

# Bi8940 Developmental Biology

## Lesson 3

### Early Development of Amphibians and Amniotes

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INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

Tato prezentace je spolufinancována  
Evropským sociálním fondem  
a státním rozpočtem České republiky



# Outline of Lesson 3

## Early Development of Amphibians and Amniotes

- Oogenesis in amphibians
- Blastula formation and dorsoventral axis formation in amphibians
  - cleavage of *Xenopus* zygote (video)
- Gastrulation
  - gastrulation of amphibians (video)
- Neurulation
  - neurulation in *Xenopus* (video)
- Oogenesis in amniotes - chicken
- Gastrulation in amniotes – chicken
  - early and late gastrulation in chicken (video)



# Outline of Lesson 3

## Early Development of Amphibians and Amniotes

- Gastrulation in amniotes – chicken
  - early and late gastrulation in chicken (video)
- Formation of extraembryonic tissues in amniotes – chicken

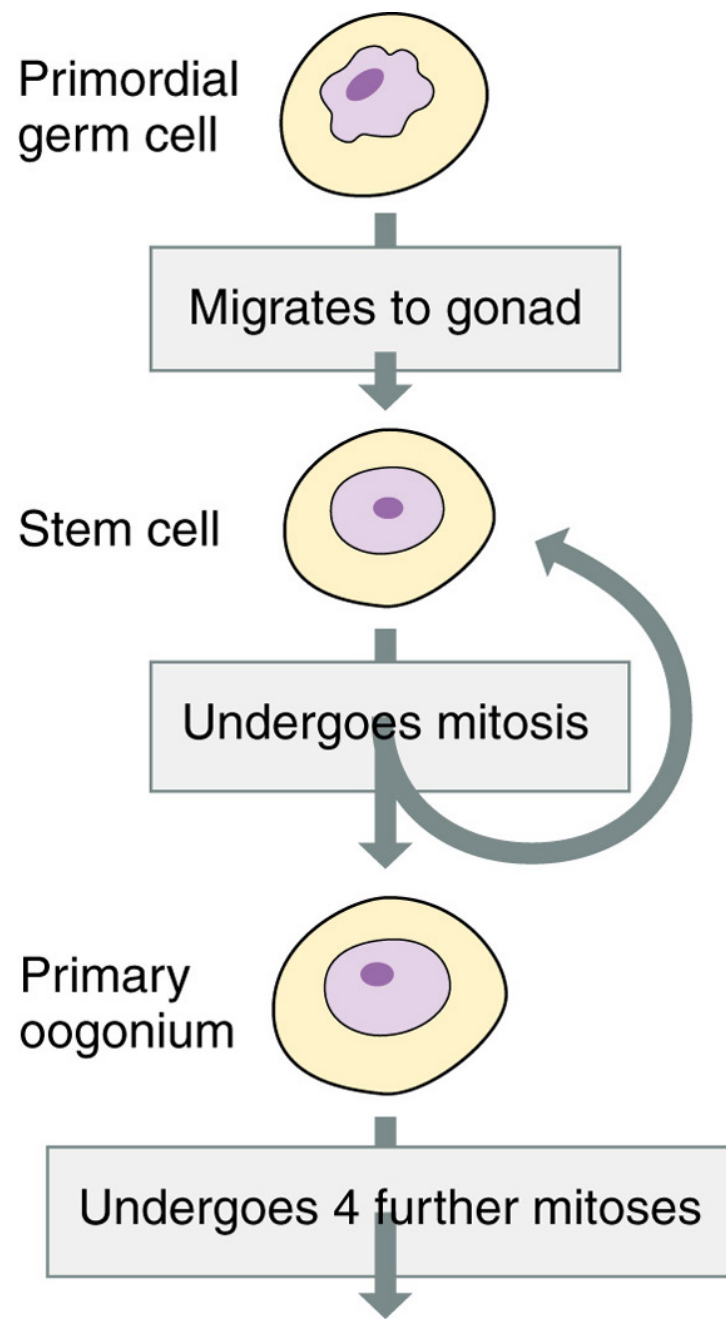


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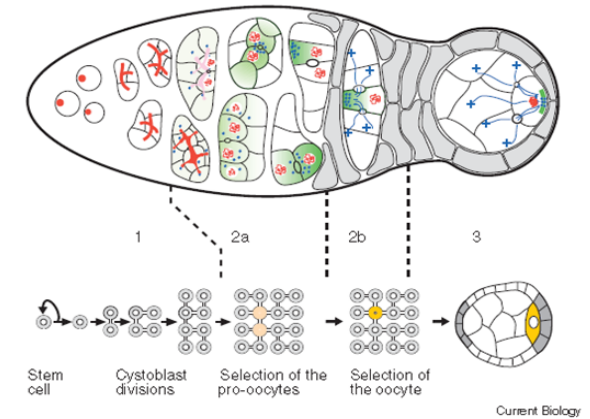
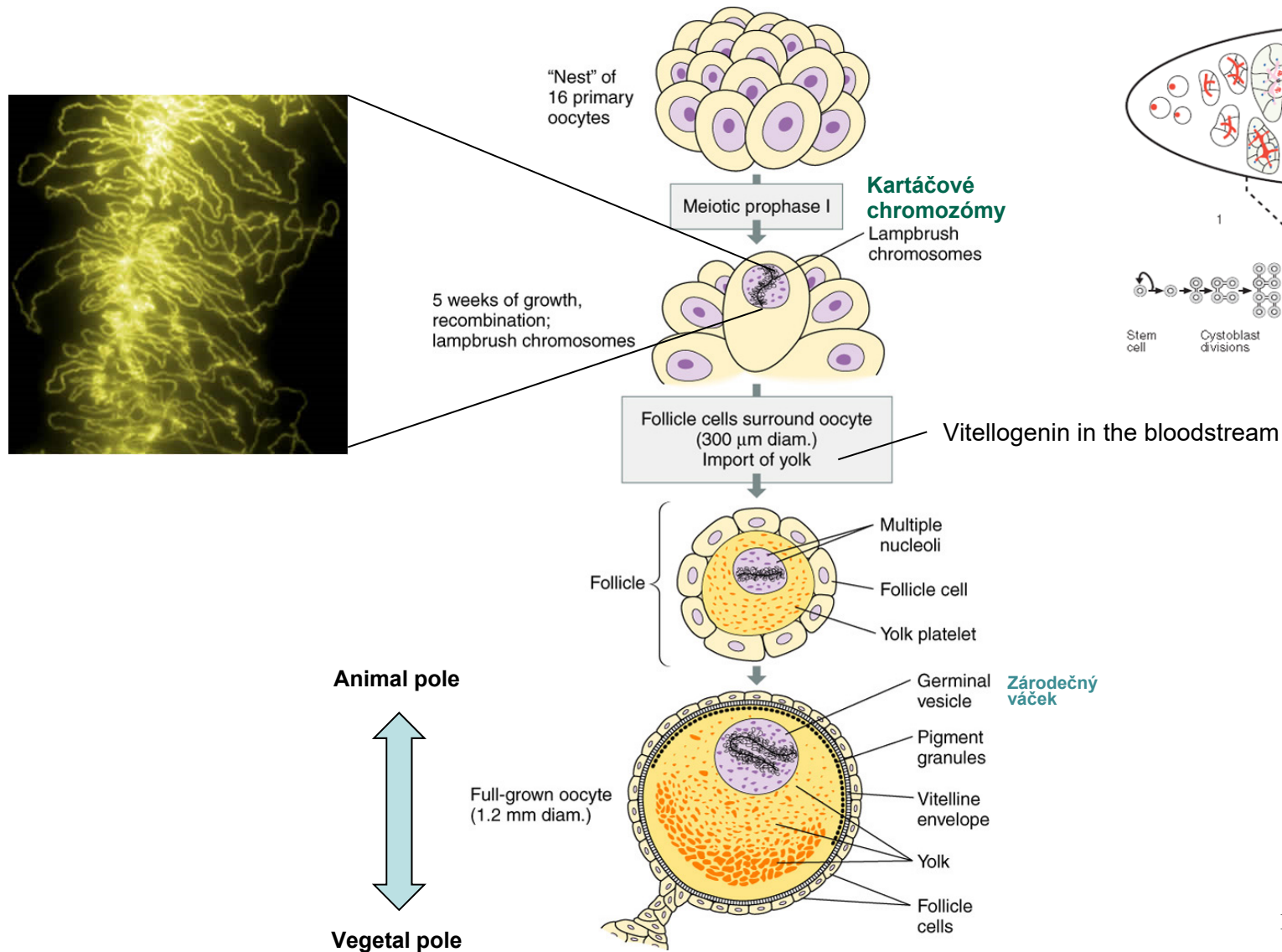
## Early Development of Amphibians and Amniotes

- Oogenesis in amphibians

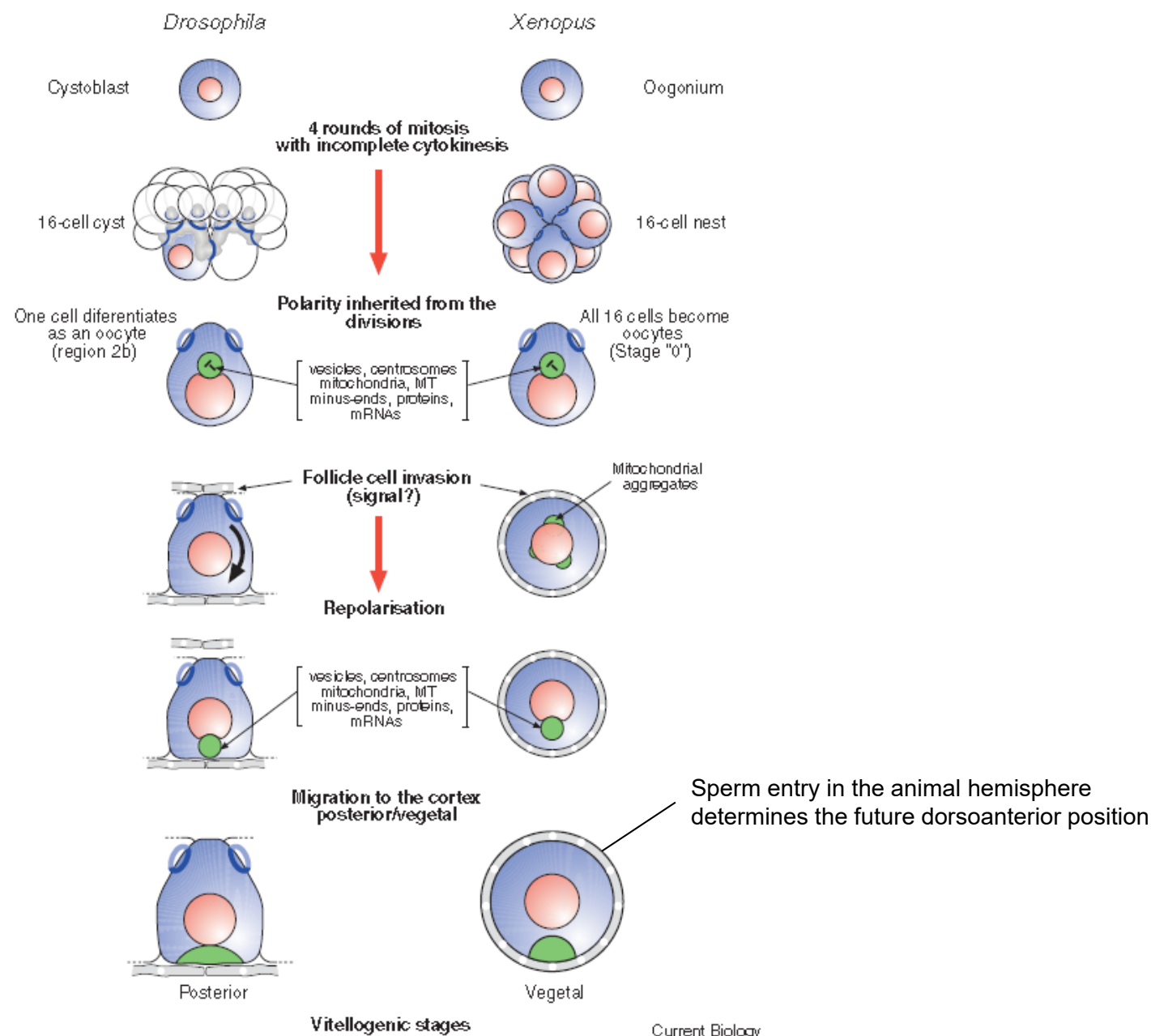




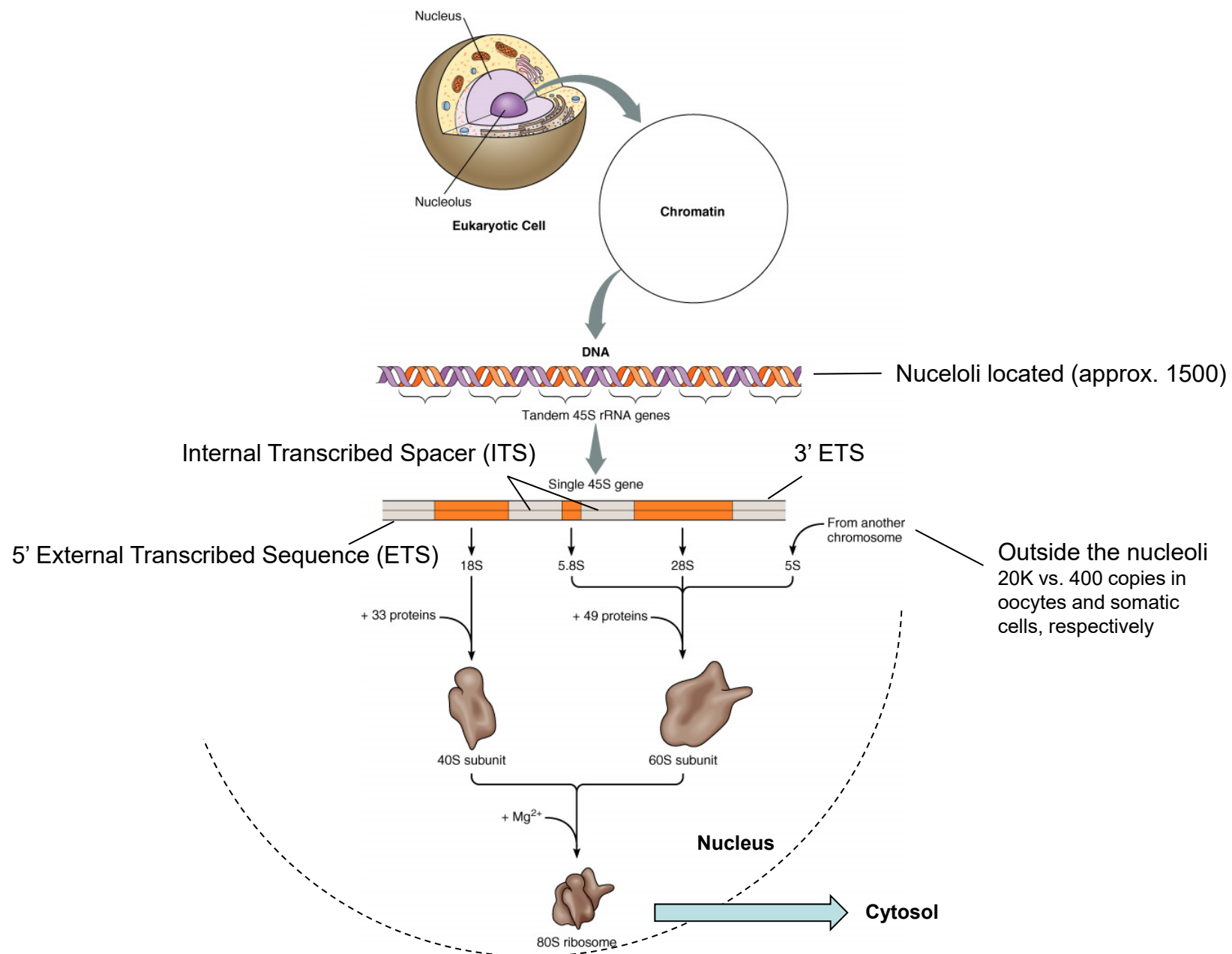
# Oogenesis in *Xenopus* vs. oogenesis in *Drosophila*



Huynh and Johnston., *Curr Biol* (2004)



Huynh and Johnston., *Curr Biol* (2004)





