

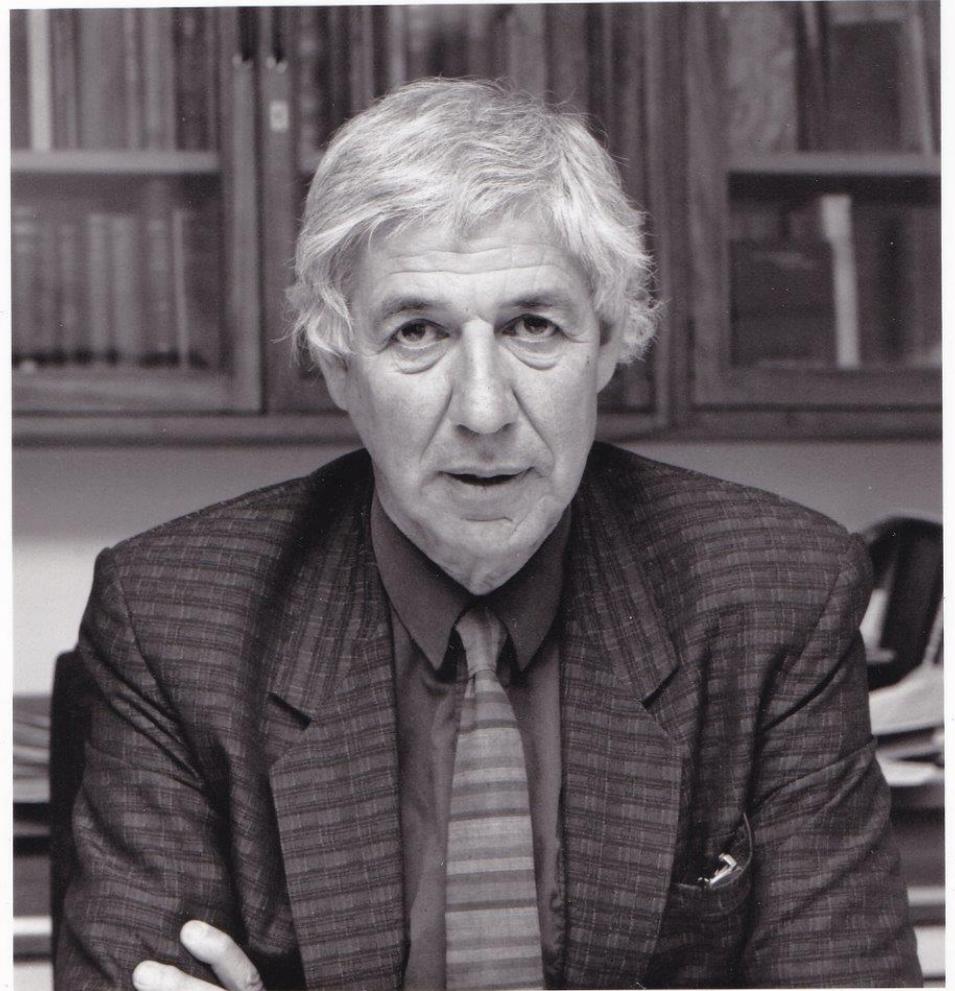
# Desarrollo temprano en metazoarios II



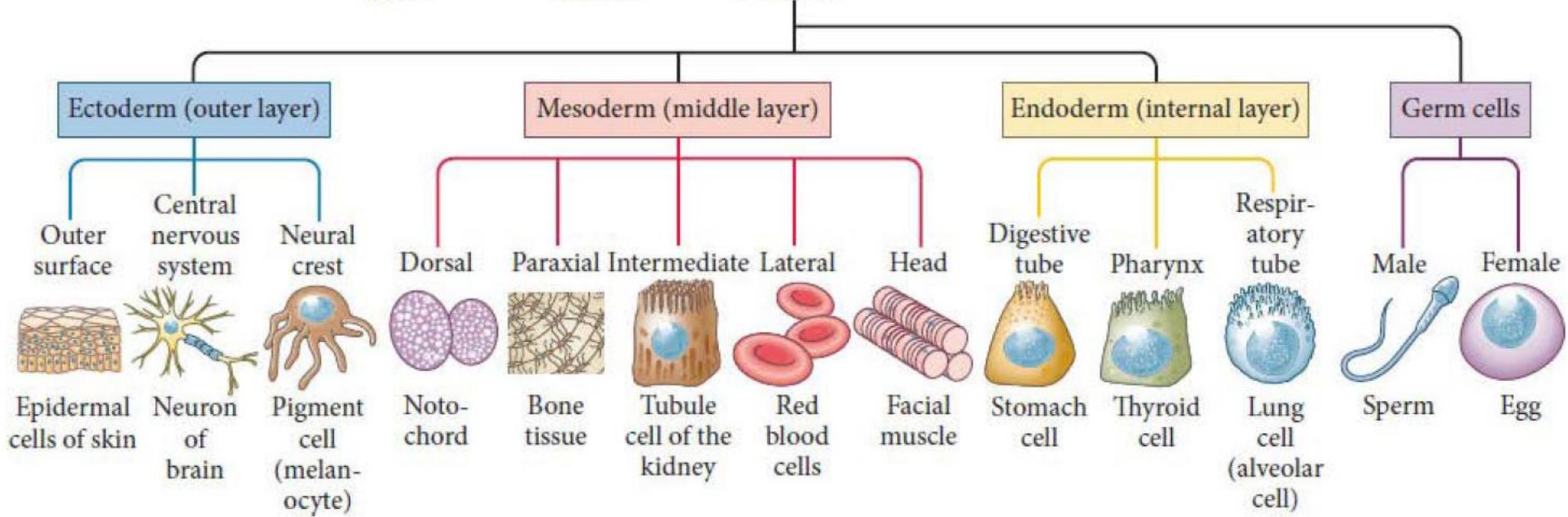
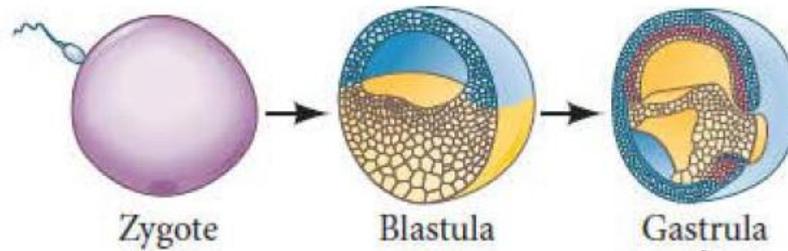
<https://www.youtube.com/watch?v=wJNRIDWjX-o>

**Gonzalo Aparicio**  
gaparicio@fcien.edu.uy

“It is not birth, marriage, or death,  
but **gastrulation** which is truly the  
most important time in your life.”



Lewis Wolpert  
(1929-2021)

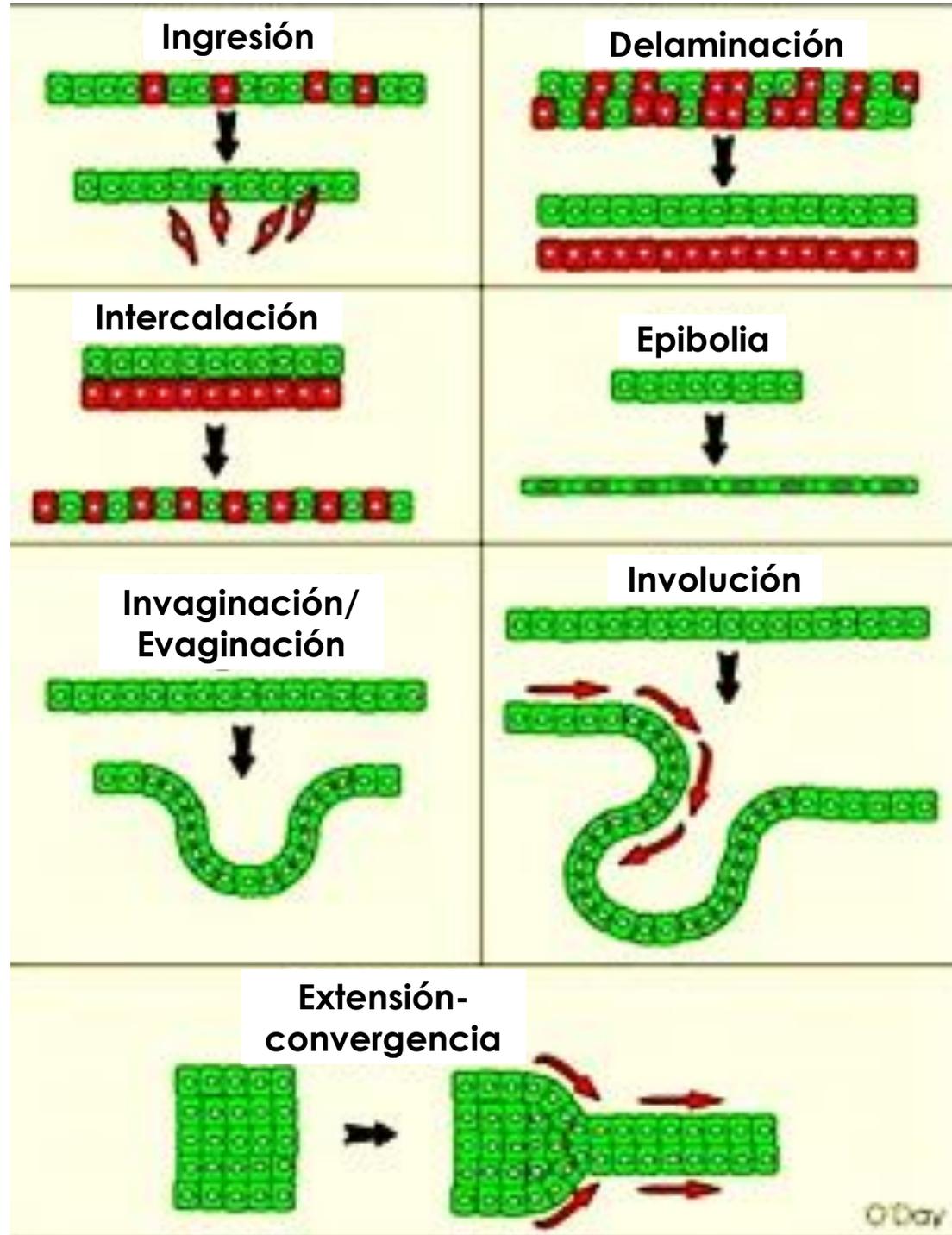


**Ectodermo** epidermis, sistema nervioso

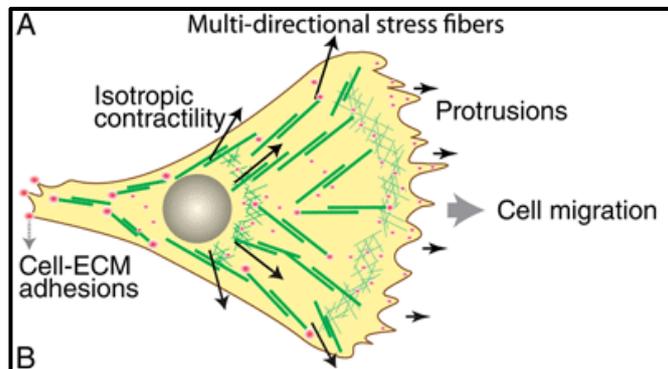
**Mesodermo** corazón, sangre, huesos, músculos, gónadas, riñón

