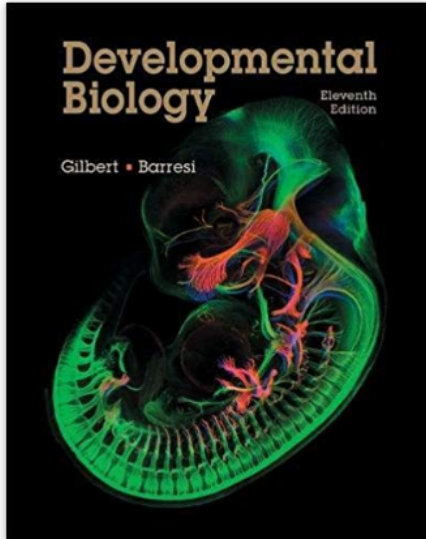


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di [Scott F. Gilbert](#) (Autore), [Michael J. F. Barresi](#) (Autore)

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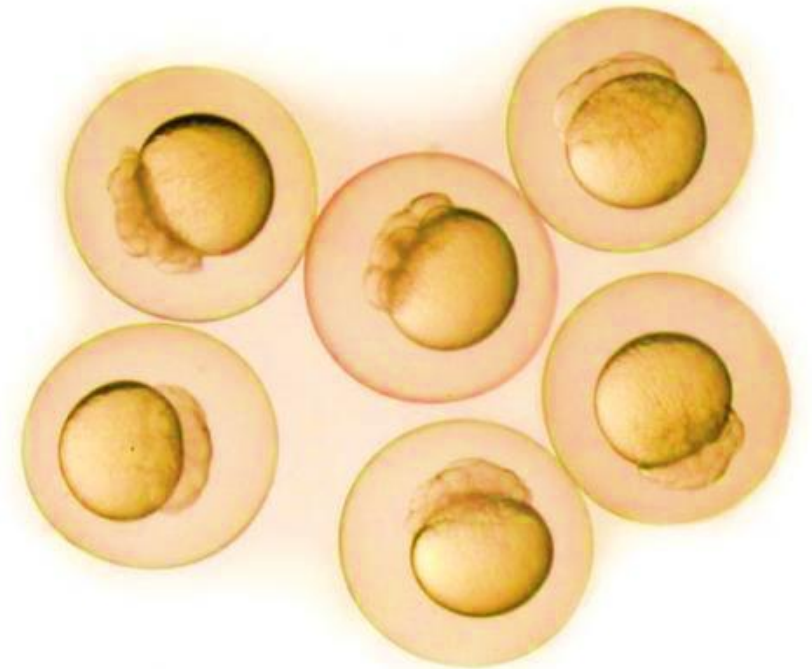
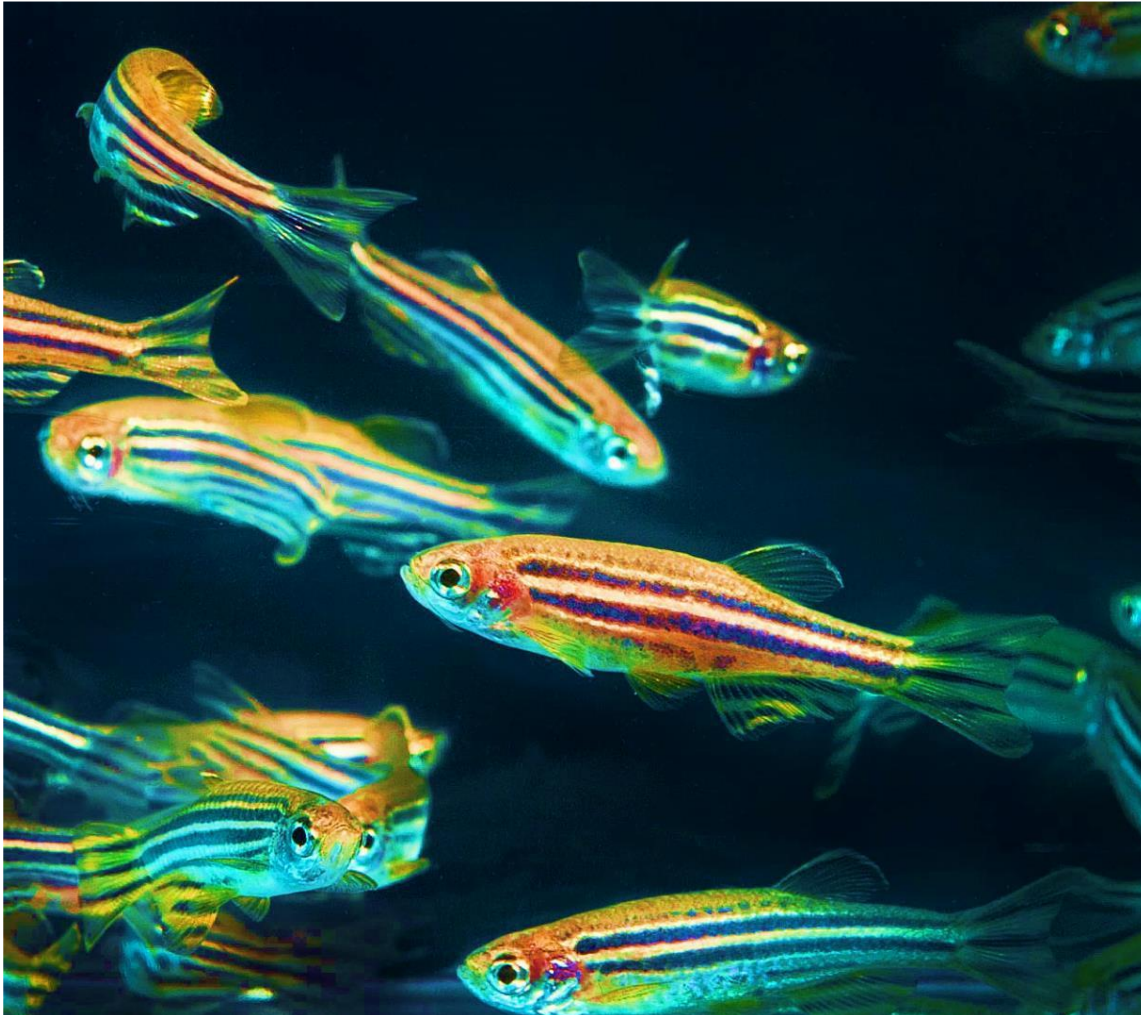
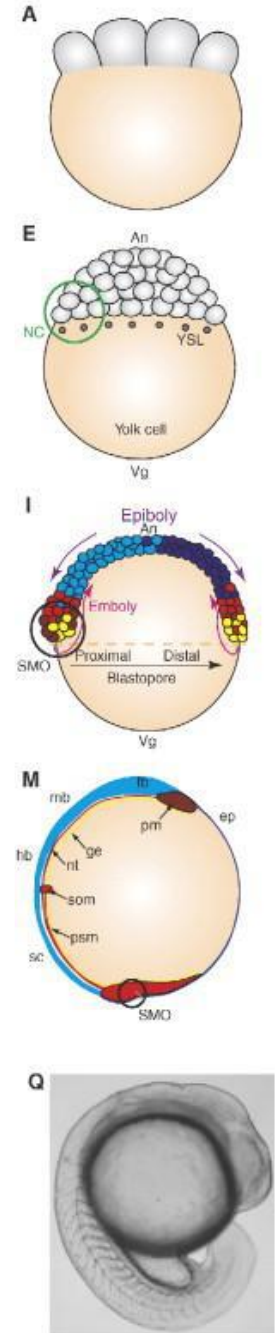
An embryo development model

Fish

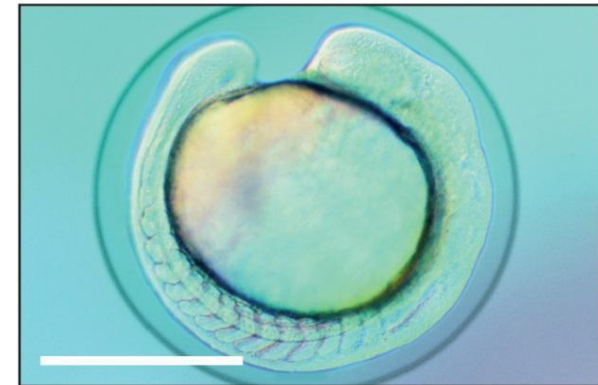
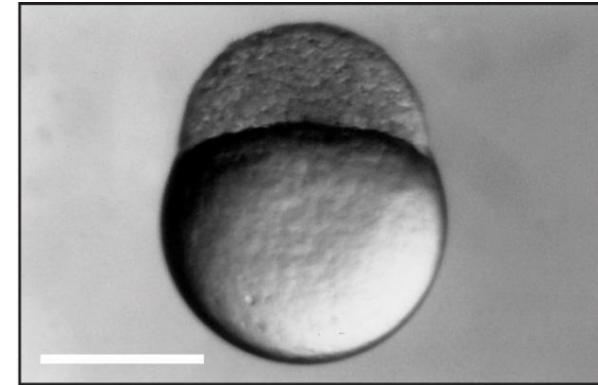
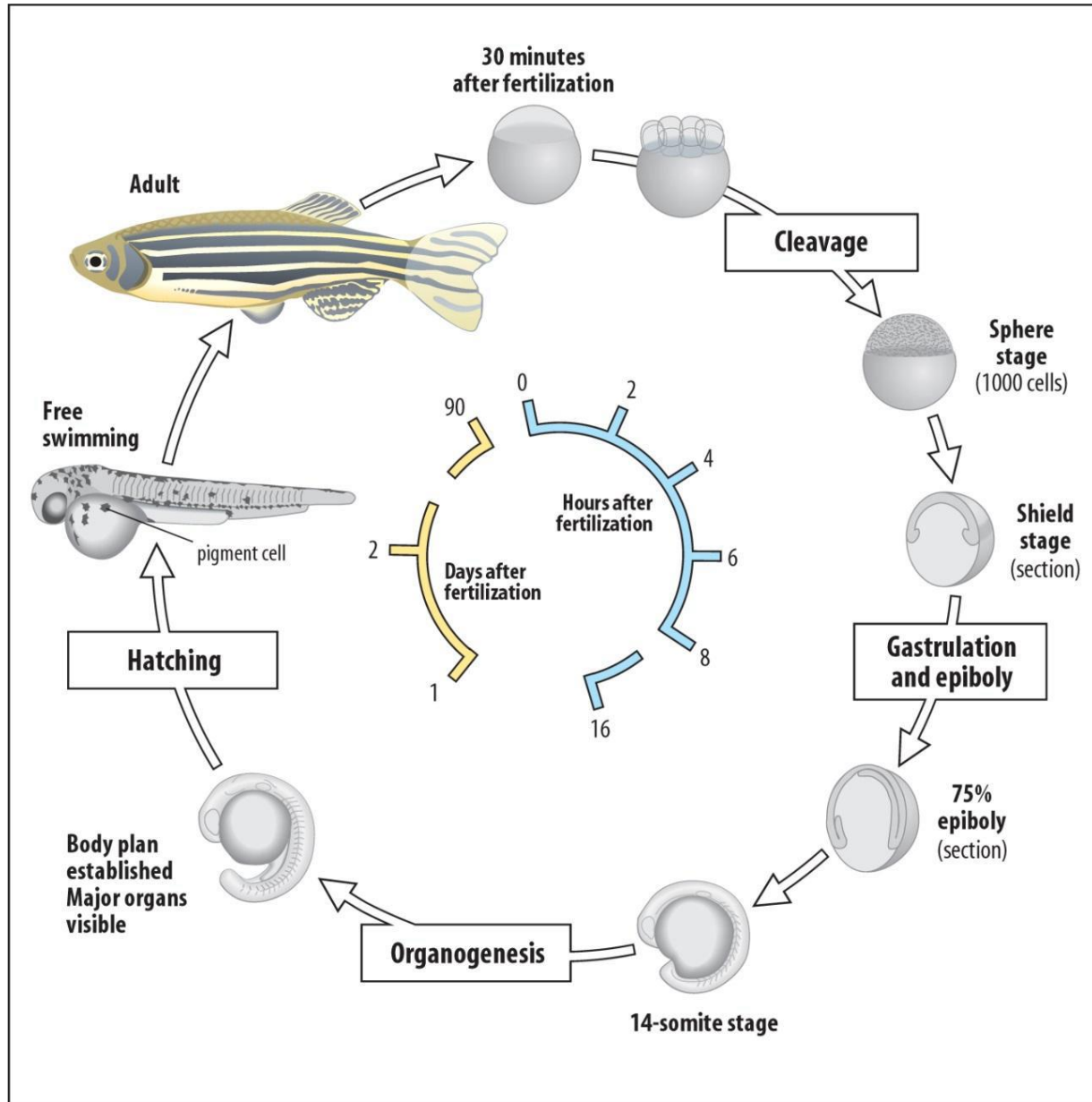


