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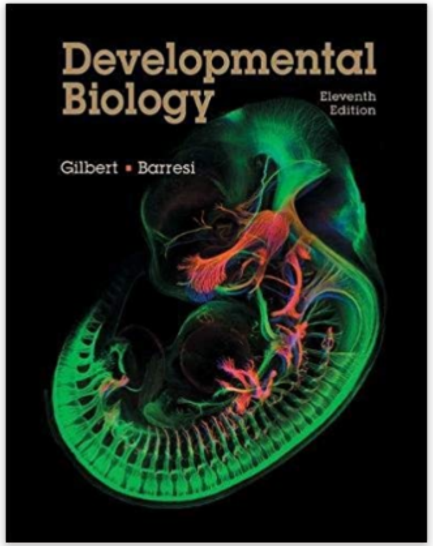

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Developmental Biology (Inglese) Copertina rigida – 15 giu 2016

di Scott F. Gilbert (Autore), Michael J. F. Barresi (Autore)

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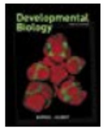

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Segmentation

Series of mitotic divisions, following fertilization, with which the volume of the egg's cytoplasm is divided into numerous smaller nucleated cells (blastomeres).

Segmentation characteristics

- Rapid cell cycle consisting only of phase S and phase M, is missing phase G.

- The type of segmentation is influenced by the composition egg (quantity of yolk).

- The fate of the cells is influenced by the interaction with the cells other cells and / or uneven distribution of factors of transcription (embryonic polarity).

Types of segmentation

Segmentation	Type of eggs	Symmetry	Examples
Holoblastic	Isolecithal (Olecolithal)	Radial	Echinoderms, Amphioxus
		Spiral	Molluscs, Annelids
		Bilateral	Ascidians
		Rotational	Mammalian
	Mesolecithics	Radial	Amphibians
Meroblastic	Telolecithics	Bilateral	Cephalopods
		Discoidal	Birds Reptiles Fishes
	Centrolecithal	Superficial	Insects

Absent or little of YOLK

Large quantities of YOLK

HOLOBLASTIC SEGMENTATION

A. Isolecithal eggs
(Yolk little and evenly distributed)

1. Radial Segmentation
(Echinoderms, Amphioxus)

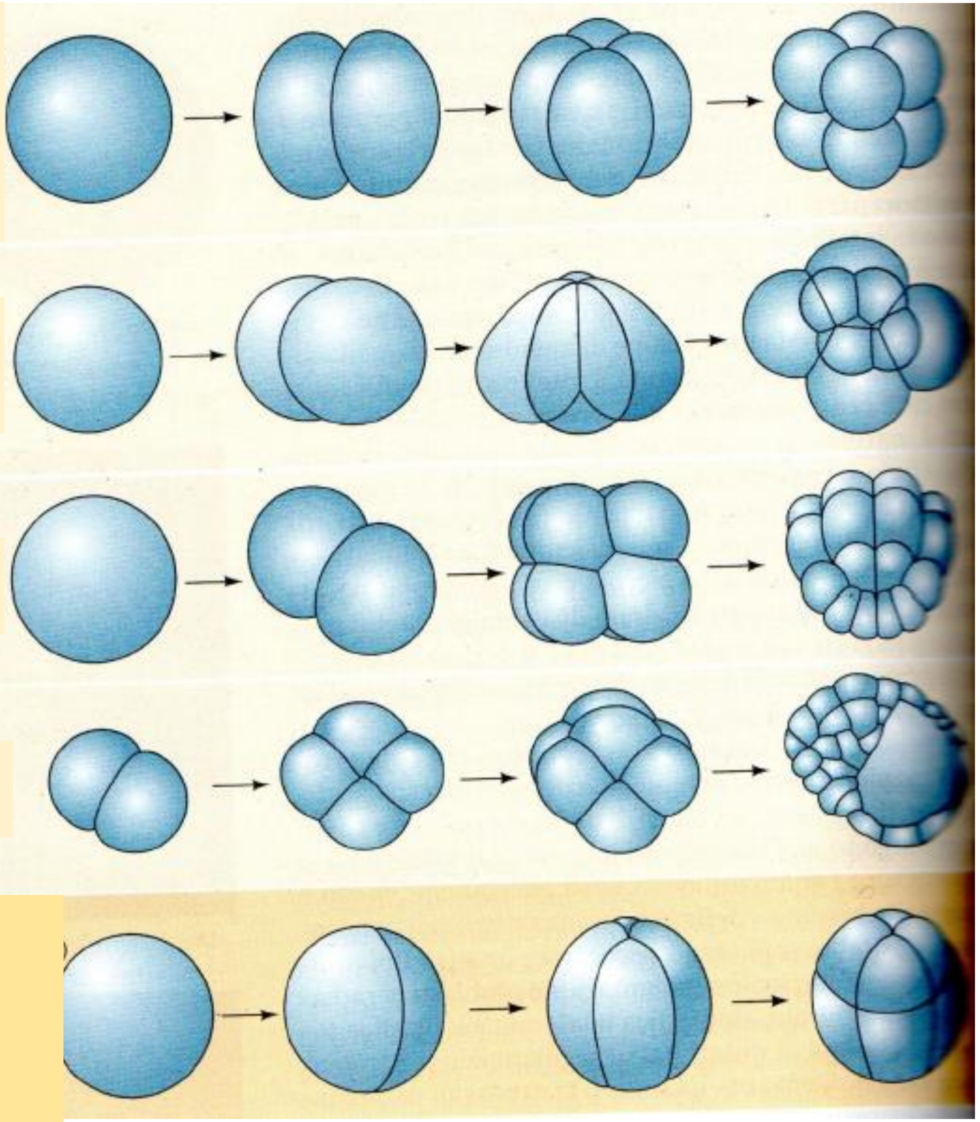
2. Spiral Segmentation
(Molluscs, Annelids, Plathelminths)

3. Bilateral Segmentation
(Tunicates)

4. Rotational Segmentation
(Mammalians, Nematodes)

B. Mesolecithics eggs
(yolk in modest quantities in the vegetative pole)

Inequal Radial Segmentation
(Amphibians)



MEROBLASTIC SEGMENTATION

MEROBLASTIC SEGMENTATION (PARTIAL)

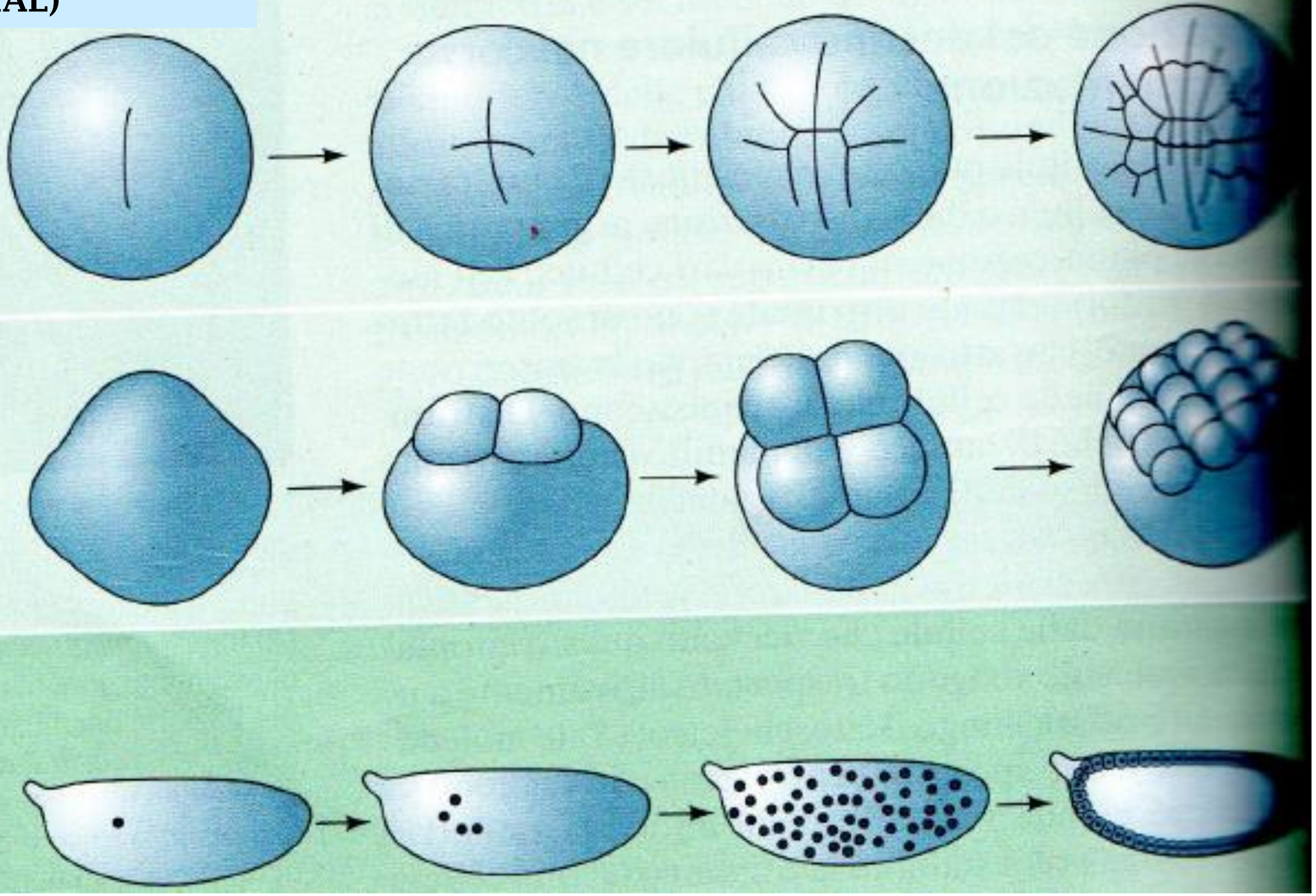
A. Telolecithics Eggs
(abundant yolk that occupies almost the entire cell)