**Endodermo** epitelio del sistema digestivo y órganos asociados, pulmones

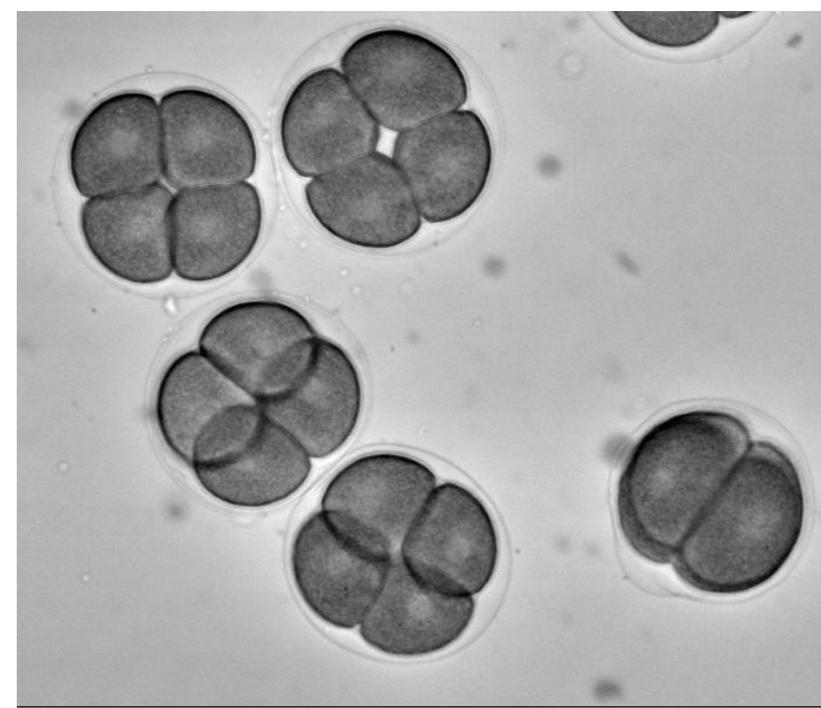
# Movimientos morfogénéticos



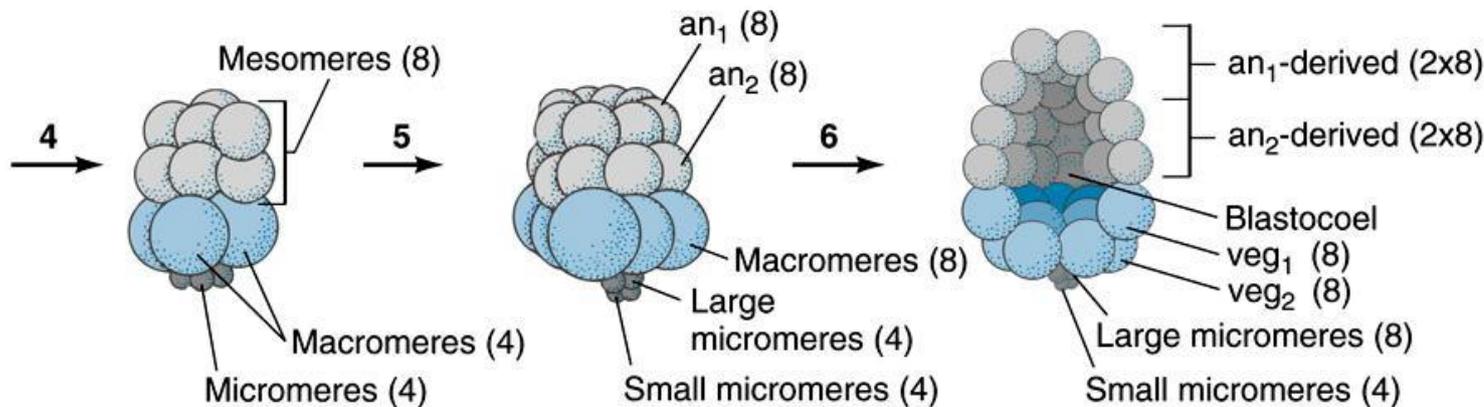
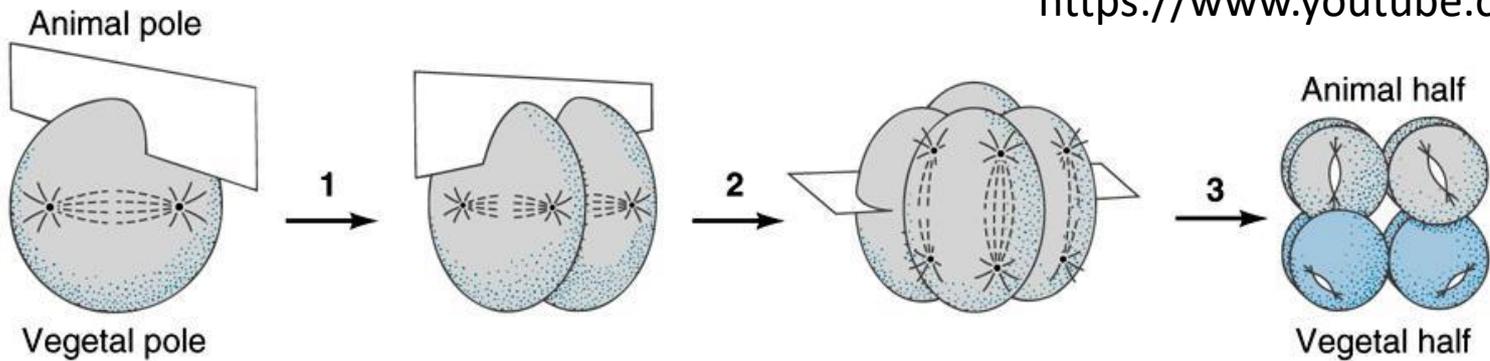
## Migración celular

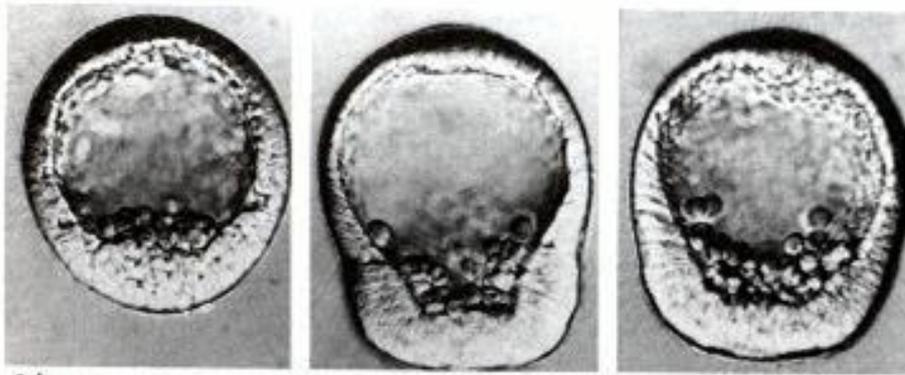


# Clivaje holoblástico radial: equinodermos



<https://www.youtube.com/watch?v=F6zCp29awxA>

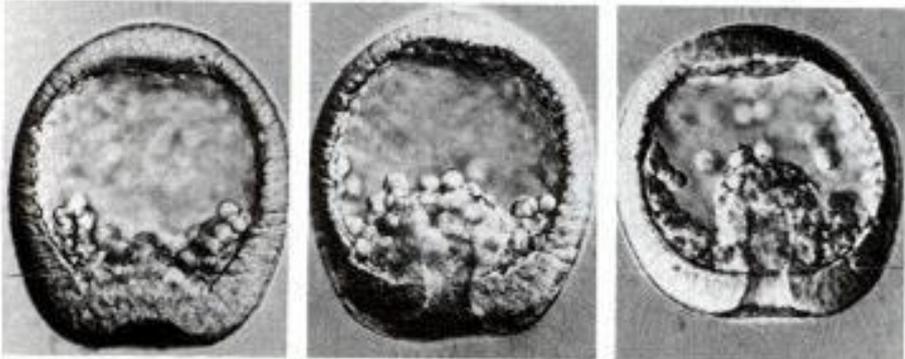




9 hrs.

9.5 hrs.

10 hrs.



10.5 hrs.

11 hrs.

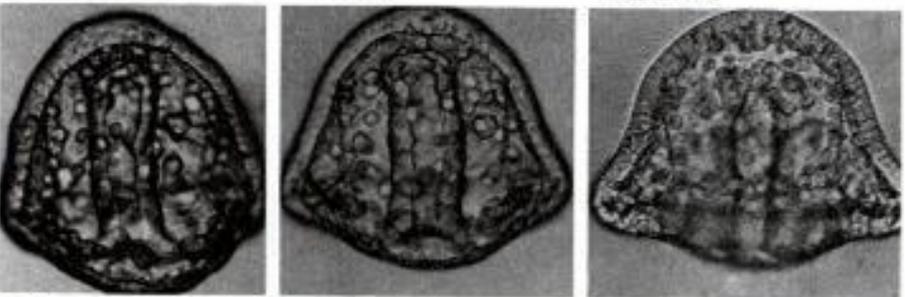
11.5 hrs.



12 hrs.

13 hrs.

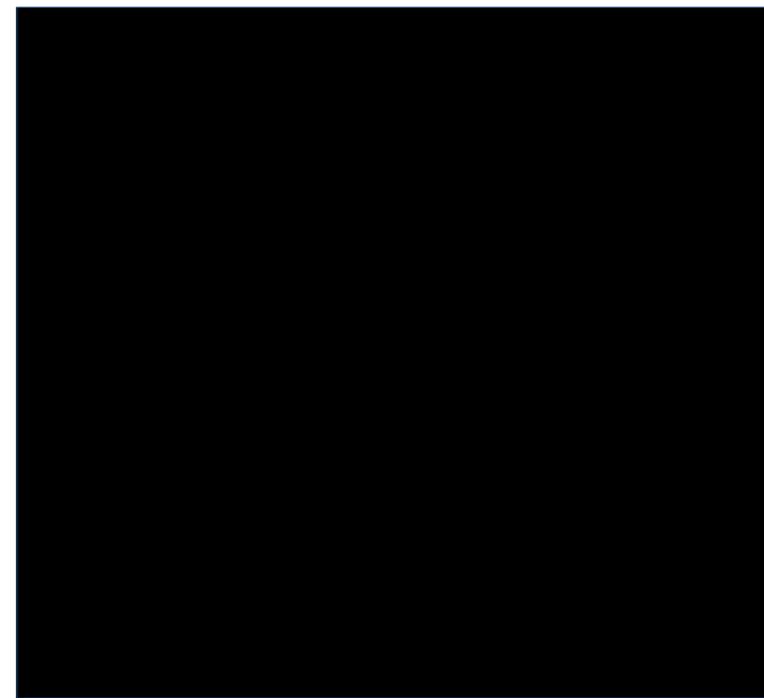
13.5 hrs.



15 hrs.

17 hrs.

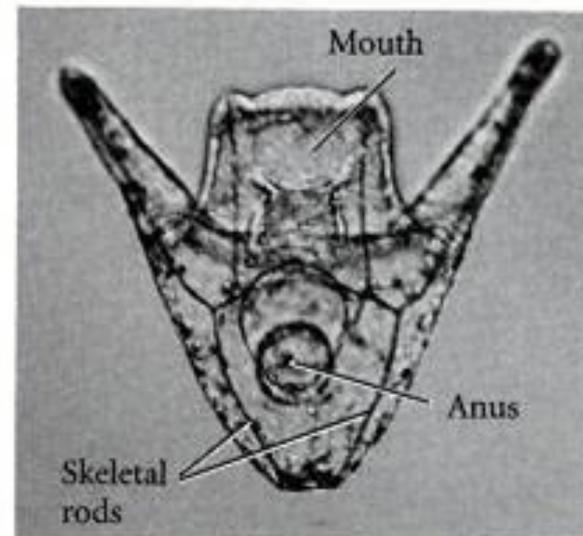
18 hrs.