**Hormonální stimulace  
hormony hypofýzy  
(gonádotropin)**

**Hormonal stimulation  
from pituitary**

**Zárodečný váček**

Germinal vesicle

**Progesterone  
from follicle  
to oocyte**

**Progesteron**

**Intracellular perceived progesterone  
signal induces oocyte maturation.**

**Primary oocyte**

**Meiosis I**

**Germinal vesicle  
breaks down**

**Folicle  
disassembles,  
release to oviduct**

**Sperm  
cell  
entry**

**Animal  
pole**

**Polar  
body**

**Meiosis II  
spindle**

- **sperm cell nucleus**
- **centrosome**

**Vegetal pole**

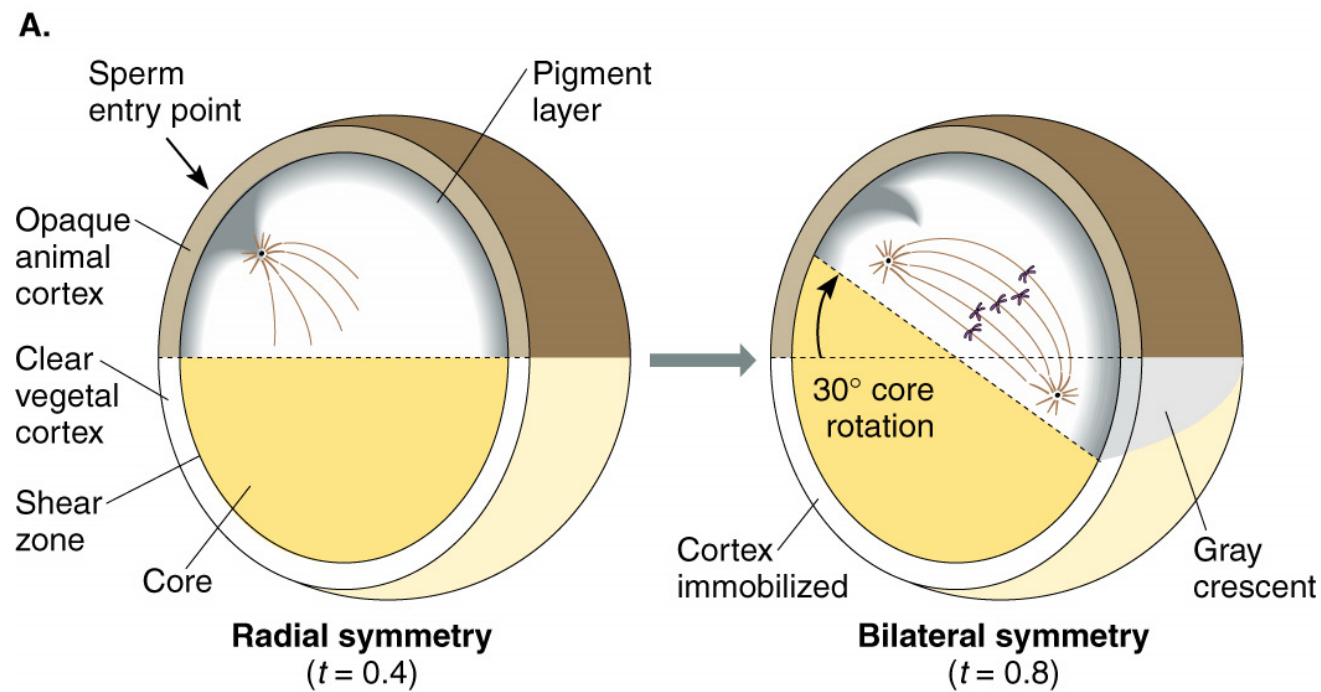
**“Fertilizable”  
secondary oocyte**



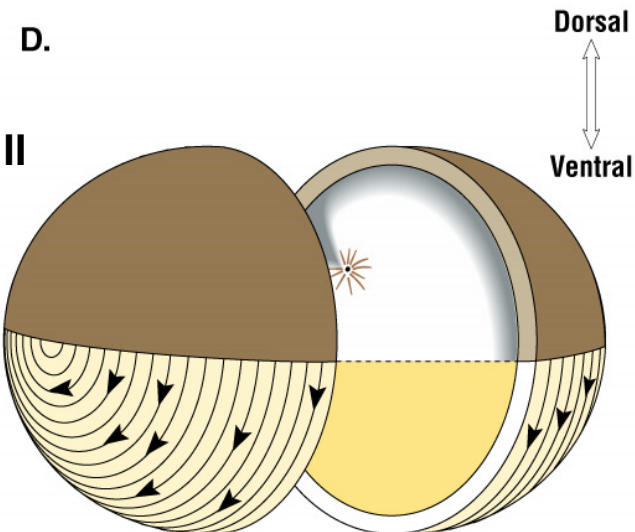
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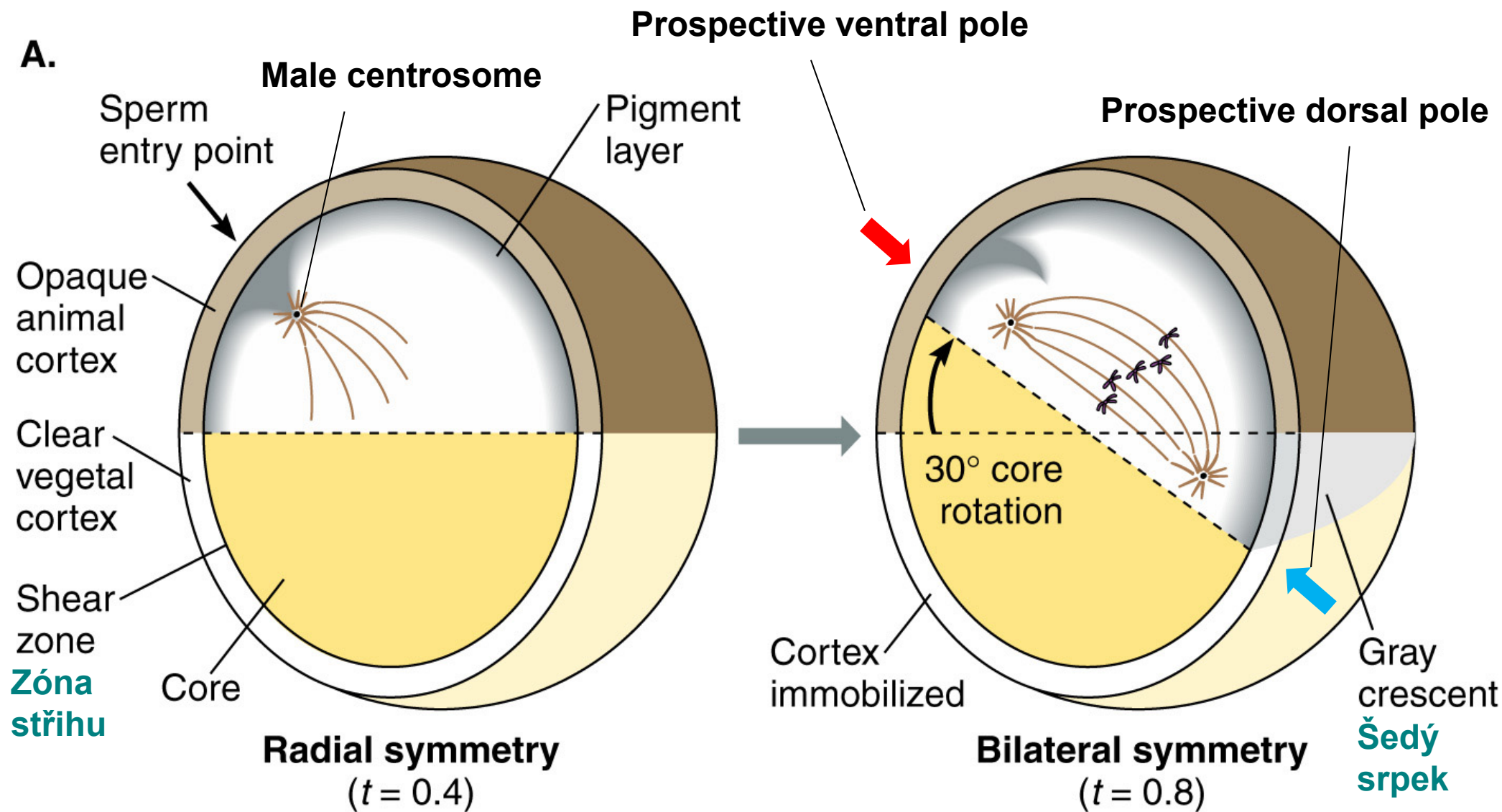
- Oogenesis in amphibians
- Blastula formation and dorsoventral axis formation in amphibians



- ↓
- Completion of meiosis II
  - Syngamy

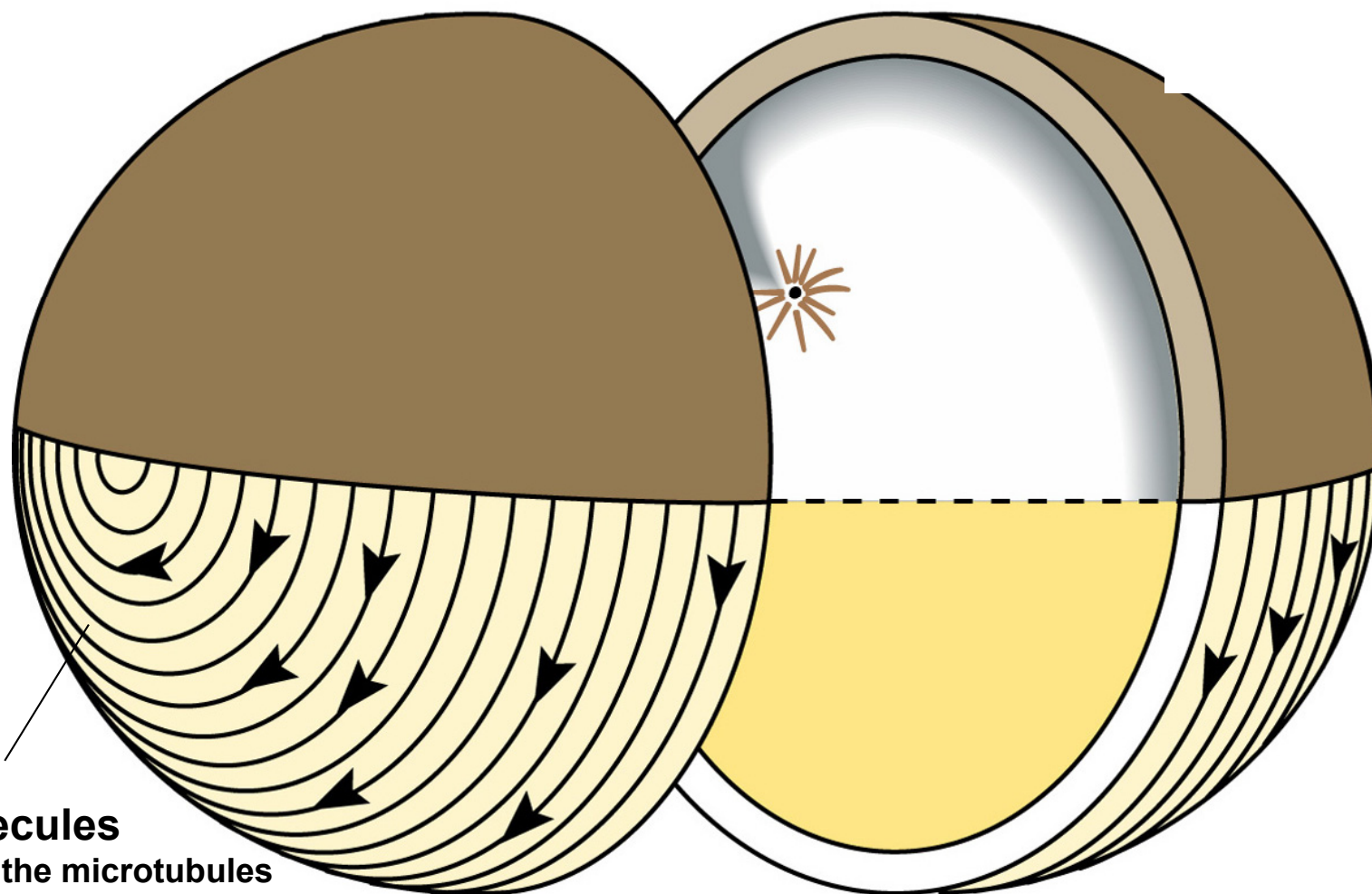




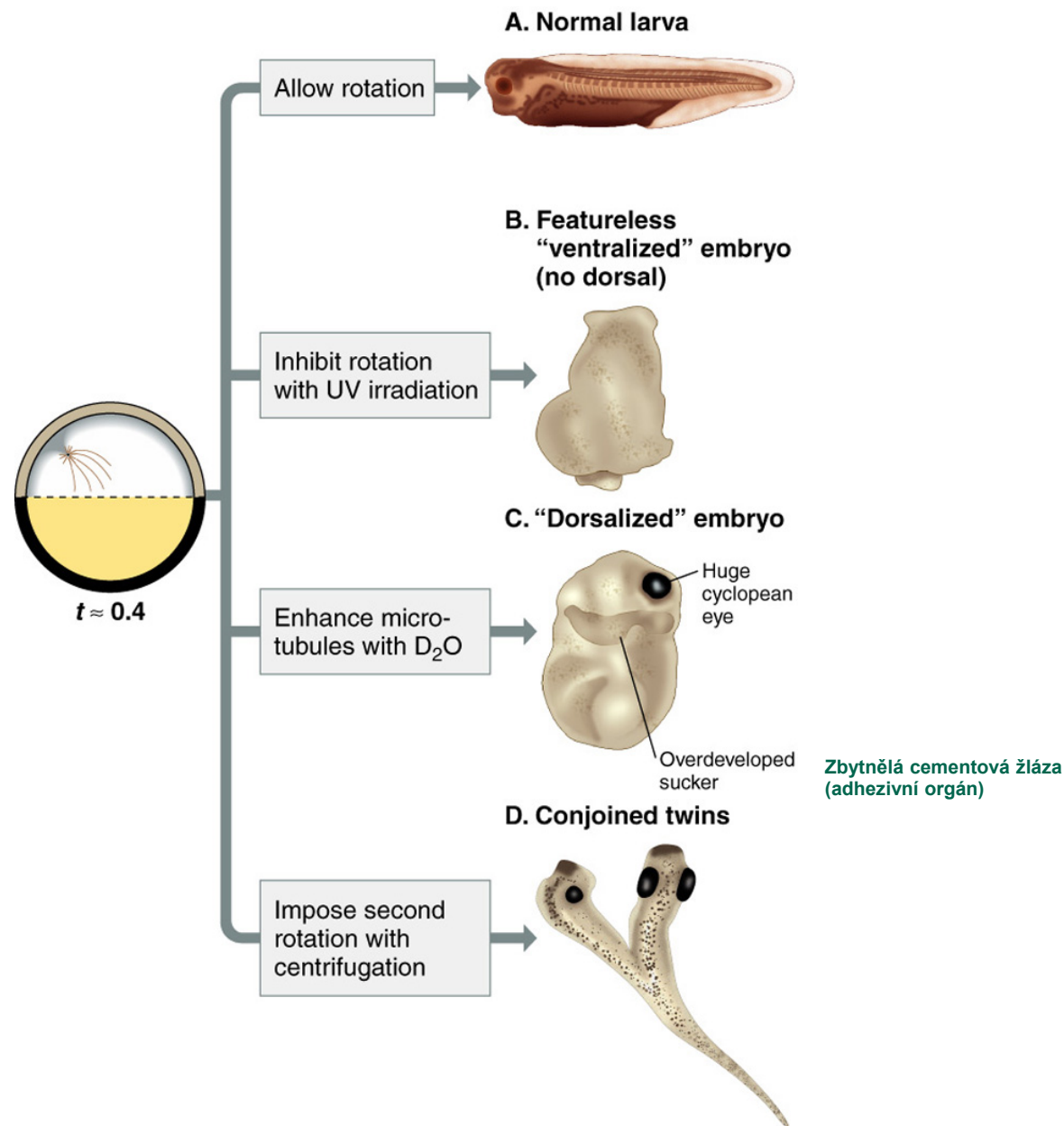




D.



**Motor molecules**  
located along the microtubules

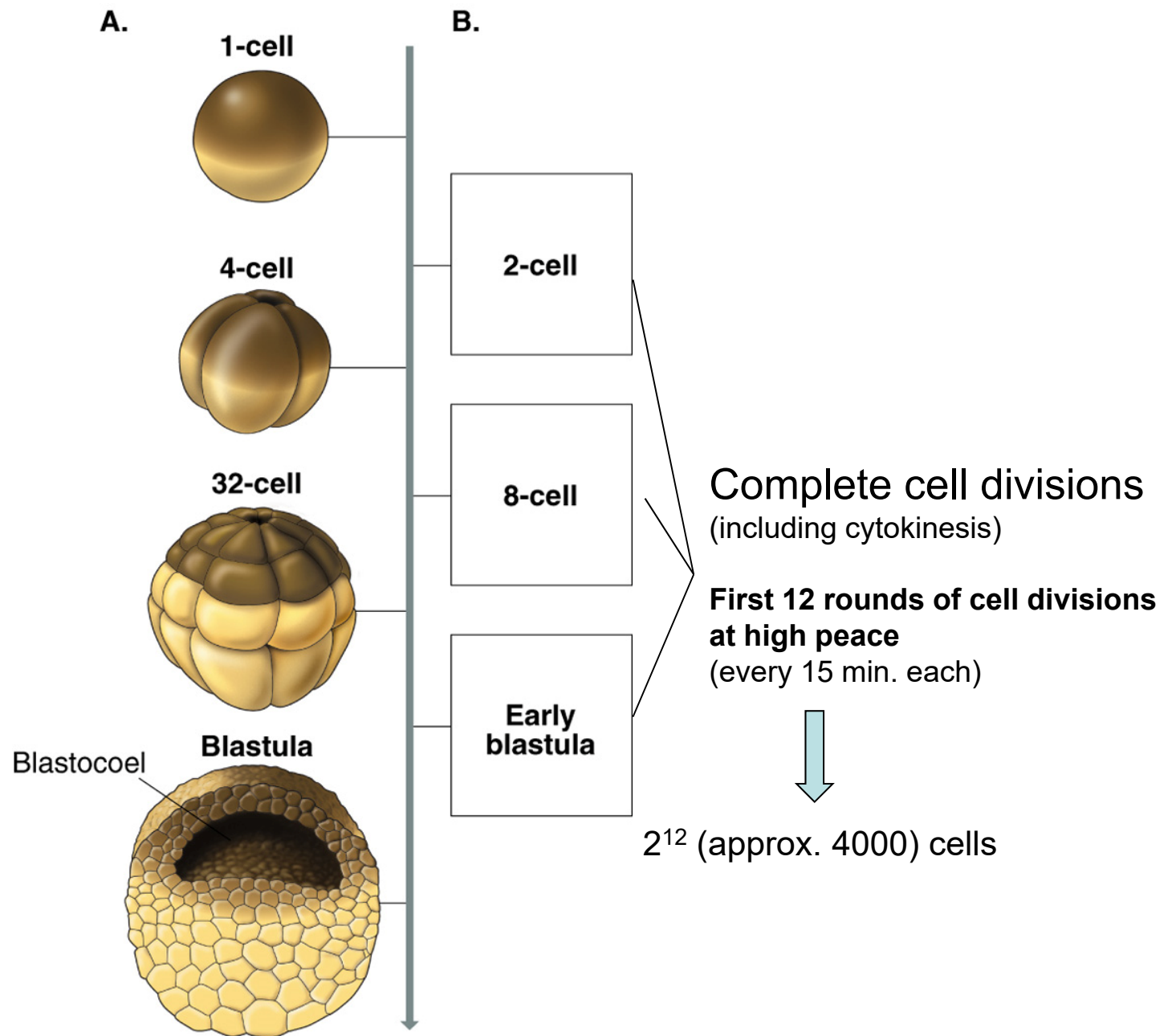




*Morus nigra* (mulberry)