Zebrafish
Danio rerio

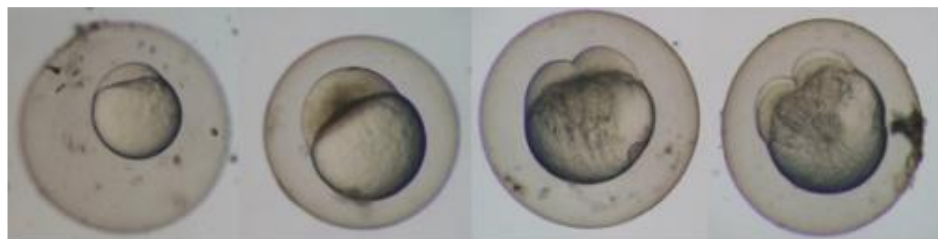
Danio rerio, Zebrafish



Zebrafish Development



Zebrafish First Development Stages

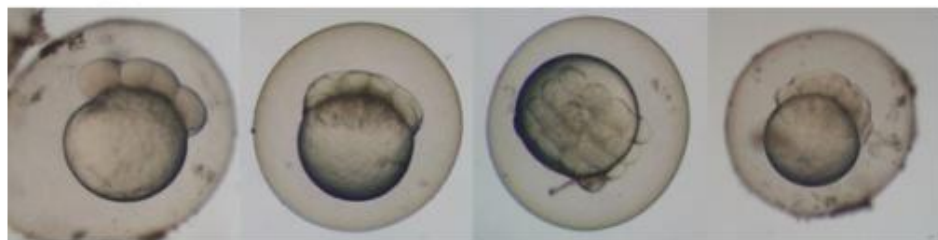


zygote

1-cell

2-cell

4-cell

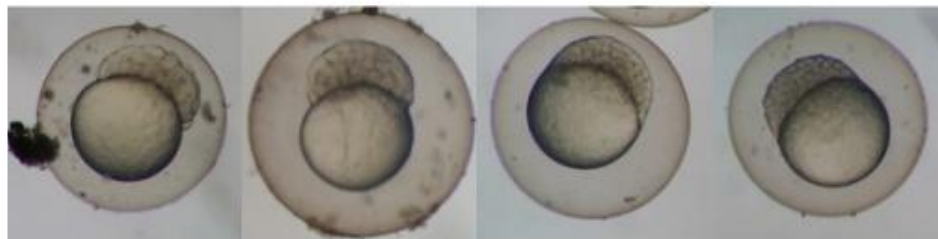


8-cell

16-cell

16-cell

32-cell

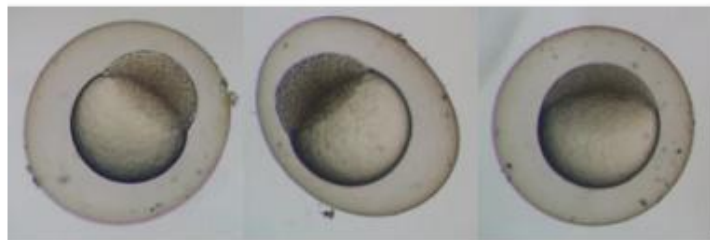


64-cell

128-cell

256-cell

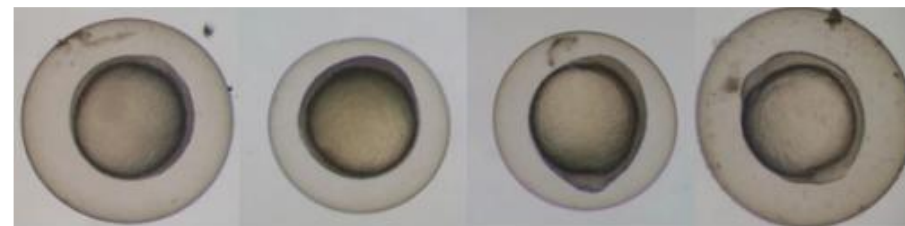
512-cell



1K-cell

2K-cell

oblong

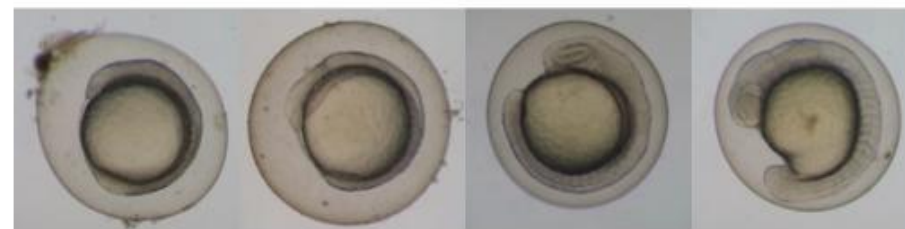


80% epiboly

90% epiboly

tailbud

2-somite

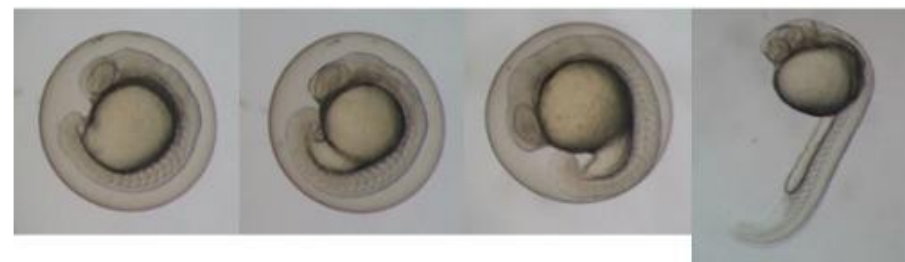


5-somite

10-somite

12-somite

14-somite



17-somite

18-somite

20-somite

prim-5



prim-11

48-hour

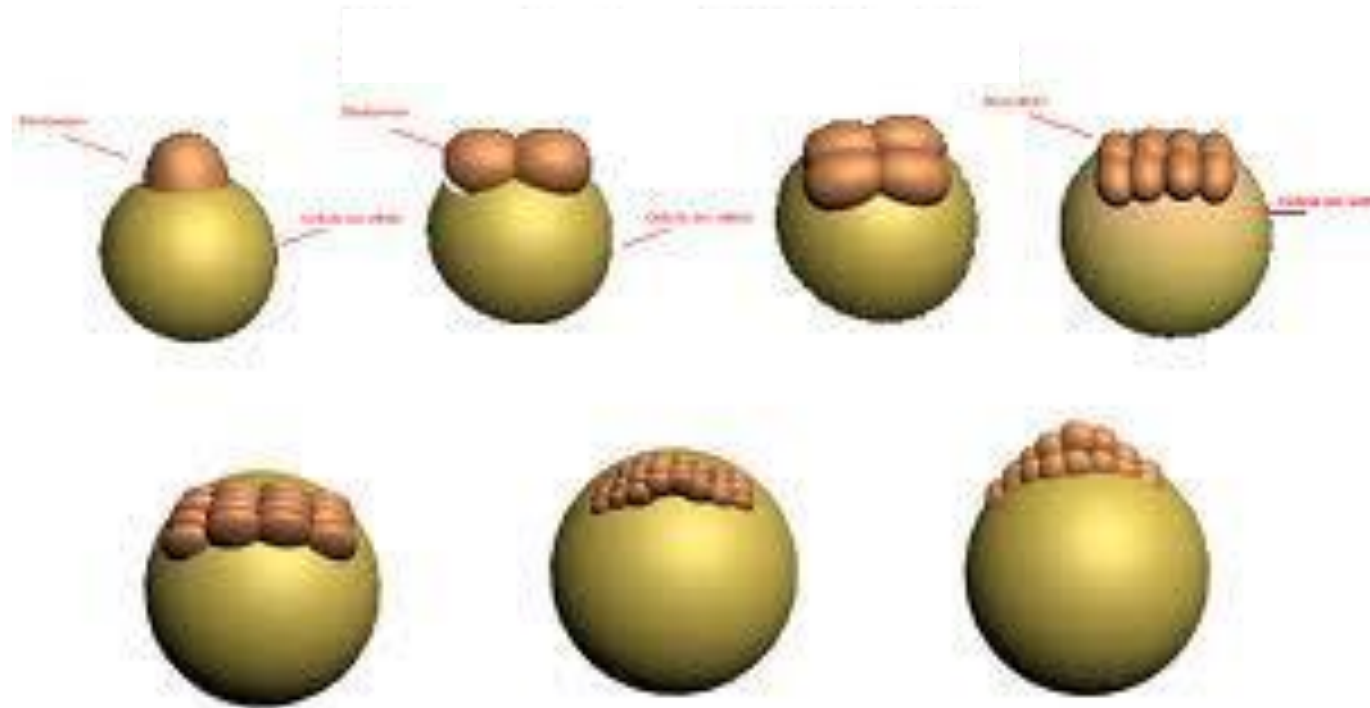
72-hour

Segmentation in Zebrafish