<https://www.youtube.com/watch?v=Lgb4wMsZwZA>

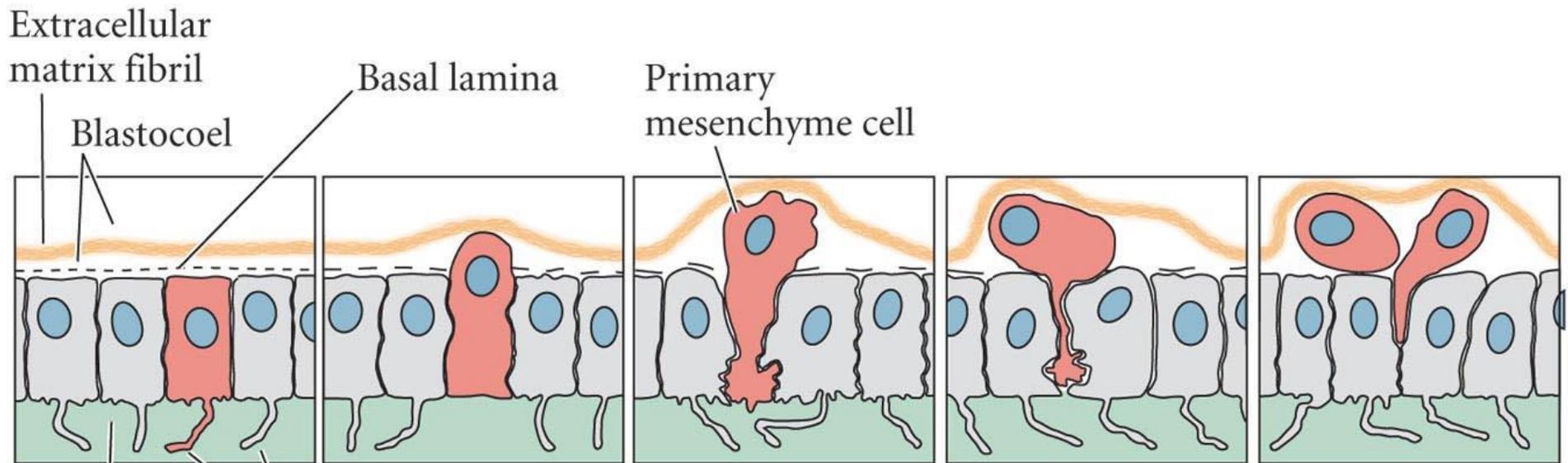
Comienzo gastrulación:

Polo vegetal

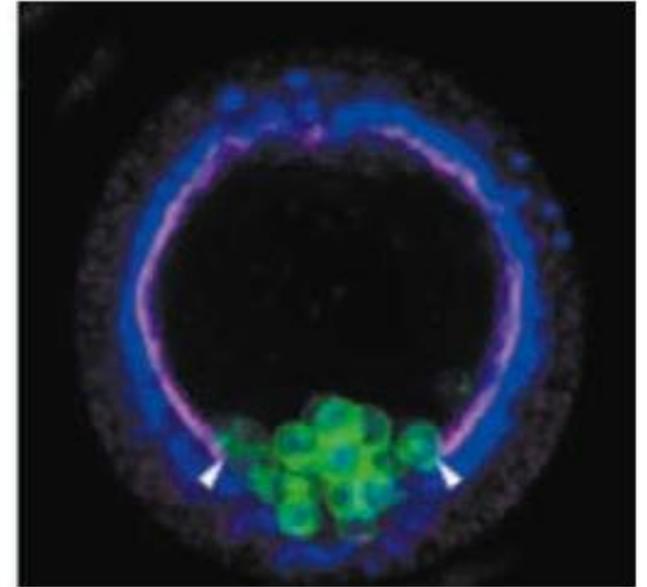
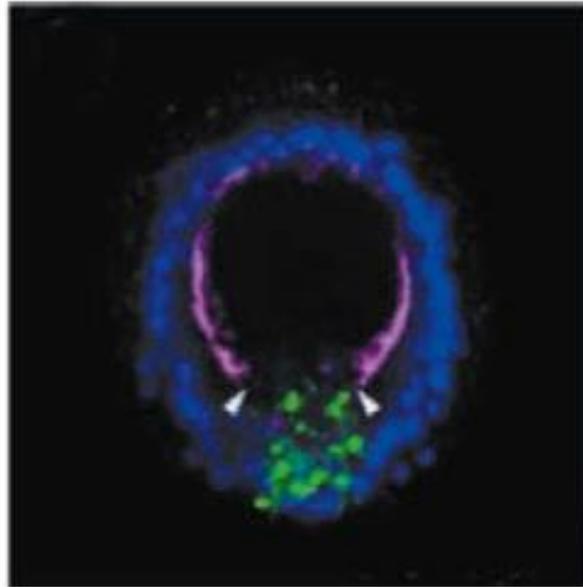
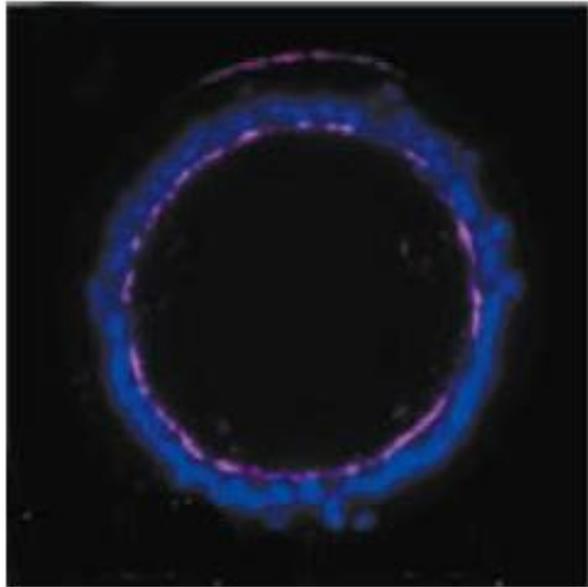


# Transición epitelio-mesénquima

- 1 Polaridad ápico-basal
- 2 Constricción apical
- 3 Remodelación de la lámina basal
- 4 Pérdida de adhesión celular
- 5 Movilidad celular



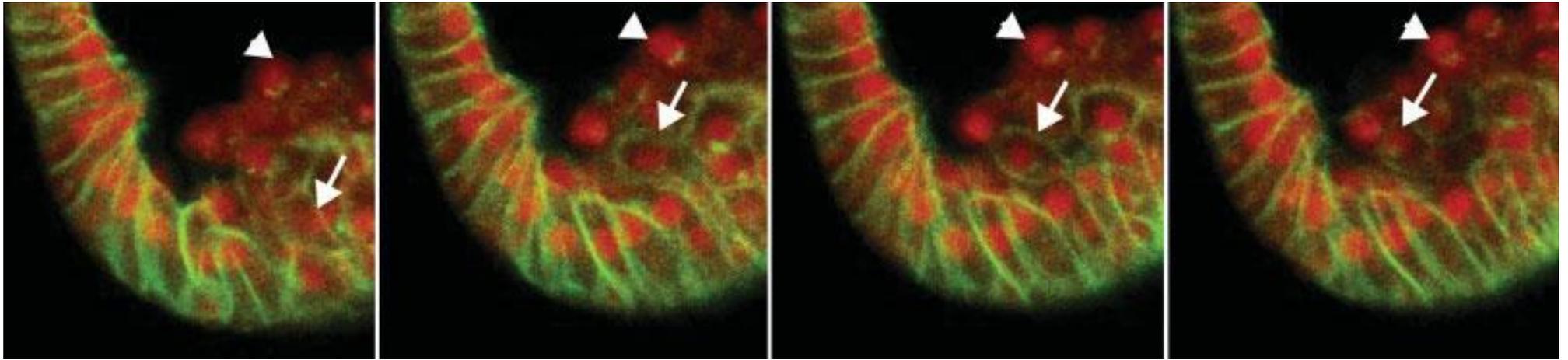
# Transición epitelio-mesénquima: degradación de la matriz extracelular



Azul - ADN  
Magenta - lamina basal  
Verde - células mesenquimales

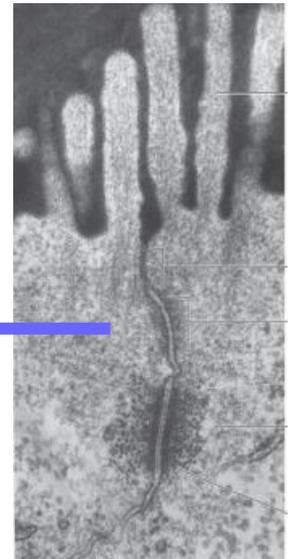
# Ingression of Primary Mesenchyme Cells of the Sea Urchin Embryo: A Precisely Timed Epithelial Mesenchymal Transition

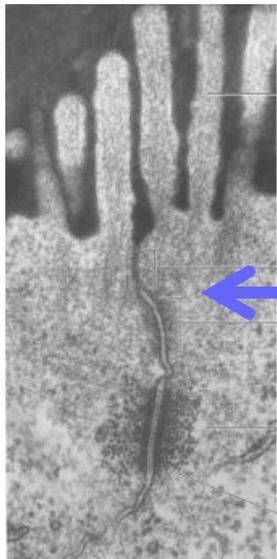
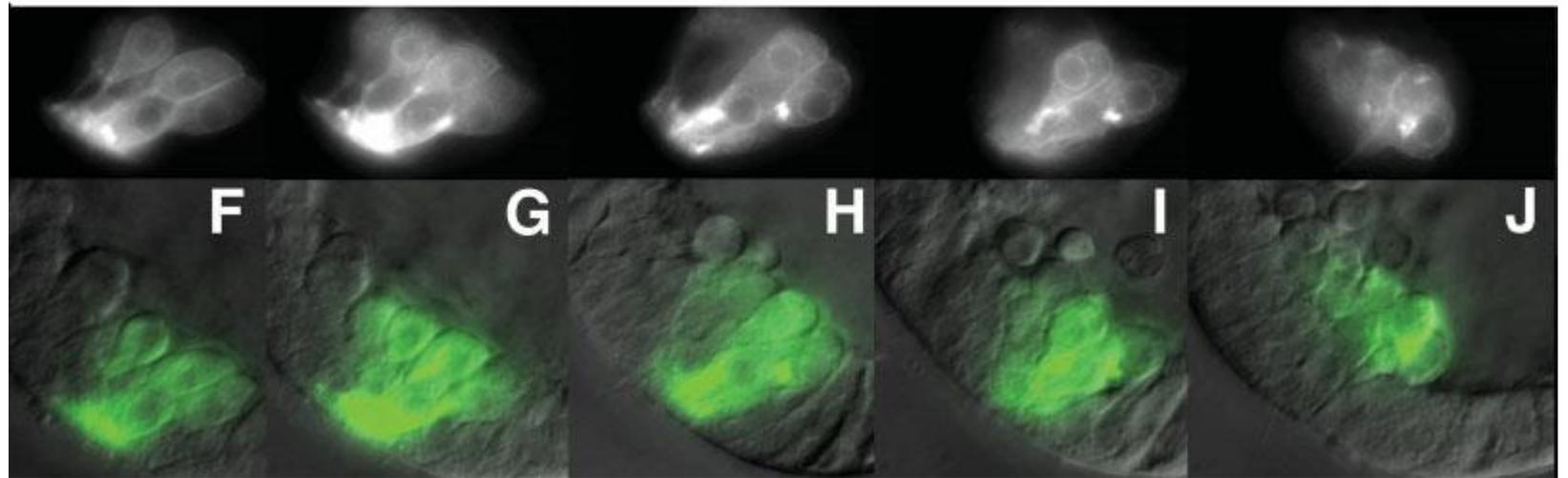
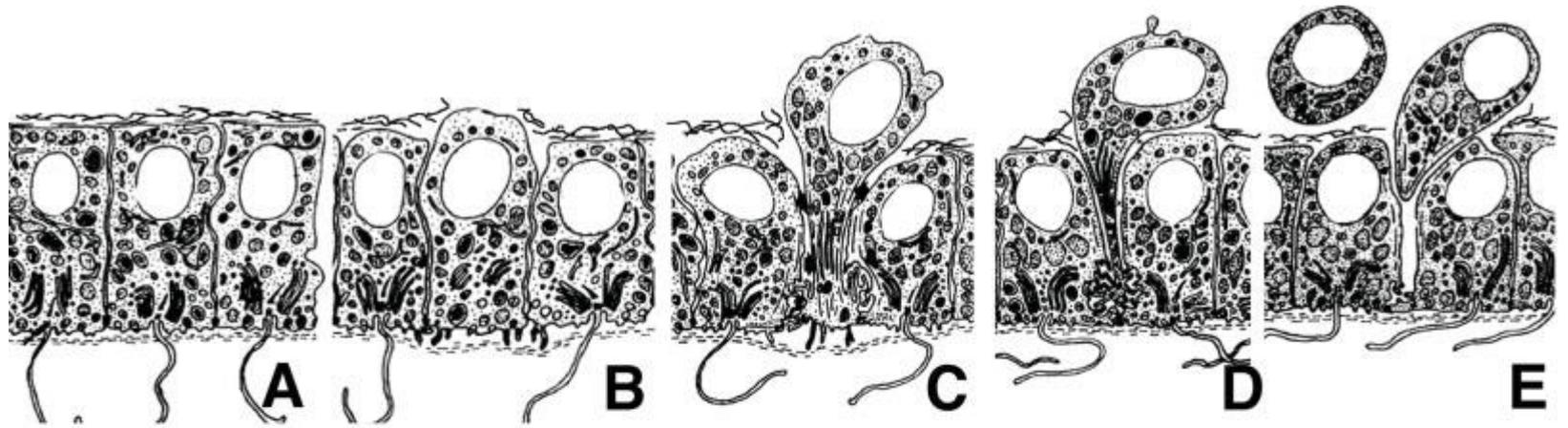
Shu-Yu Wu, Michael Ferkowicz and David R. McClay\*