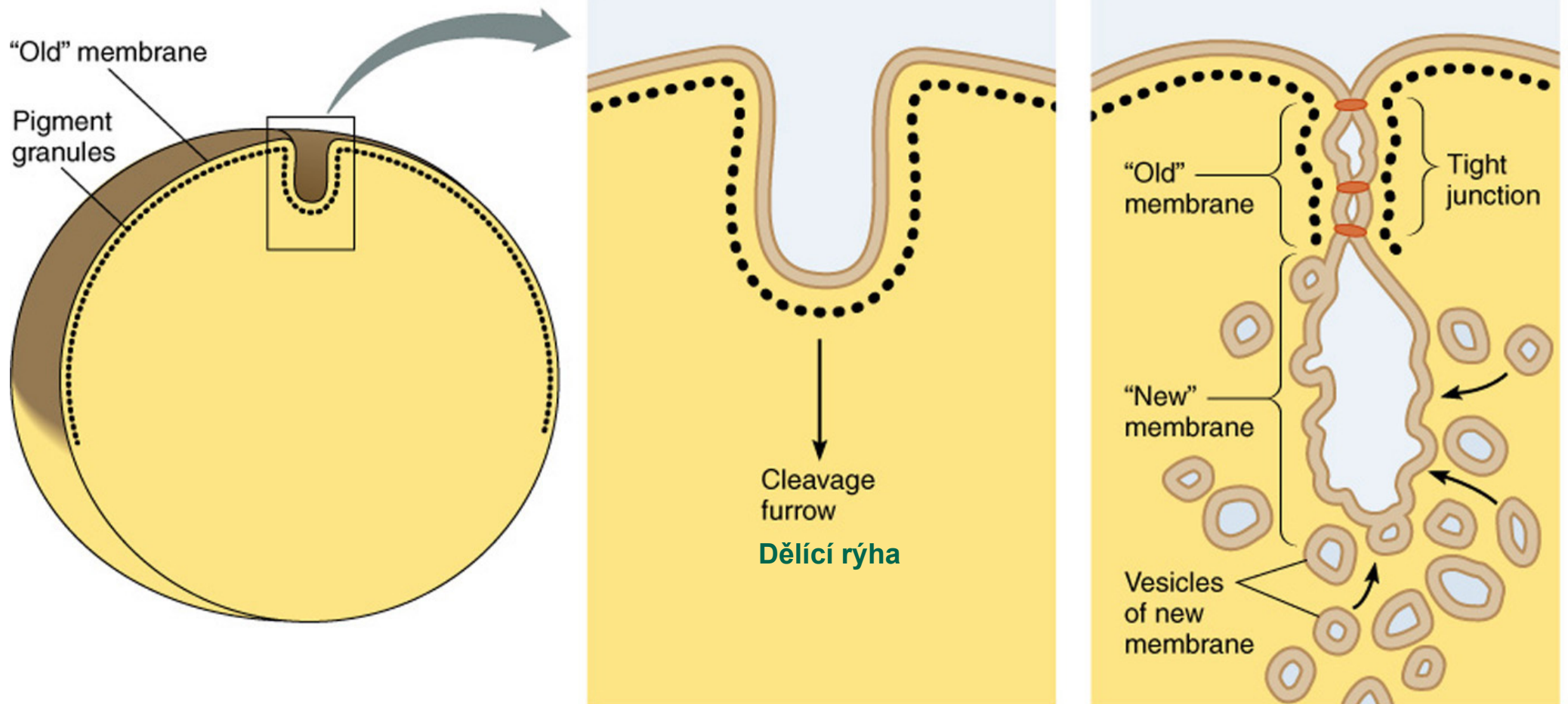
**16-64 cells: morula**

**128 cells: blastula**



## Important molecular events precede further development at the midblastula transition (MBT)

- Induction of transcription
- Acquiring potential of cell motility
- Slowing down the cell division cycle



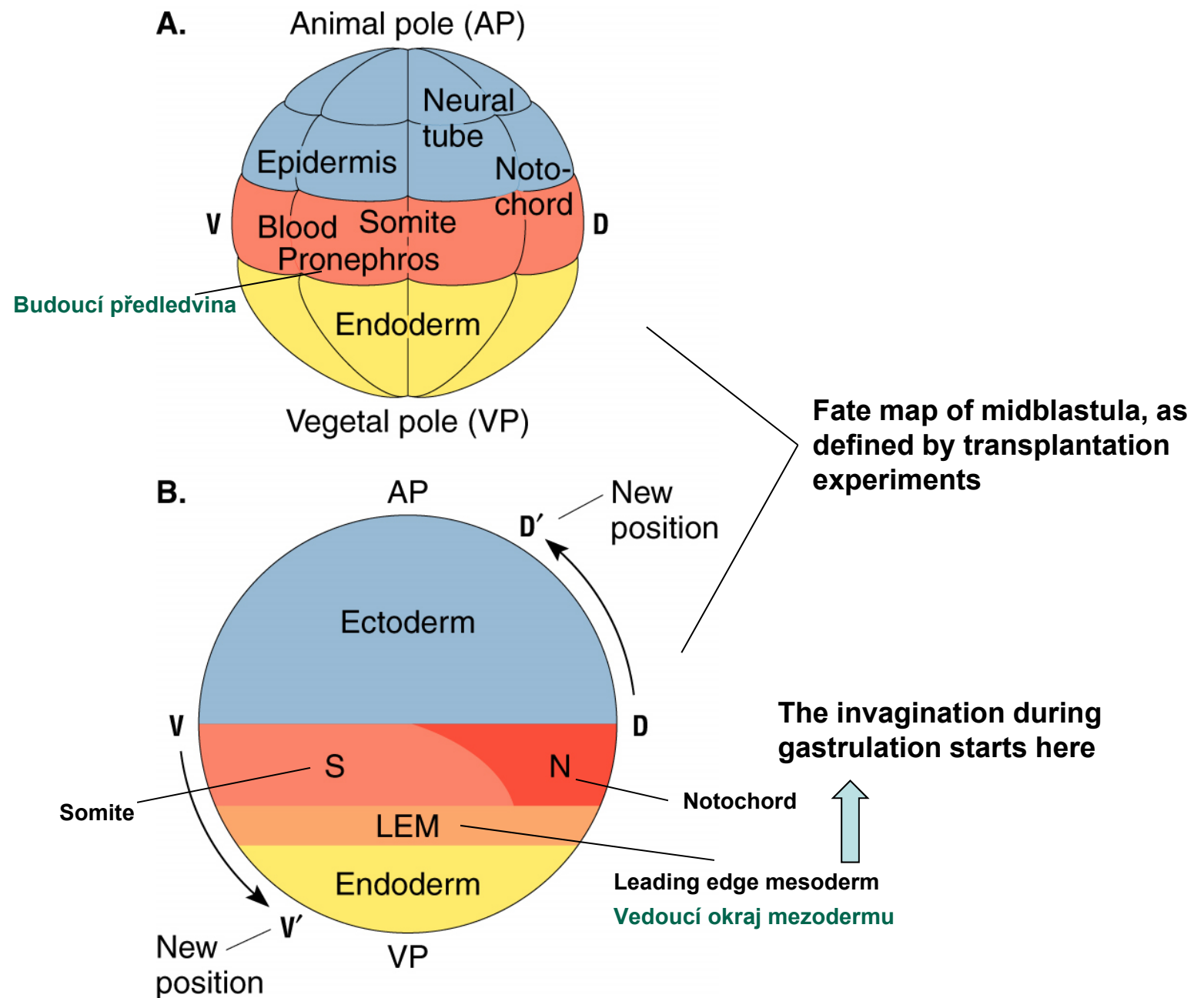


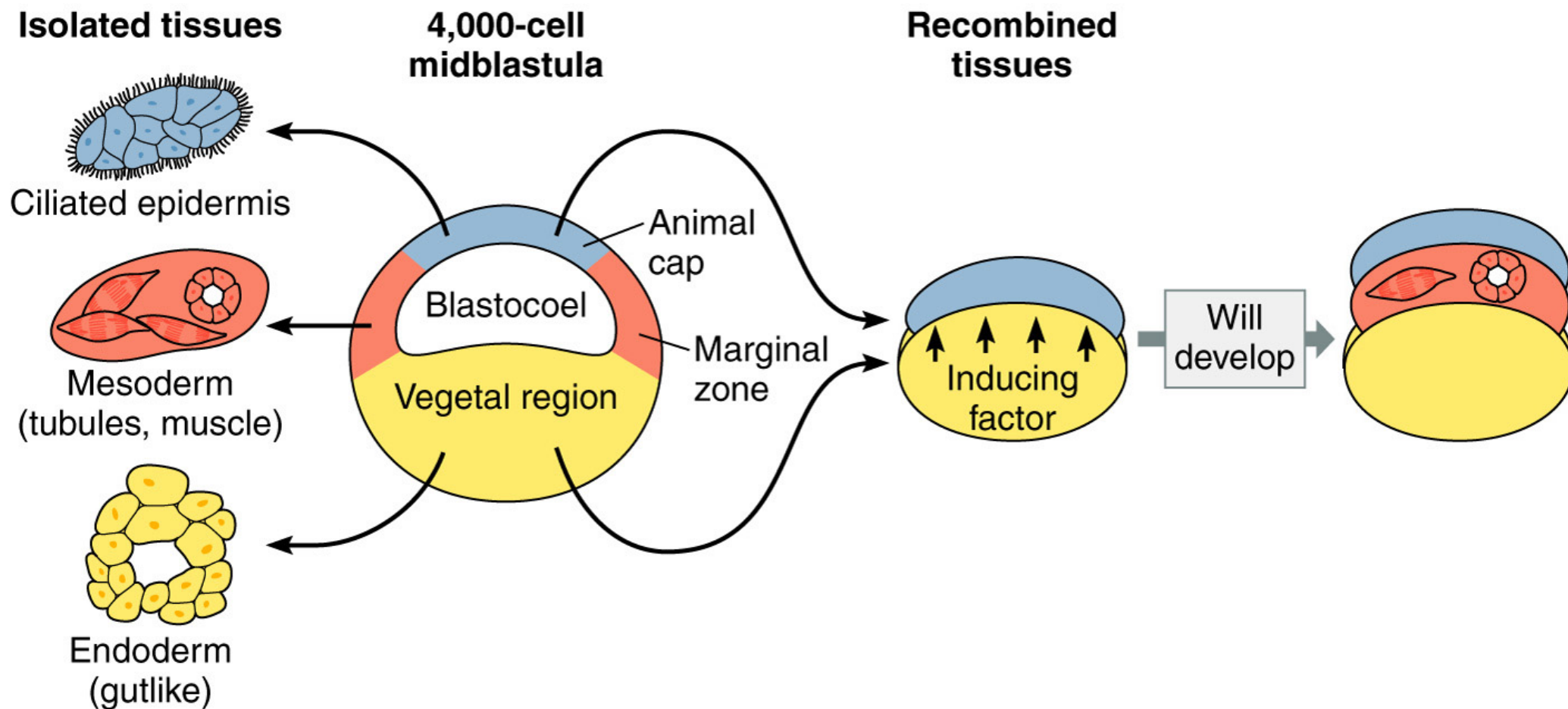


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- Oogenesis in amphibians
- Blastula formation and dorsoventral axis formation in amphibians
  - cleavage of *Xenopus* zygote (video)





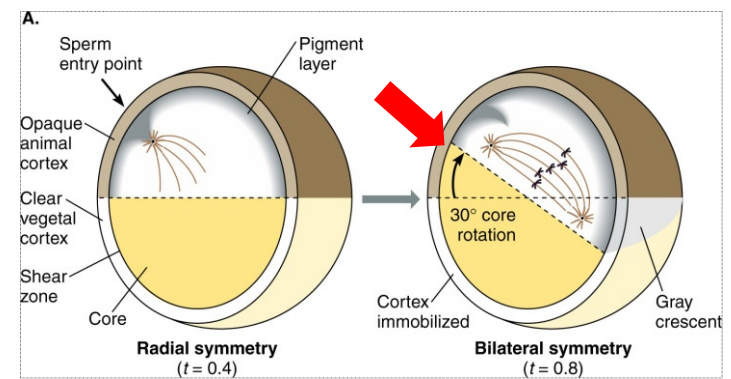


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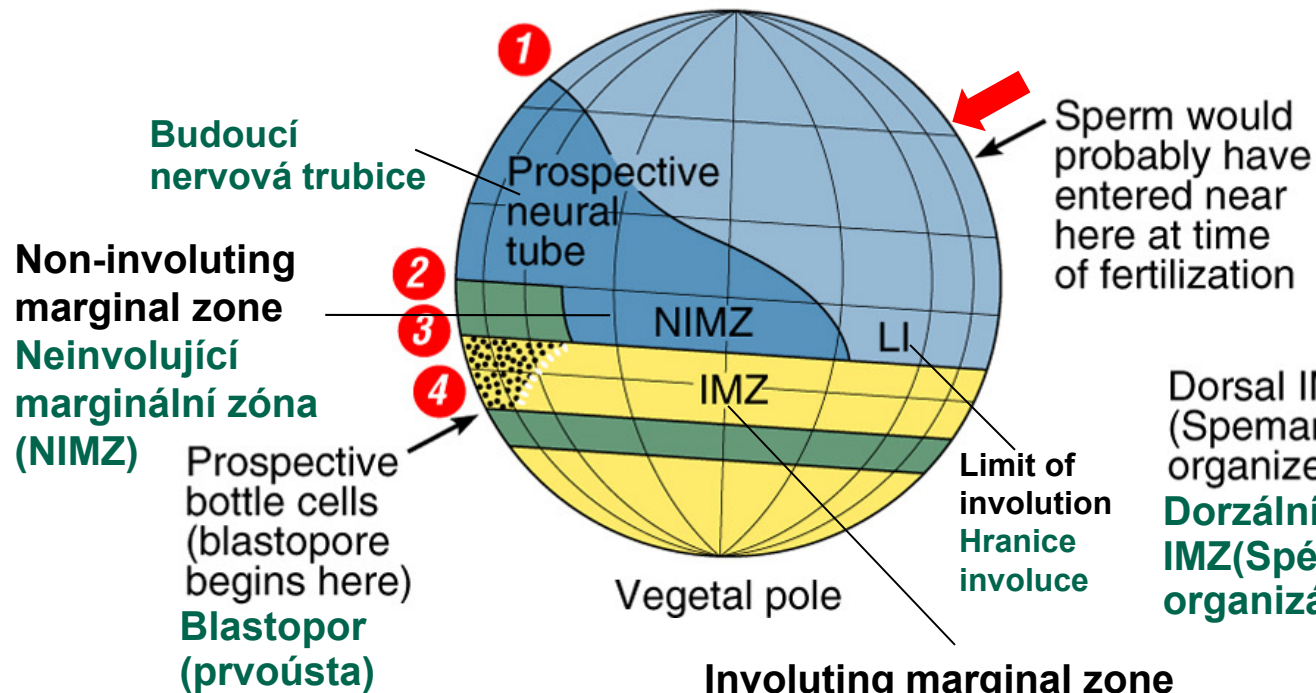
- Oogenesis in amphibians
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  - cleavage of *Xenopus* zygote (video)
- Gastrulation in amphibians