1. Bilateral Segmentation
(Cephalopods, Molluscs)

2. Discoidal Segmentation
(Fishes, Reptiles, Birds)

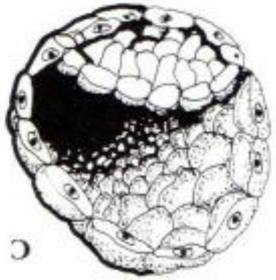
B. Centrolecithal Eggs
(yolk in the middle of the egg)

1. Superficial Segmentation
(Most insects)

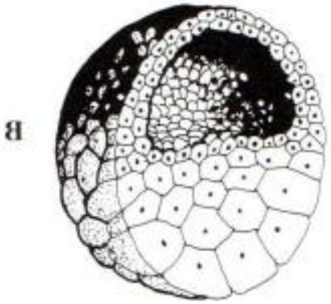


Blastula types

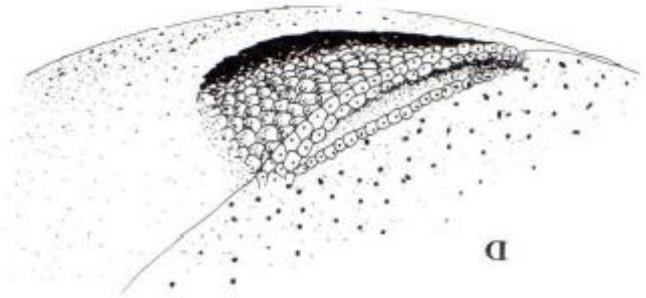
Coeloblastula with central
Blastocoele
Amphioxus



Blastocyst
Mammalians



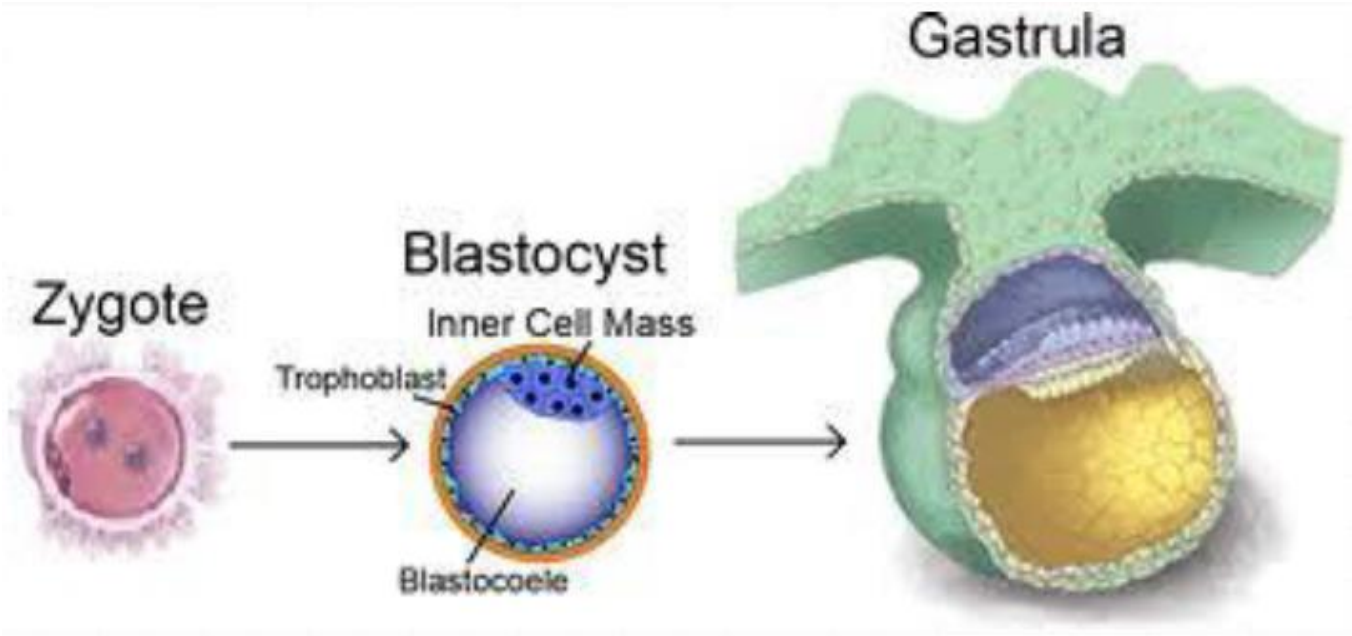
Coeloblastula with
eccentric Blastocoele
Amphibians



Discoid Blastula
Reptiles, Birds

Gastrulation

Developmental phase, following segmentation, consisting of a series of MORPHOGENETIC MOVEMENTS that leads to the formation of the three embryonic layers (ectoderm, mesoderm, endoderm).



Primary mechanisms of gastrulation

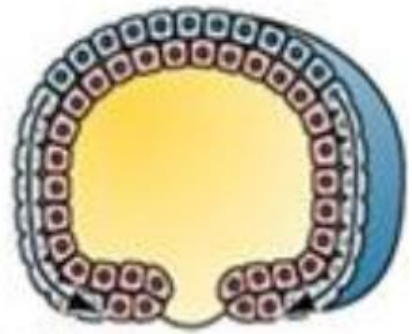
- Epibolia

- Delamination

- Cell movements from the inside surface
  - Intussusception
  - Involution
  - Entry or immigration

Primary mechanisms of gastrulation

Epibolia: Expansion of surface cells to cover the inner ones.



ectoderm formation in amphibians, sea urchins and tunicates.

Delamination: Division of a cell layer in two parallel layers.

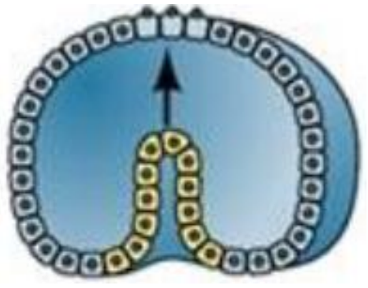
hypoblast formation in mammalians and birds.

Primary mechanisms of gastrulation

Cell movements from the inner surface

Intussusception

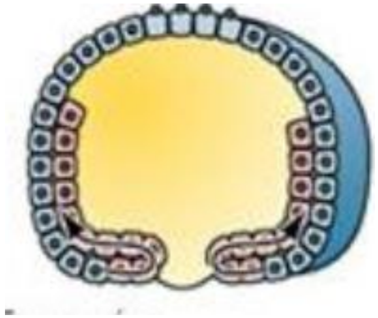
Folding of a portion of blastoderma inwards.



sea urchin's endoderm

Involution

Folding or sliding of cells so as to bear on the inner surface (EMBOLISM).



Amphibians' mesoderm

Ingression

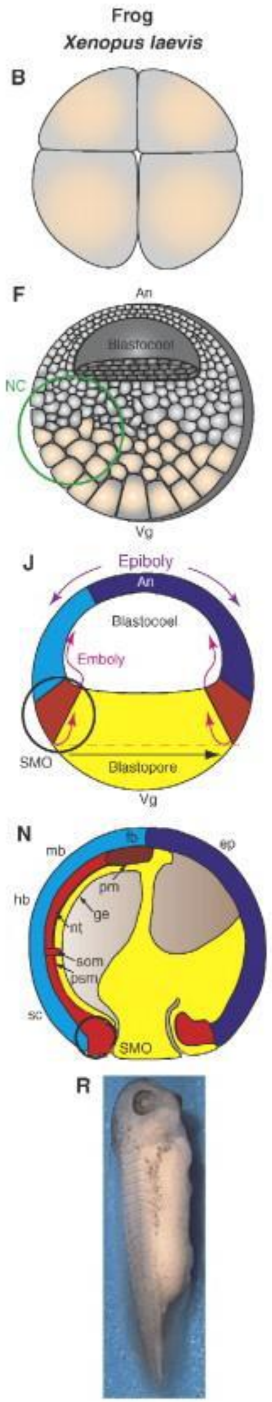
Migration of cells from external sheets towards the inside of the embryo.