Telolecithal egg



Discoidal Meroblastic Segmentation



Fertilization



Intracellular calcium increase



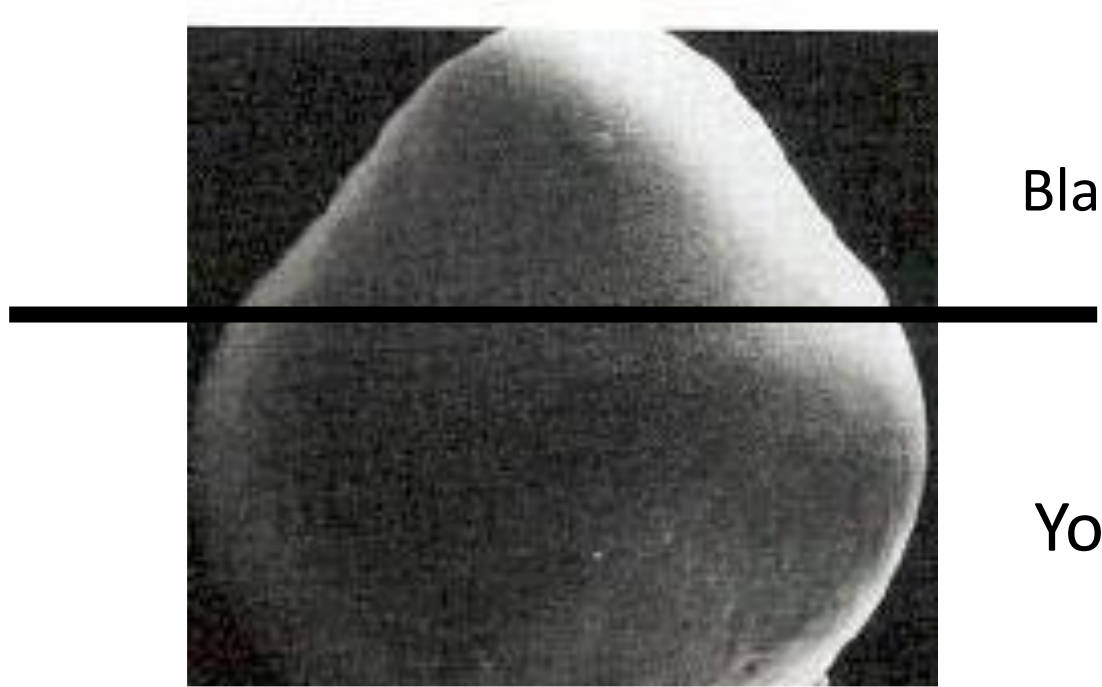
Actinic cytoskeleton contraction



The calf-free cytoplasm is pushed towards the animal pole

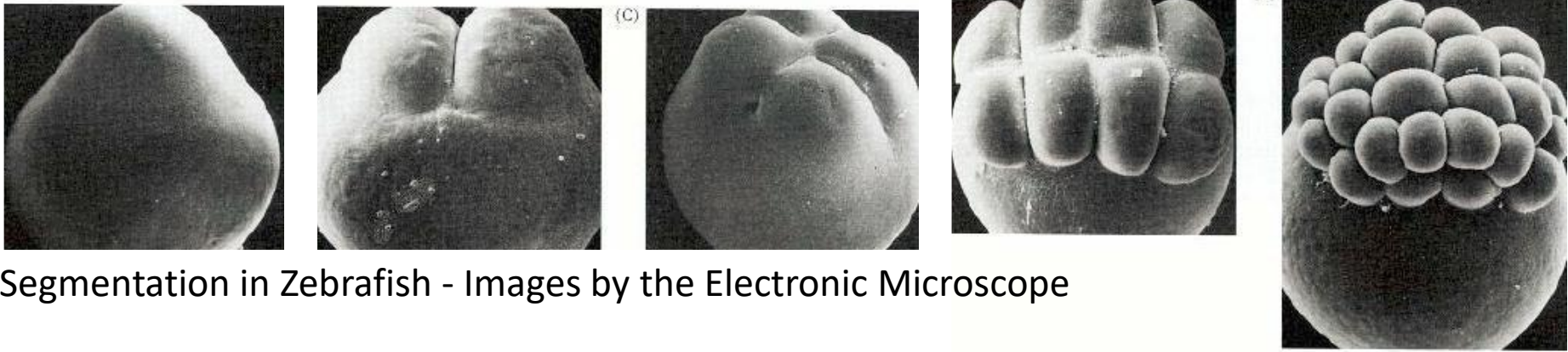


Piriform zygote



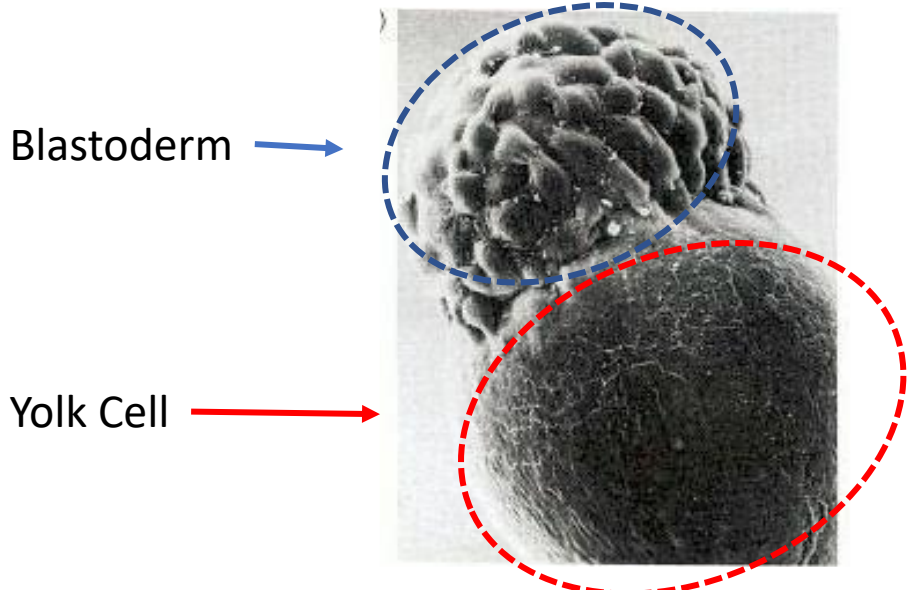
Blastodisc

Yolk



Segmentation in Zebrafish - Images by the Electronic Microscope

The first 12 divisions are synchronous at 15 minute intervals



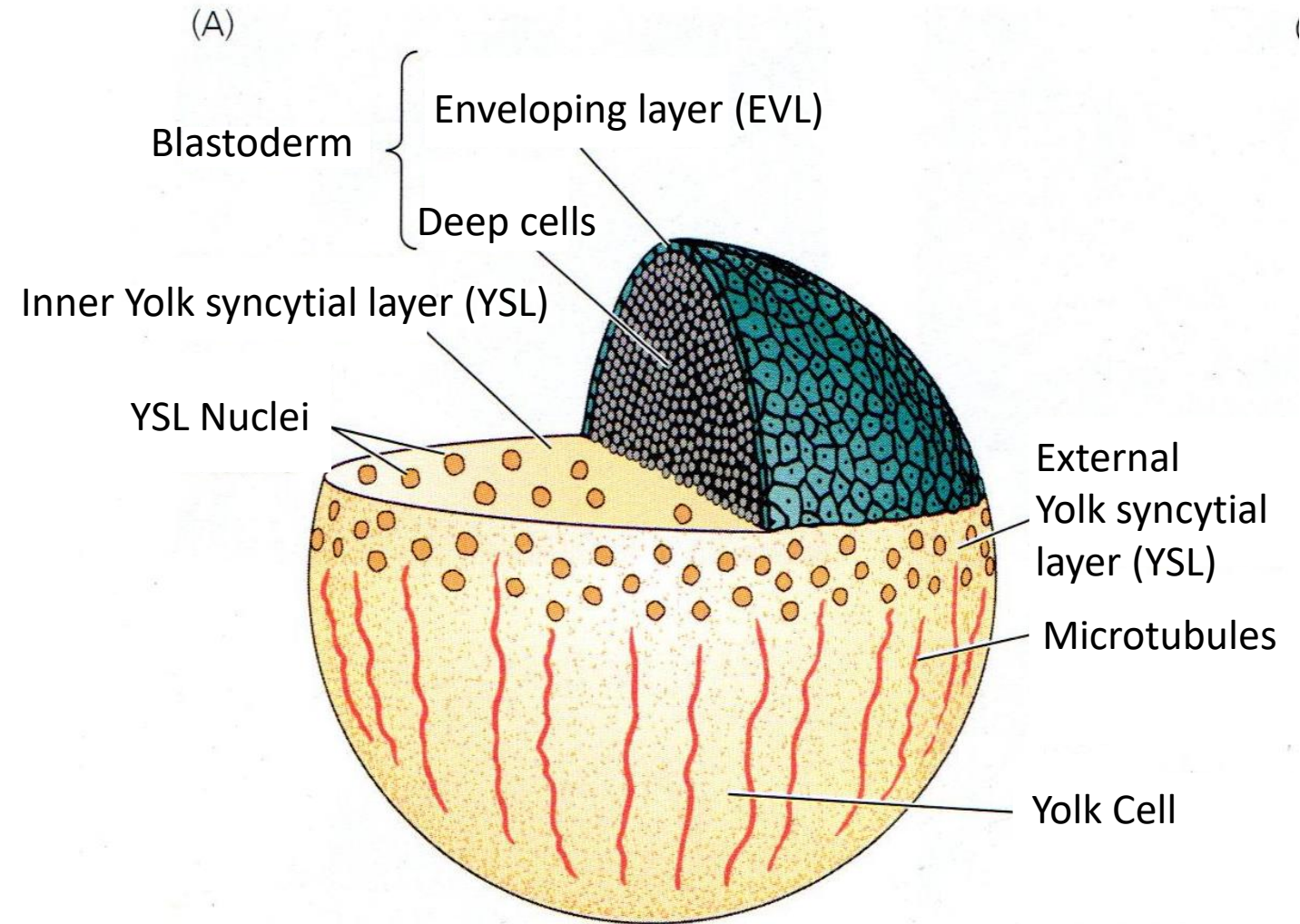
Starting from the 10th division we have MBT and the cell divisions slow down

In Blastula we can distinguish 3 cellular populations:

1. Yolk Syncytial Layer (YSL)

2. Enveloping Layer

3. Deep Cells



Yolk Syncytial Layer (YSL)