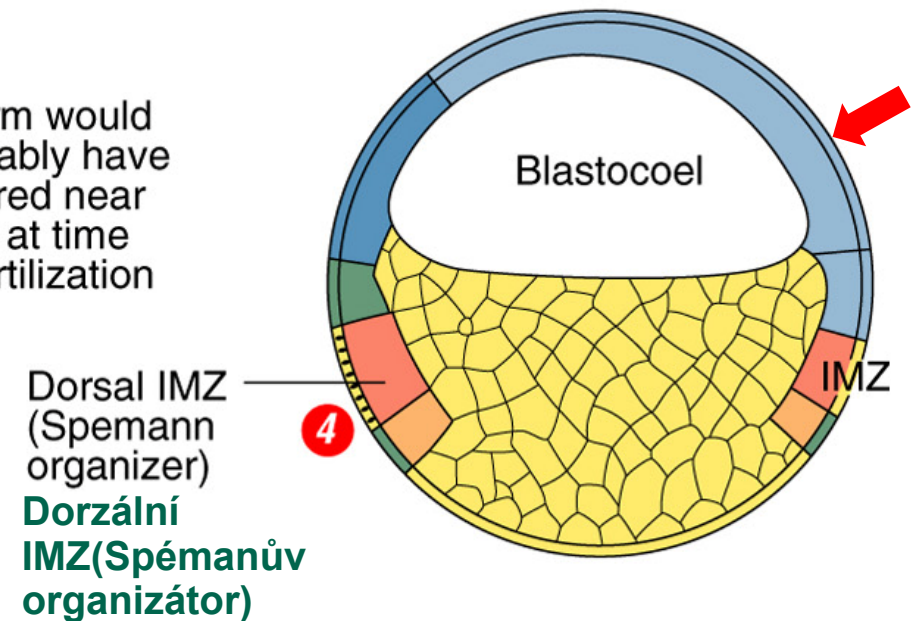


## Stage A. Late Blastula

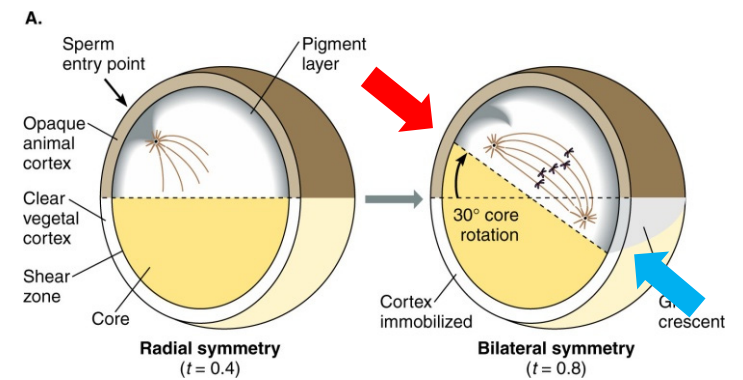
### Surface Views Animal pole



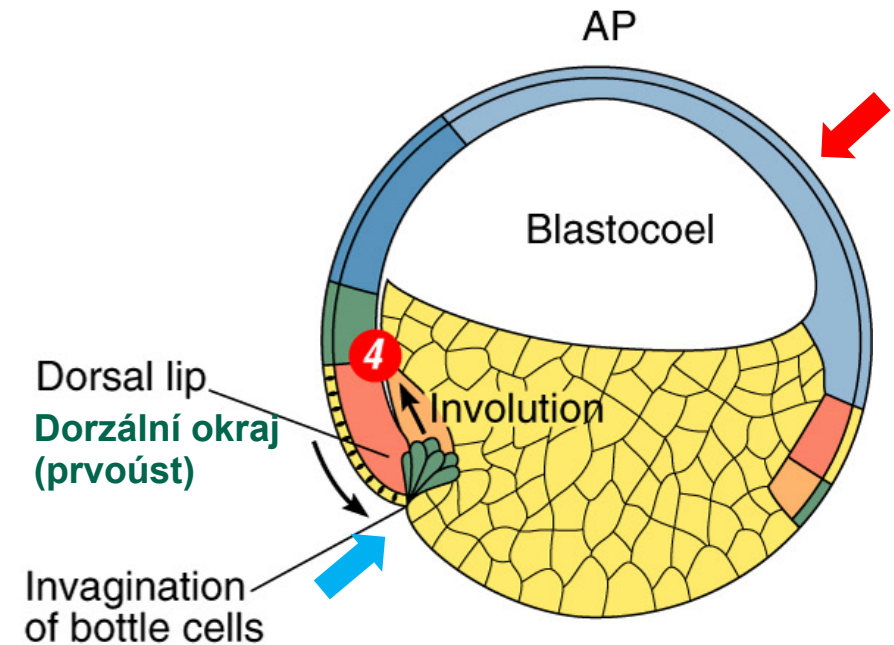
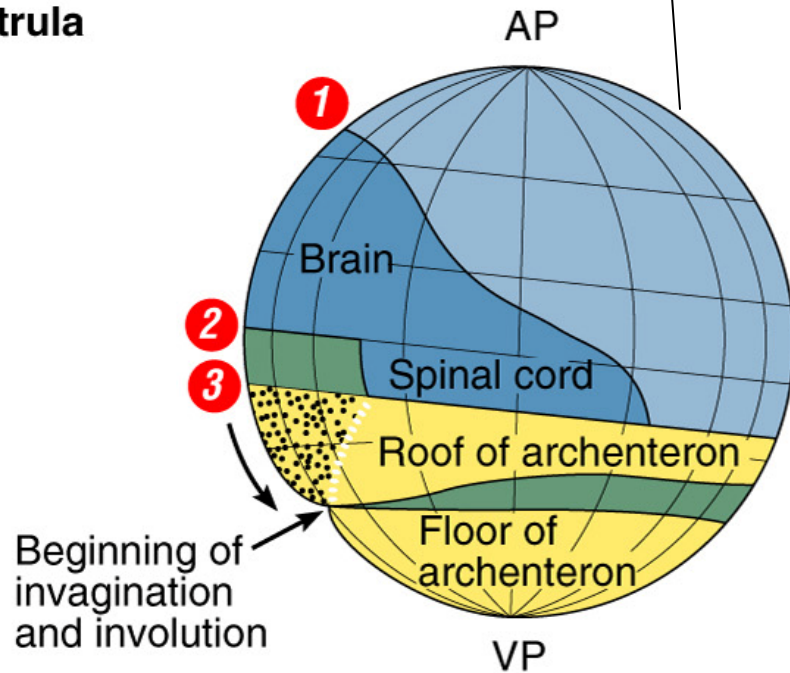
### Cutaway Views AP



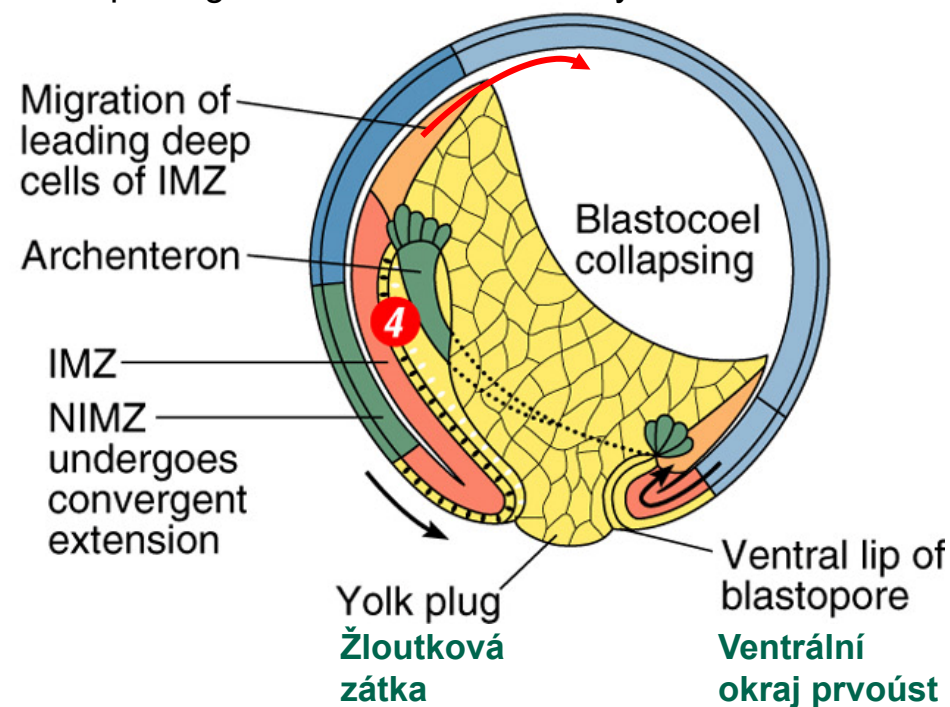
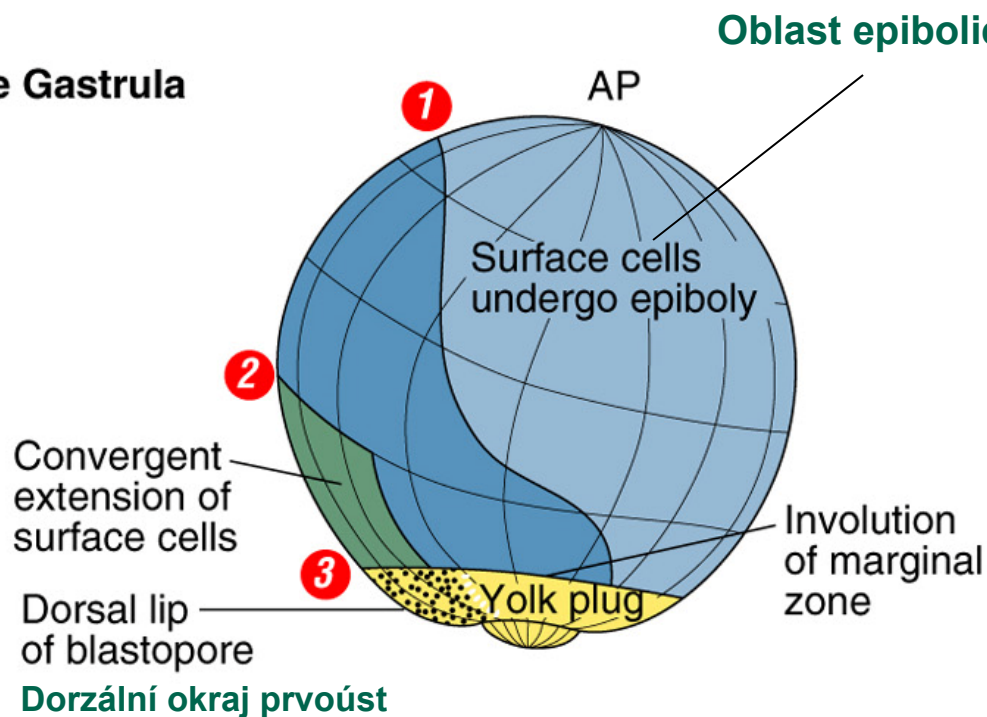
Entry of sperm cell



## B. Early Gastrula

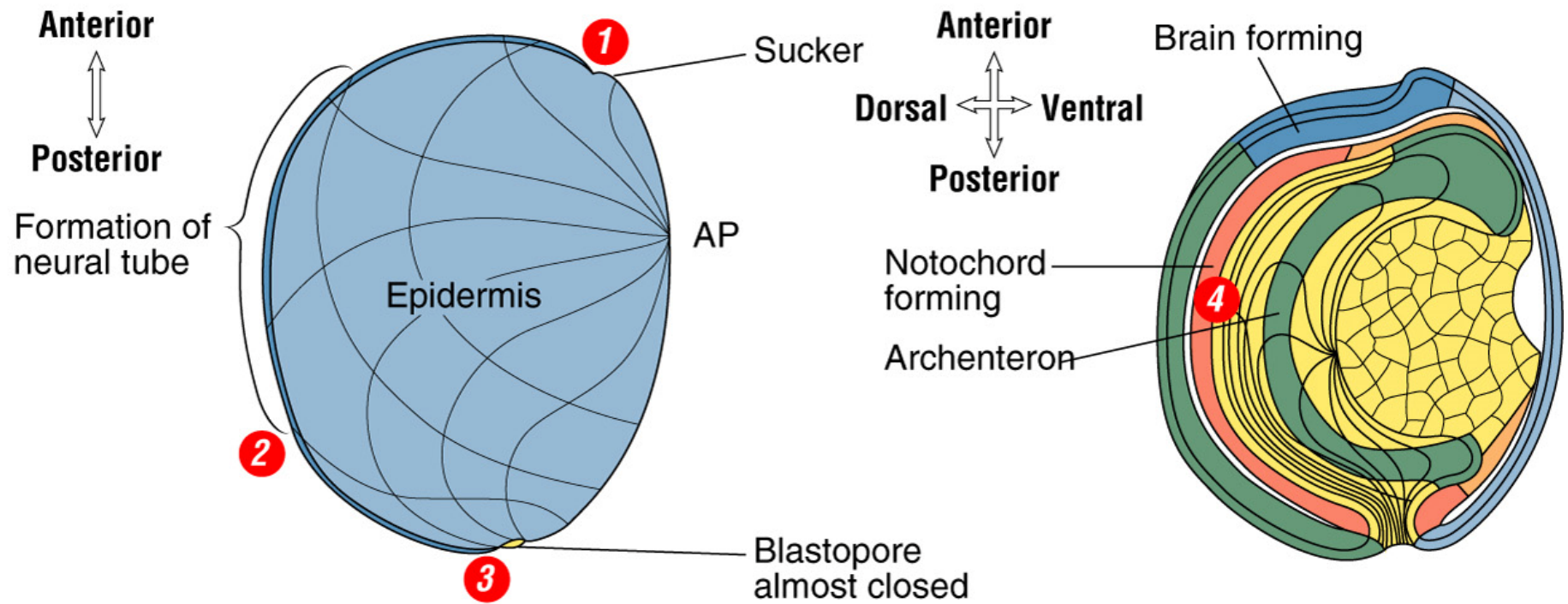


## C. Late Gastrula





## D. Neurulation Finished





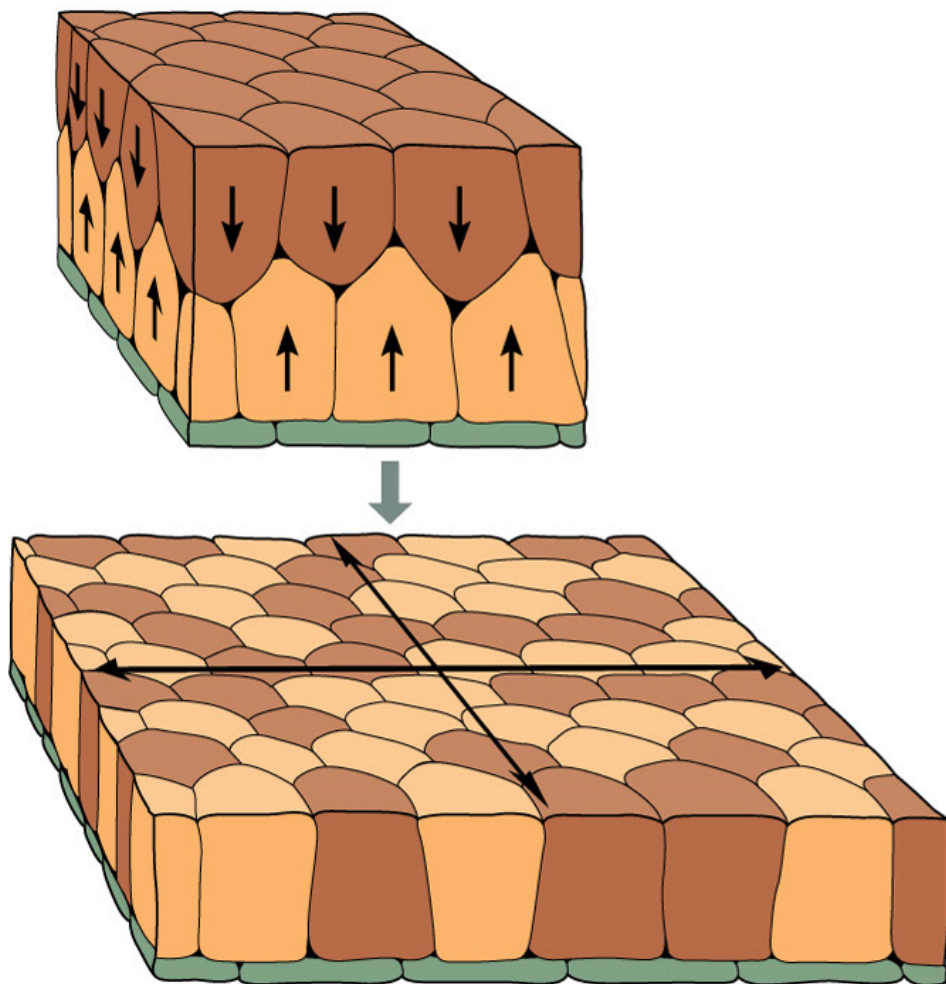
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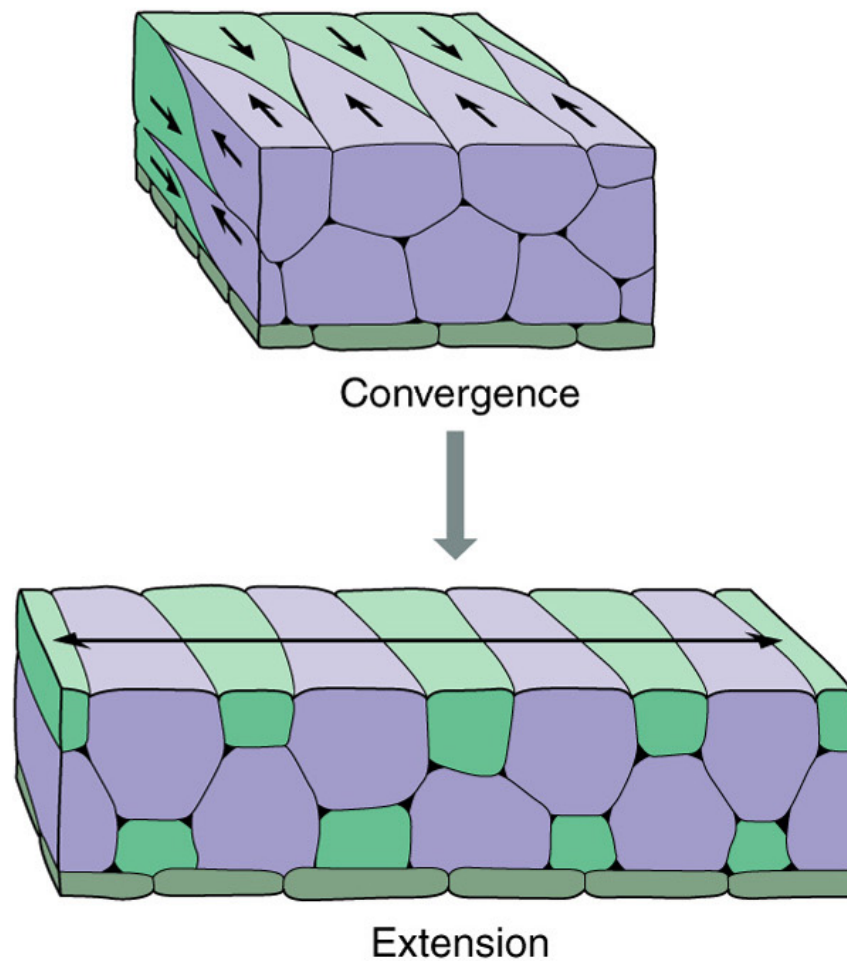
## Radiální interkalace