Cadherina-GFP

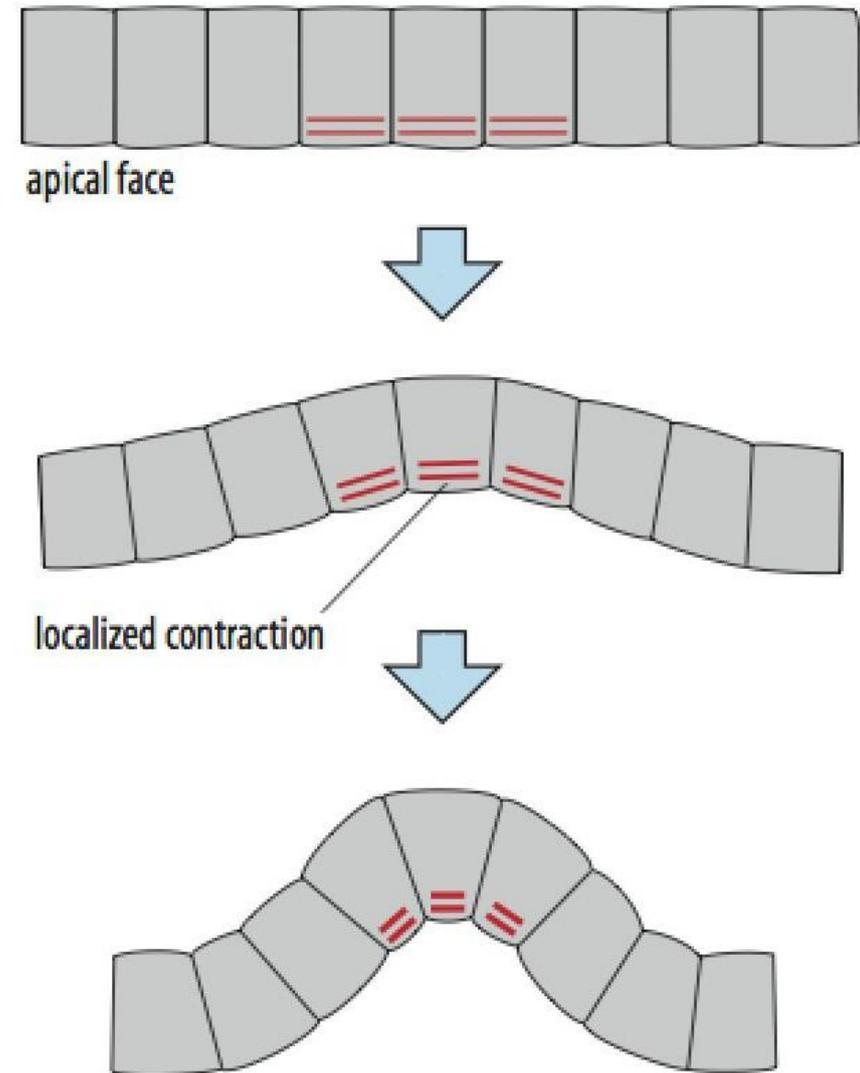
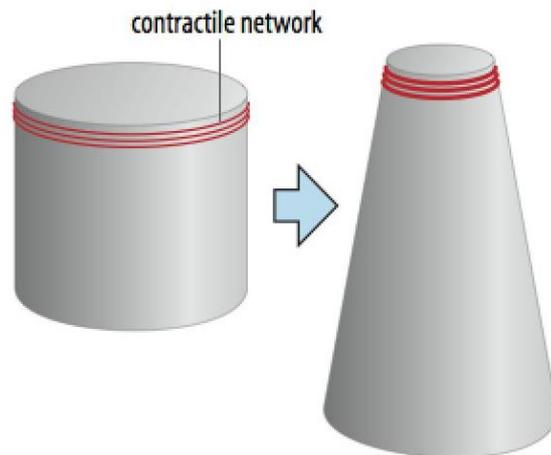
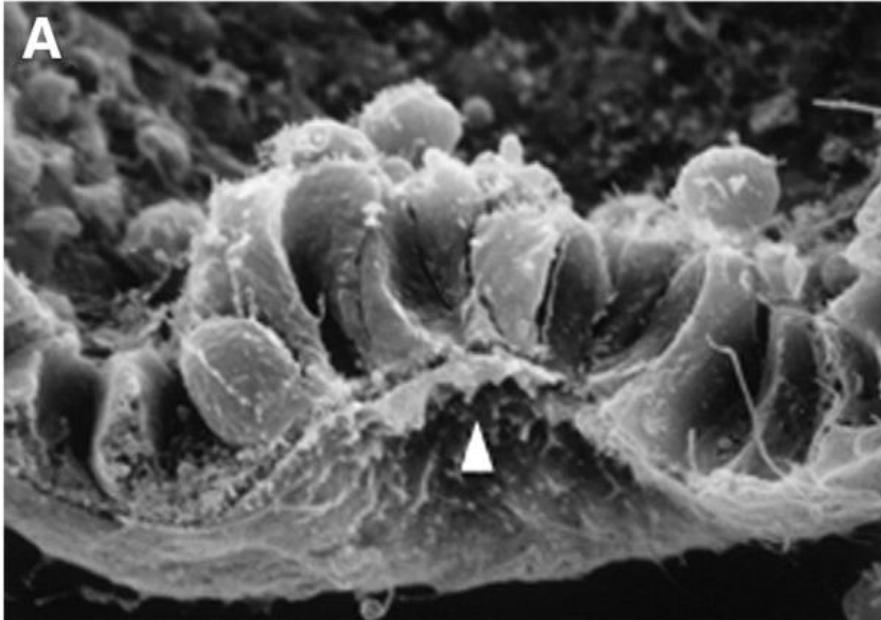
Cinturón de adhesión ←



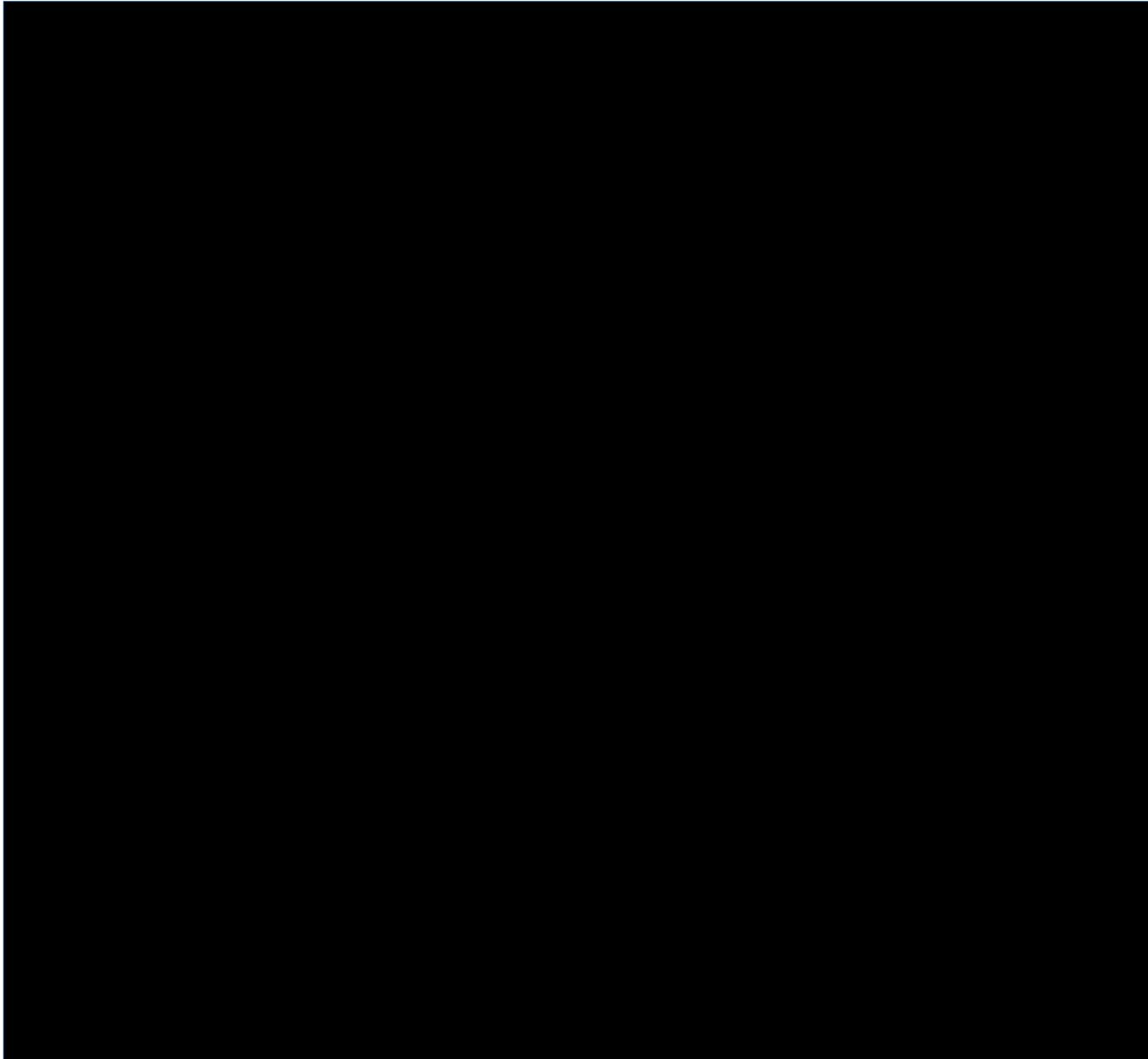


← Cinturón de adhesión

# Constricción apical



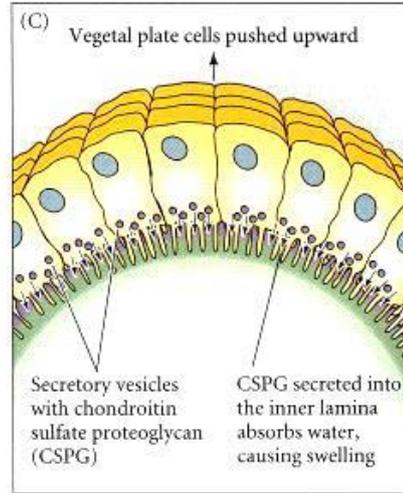
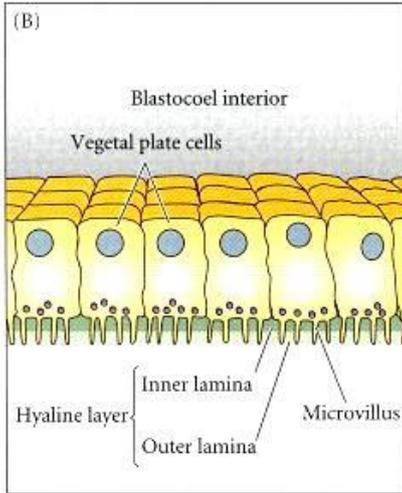
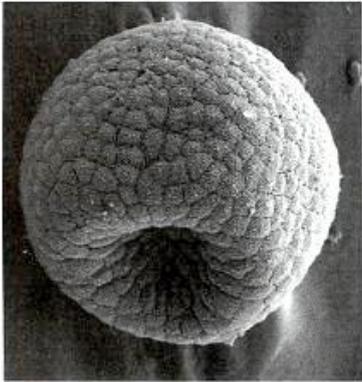
# Formación del blastoporo



