

Gastrulation

1-Generalities

Gastrulation corresponds to the second phase of embryonic development after segmentation.

- It is characterized by cellular and tissue movements, known as morphogenetic, coordinated in time and space.

• It modifies the position of the blastomeres and leads to the formation of the two (diploblastic species) or three (triploblastic species) primitive germ layers of the embryo:

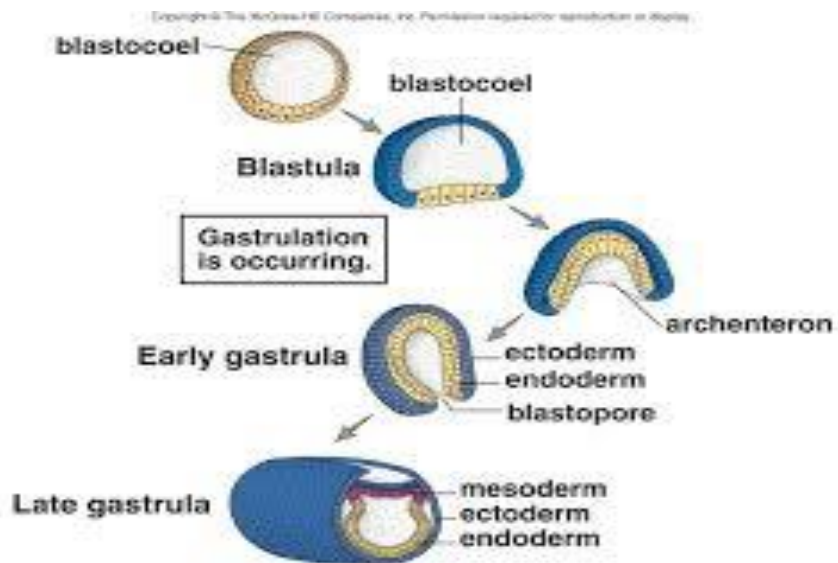
- Ectoderm (ectoblast): superficial layer

- Mesoderm (mesoblast): middle layer

- Endoderm (endoblast): inner layer

It is from these layers that all the tissues and organs in the embryo will be formed.

It is characterized by the appearance of a secondary digestive cavity, the archenteron.



2-The different morphogenetic cellular movements

We can define six major types of morphogenetic cell movements, according to the type of zygote: - Invagination (emboly)

- Epiboly

- Involution
- Delamination
- Ingression (immigration)
- Polar proliferation

3- Modalities of gastrulation

Depending on the modalities of morphogenetic movements, five types of gastrulation can be defined:

- **Gastrulation by invagination (or emboly)**

It concerns embryos possessing a developed blastocoel and endodermic cells that are small in volume and less loaded with yolk. The layer of the vegetative hemisphere sinks into the blastocoel, which reduces and tends to disappear. It delimits a second cavity, the archenteron (or primitive intestine), which opens to the outside through the blastopore. It is the establishment of a rudimentary digestive tube (e.g., sea urchins).

- **Gastrulation by epiboly (or covering)**

When the vegetative blastomeres are too large to sink into the blastocoel, the cells of the vegetative hemisphere become internal passively, through multiplication and covering of the cells of the animal hemisphere, forming a layer that gradually envelops them. In Amphibians, this mechanism can combine with the previous one when the yolk load is of medium importance.

- **Gastrulation by delamination**

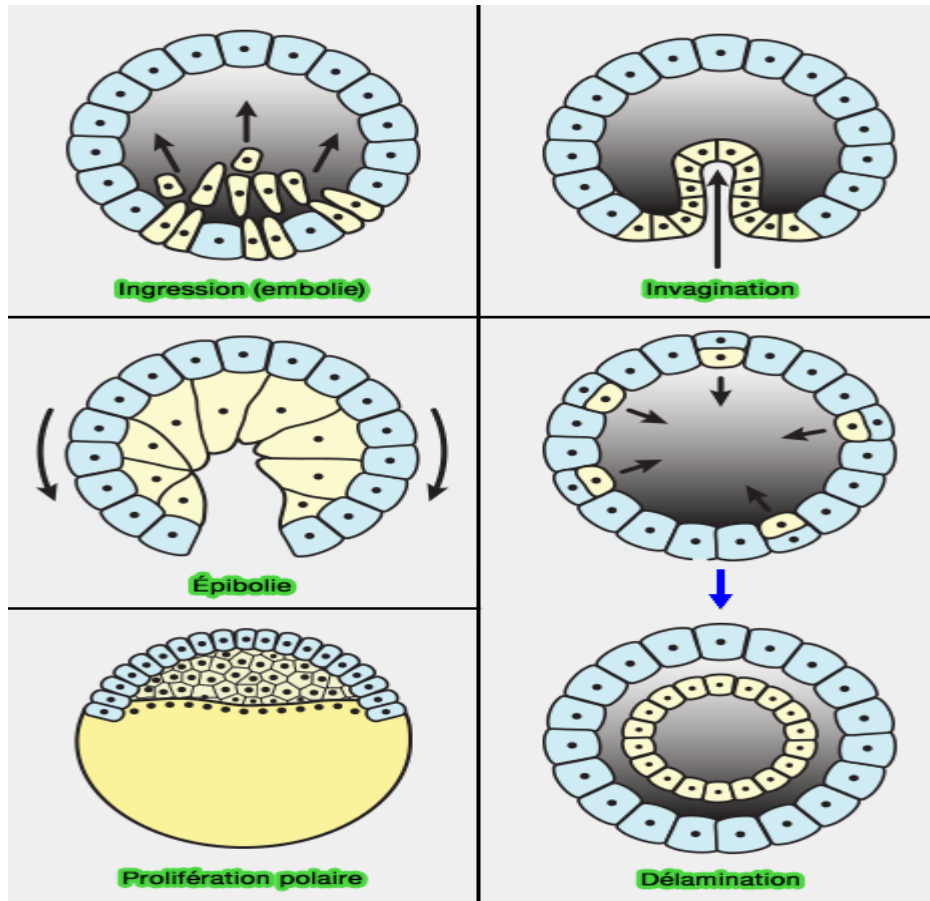
Corresponds to cell divisions perpendicular to the limiting cell layer of the blastocoel, resulting in the release of daughter cells that arrange themselves within the blastocoel to form another embryonic layer (e.g., coelenterates).

- **Gastrulation by polar proliferation**

It consists of the multiplication of cells at one of the poles of the blastula. The daughter cells resulting from this localized proliferation form the new internal structures (e.g., birds).

- **Gastrulation by immigration**

It is found in birds, where cells actively migrate from the blastodisc into the blastocoel; they become free there and then arrange themselves to form an inner layer, the hypoblast, and then the endoderm. The mesoderm then forms from the primitive streak.



Invagination:
Infolding of cell sheet into embryo



Example:
Sea urchin endoderm

Involution:
Inturning of cell sheet over the basal surface of an outer layer



Example:
Amphibian mesoderm

Ingression:
Migration of individual cells into the embryo



Example:
Drosophila neuroblasts

Delamination:
Splitting of one sheet into two



Example:
Mammalian hypoblast

Epiboly:
Expansion of one cell sheet over other cells



Example:
Amphibian ectoderm