sea urchin mesoderm, drosophila neuroblasts

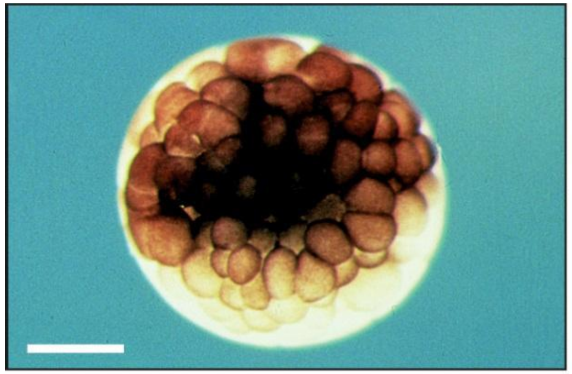
An embryo development model

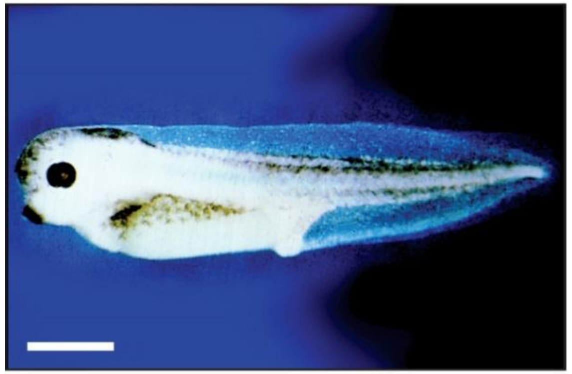
Anphibius

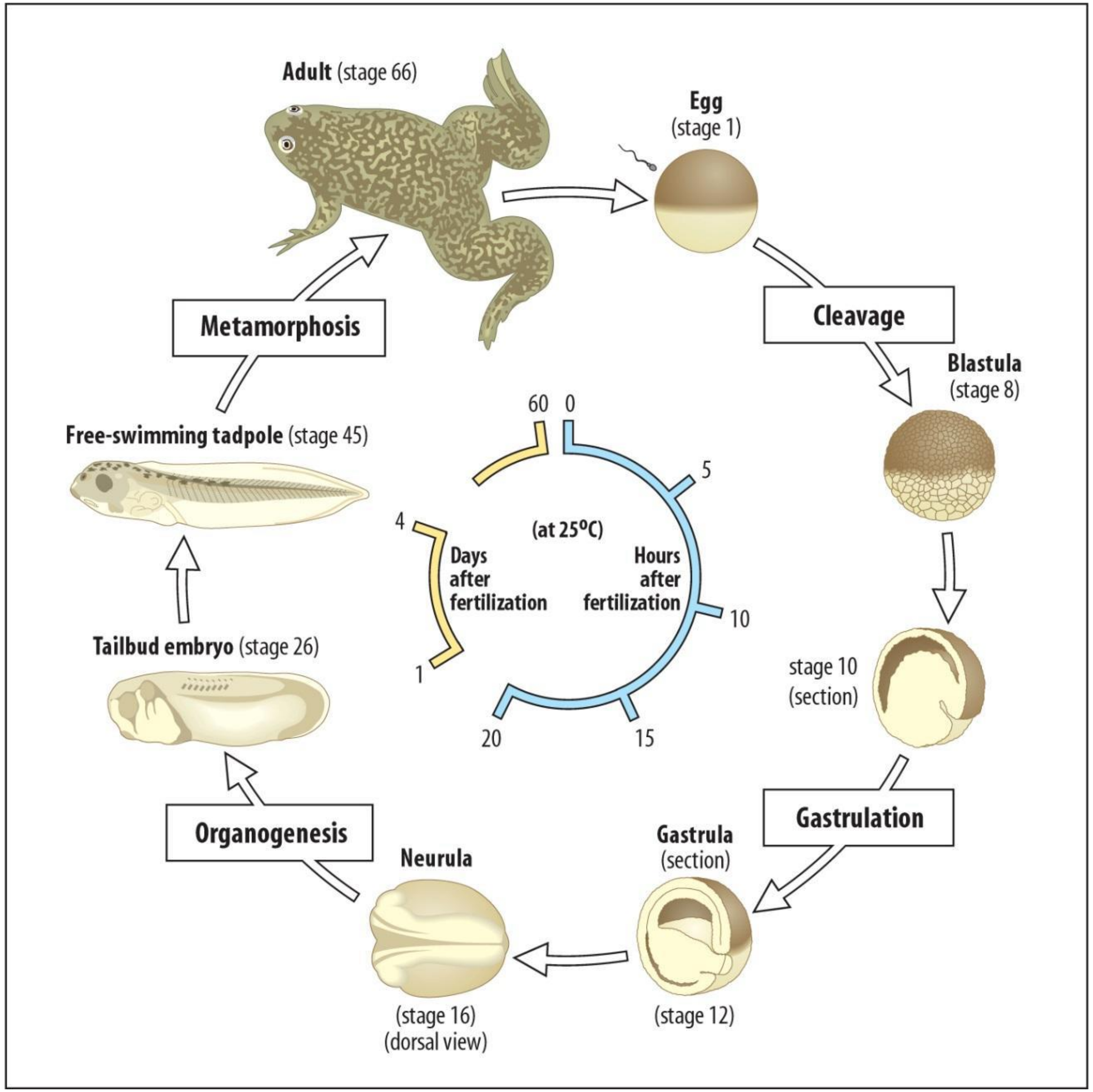
Xenopus Laevis



Reproduction in amphibians

