [gastrulation](#) <sup>[12]</sup>.

Although Rauber described [gastrulation](#) <sup>[12]</sup>, it wasn't until one-hundred years later that [Viktor Hamburger](#) <sup>[24]</sup> and Howard Hamilton used Rauber's and other researcher's information to create a series of chronological stages in [chick](#) <sup>[18]</sup> development, the Hamburger-Hamilton staging series in 1951. In 1976 [Hefzibah Eyal-Giladi](#) <sup>[25]</sup> and [Joseph Kochav](#) <sup>[26]</sup> also observed *G. gallus* and created another staging series documenting beginning phases of development. The improvement of microscopes, staining methods, and microtomes helped those documents provide detailed descriptions of embryonic stages of [chick](#) <sup>[18]</sup> development.

With the help of researchers such as Rauber, Haeckel, Hamburger, and Hamilton, people now understand that [chick](#) <sup>[18]</sup> [gastrulation](#) <sup>[12]</sup> begins approximately seven to eight hours after [fertilization](#) <sup>[27]</sup>. In the [chick](#) <sup>[18]</sup> [epiblast](#) <sup>[22]</sup>, a totipotent primordial cell layer, cells begin to rearrange at the posterior end. Those cells migrate inward to form the [primitive streak](#) <sup>[28]</sup>, a midline thickening of the [epiblast](#) <sup>[22]</sup>. During that time, the [epiblast](#) <sup>[22]</sup> is separated from the hypoblast, a deeper layer of cells in the [blastoderm](#) <sup>[23]</sup>, by the [blastocoel](#) <sup>[29]</sup>, a fluid filled cavity. Future [endoderm](#) <sup>[8]</sup> cells are the first cells to pass through the [primitive streak](#) <sup>[28]</sup>. Those cells displace the hypoblast cells moving them towards the anterior pole of the embryo.

Next, Hensen's node, a mass of cells lying at the most anterior end of the [primitive streak](#) [28], drives elongation towards the posterior end of the embryo. The order in which the cells enter the [blastocoel](#) [29] through Hensen's node determines which of the three [germ layers](#) [5] they will become in the future embryo. As the embryo continues to grow and proliferate, Hensen's node regresses, leaving behind the [notochord](#) [30] and signaling the beginning of [neurulation](#) [9], which is the formation of the [central nervous system](#) [31].

In [chick](#) [18] embryos, the [ectoderm](#) [6], [mesoderm](#) [7], and [endoderm](#) [8] cells ultimately give rise to different tissues and organs. Ectoderm cells generate the skin and neural tissue. Endoderm cells become the lining of the gastrointestinal and the respiratory tracts. Mesoderm cells differentiate into the circulatory system, kidneys, and skeletal compartments among many other features. Those tissues and organs are created during [organogenesis](#) [10].

Gastrulation of the [chick](#) [18] is a crucial step in development that turns a simple multi-cellular embryo into a complex fully functional organism. Regardless of the many researchers involved, questions still remain regarding the mechanisms of [induction](#) [32] and genetics involved in the cells movements that occur during [gastrulation](#) [12]. The [chick](#) [18] embryo is still used today by researchers who hope to answer those developmental questions.

## Sources

1. Gilbert, Scott F. [Developmental Biology](#) [33], 8th ed. Sunderland, MA: Sinauer, 2006. 336-48.
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Gastrulation is an early stage in embryo development in which the blastula reorganizes into three germ layers: the ectoderm, the mesoderm, and the endoderm. Gastrulation occurs after cleavage but before neurulation and organogenesis. Ernst Haeckel coined the term; gaster, meaning stomach in Latin, is the root for gastrulation, as the gut is one of the most unique creations of the gastrula.

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