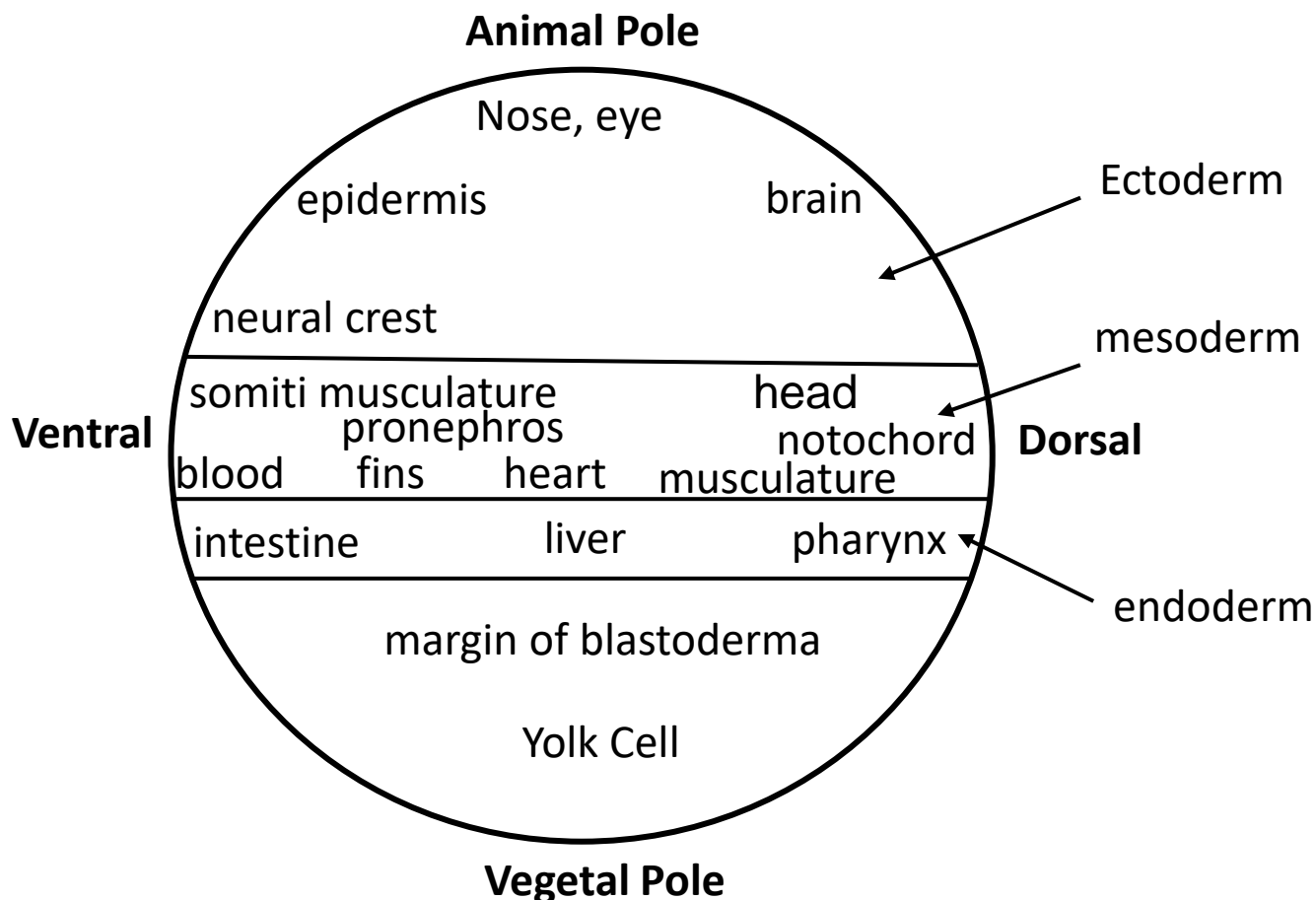
- It is formed from the fusion of the cells to the vegetative margin of the blastoderma with the underlying yolk cell
- Following cellular movements of the blastoderma, **inner YSL** (below the blastoderm) and **external YSL** (in front of the blastoderm margin) can be distinguished
- YSL will be important for directing certain movements during gastrulation

Enveloping Layer

- It consists of the outermost blastoderm cells that form a monolayer epithelial lamina
- EVL forms an extra-embryonic protective coating (**periderm**) which detaches during subsequent development

Deep Cells

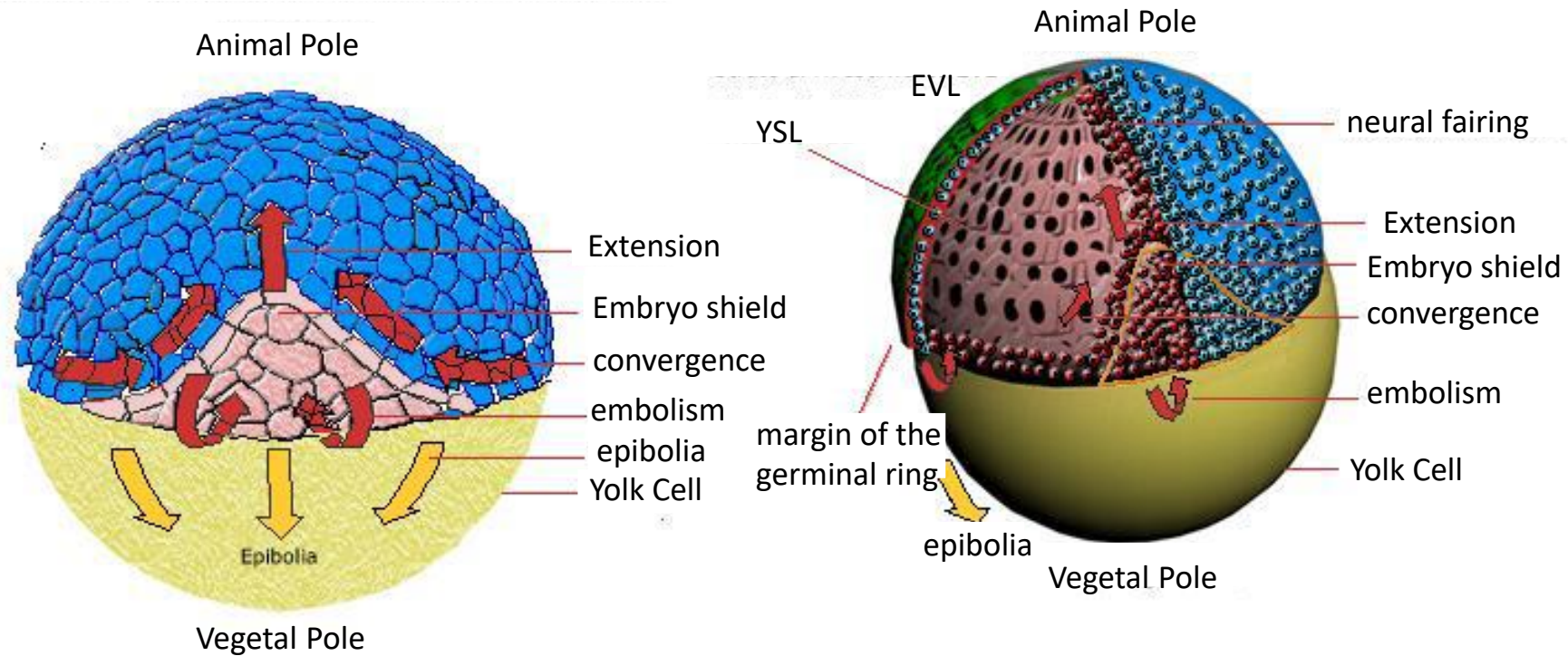
- They are placed between YSL and EVL
- They will give rise to the actual embryo