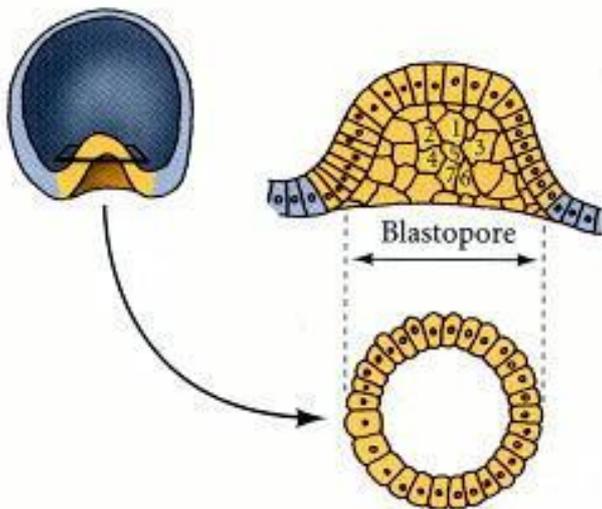
<https://www.youtube.com/watch?v=Lgb4wMsZwZA>

<https://www.youtube.com/watch?v=w611XMbUCIs>

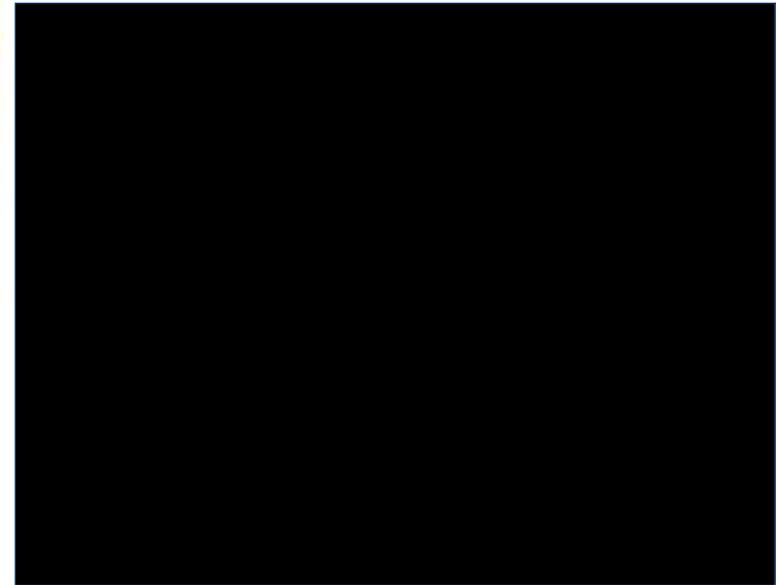
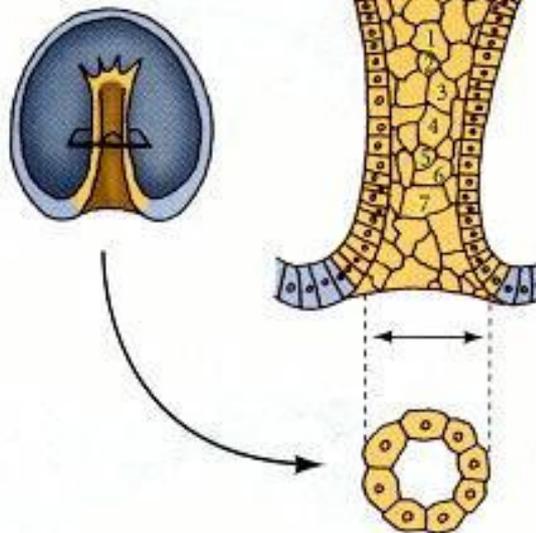
(A)



EARLY GASTRULATION

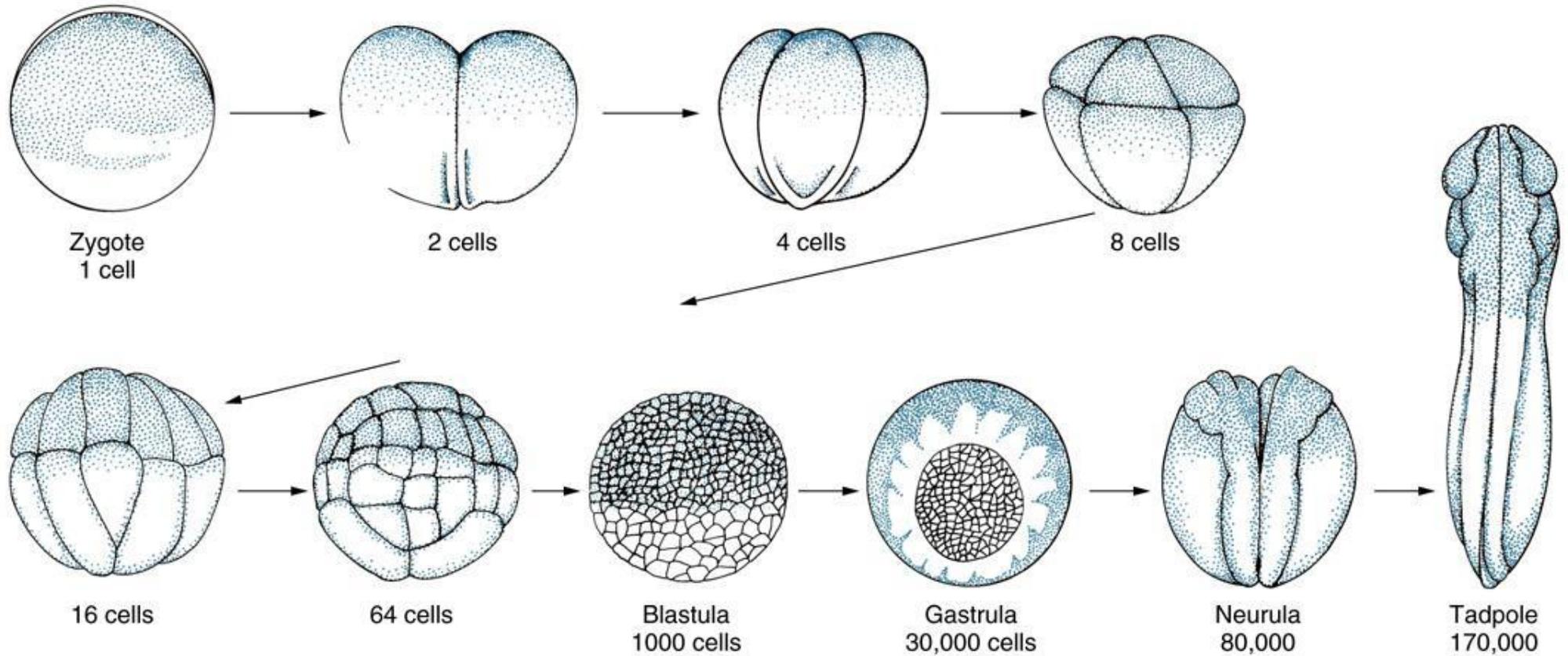


LATER GASTRULATION

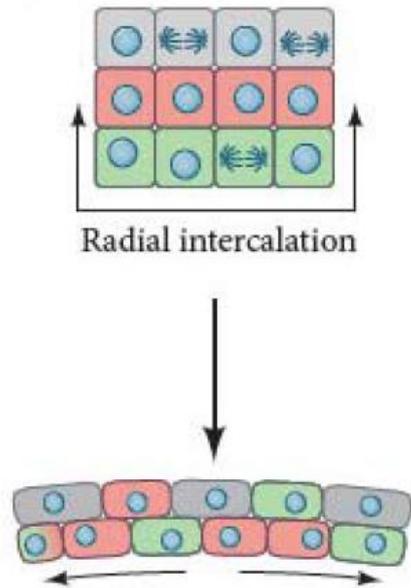


# Gastrulación

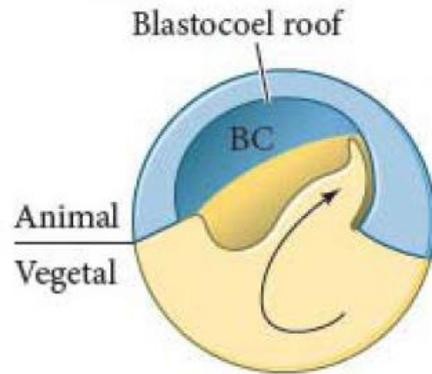
## Embriones con clivaje holoblástico: Anfibios