### A. Radial intercalation

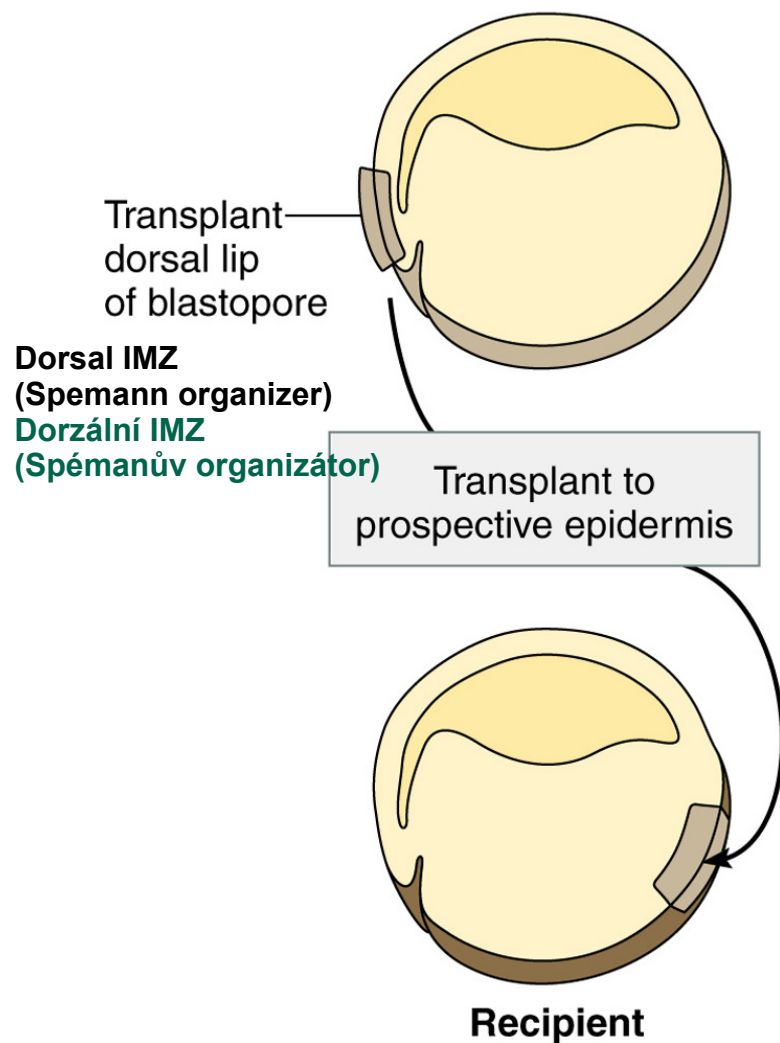


## Mediolaterální interkalace

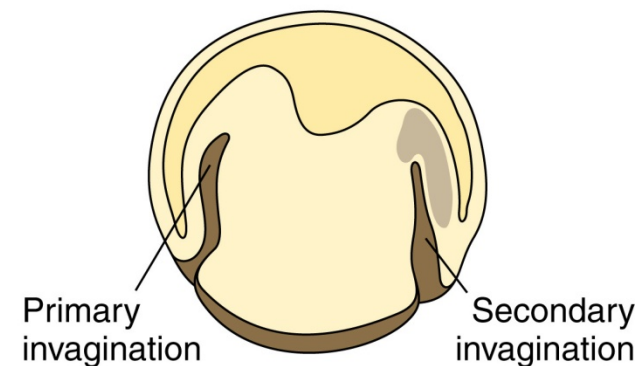
### B. Mediolateral intercalation



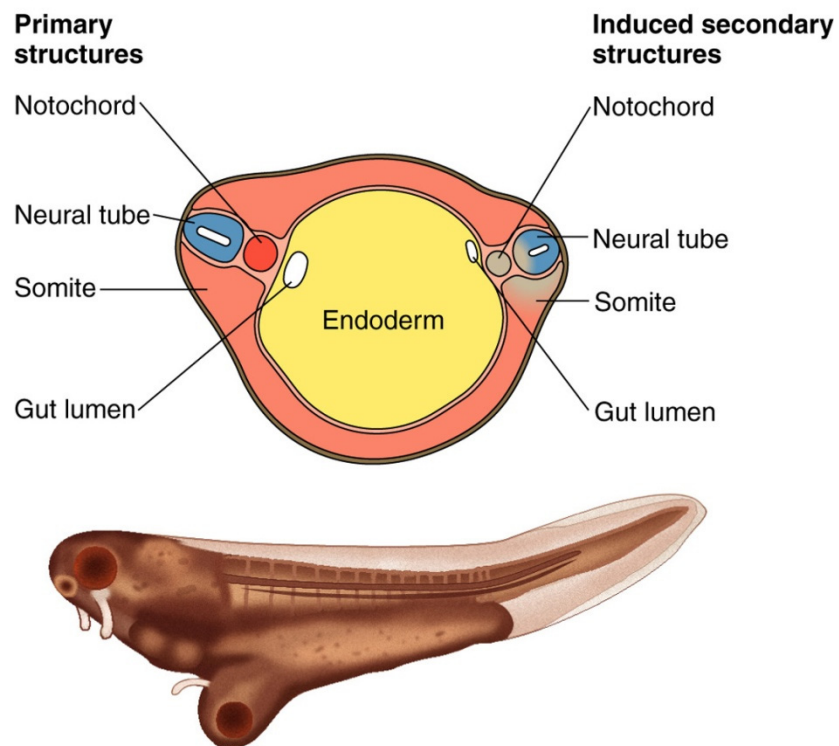
**A.**



**B.**



**C.**







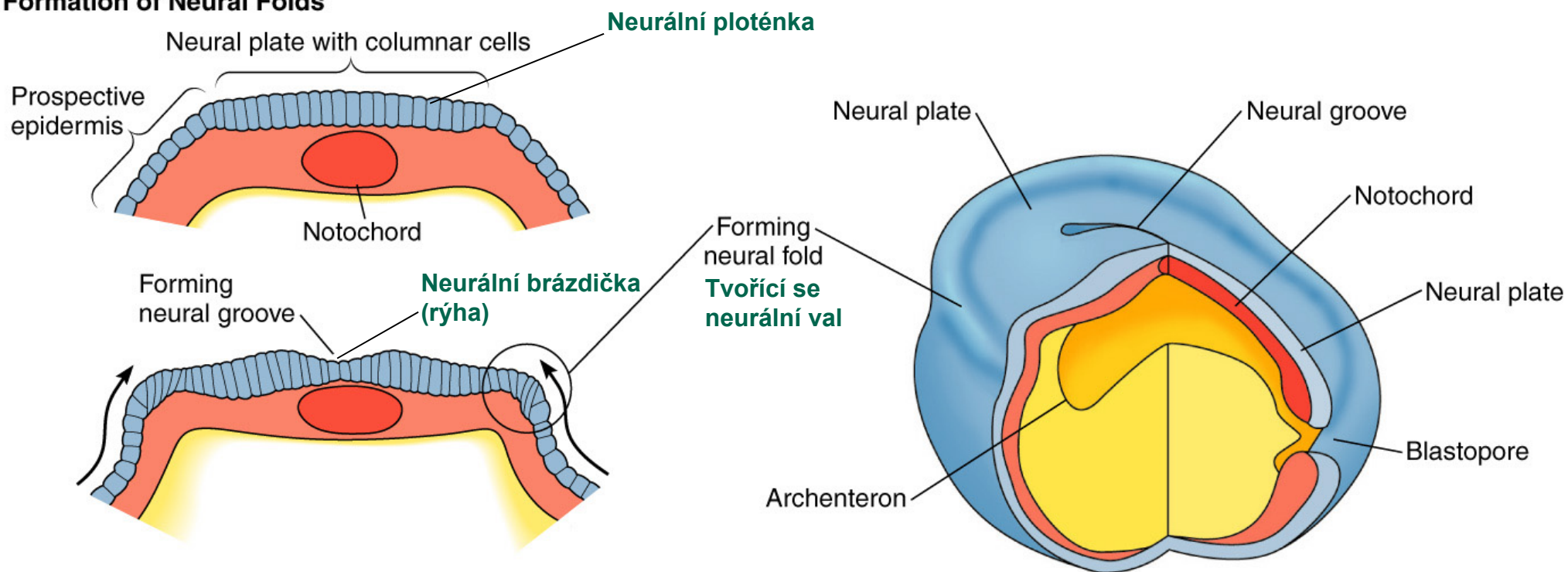
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  - gastrulation of amphibians (video)
- Neurulation



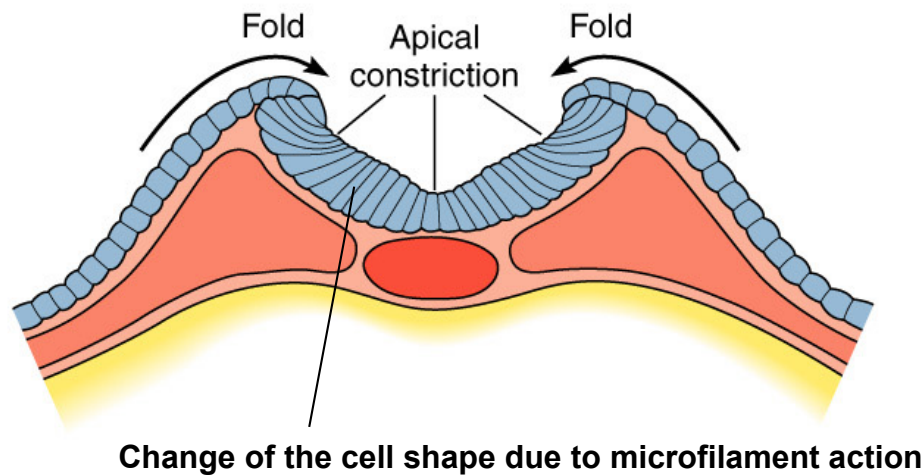
## A. Formation of Neural Folds



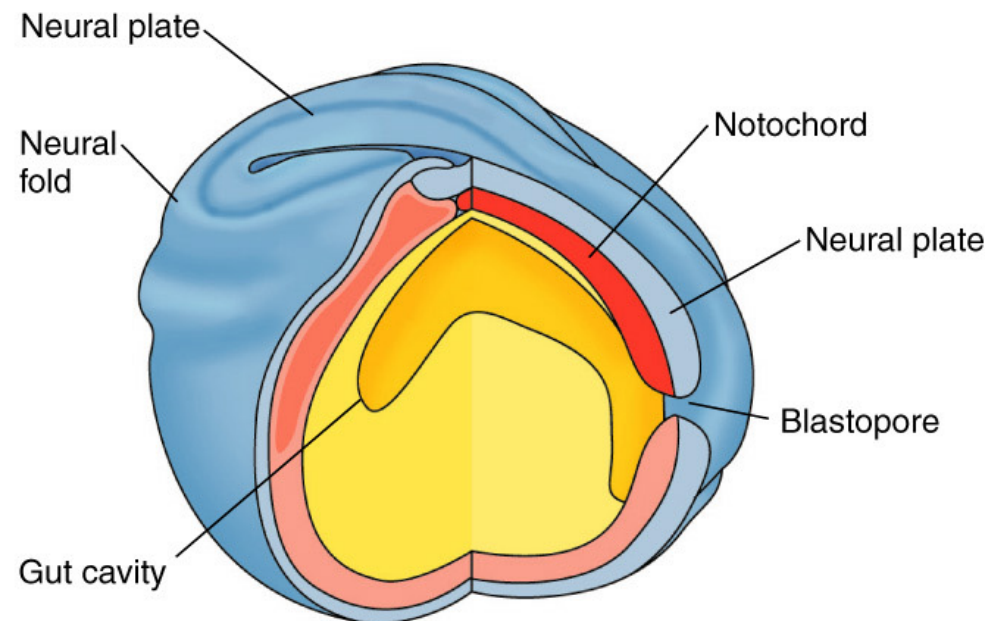
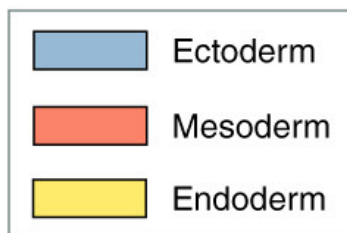
## KEY