**Presumptive map of deep cells
at the end of mixing**

Gastrulation in Zebrafish

Fish gastrulation starts with the epibolia of blastoderm cells above the yolk



Cellular movements during gastrulation

Epibolia → Expansion of the blastoderma above the yolk



Thickening of the blastoderma

Germinating ring



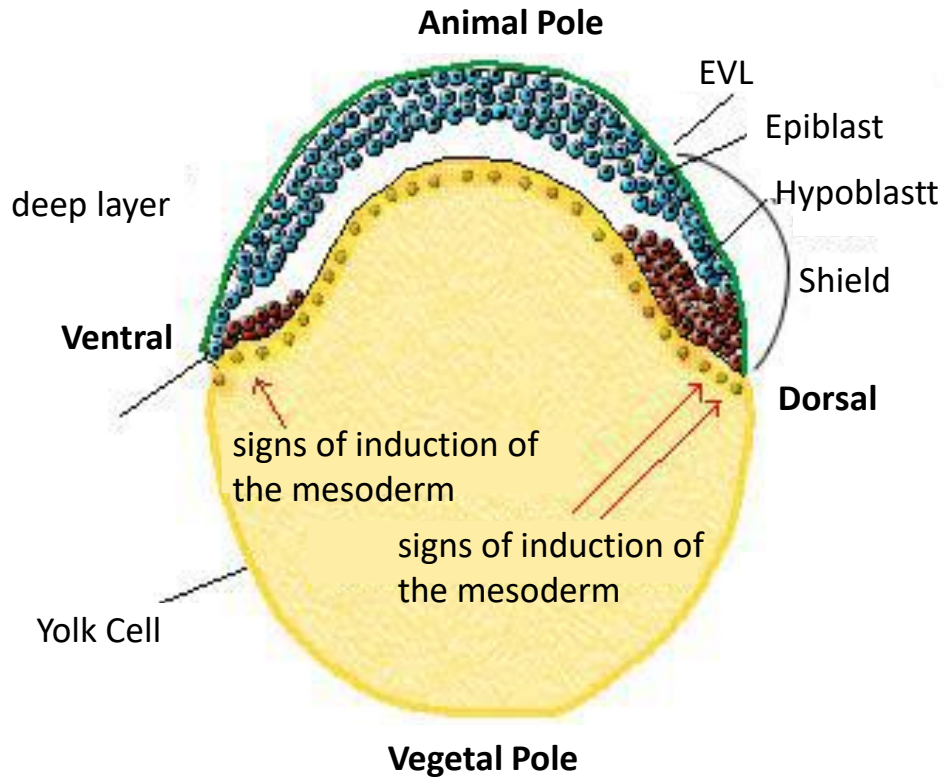
Hypoblast

Epiblast

Endoderm, mesoderm

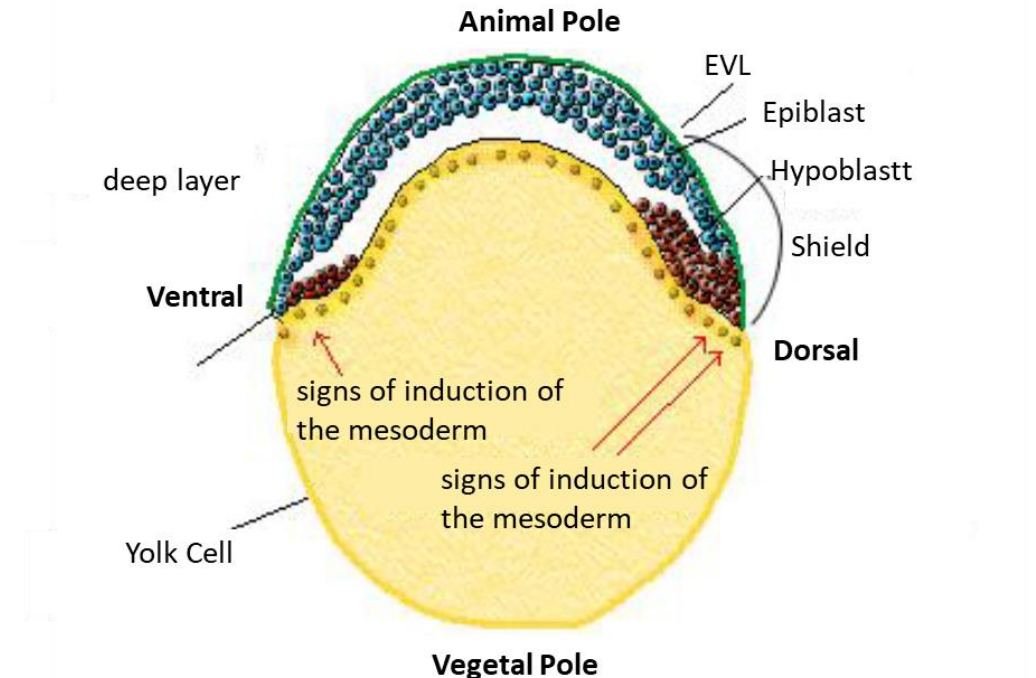


Movement on the dorsal side of the embryo

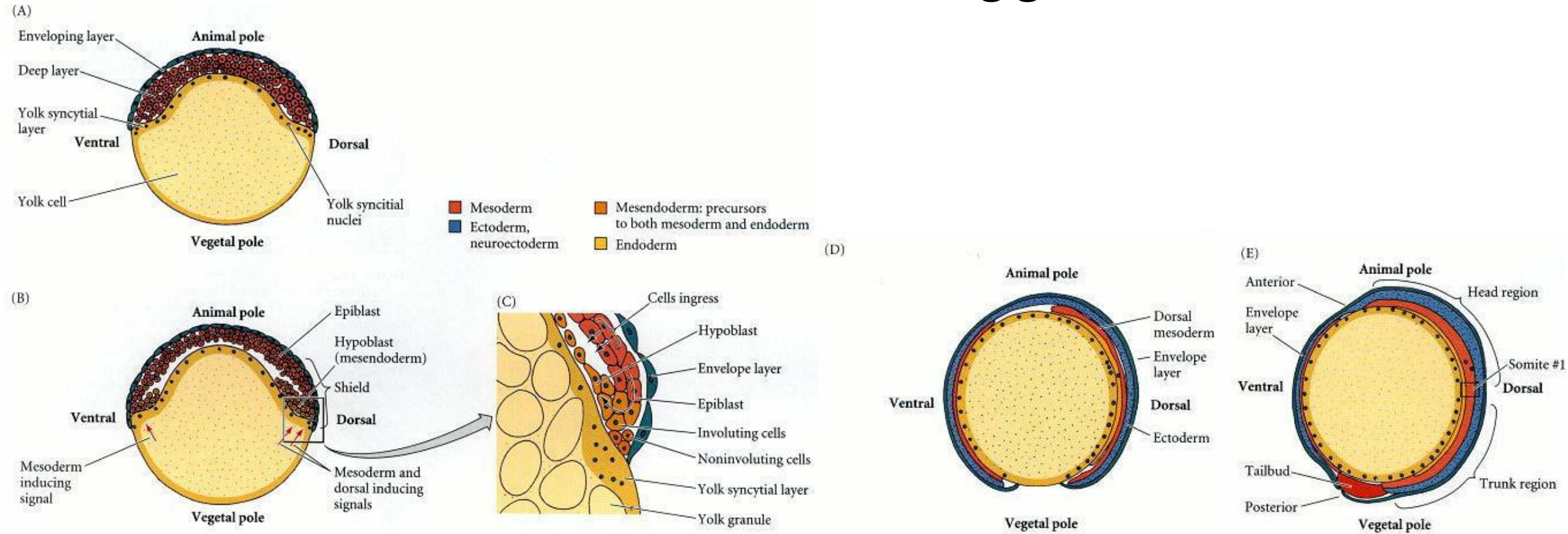


- 1) The **hypoblast** is formed by a synchronous internalization «wave» that has some **entry** characteristics (especially in the dorsal region).
- 2) The cells of the future mesoderm (hypoblasto) migrate initially towards the vegetative part and at the same time proliferate to produce new mesoderm cells
- 3) The hypoblast and epiblast cells interlayer in the future dorsal side of the embryo, forming a localized thickening

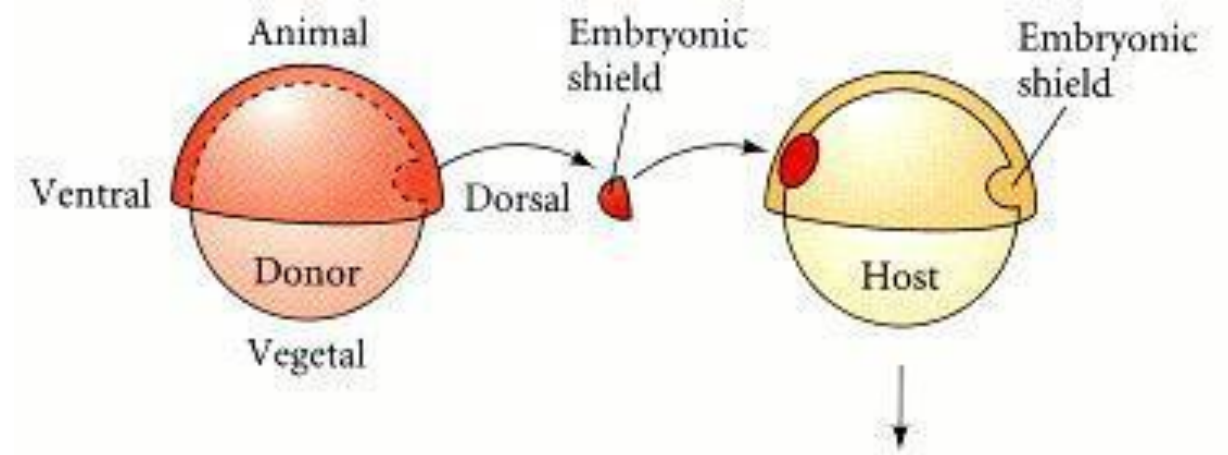
↓
Localized thickening
Embryo shield



Cellular movements during gastrulation

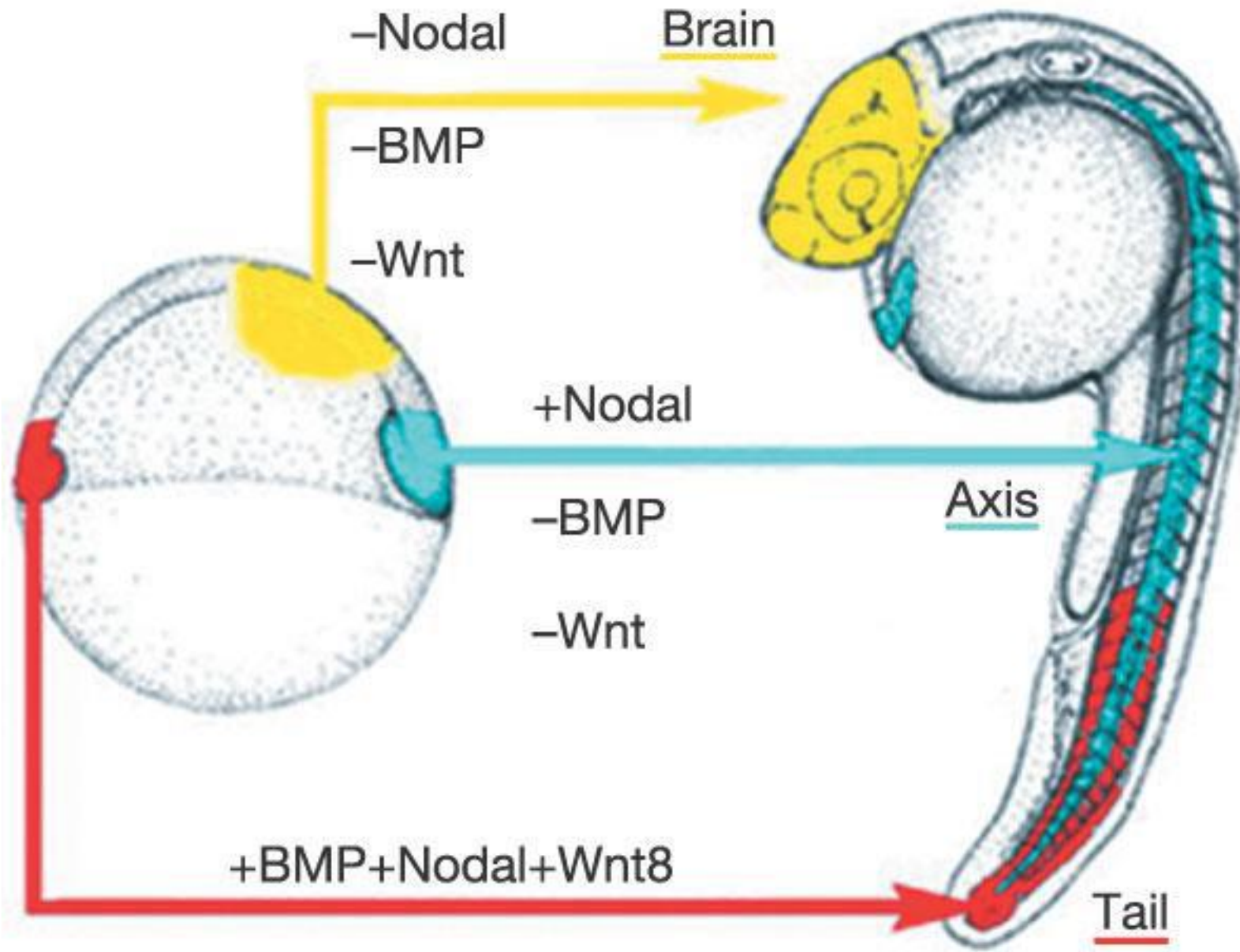


- A. Blastoderm – 30% Epobolia
- B. Hypoblast formation
- C. Enlarged image of the marginal region
- D. Stage 90% epibolia, presence of mesoderm around the yolk, between endoderm and ectoderm
- E. Complete gastrulation