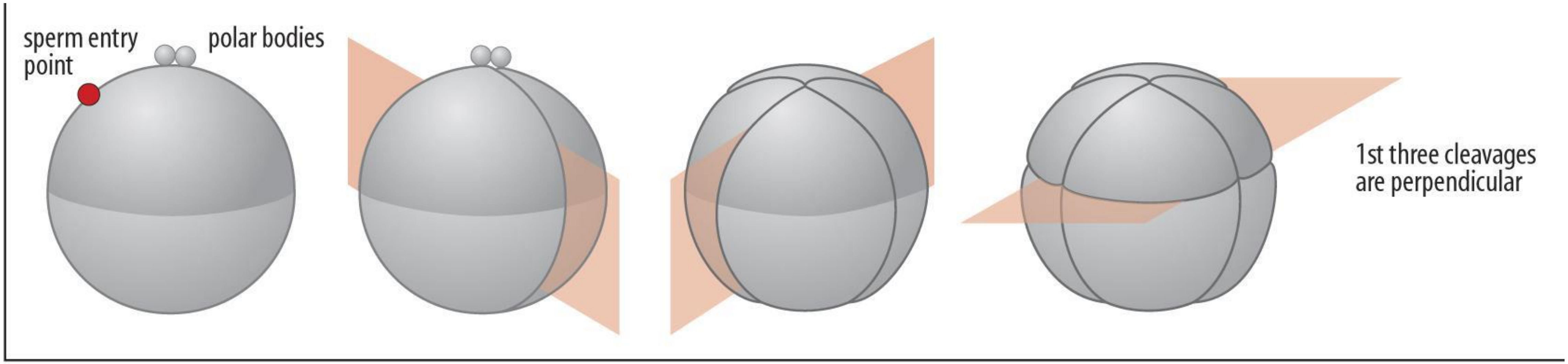




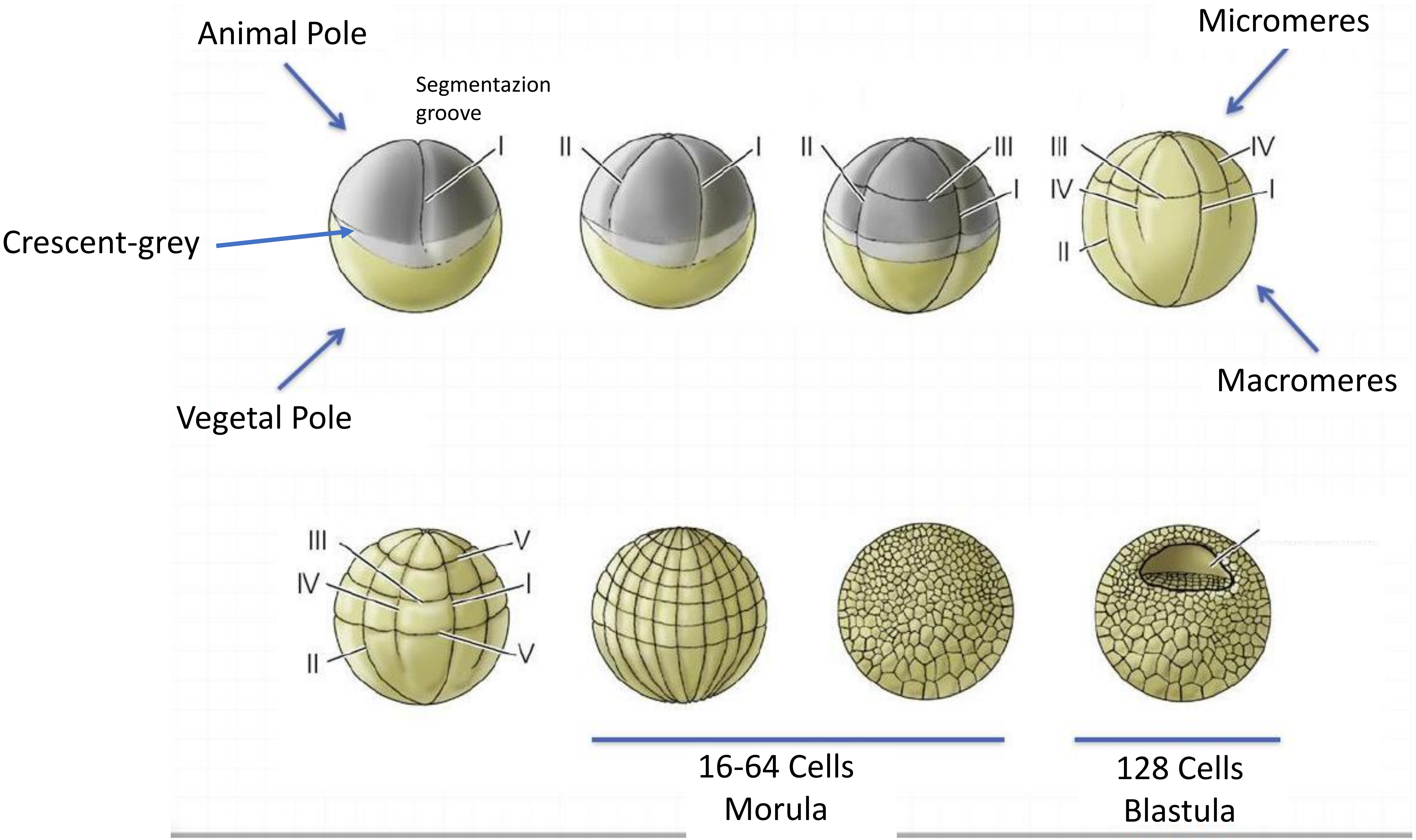


Reproduction in amphibians can be internal or external

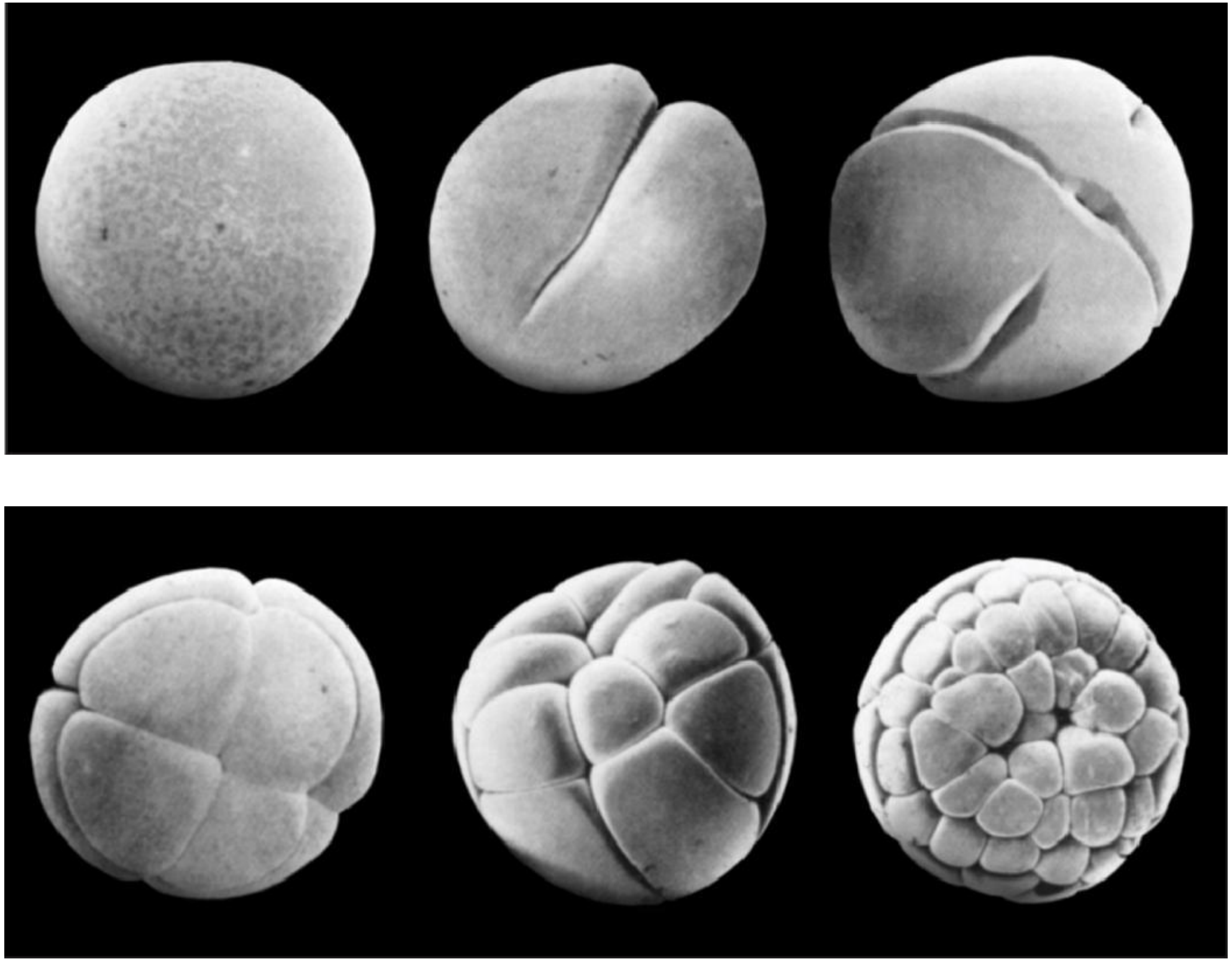
Mesolecitic egg → Radial unequal holoblastic segmentation