	Ectoderm
	Mesoderm
	Endoderm

## B. Elevation of Neural Folds



### KEY

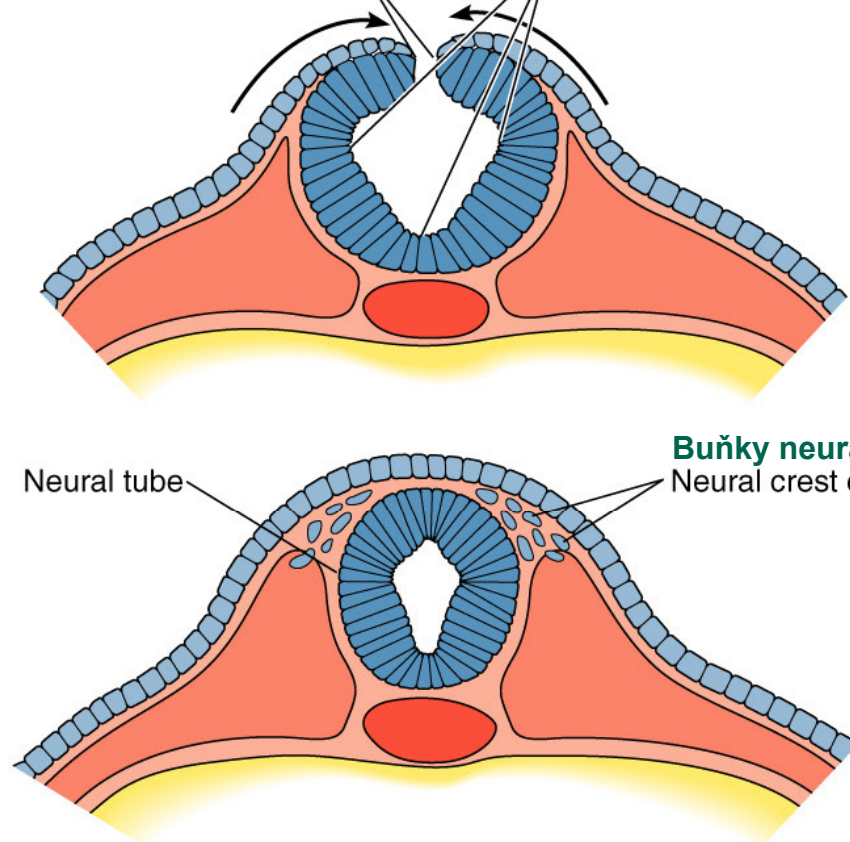


### C. Formation of Neural Tube

Prospective neural crest

Místa ohybu

Hinge points

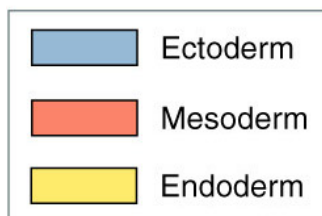


Neural tube

Buňky neurální lišty

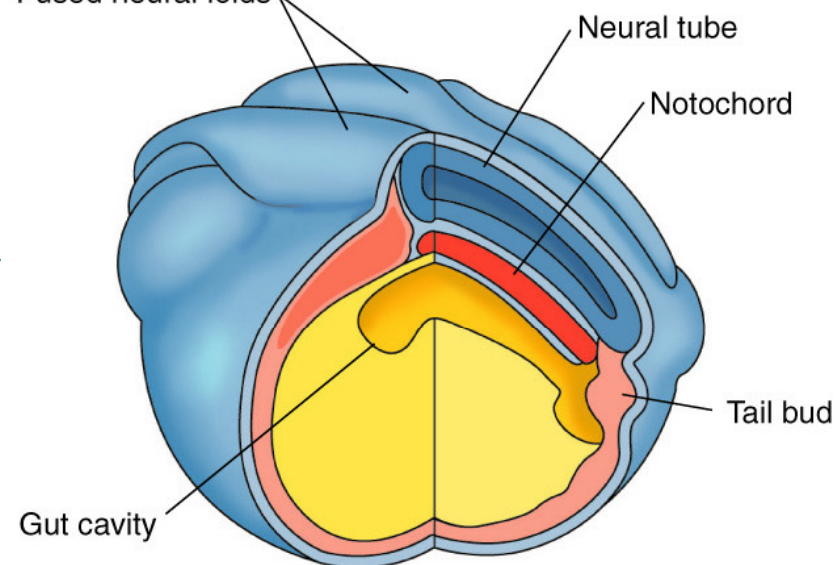
Neural crest cells

KEY



Fúzané  
neurální valy

Fused neural folds



Neural tube

Notochord

Tail bud

Gut cavity



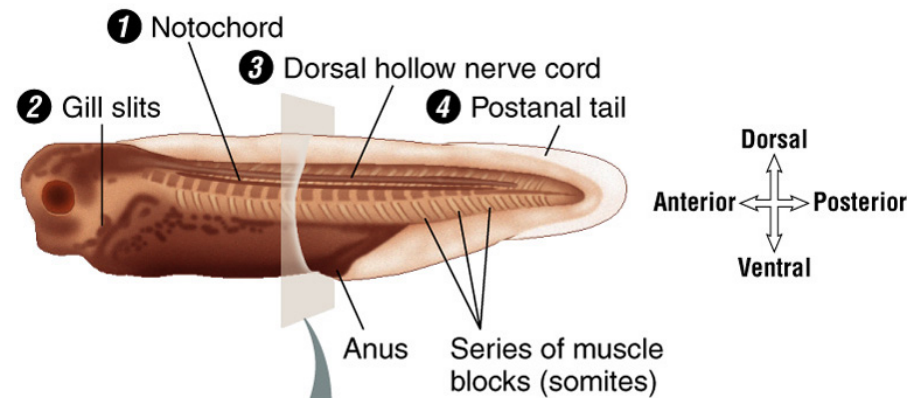
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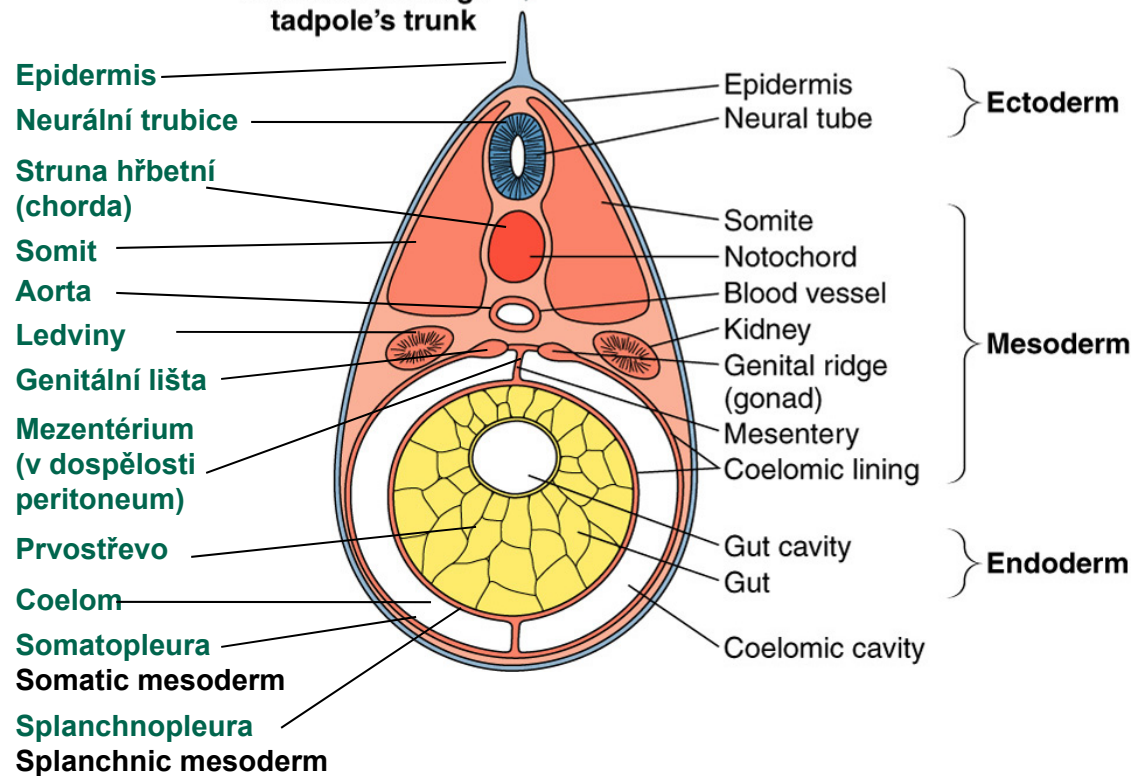
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- Gastrulation
  - gastrulation of amphibians (video)
- Neurulation
  - neurulation in *Xenopus* (video)



**A. The vertebrate “body axis” (head–trunk–tail)  
and the four characteristics of chordates**



**B. Section through tadpole's trunk**

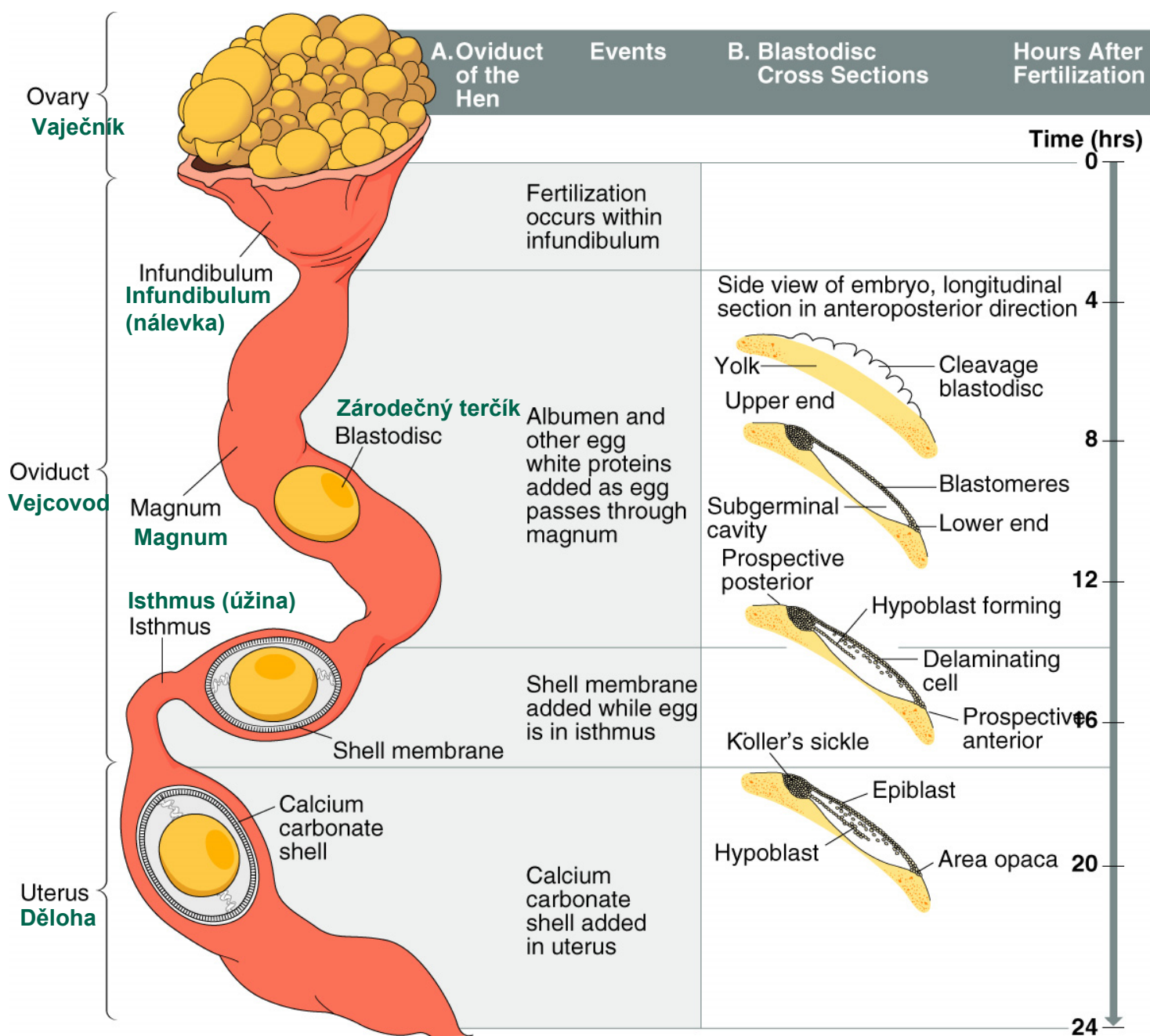




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  - gastrulation of amphibians (video)
- Neurulation
  - neurulation in *Xenopus* (video)
- Oogenesis in amniotes - chicken





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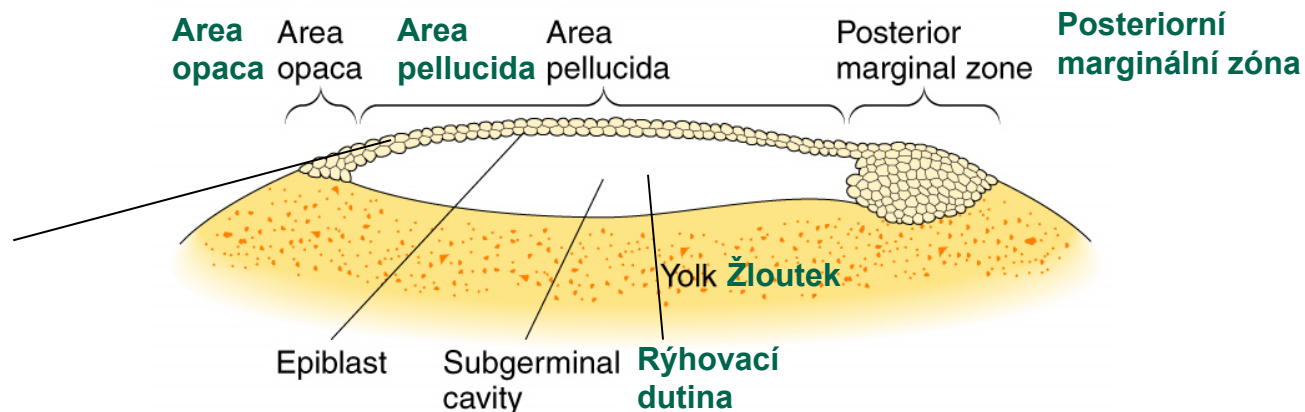
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- Blastula formation in amniotes - chicken

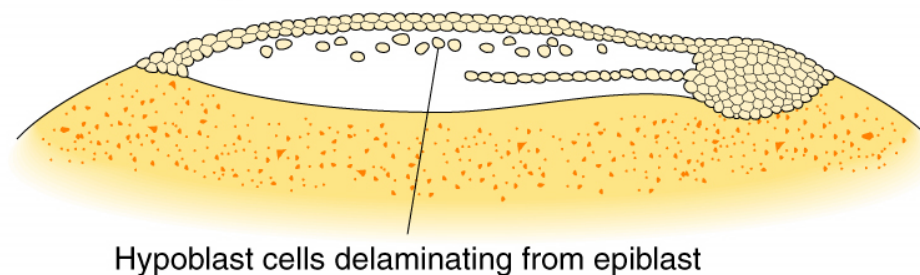


Egg laying:  
60,000 cells,  
about 1 mm in  
diameter

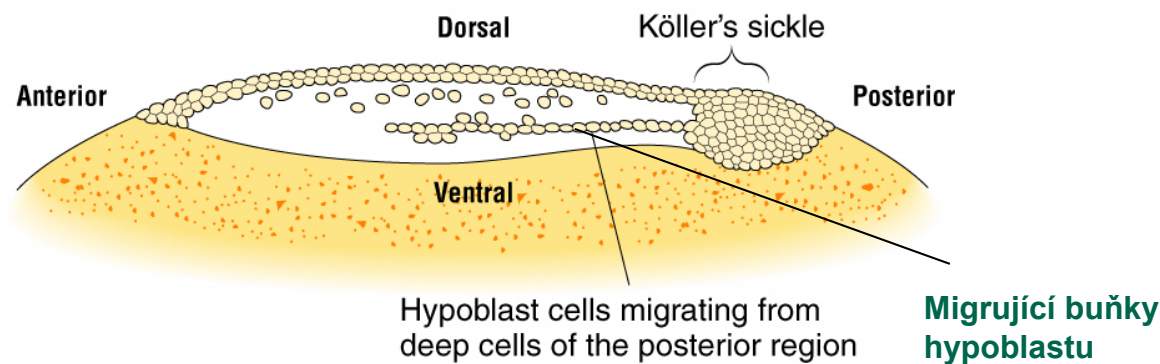
### A. Egg before formation of hypoblast



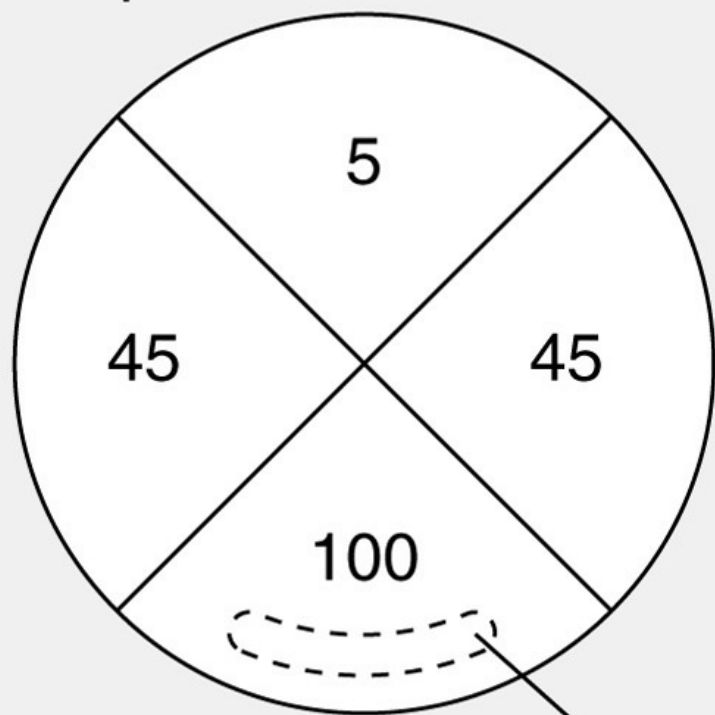
### B. Primary hypoblast Primární hypoblast



### C. Secondary hypoblast Sekundární hypoblast

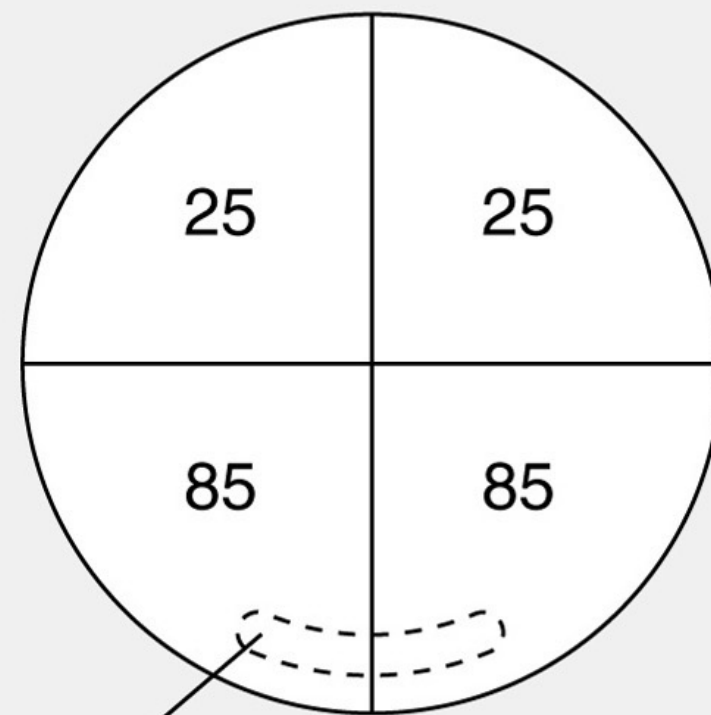


Cut blastoderm in pieces like this...



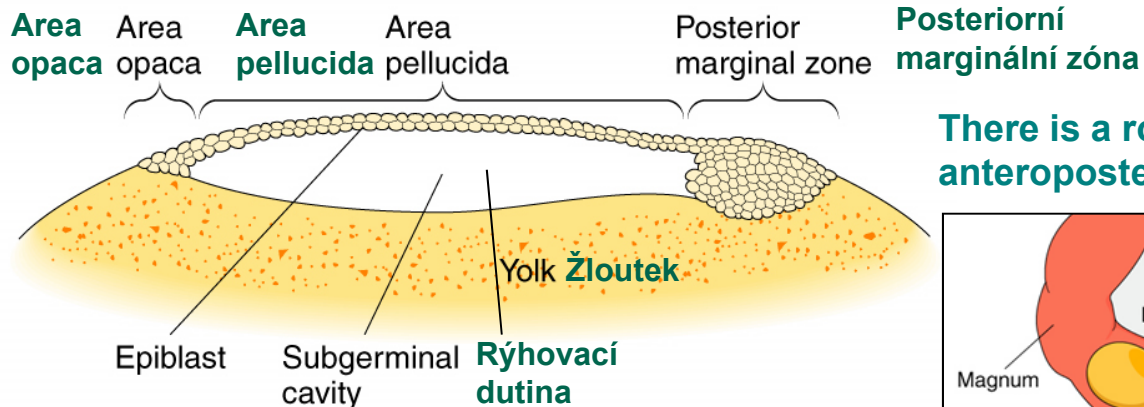
Numbers show percentage of total pieces from a given region that could form an axis