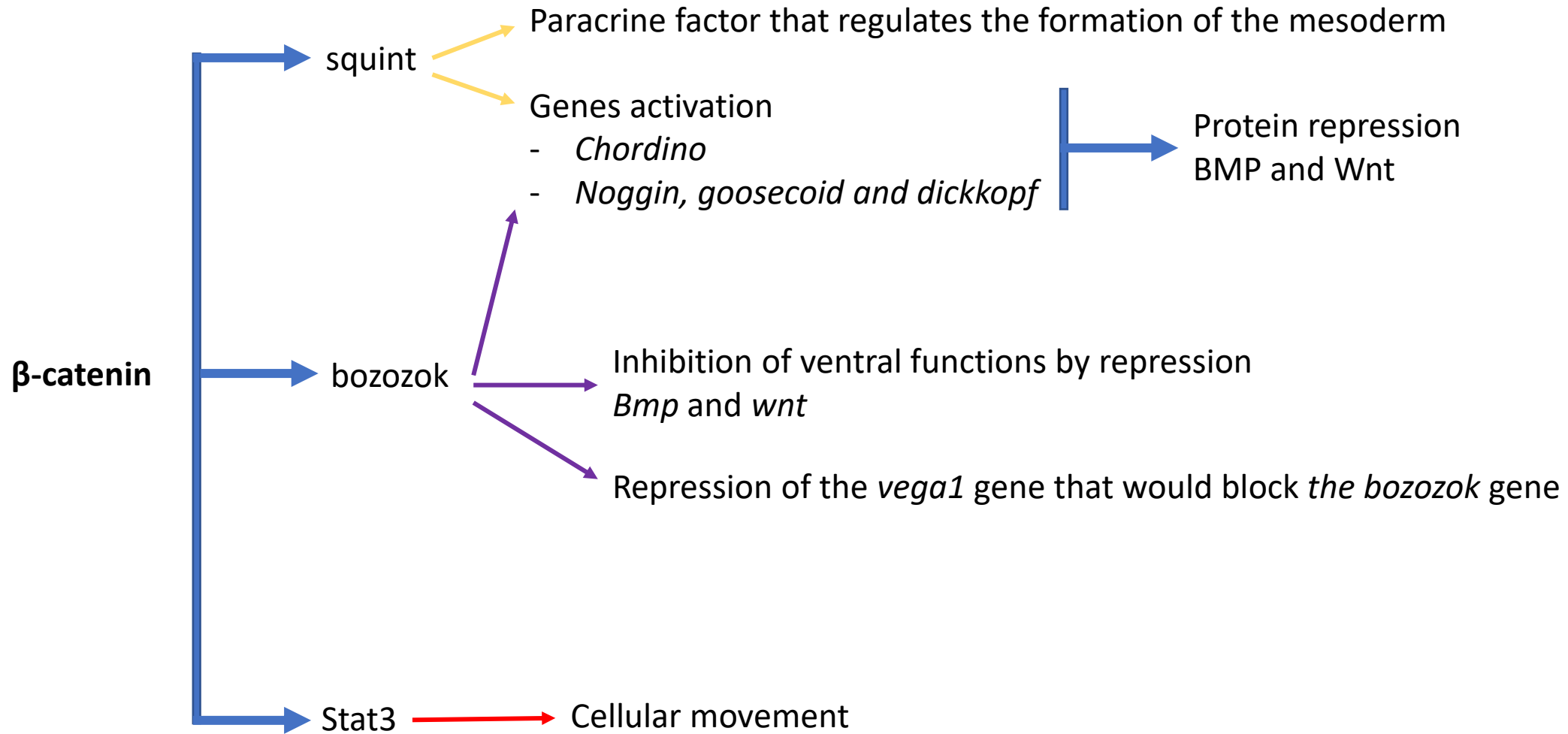


The embryonic shield is the organizer of the fish embryo

Axis formation in Zebrafish



The embryonic shield regulates the formation of the ventral- dorsal axis

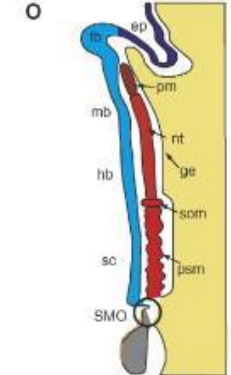
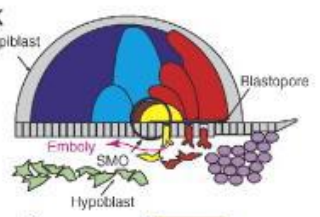
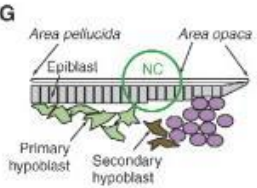
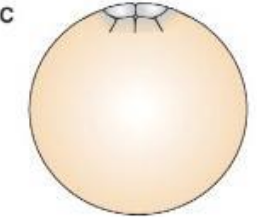