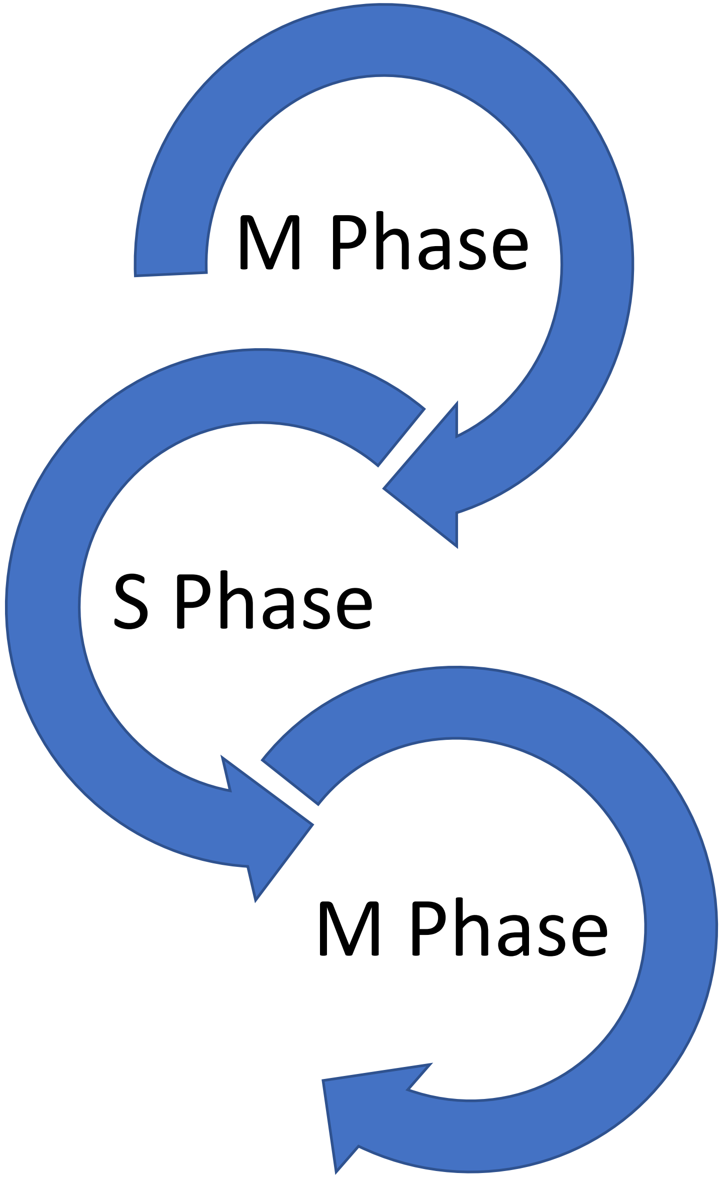
Radial unequal holoblastic segmentation



Xenopus Laevis Segmentation



Phase G is missing in the early stages of development

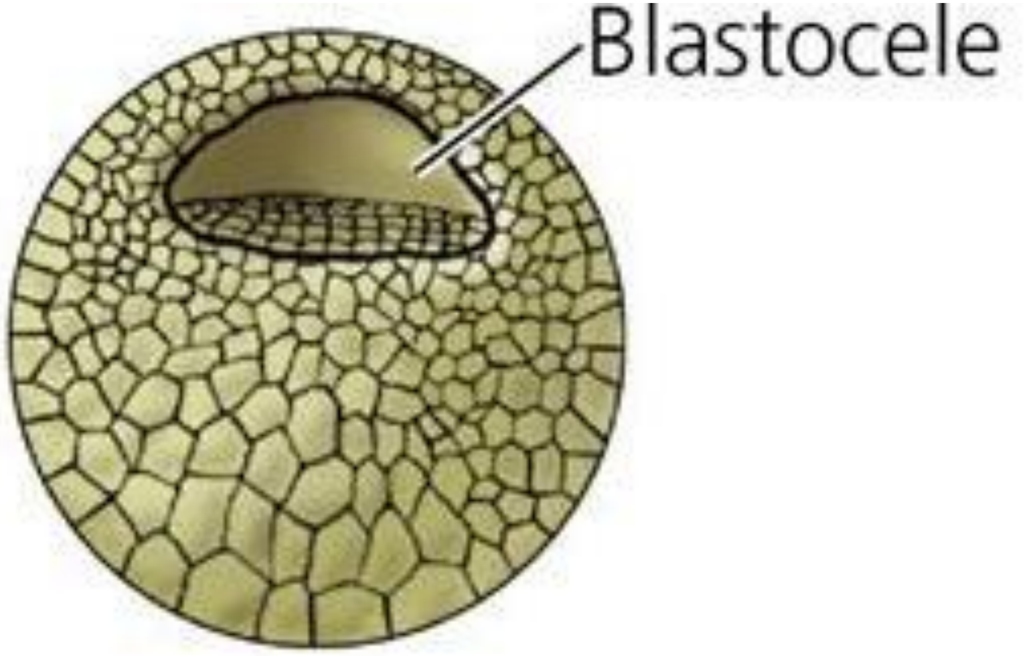


The cell cycle is regulated by the Mitosis Promoter Factor (MPF)

↑ MPF: entry to Mitosis

↓ MPF: entry to S phase

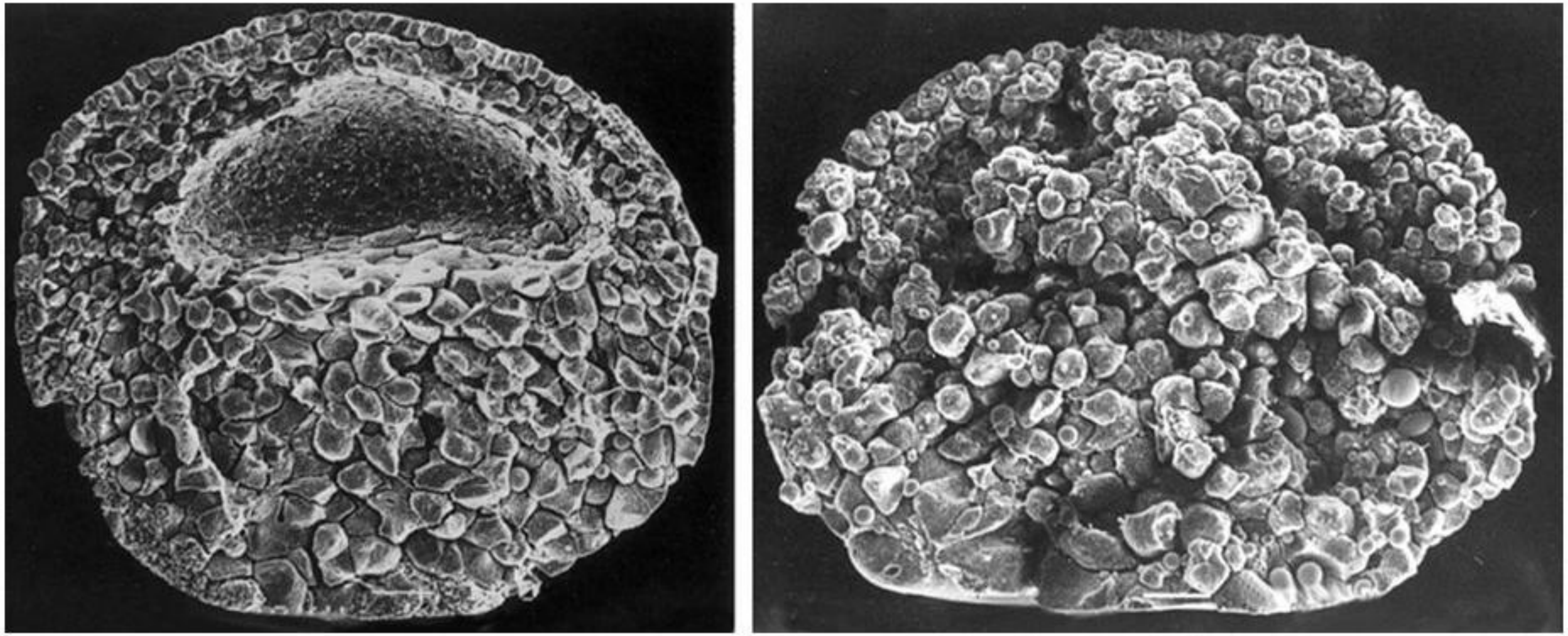
Blastocele functions



1. It allows the migration of cells during gastrulation
2. It prevents premature interaction between the cells above and below it

Adhesion between blastomeres is mediated by cadherins

CTR | **Anti-EP-Cadherins antisense oligonucleotides**



Heasman *et al*, 1994

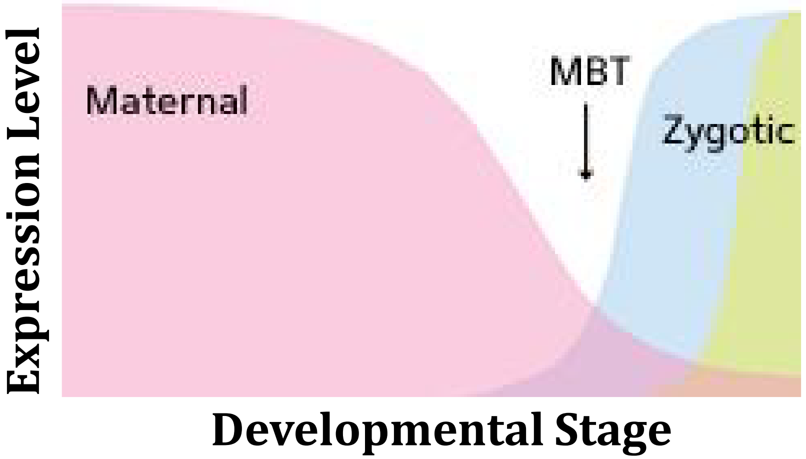
Mid-blastula transition (MBT)

Activation of the embryo's genome
Start around 12° division

associated with demethylation events of specific promoters

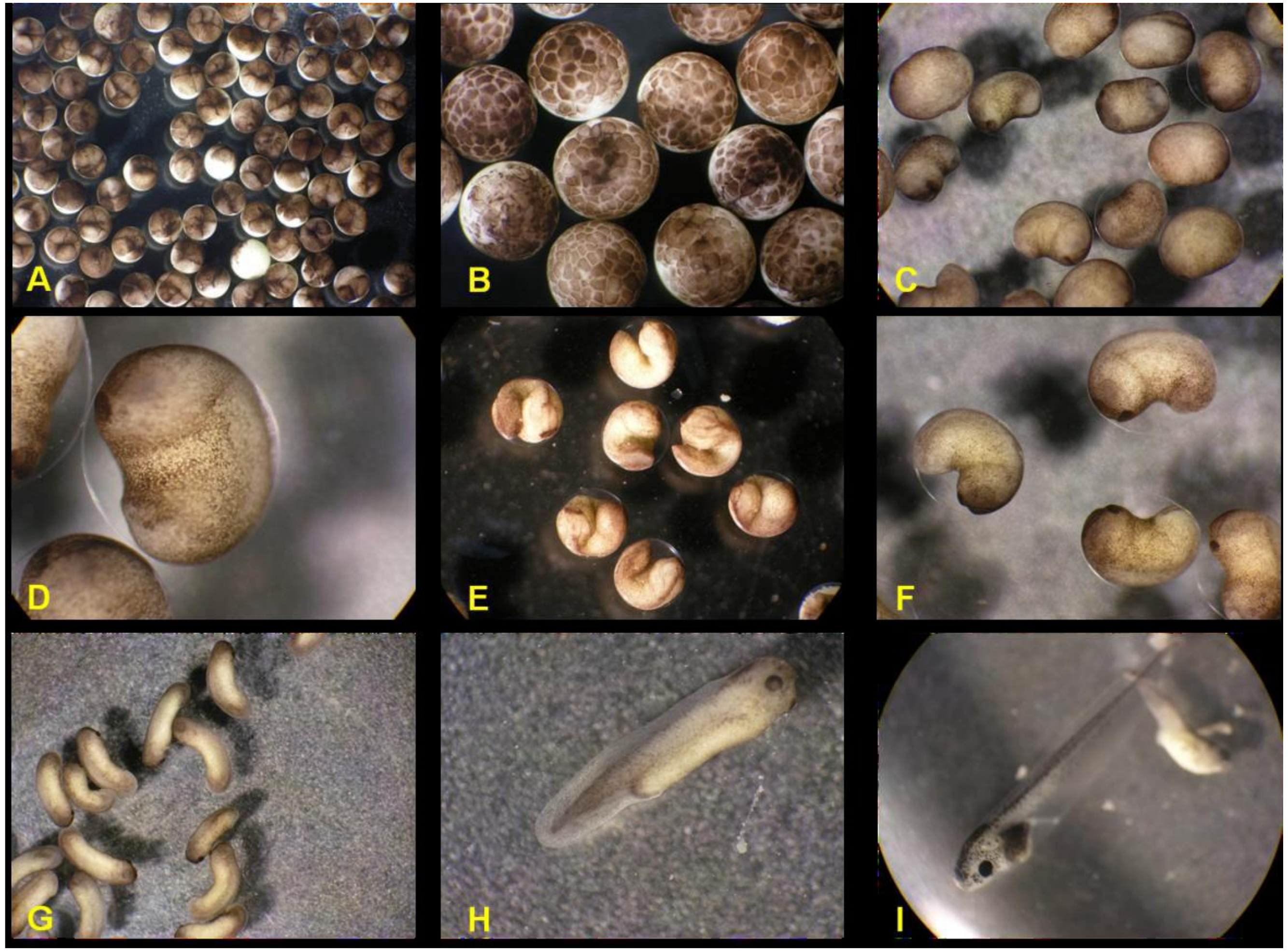
MBT is influenced by the cytoplasm / nucleus relationship and by a specific chromatin reorganization