...or like this



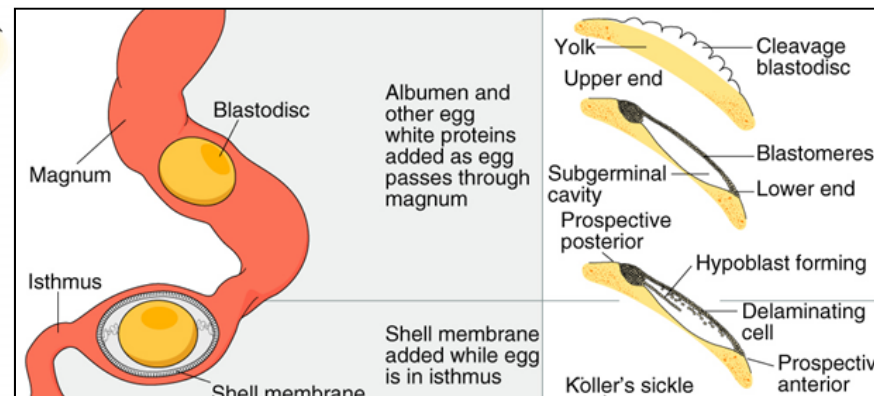
Posterior marginal zone

# A. Egg before formation of hypoblast

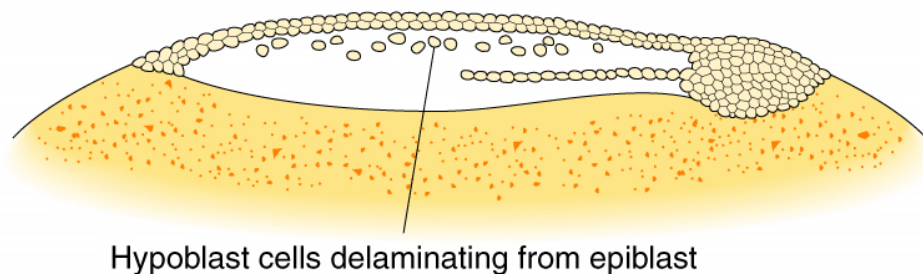


Posteriorní  
marginální zóna

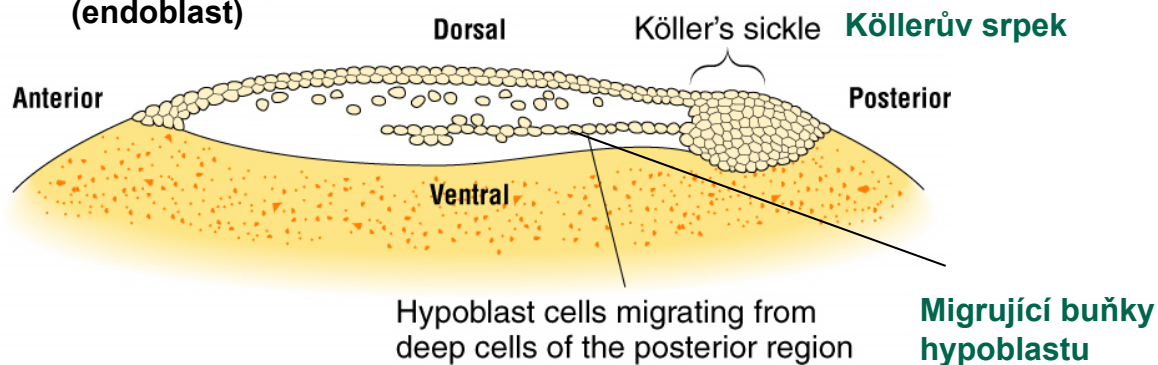
There is a role of gravitropism in the anteroposterior axis formation in birds



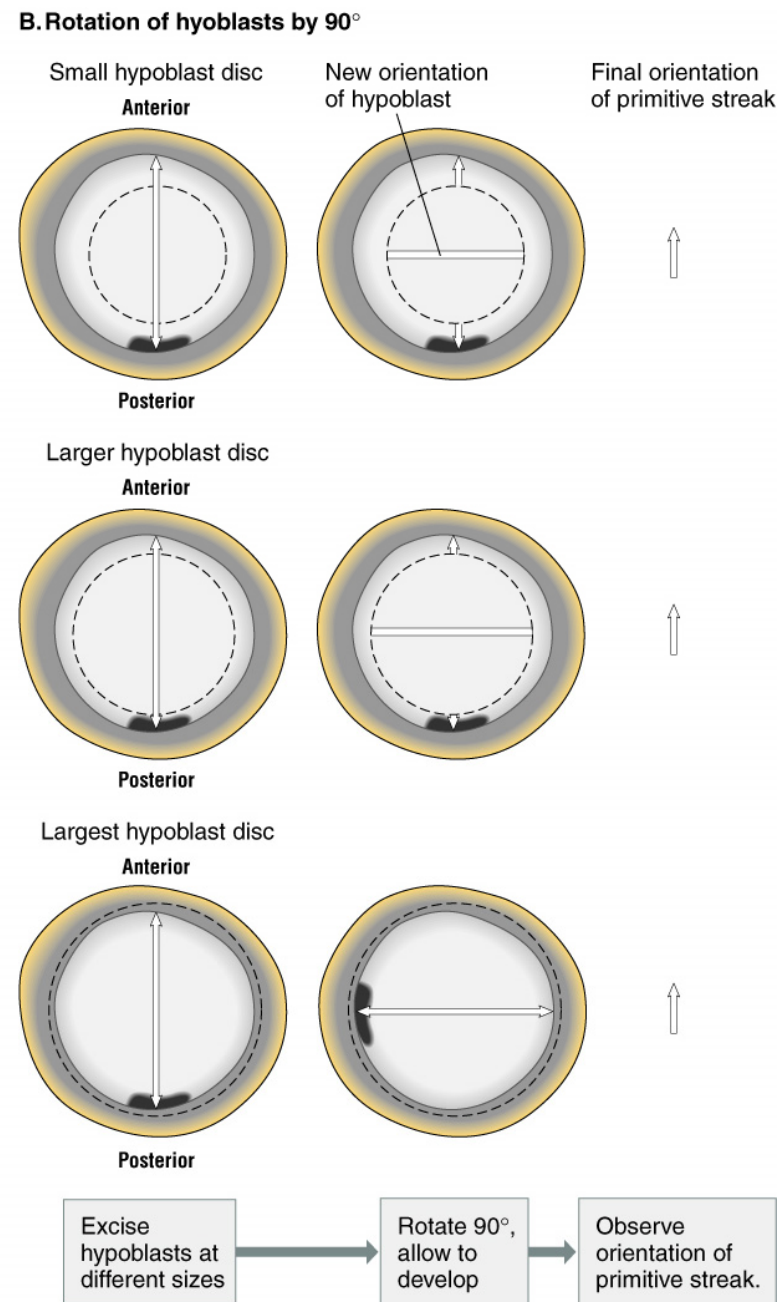
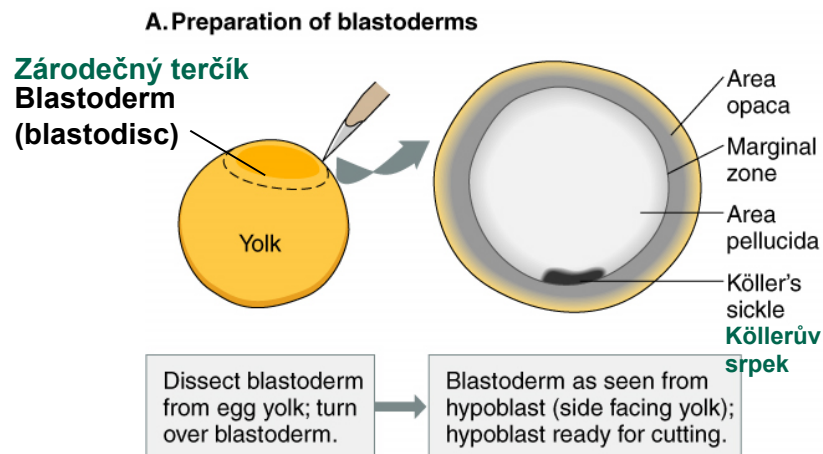
# B. Primary hypoblast Primární hypoblast



# C. Secondary hypoblast (endoblast) Sekundární hypoblast







**Does hypoblast determine the anteroposterior axis of epiblast?**



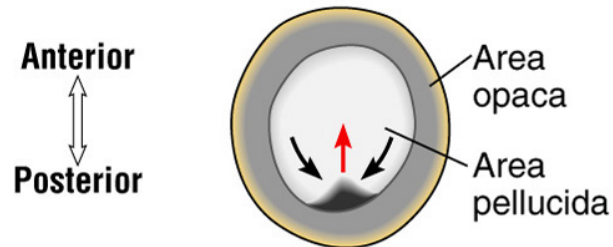


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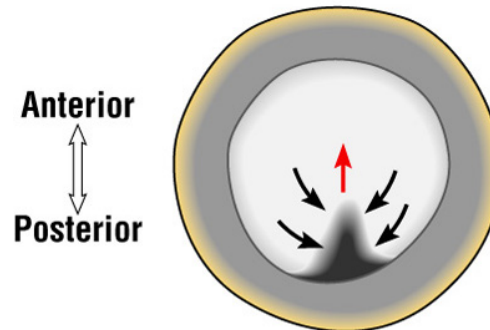
## Early Development of Amphibians and Amniotes

- Gastrulation in amniotes – chicken

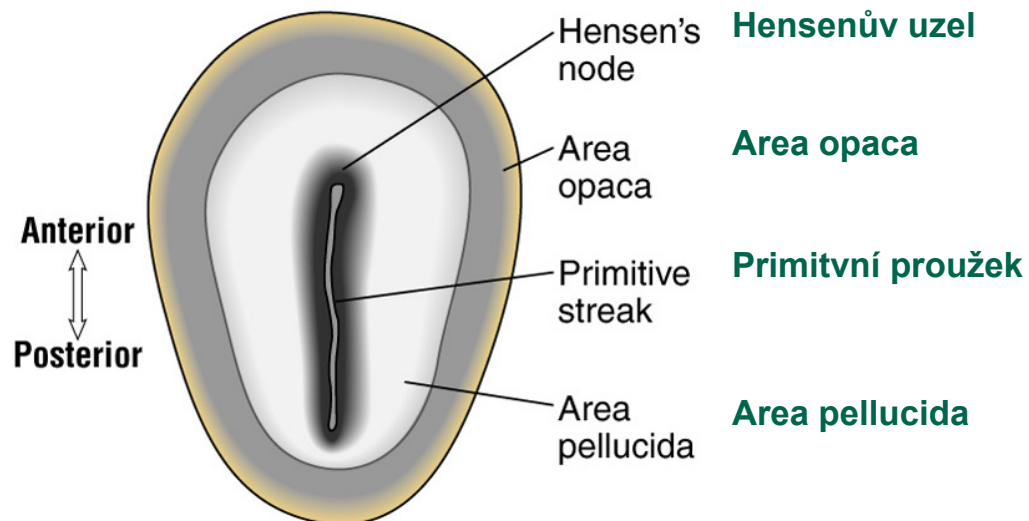
### A. After 3 – 4h of incubation



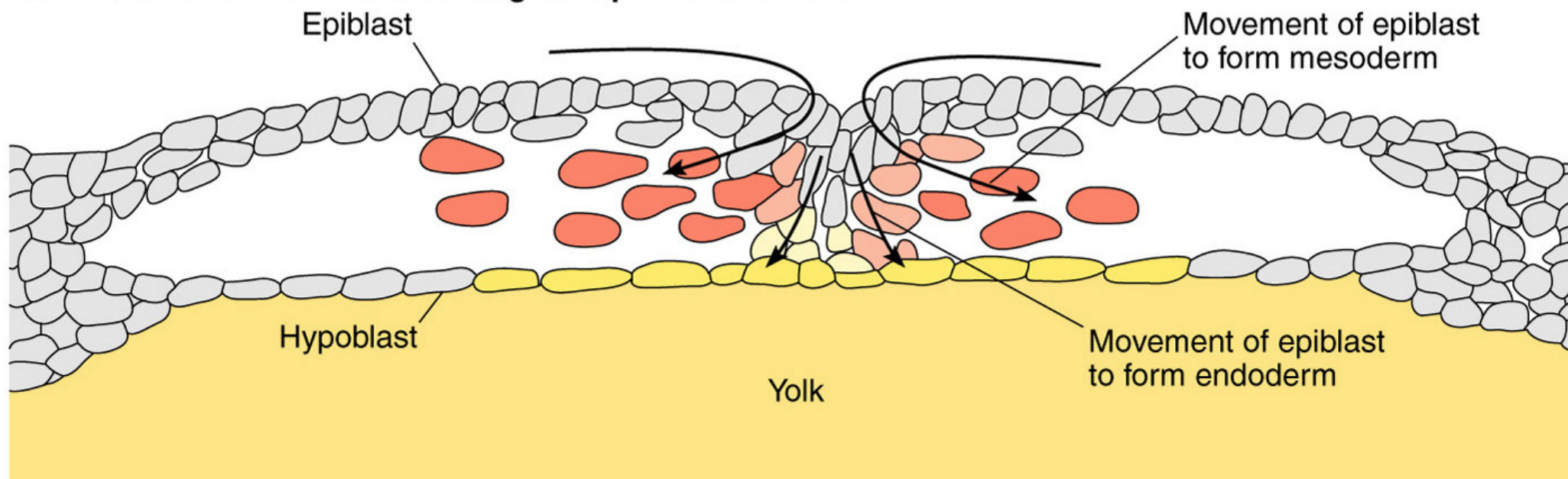
### B. 10 – 12h of incubation

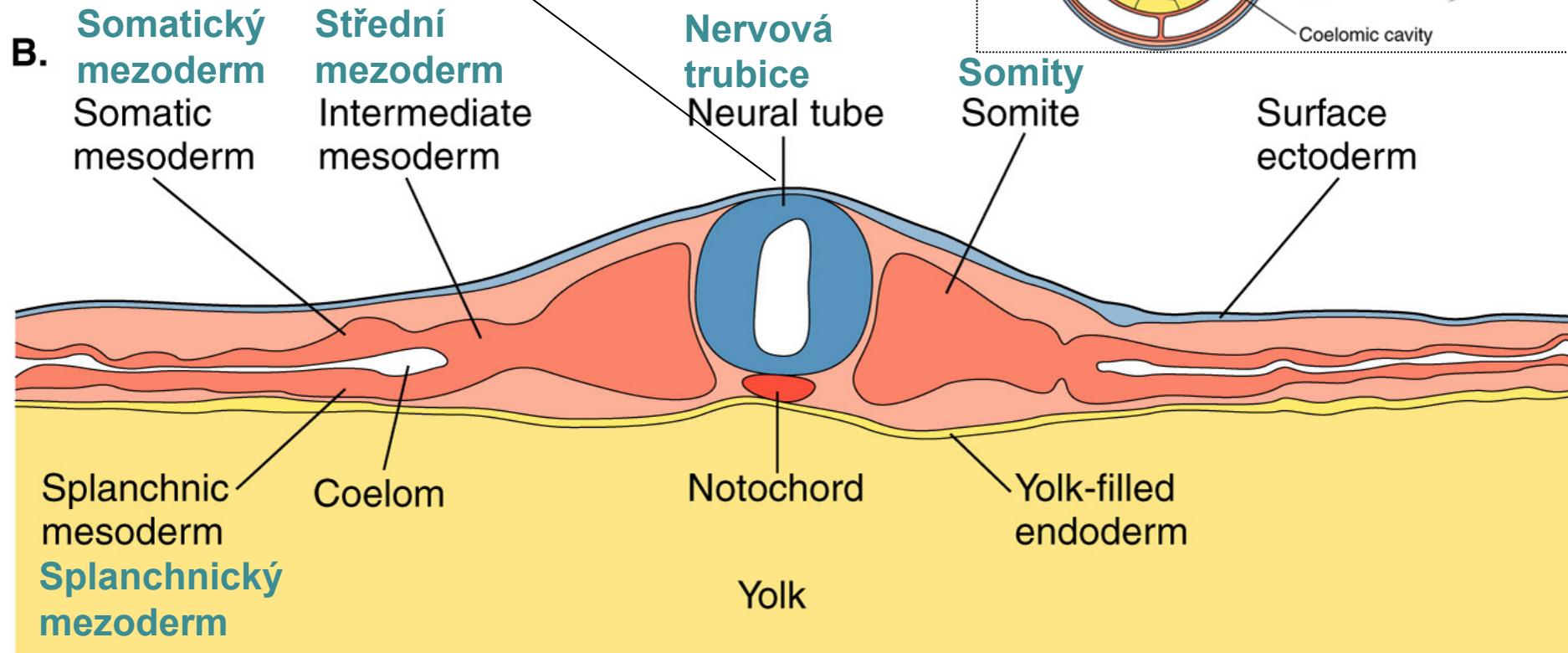
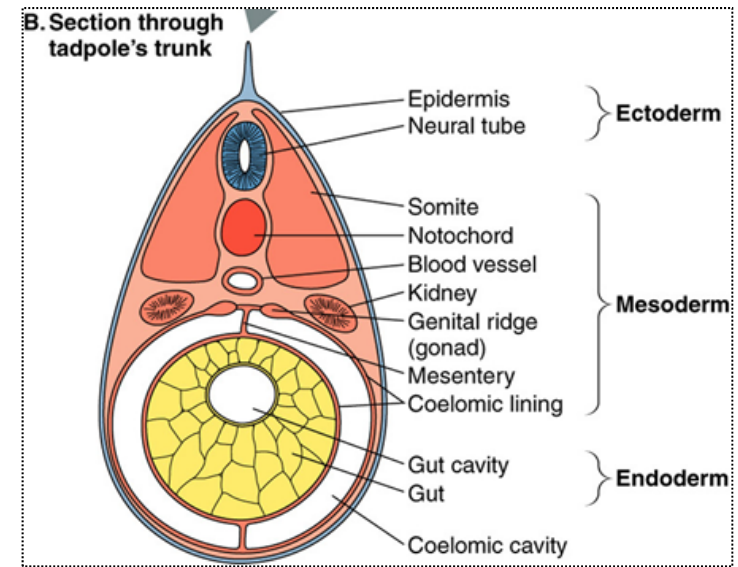


### C. 18 – 20h of incubation



## D. Schematic of movements through the primitive streak









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- Gastrulation in amniotes – chicken
  - early and late gastrulation in chicken (video)