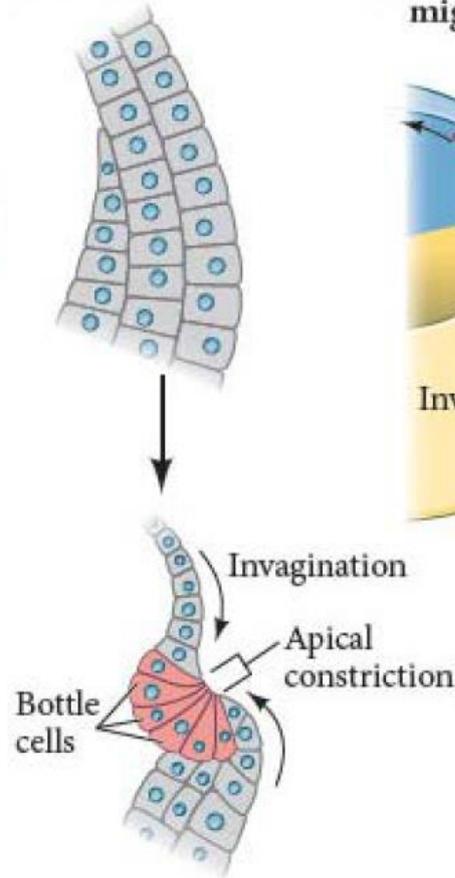
**1 Epiboly**



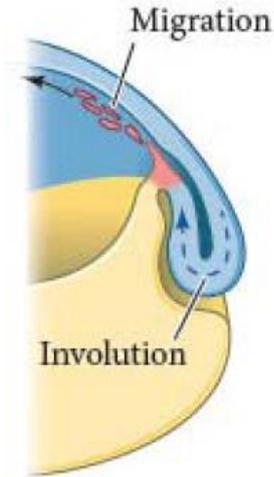
**2 Vegetal rotation**



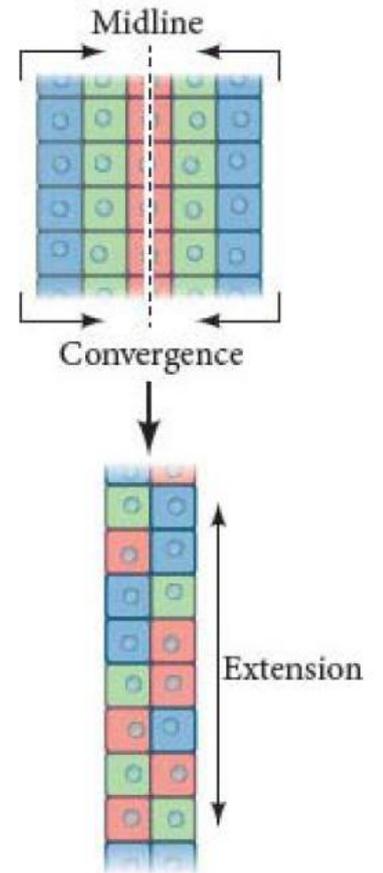
**3 Invagination**

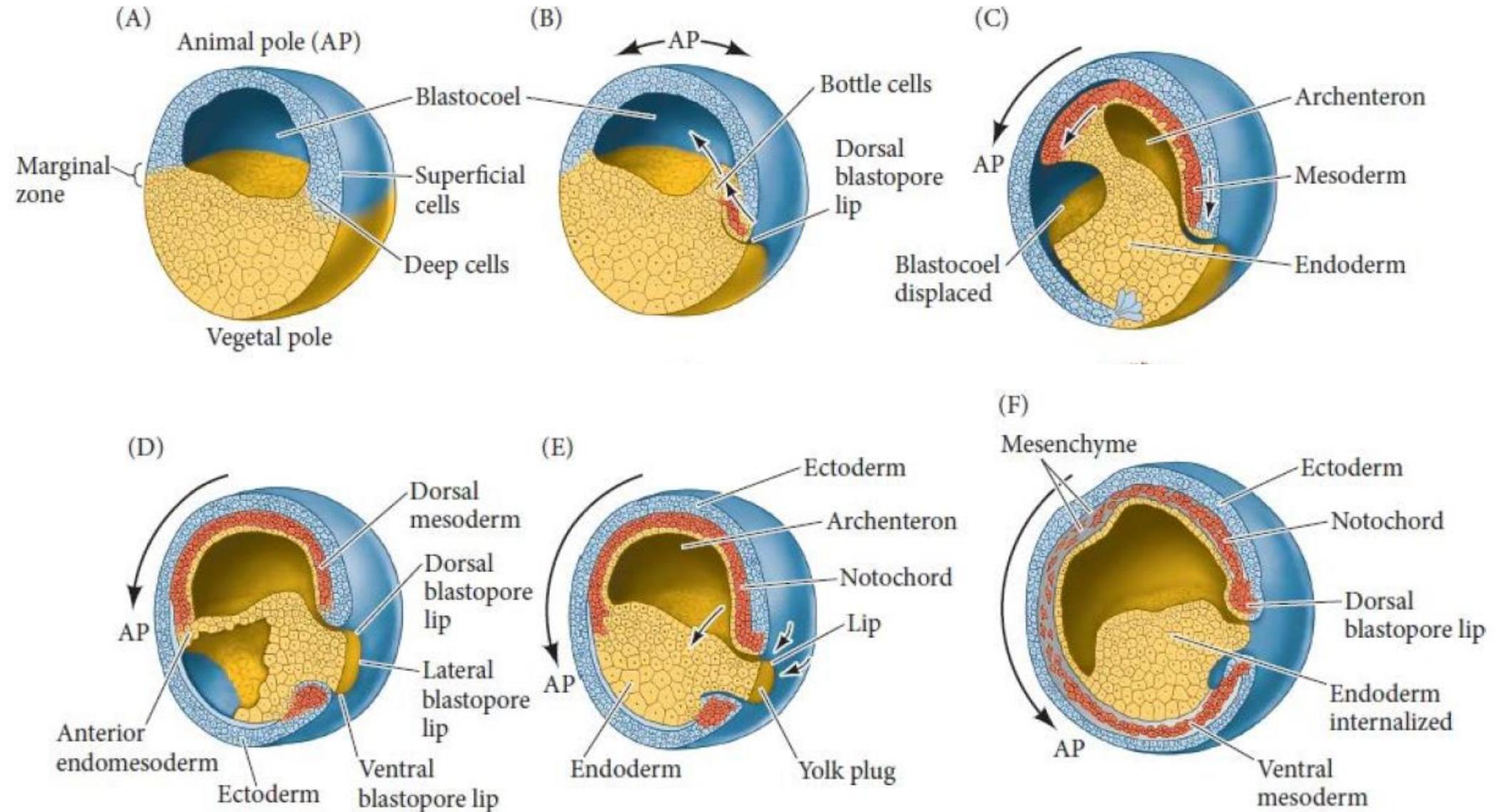


**4 Involution and migration**



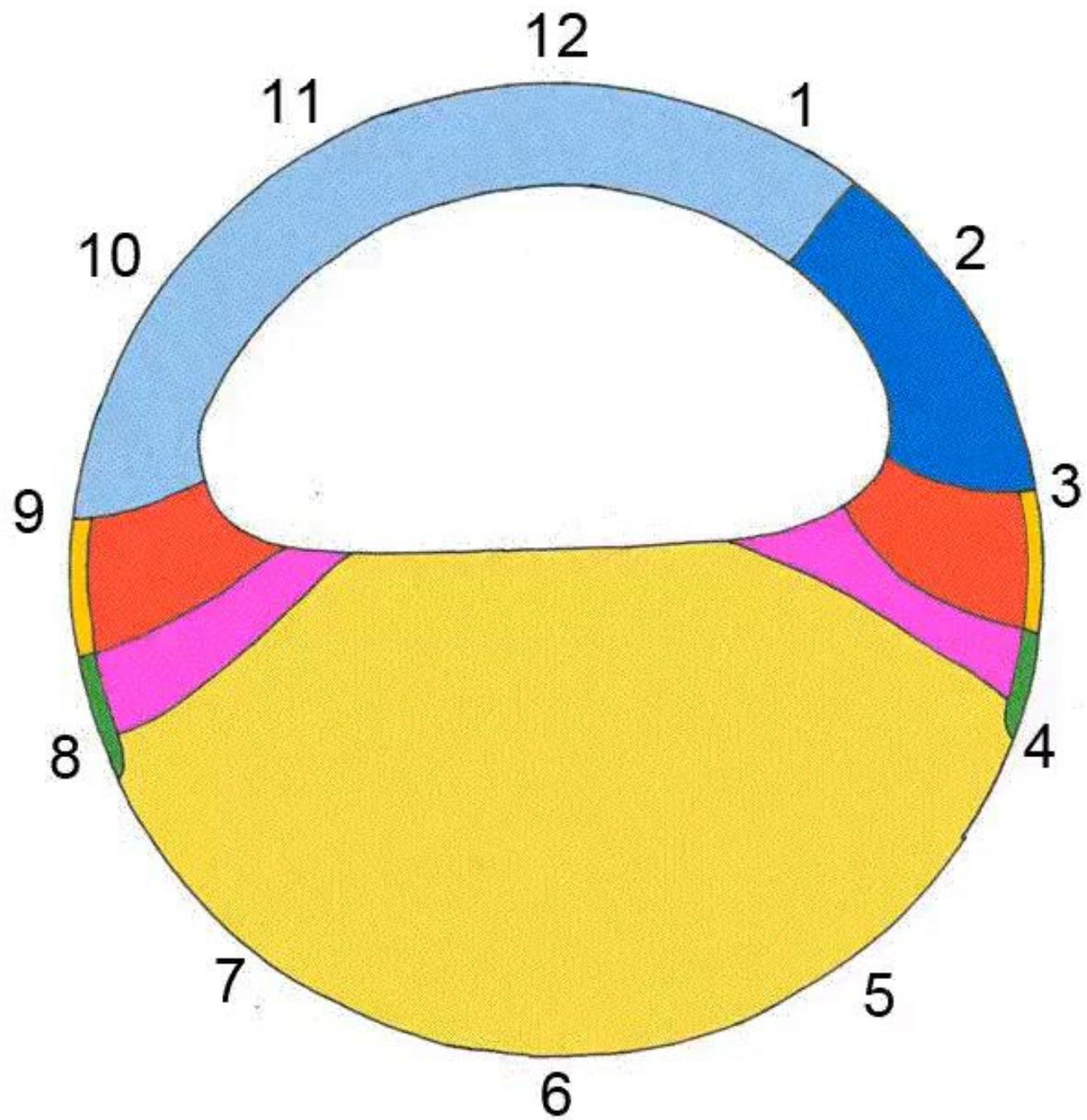
**5 Convergent extension**

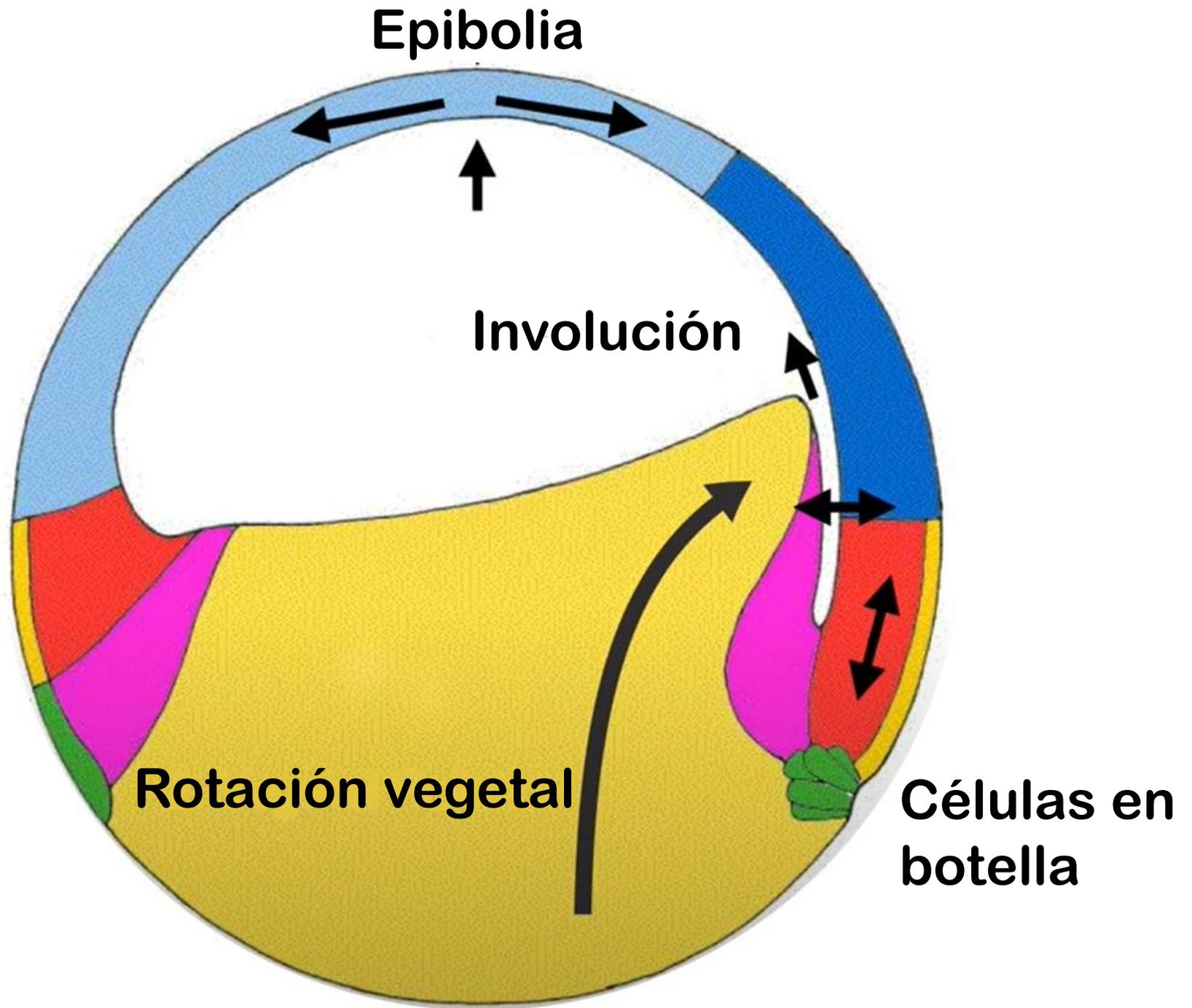