Maternal and Zygotic Transcript during Development



In-depth analysis: Newport & Kirschner 1982, Yang et al, 2002

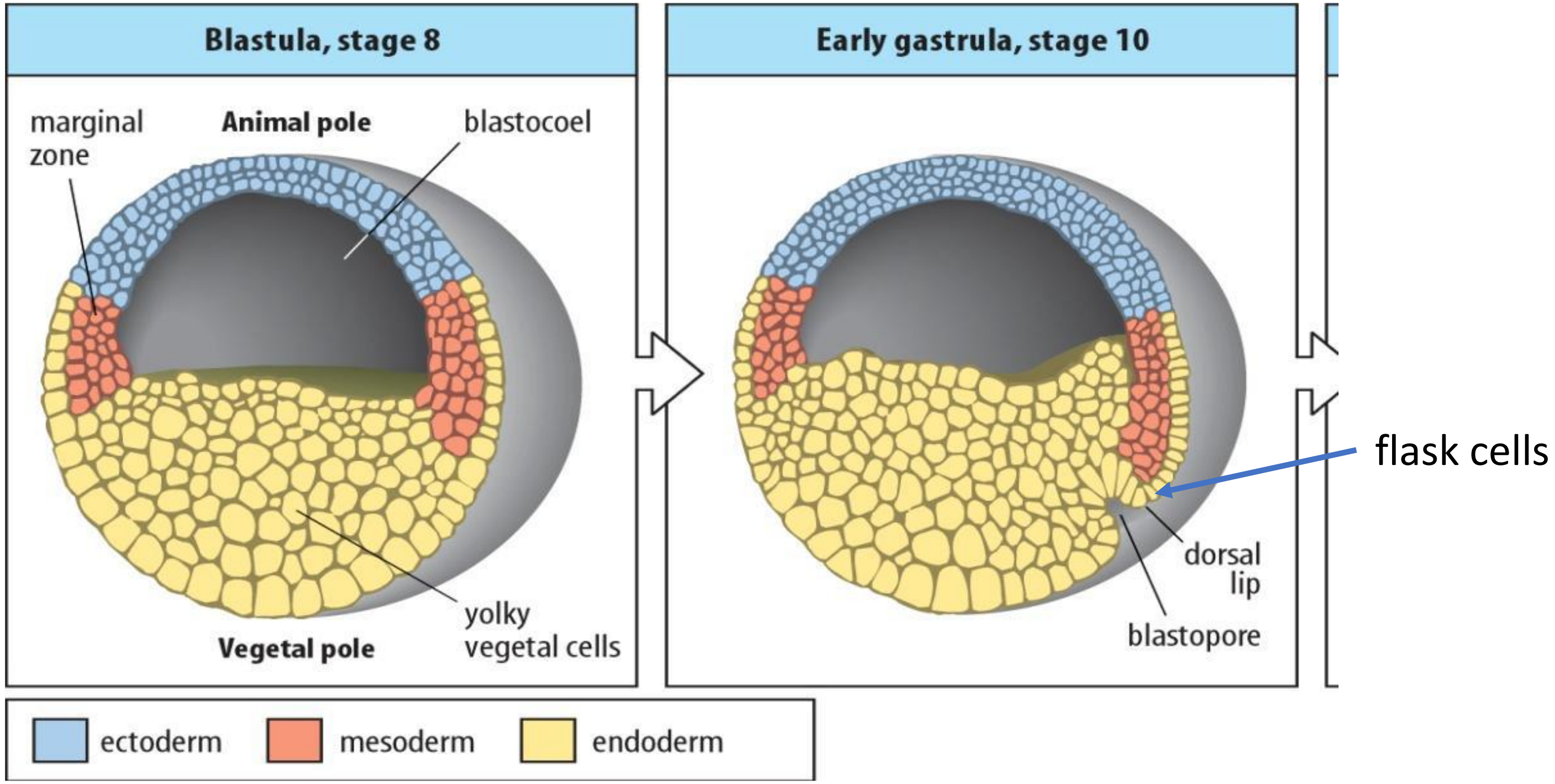
Gastrulation in Xenopus Laevis



Embryogenesis time course of *Xenopus laevis* oocytes until the tadpole stage. Courtesy of Dr. Daniel Fisher, IGMM, Montpellier, France.

Gastrulation in Xenopus Laevis (I)

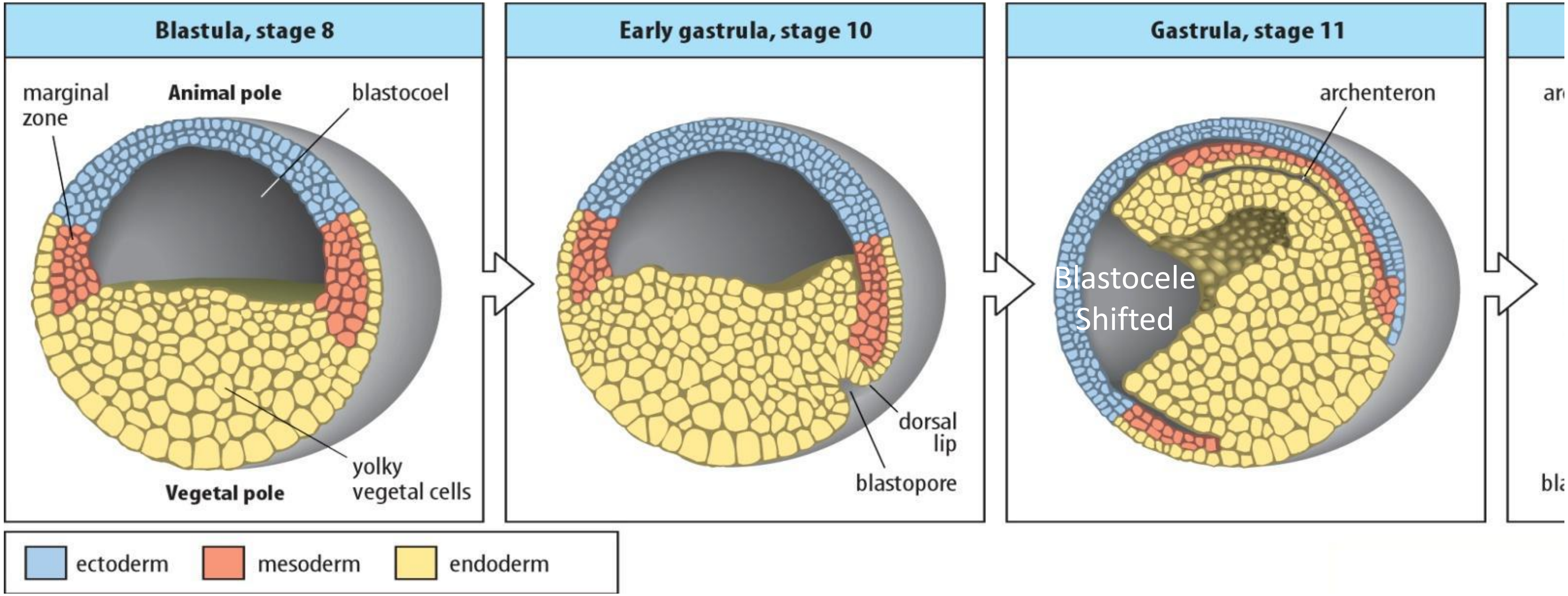
Initial phase



Invagination process, formation of the dorsal lip in a ventral direction

Gastrulation in Xenopus Laevis (II)