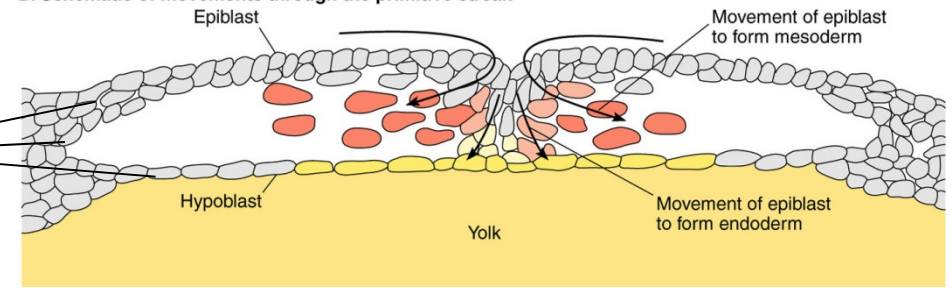


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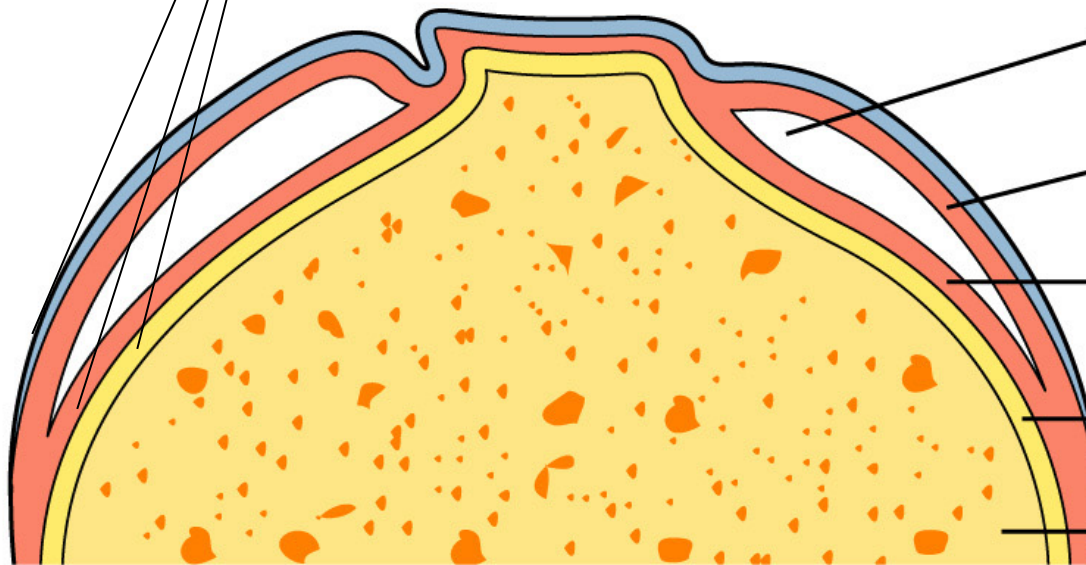
- Gastrulation in amniotes – chicken
  - early and late gastrulation in chicken (video)
- Formation of extraembryonic tissues in amniotes - chicken

D. Schematic of movements through the primitive streak



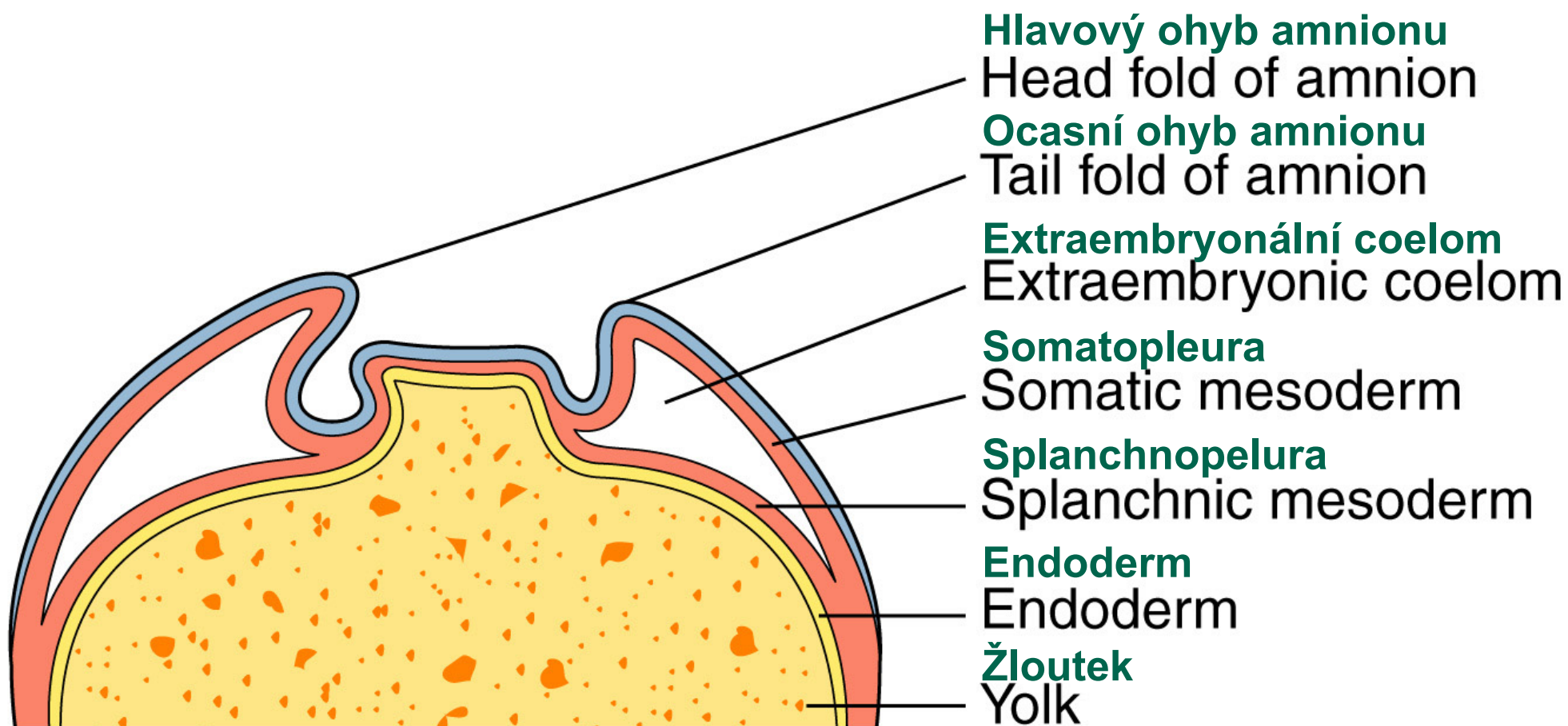
Origin of extraembryonic tissue

A.



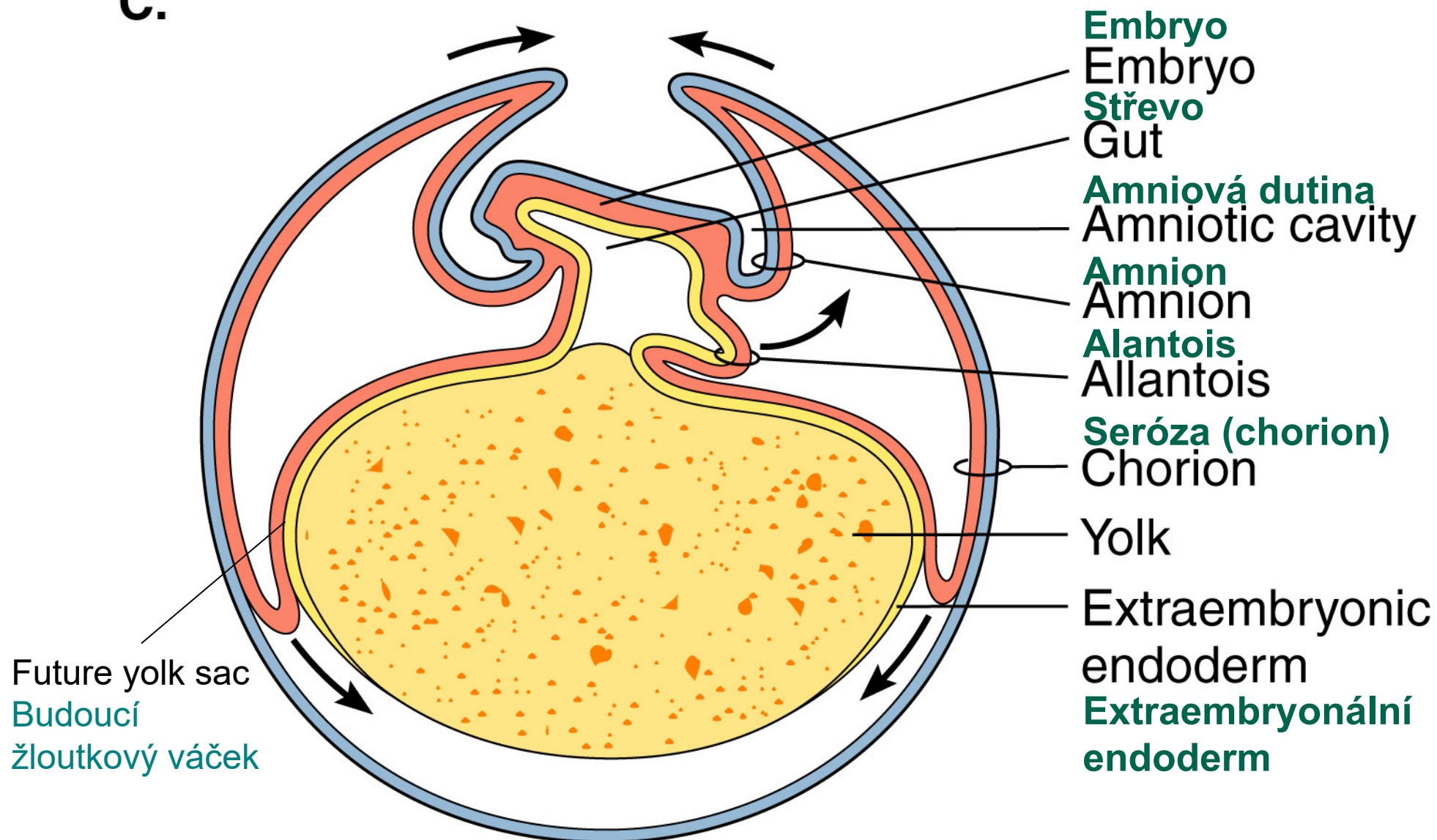
Extraembryonální coelom  
Extraembryonic coelom  
Somatopleura  
Somatic mesoderm  
Splanchnopleura  
Splanchnic mesoderm  
Endoderm  
Endoderm  
Žloutek  
Yolk

B.

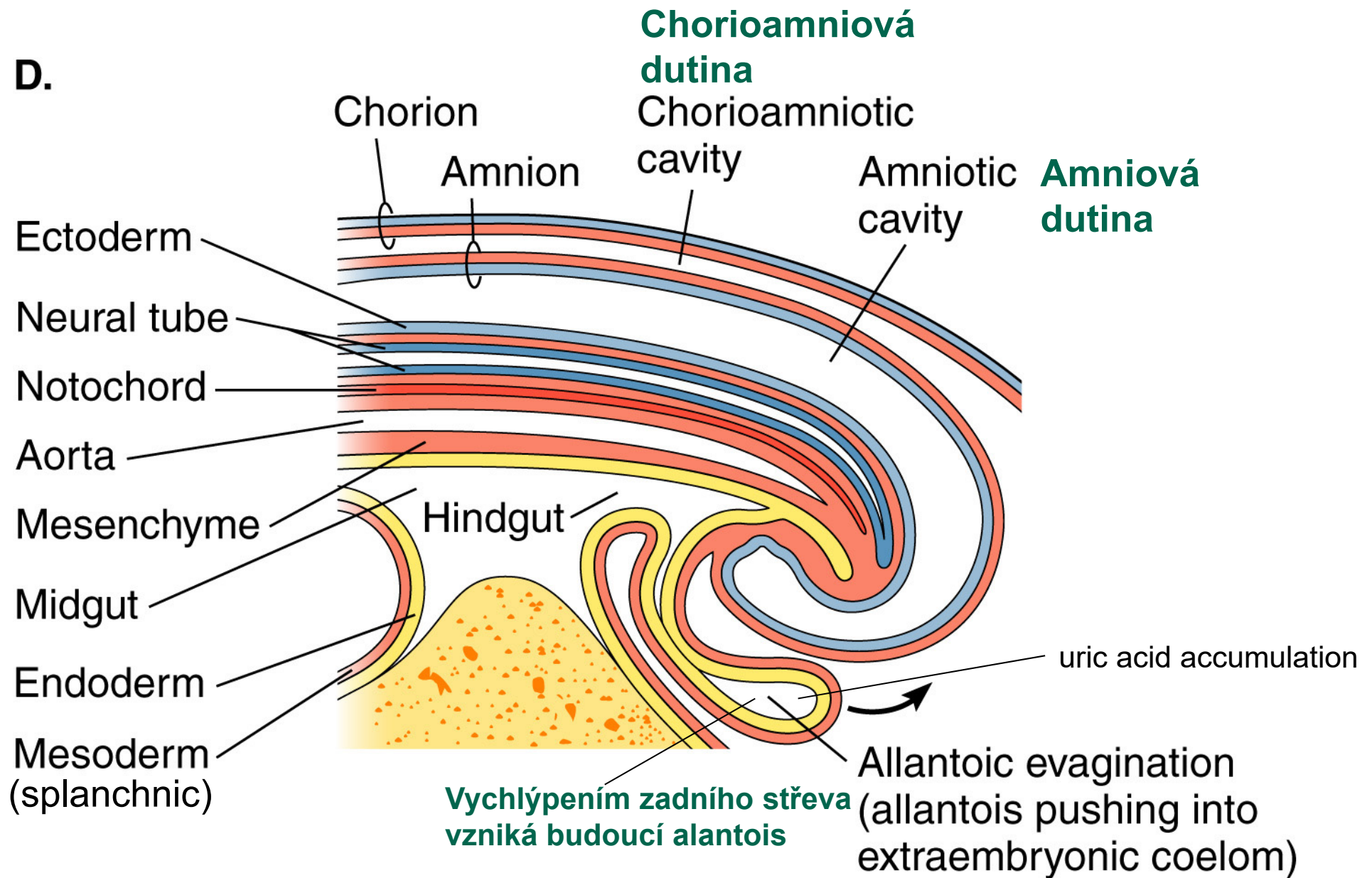




C.

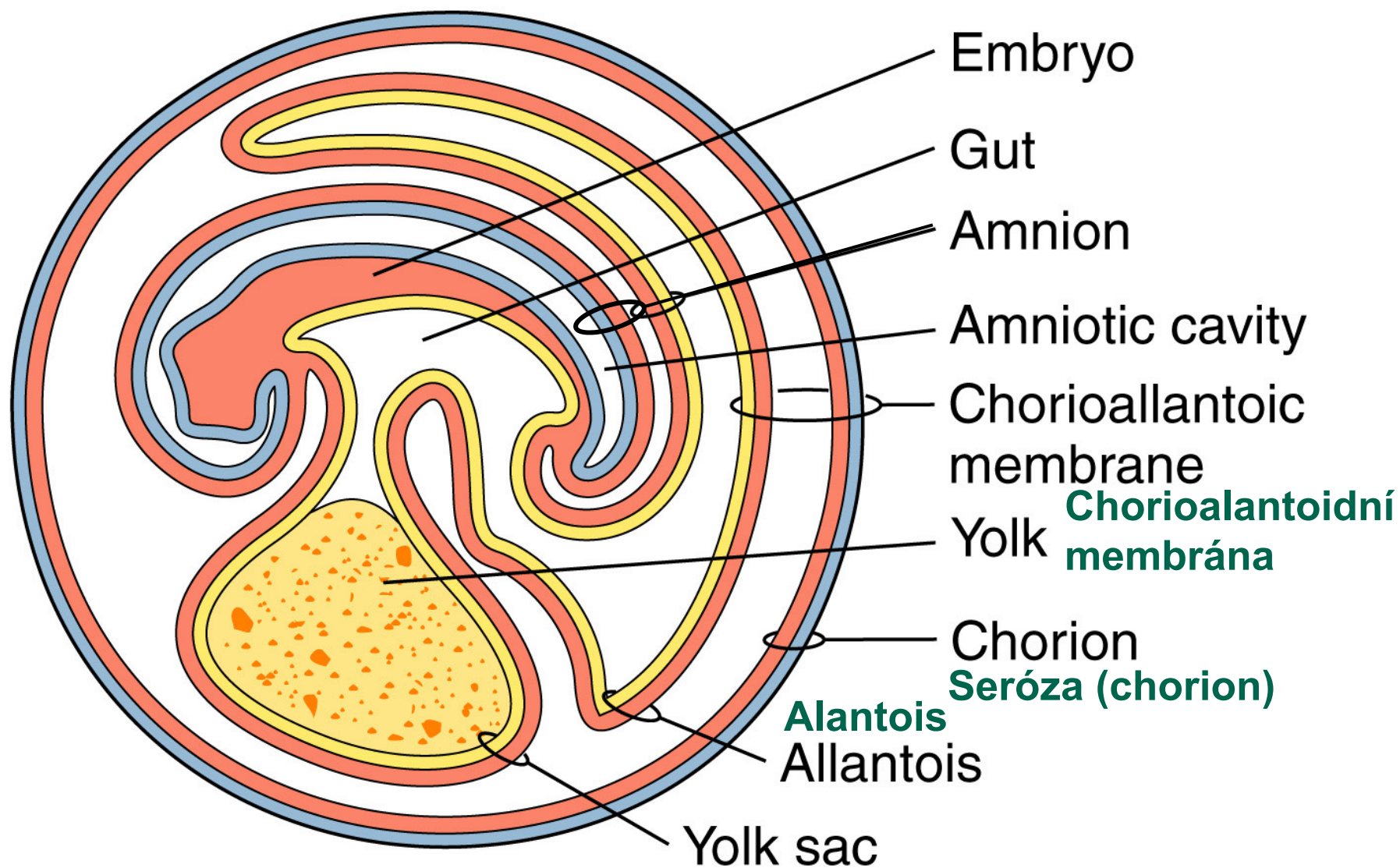


D.





E.



# Key Concepts

- First source of **asymmetry originates from the oogenesis** both in *Drosophila* and *Xenopus*.
- In *Xenopus*, another **important source of asymmetry** leading to breaking of the virtual radial symmetry of the egg and **dorsoventral axis specification** is the **sperm entry** that induces **cytoplasm rotation**.
- These processes result into **Speman organizer differentiation** and allow **specification of the cell fate** during **blastula formation**.
- **Gastrulation** allows **further delimitation of the developmental fate**.
- **Amniotes** developed **terrestrial adaptations** that are of **extraembryonic origin**.