The Wnt 8 protein has a central role in determining the anteroposterior axis

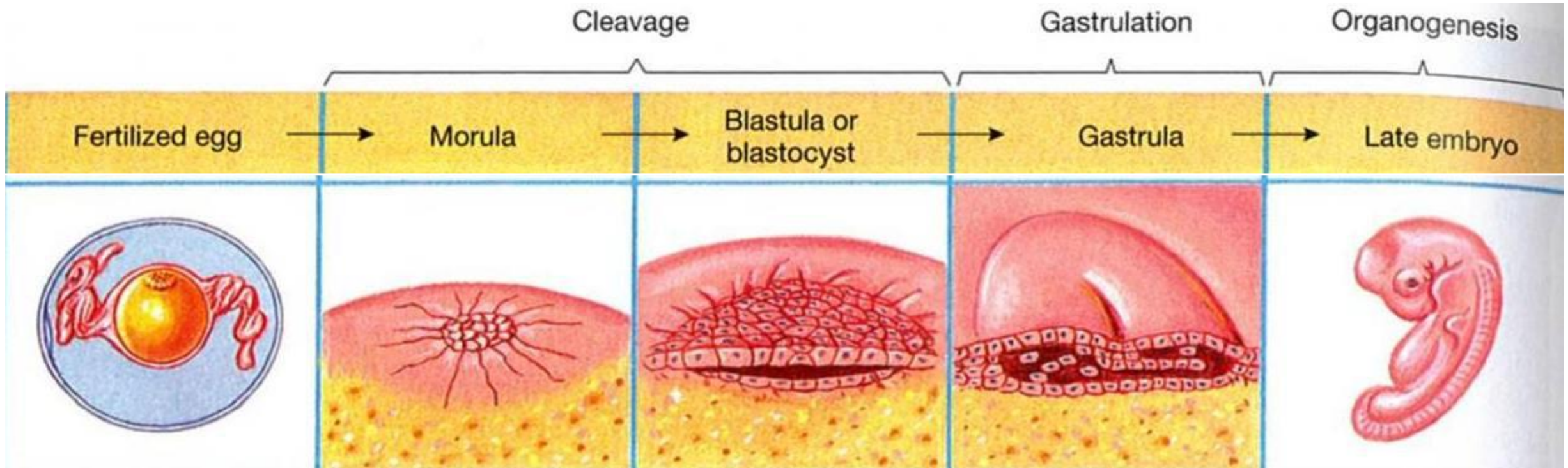
Birds



Chicken
Gallus gallus



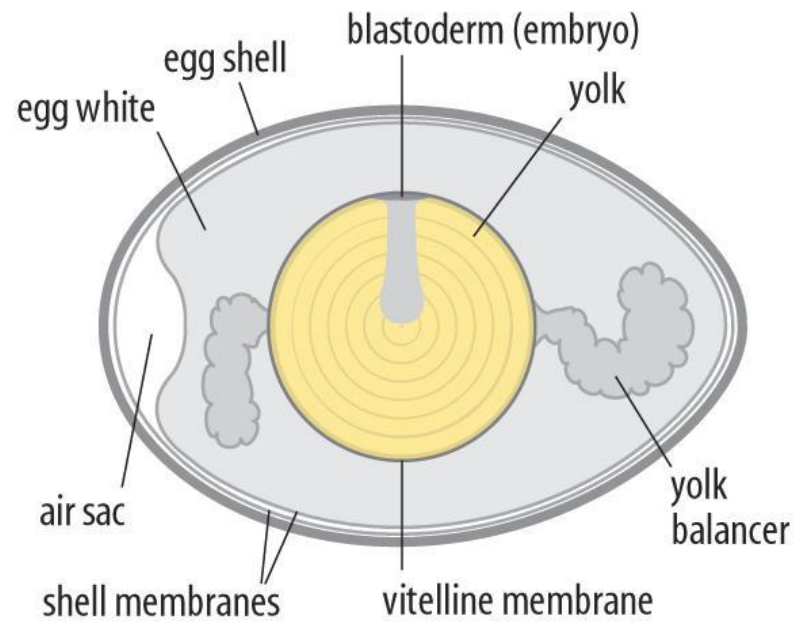
Origin of a new organism in birds



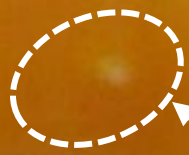
Internal fertilization



Structure of the fertilized hen's egg when laid



Yolk →

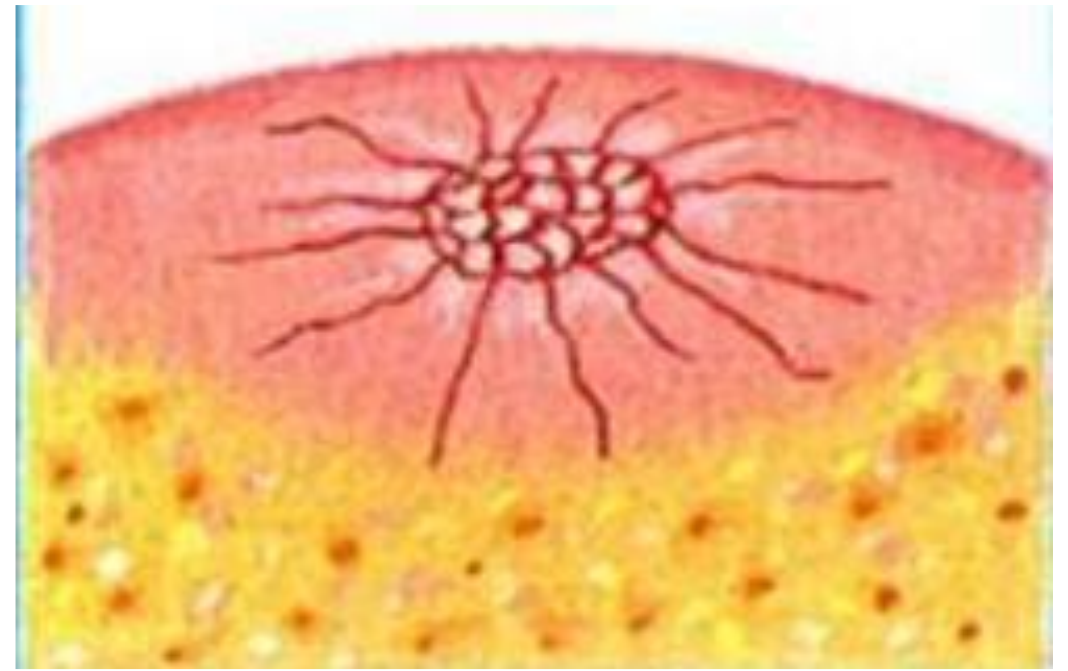


← Blastoderm

Telolecitic Egg

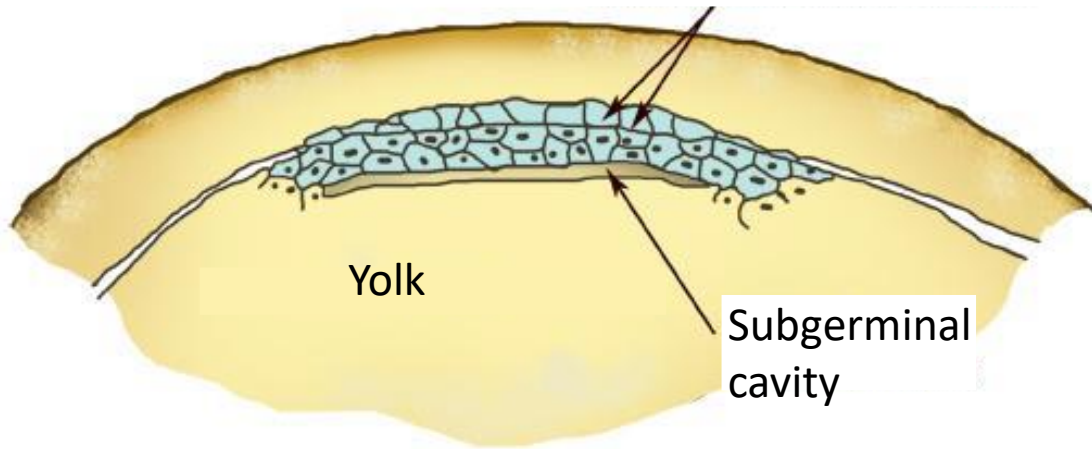


Discoidal Meroblastic Segmentation



Discoblastula of the chicken embryo

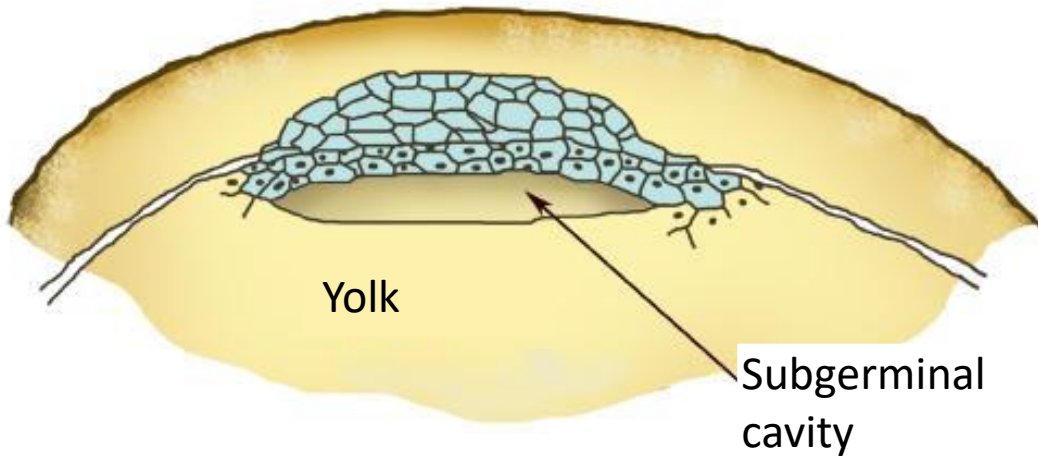
Blastomeres of blastoderm

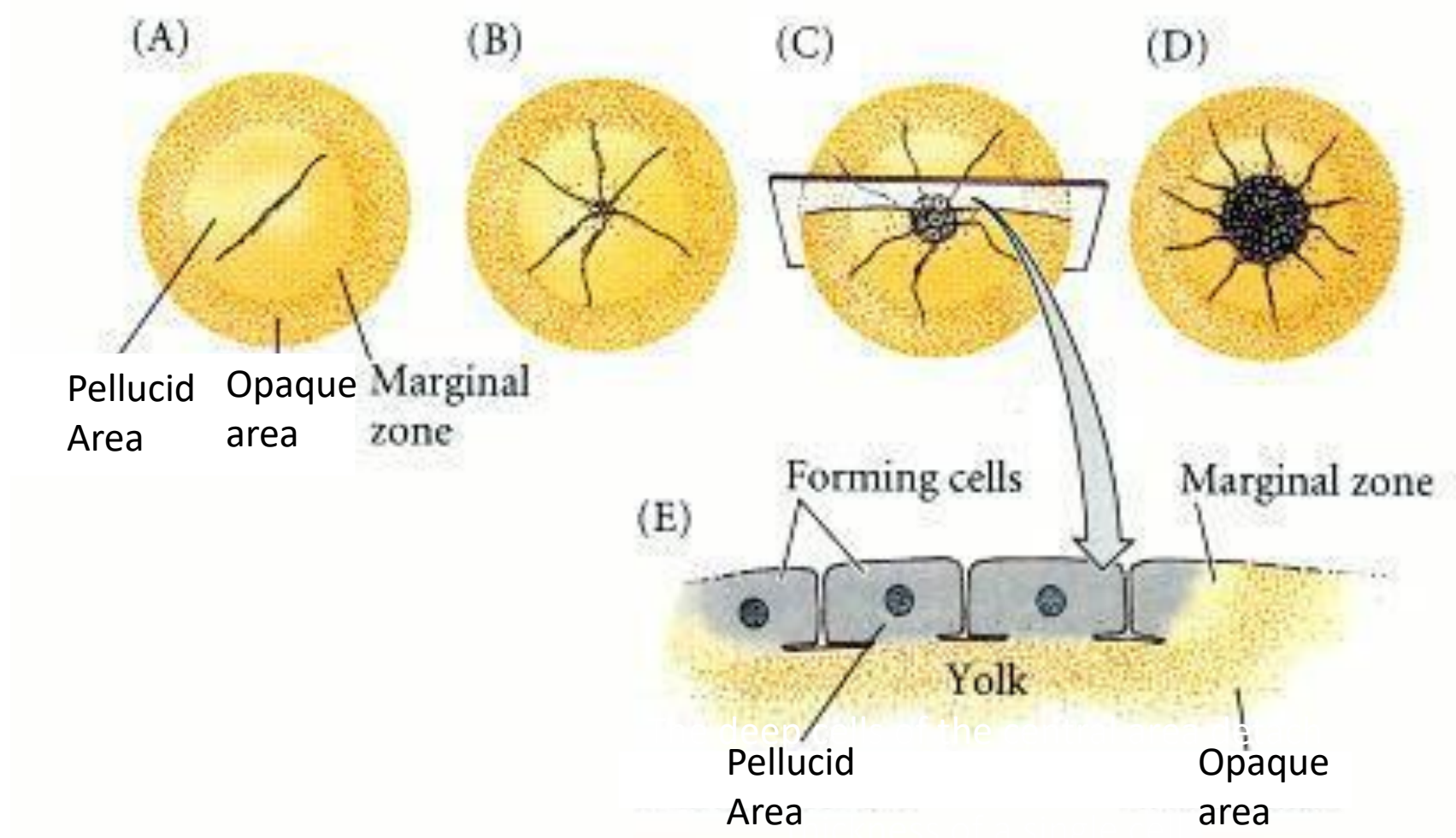


The blastoderma consists of 5-6 layers of cells joined by tight junctions



The accumulation of liquid causes the formation of a cavity between blastoderma and calf: the **subgerminal cavity**



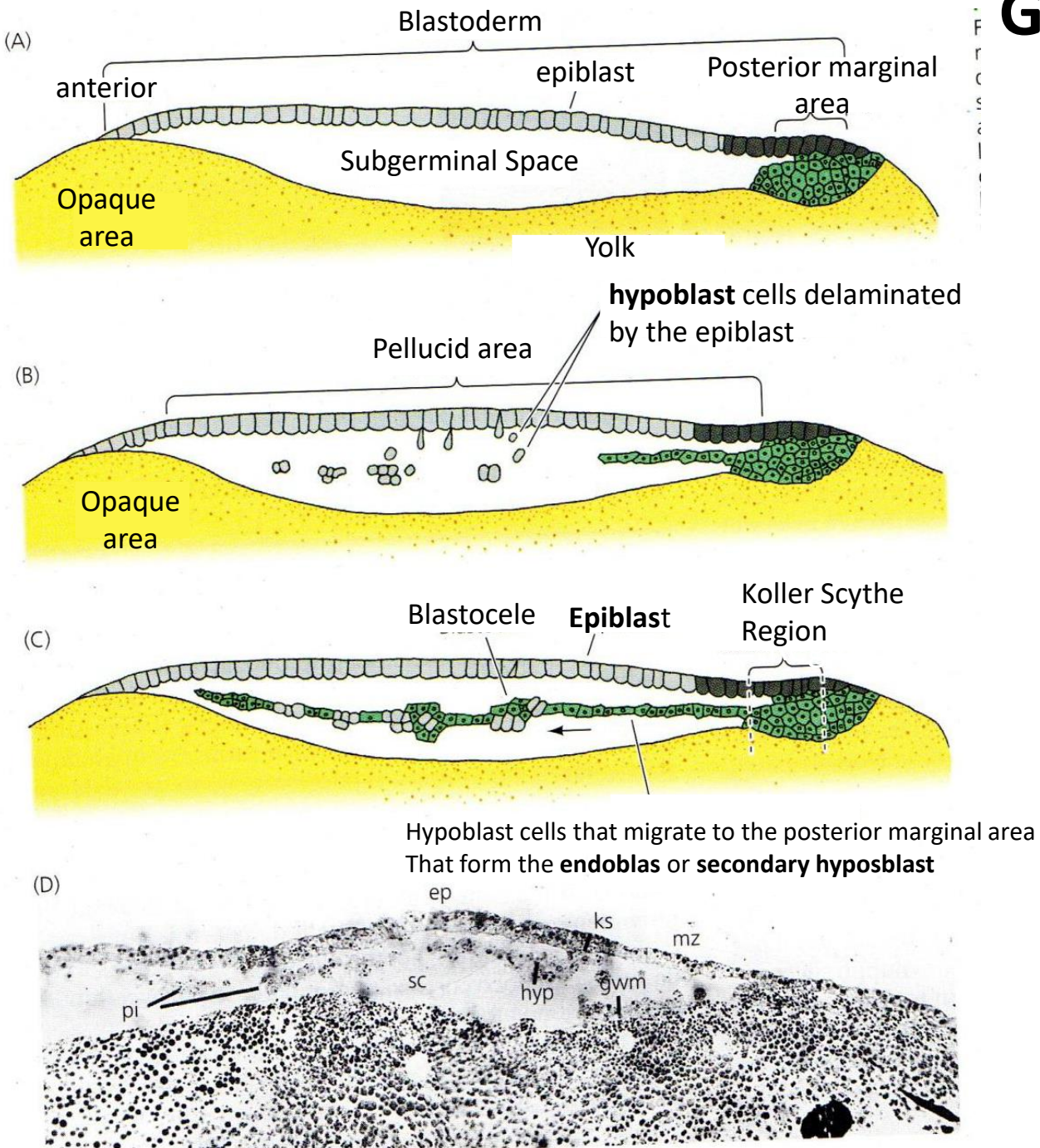


The deep cells of the central area detach and die forming the **pellucid area** of the thickness of a single cell