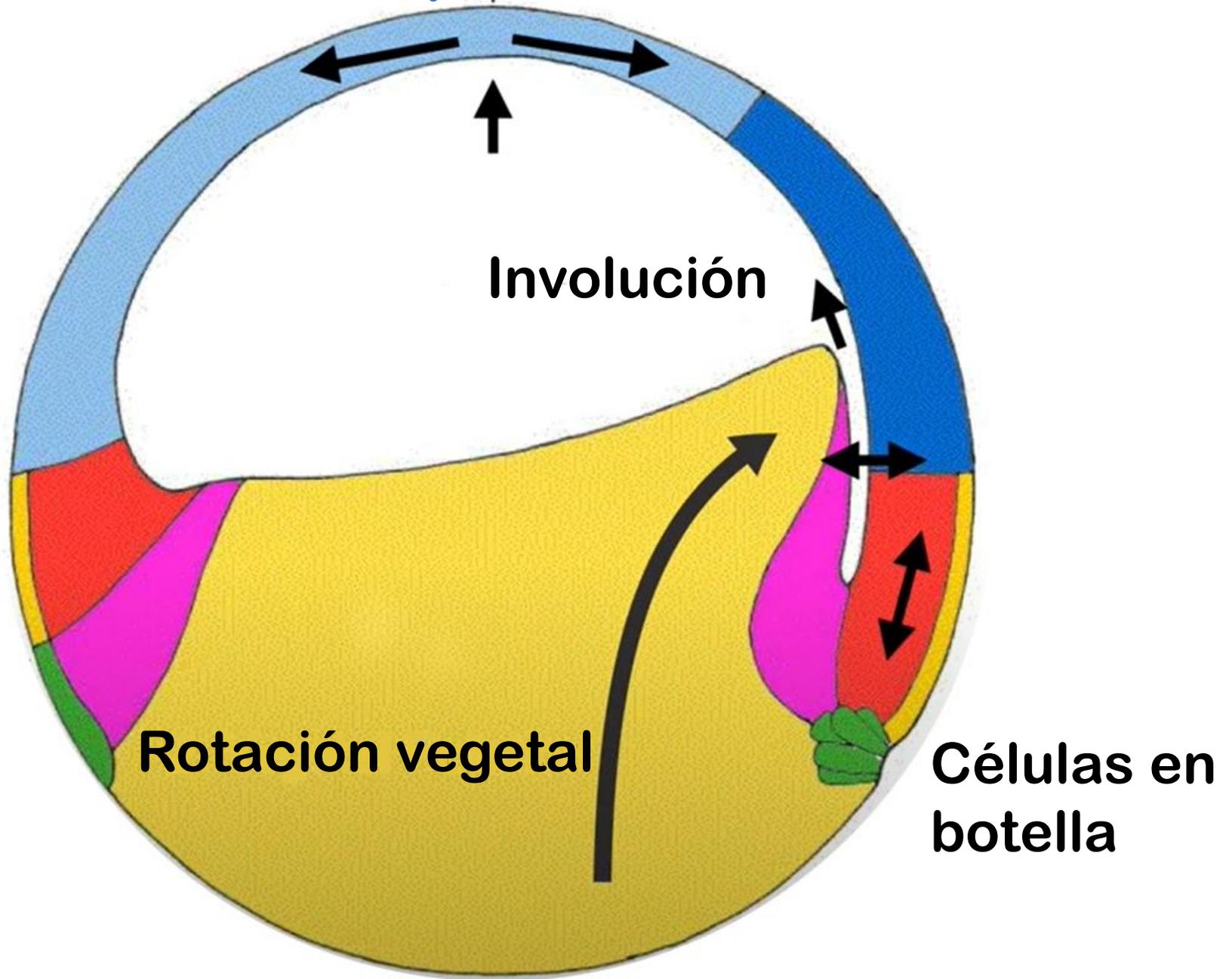
Comienzo gastrulación:  
Zona marginal

Ectodermo  
Mesodermo  
Endodermo





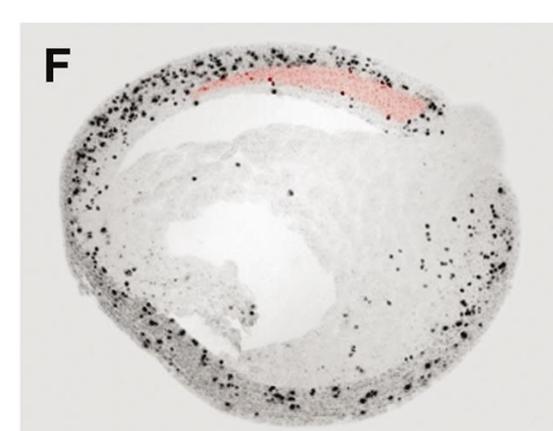
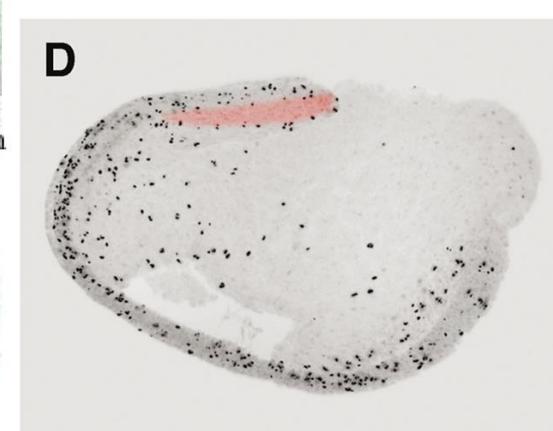
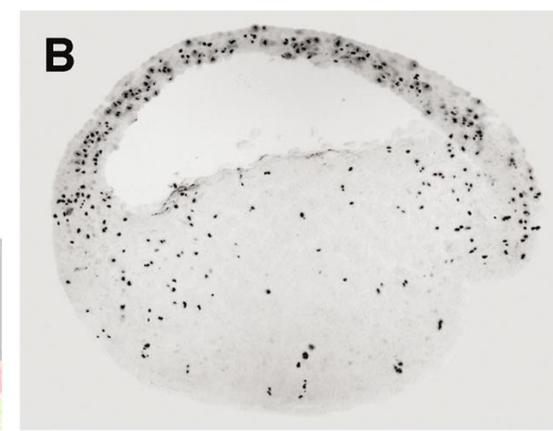
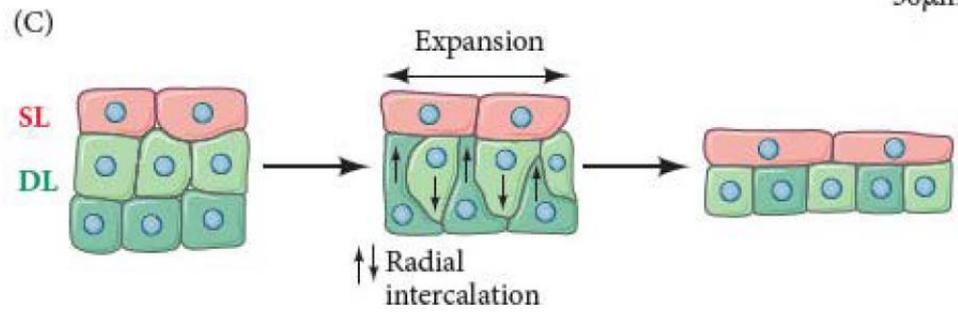
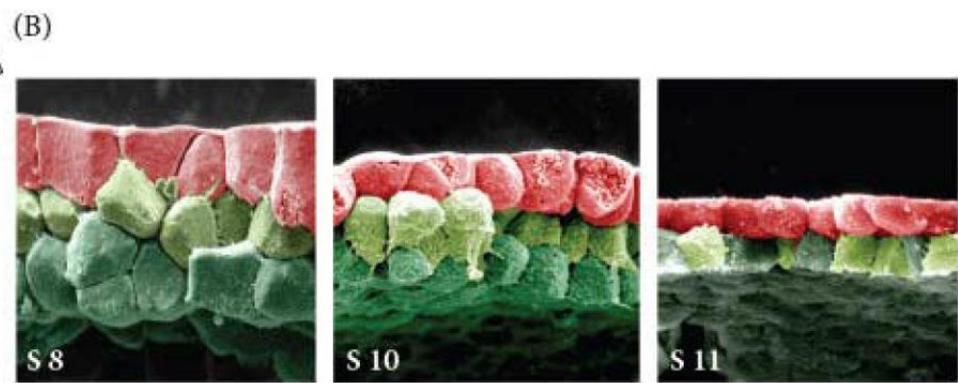
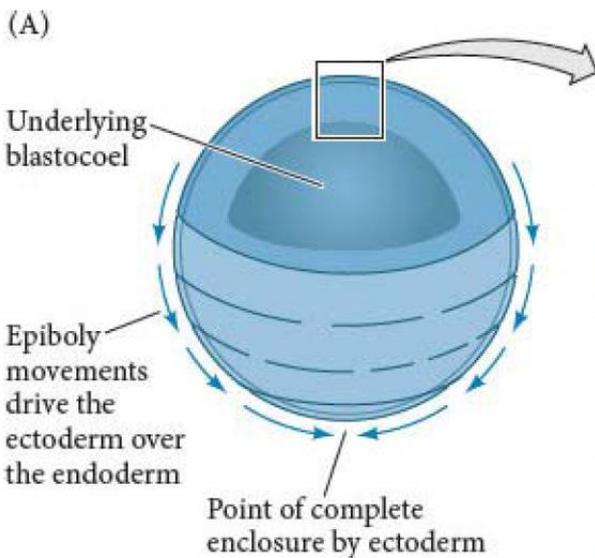
**Epibolia**