Intermediate Stage

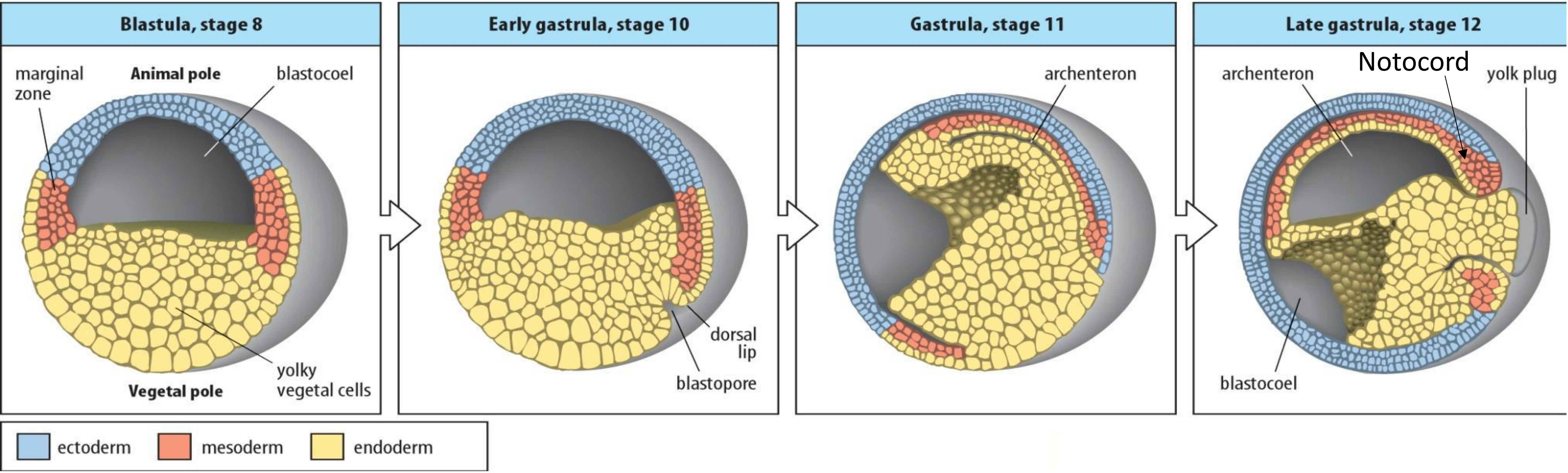


Formation of a new cavity: Archenteron (primitive digestive tract)

Cellular movements of involution, epibolia and invagination lead to the formation of the three embryonic layers

Gastrulation in Xenopus Laevis (III)

Final Stage



The embryo is coated with the ectoderm, the endoderm has been brought in, the mesoderm cells are arranged between ectoderm and endoderm

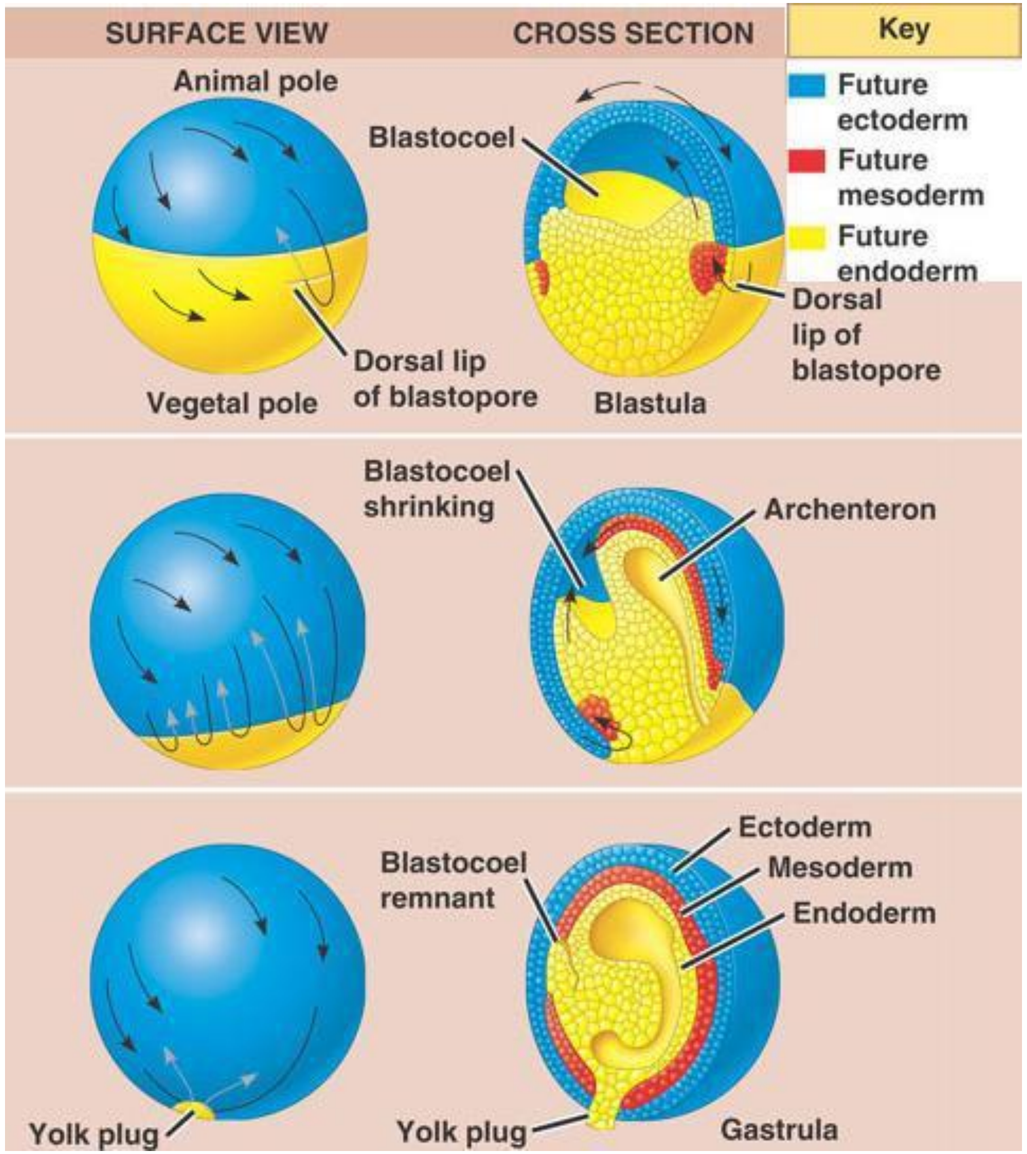
The blastocele is reduced until it disappears

At the end of the gastrulation the embryo consists of:

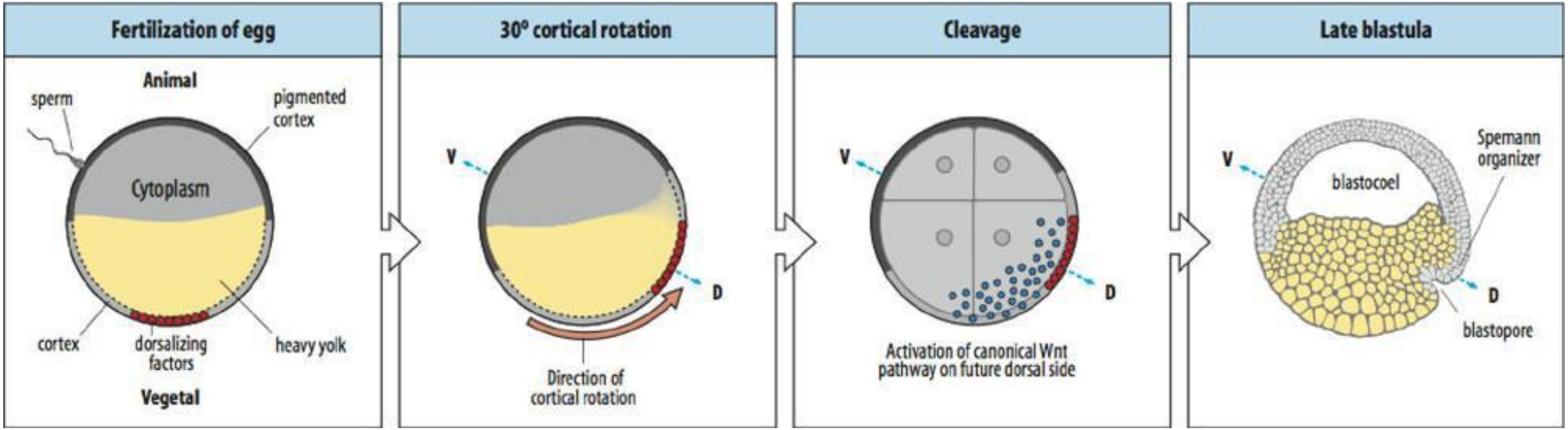
Ectoderma, external layer

Mesoderm, intermediate layer

Endoderm, internal layer



Determination of the axes

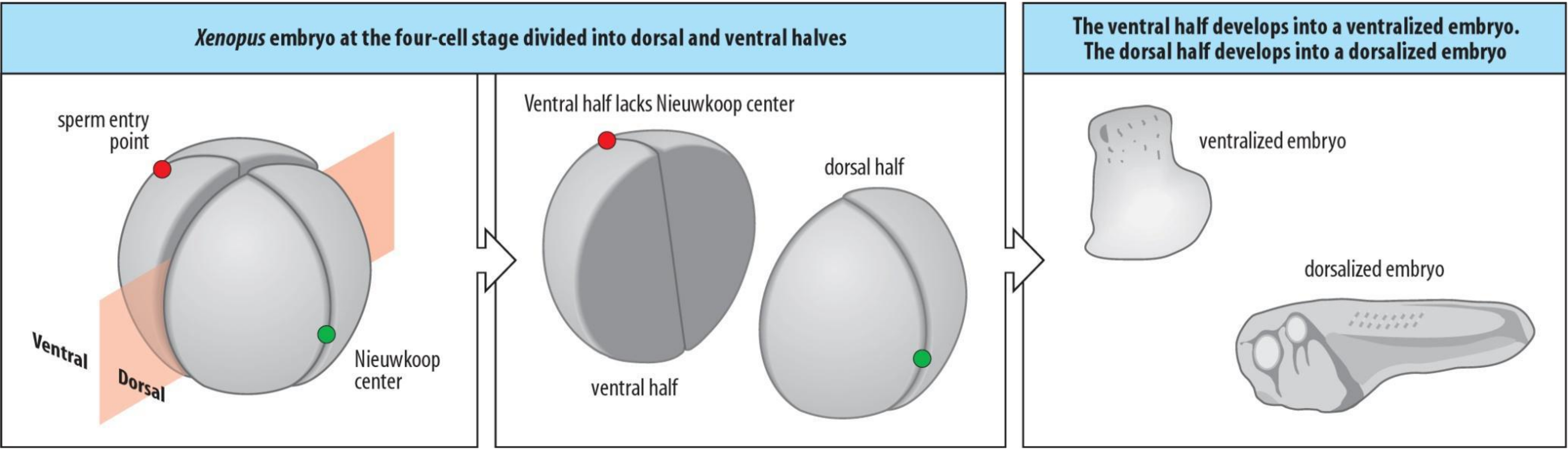


Axis

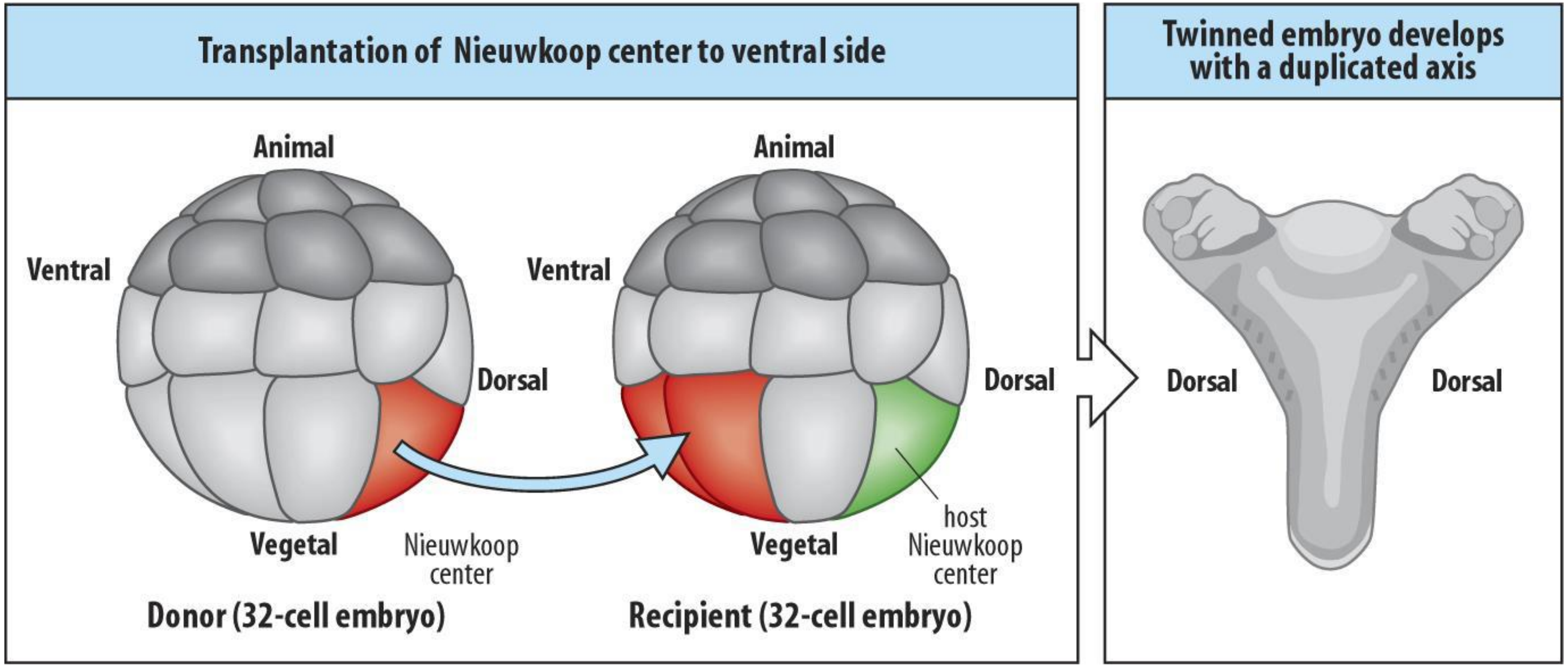
Dorsal – Ventral →
- Determined by sperm entry site
- Regulated from the center of Nieuwkoop and specific proteins

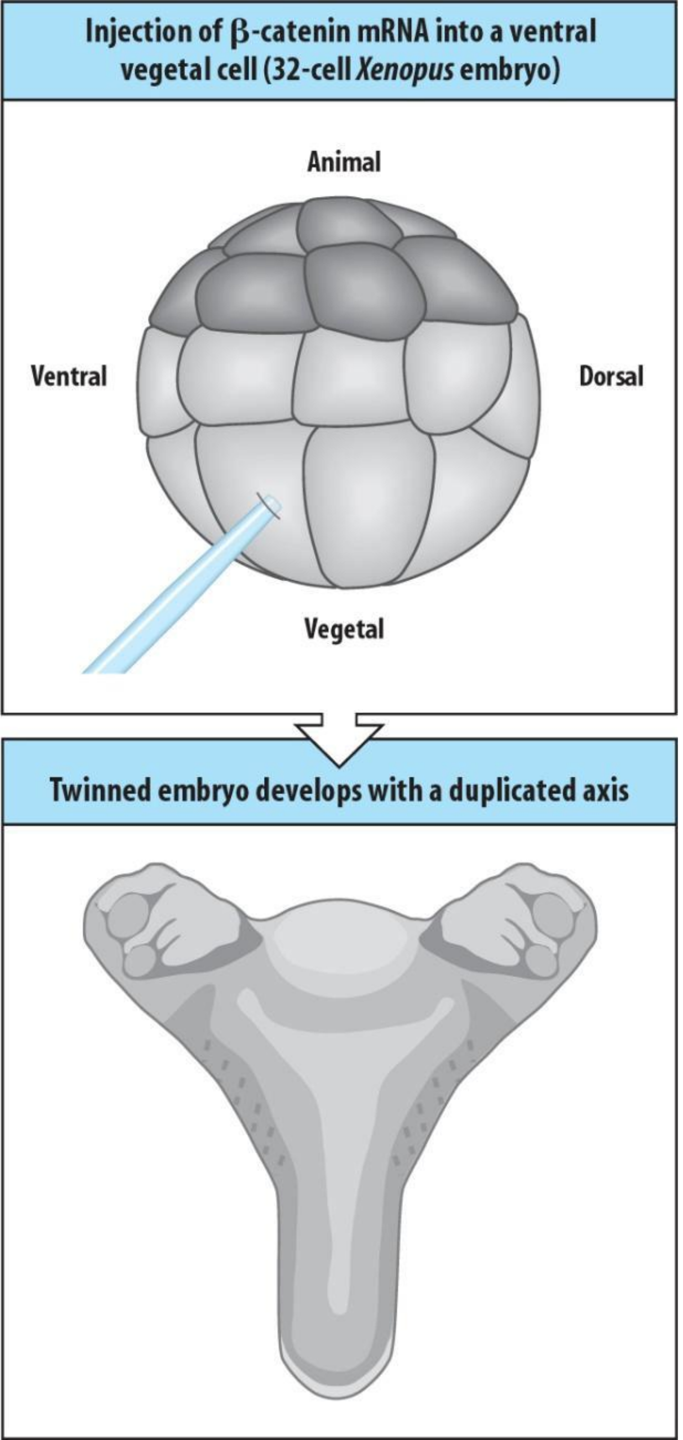
Anterior – Posterior → Regulated by Spemann organizer

The Nieuwkoop center is essential for normal development



The transplantation of cells containing the center of Nieuwkoop in a receiving blastula determines the formation of two dorsal axes





β-catenin cooperates with the Nieuwkoop center in the formation of the dorsal-ventral axis.

It accumulates in the dorsal region starting from the 16-cell stage

It is a component of the Wnt pathway

- **β-catenin** is synthesized from mother mRNA

- **Dishelled proteint (Dsh)** traslocation from ventral region to dorsal region after fertilization

- β-catenin is degradeited by **Glycogen Synthase kinase 3 (GSK3)**

- GSK3 is inhibited by **GSK3 binding protein (GBP)** and Dsh