Deep cells that have not detached from the blastoderm form the **opaque area**

Between the cells of the pellucid and opaque area there is a thin layer of cells called the **marginal zone**

Gastrulation in the chicken embryo



Bidermal blastoderm formation



hypoblast + epiblast



External membrane, link between the yolk and endodermal digestive tube



Embryo

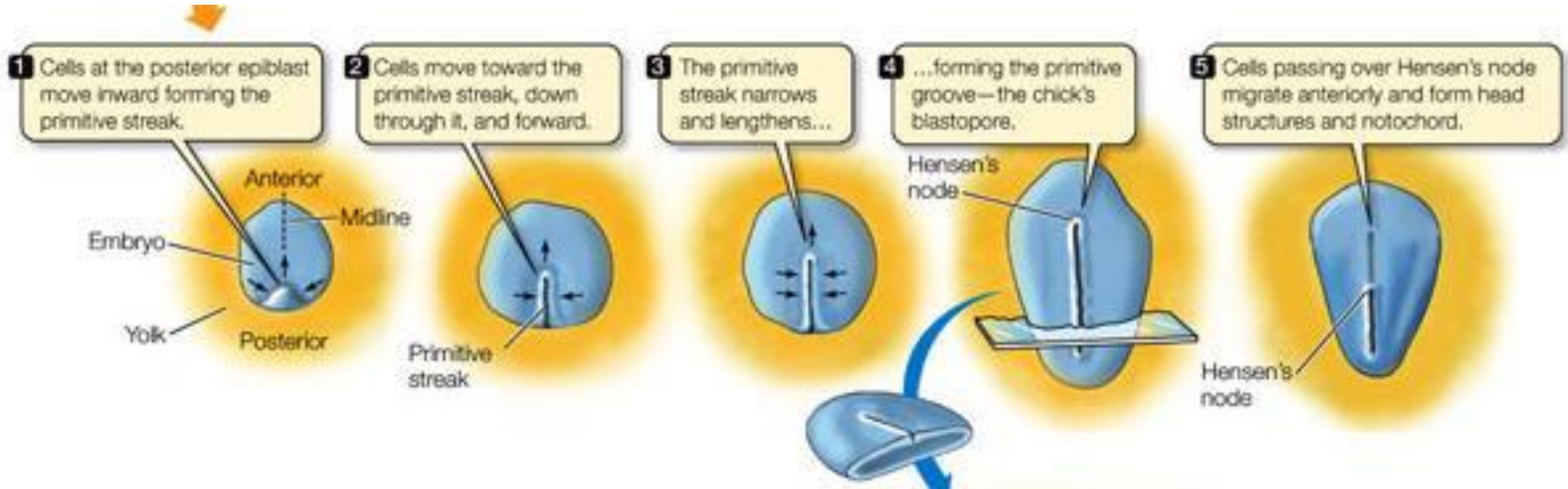
The **primitive line** forms in the posterior marginal region



Thickening of the epiblast



Depression of the epiblast
Primitive furrow

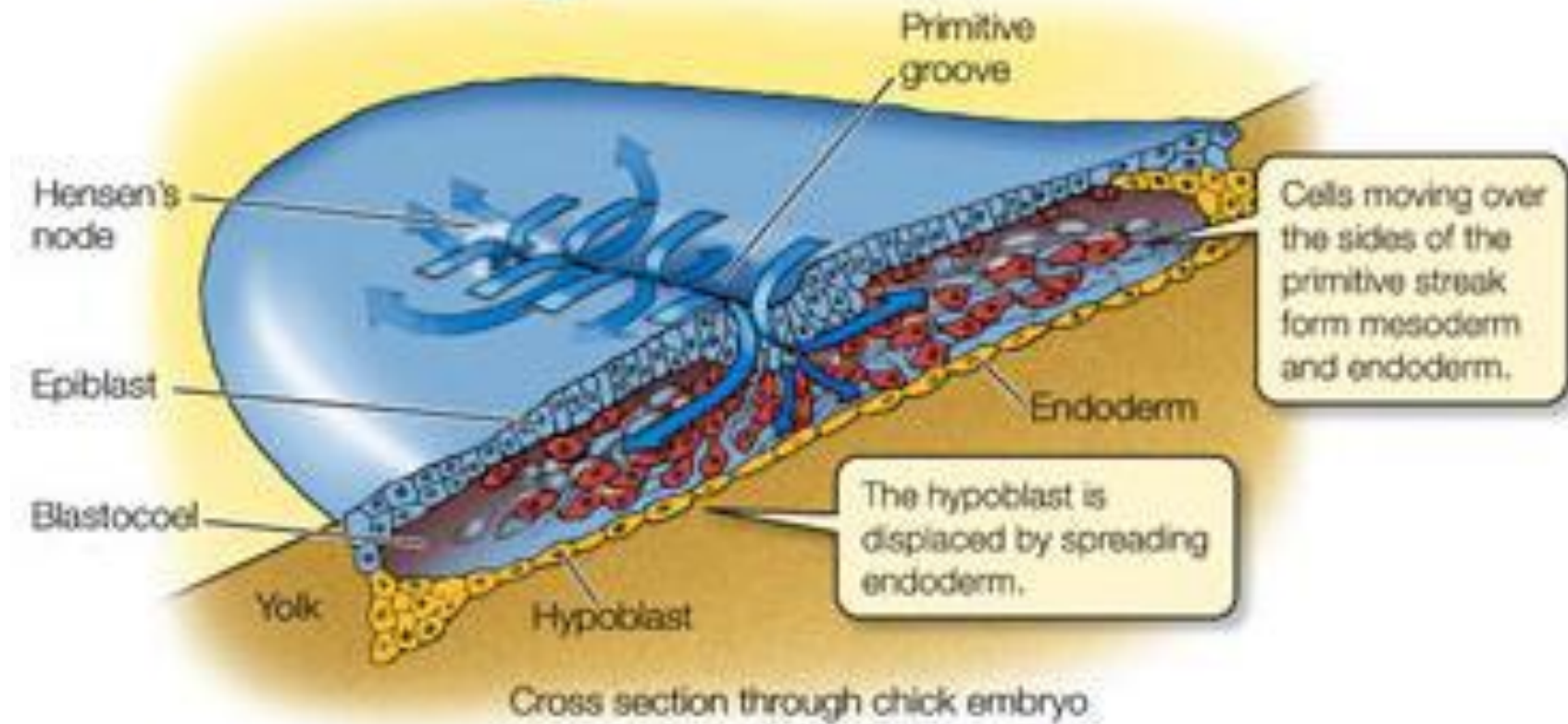


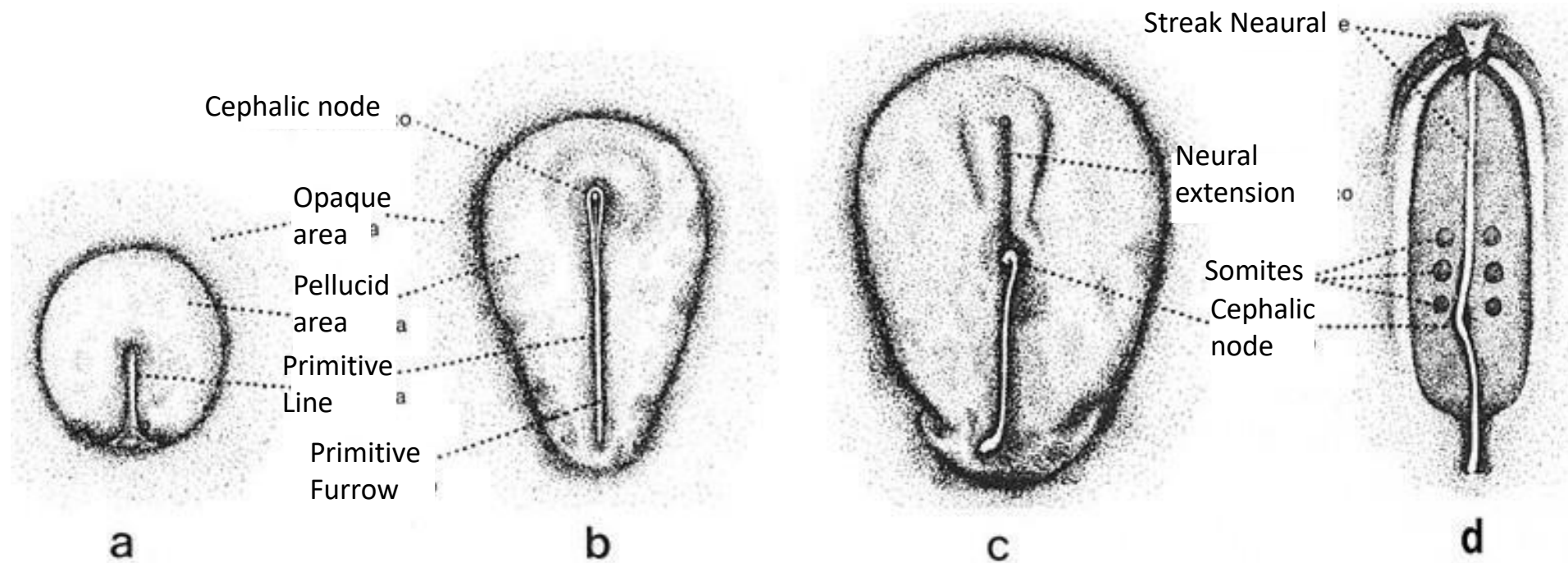
Hensen's node looks like a thickening of the primitive line in the anterior area. At the center of Hensen's Node is the **primitive dimple**, a funnel-shaped depression that allows the passage of cells towards the blastocele

The cells migrate and differentiate passing through the primitive line



Endoderm and mesoderm formation





The **primitive line** begins to regress and **Hensen's node** assumes a more caudal position. The notochord is formed

The **mesoderm and endoderm cells** are placed within the embryo and the epiblast consists of the **presumptive ectoderm**

The **cells of the ectoderm** migrate and proliferate by surrounding the Yolk (epibolia)

Determination of the axes in the chicken embryo

**AXIS
DORSAL-VENTRAL**



established early during segmentation

The pH is fundamental
basic pH - albumend- **DORSAL**
acid pH - sub-terminal cavity - **VENTRAL**

**AXIS
ANTEROPOSTERIOR**



force of gravity

