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Types of Embryonic Gastrulation

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About the Study

Gastrulation is the process during embryonic development that changes the embryo from a blastula with a single layer of cells to a gastrula containing multiple layers of cells. Gastrulation typically involves the blastula folding in upon itself or dividing, which creates two layers of cells. Organisms that do not form a third layer are known as diploblastic organisms. These include the jellyfish and related animals. Triploblastic organisms contain a third layer, the mesoderm, which is created from one of the first two layers. Triploblastic organisms account for the majority of higher animals. The layers created by gastrulation become germ layers, or special tissues that give rise to specific parts of the organism. These germ layers always give rise to the same types of tissues, even in very different animals. The endoderm will give rise to the gut and associated organs.

The ectoderm is the outermost layer, and will create the skin and the nervous system. Between them lies the mesoderm, which will created the connective tissues and musculature in most organisms. Before gastrulation, these layers are not defined. Gastrulation proceeds differently based on the organism it is taking place in and the type of blastula it starts from. Before gastrulation, a single-celled zygote must divide many times to form a ball of cells called a blastula. This process is known as cleavage, and has different patterns in different organisms. The blastulas of different organisms can take many different shapes. Some blastulas are a hollow ball of cells, some a solid ball of cells, while other types retain yolk as an energy source and form around or on the yolk. The cell layers created during gastrulation distinguish metazoan animals from protozoan animals. Gastrulation also marks the point in development that the internal cells are separated from the cells that will interact with the environment. The archenteron, or gut, forms during gastrulation. The singular opening to the gut is known as the blastopore. In jellyfish it serves as both the mouth and the anus. In higher animals, a second opening develops during the formation of the internal organs. Animals are divided into two categories, based on what the blastopore becomes. In the protostomes, the blastopore will become the mouth. This is seen in molluscs, arthropods, annelids (earthworms), and some other animals. In the deuterostomes, the blastopore will become the anus. All of the chordates or animals with spinal cords, and echinoderms (starfish) show this pattern of development.

Types of Gastrulation

Gastrulation of a coeloblastula

A coeloblastula is a hollow ball of cells, one cell thick. Gastrulation in a blastula of this type involves invagination, ingression, or delamination. Invagination involves the blastula folding in on itself, creating a pocket with an opening. These are known as the archenteron and blastopore, and will become parts of the gut. The in-fold becomes the endoderm, while the outer later becomes the ectoderm. The resulting gastrula is known as a coelogastrula, because it remains hollow. This can be seen in the above image. The blastocoel is simply the empty space inside of the blastula. Coeloblastulae can also undergo a type of gastrulation that produces a solid gastrula, known as a stereogastrula. During this form of development, the cells of the blastula divide and migrate into the blastocoel, eventually filling the space. The movement of cells in this form of gastrulation is known as ingression. The cells on the inside will develop as endoderm, while the surface cells will develop as ectoderm. This can be seen in many cnidarians, such as sea anemones and jellyfish. The final form of gastrulation is called delamination, and exists when the cells of a coeloblastula each divide one, creating a layer of cells surrounding the original blastula. This form is seen in only in some groups related to jellyfish.

Gastrulation of a stereoblastula

A stereoblastula is a blastula that exists as a solid mass of cells. Gastrulation in stereoblastulae differs from gastrulation in a coeloblastula, because there is no internal space for the cells to divide into. Instead, cells on the surface of the ball divide at a faster rate, until the surface of the ball is covered with a new layer of cells. This layer functions as the ectoderm, while the solid ball in the middle forms the endoderm, as in the previous form of stereogastrula. The archenteron will form later, from inside the solid mass of cells.

Gastrulation of a discoblastula

A discoblastula, unlike the other forms of blastulae, does not form a ball of cells around the original cell. Rather, the cells are arranged in a disc at one end of the blastula, and each has access to a yolk reservoir at the other end. Gastrulation in a discoblastula involves the ends of the disc of cells curving, and growing back toward each other. The bottom layer develops as the endoderm, while the top layer further from the yolk develops as the entoderm. This is known as involution. In addition to these standard forms of gastrulation, many others exist in nature. They are mostly combinations of these various forms presented. Scientists can study the gastrulation of organisms as a feature that helps distinguish between related organisms. As will other traits, related organisms tend to have similar modes of development.

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