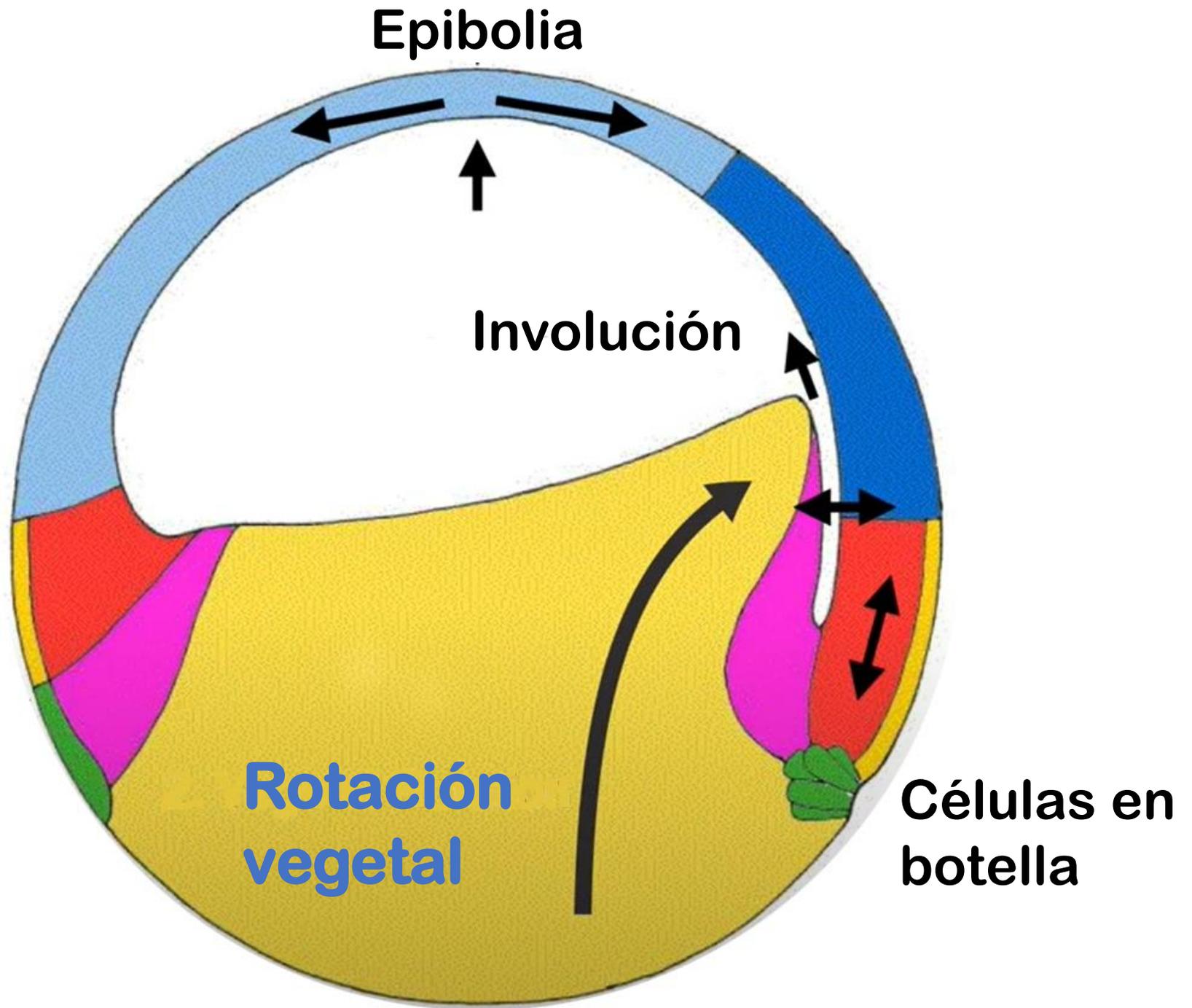
**Involución**

**Rotación vegetal**

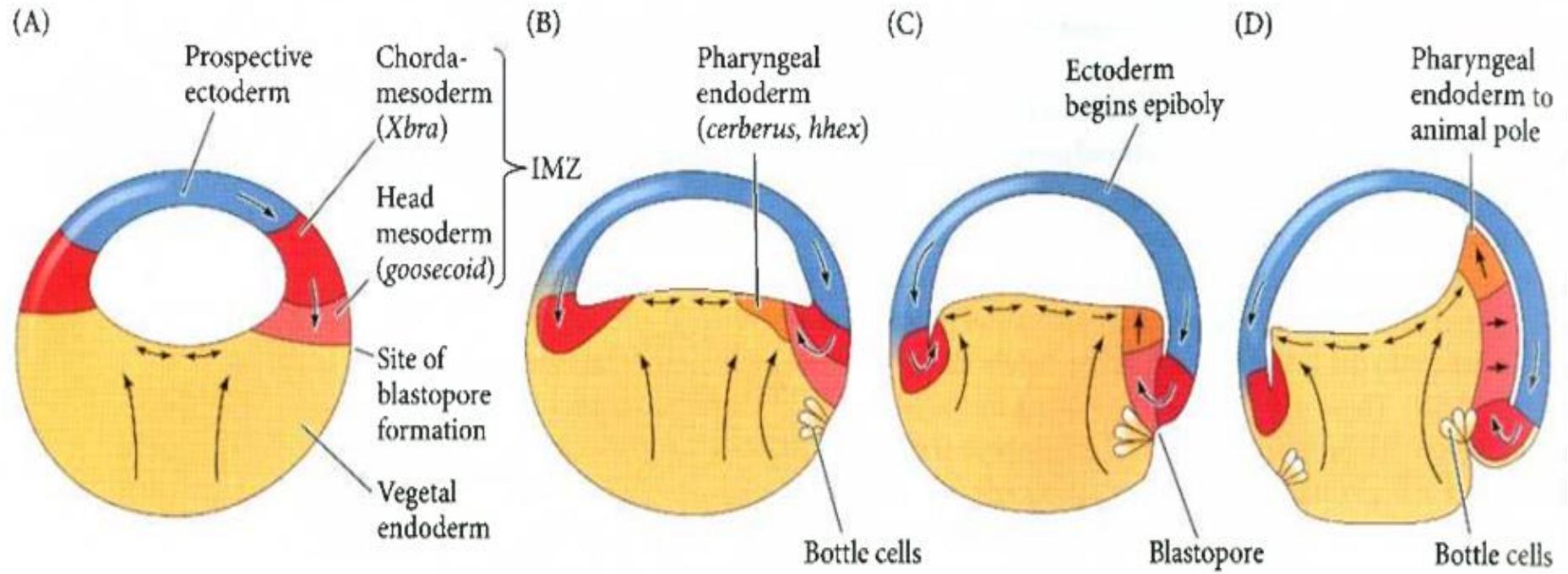
**Células en  
botella**



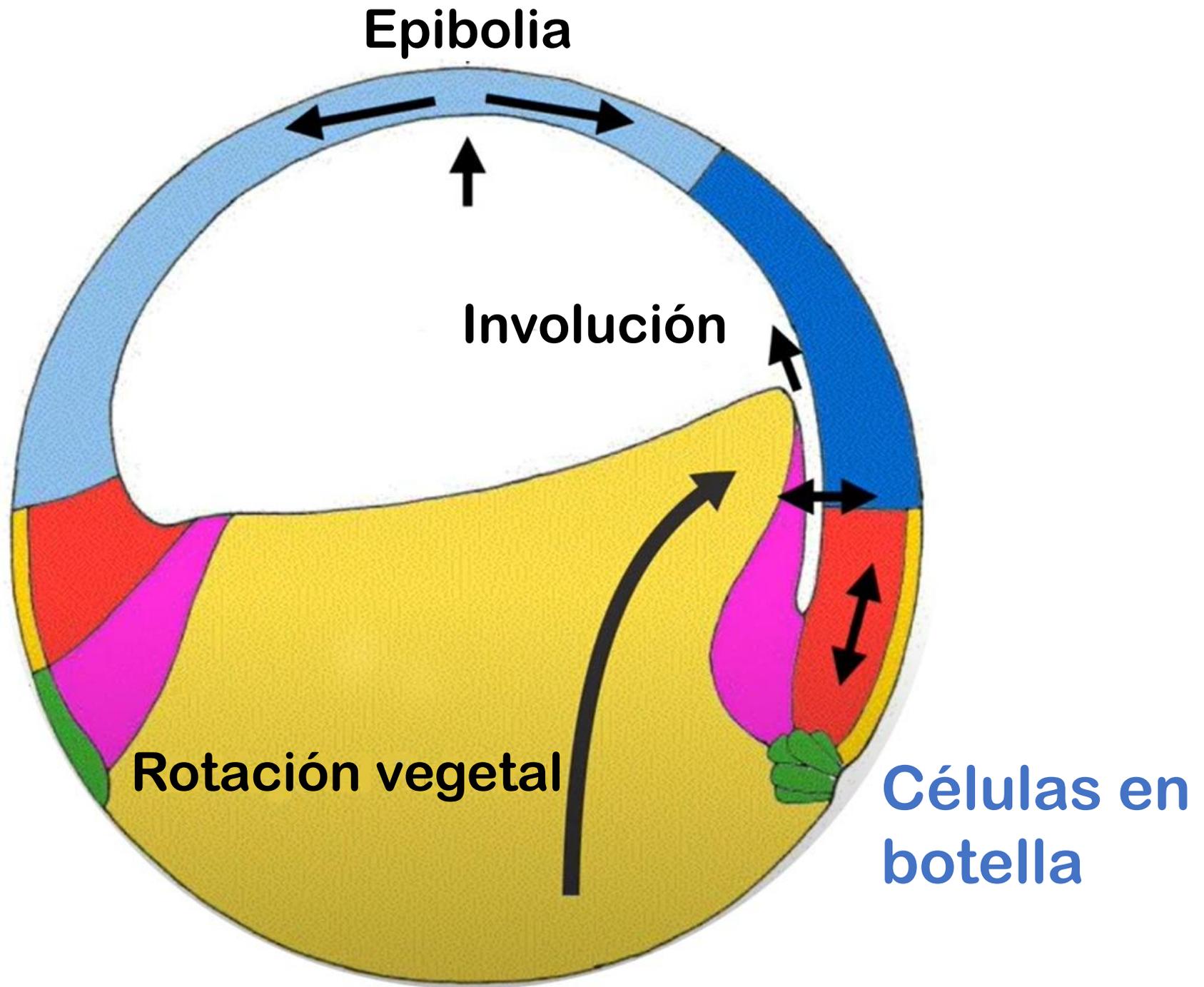
La epibolia del ectodermo es acompañada por aumento de la divisiones e intercalamientos celulares



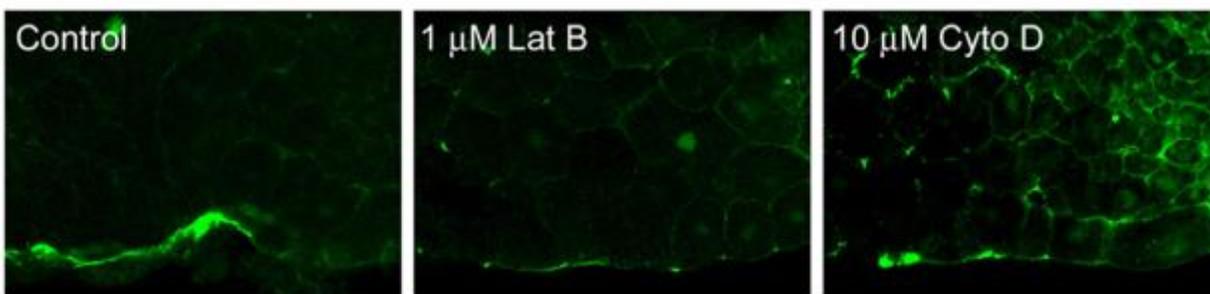
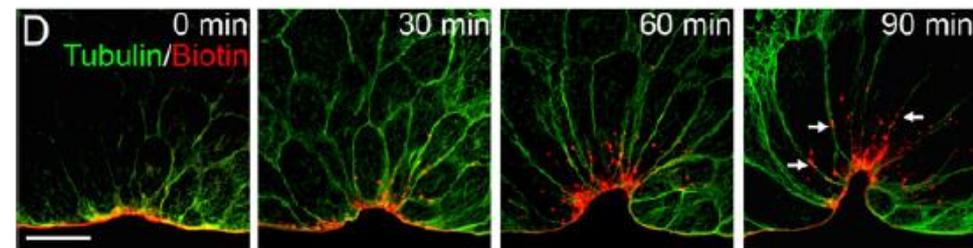
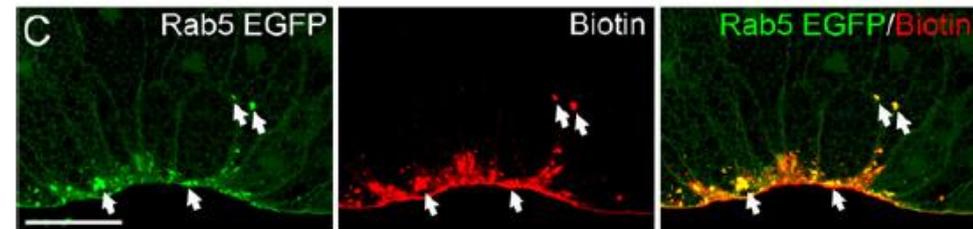
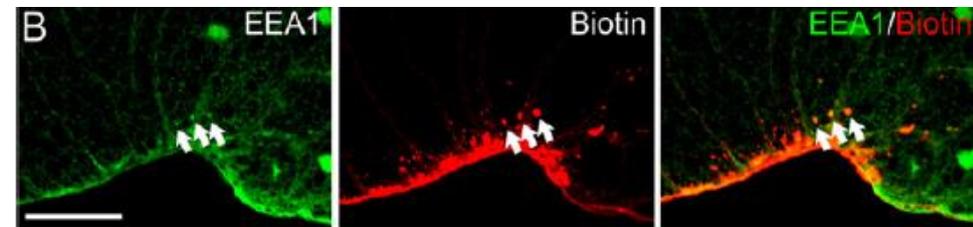
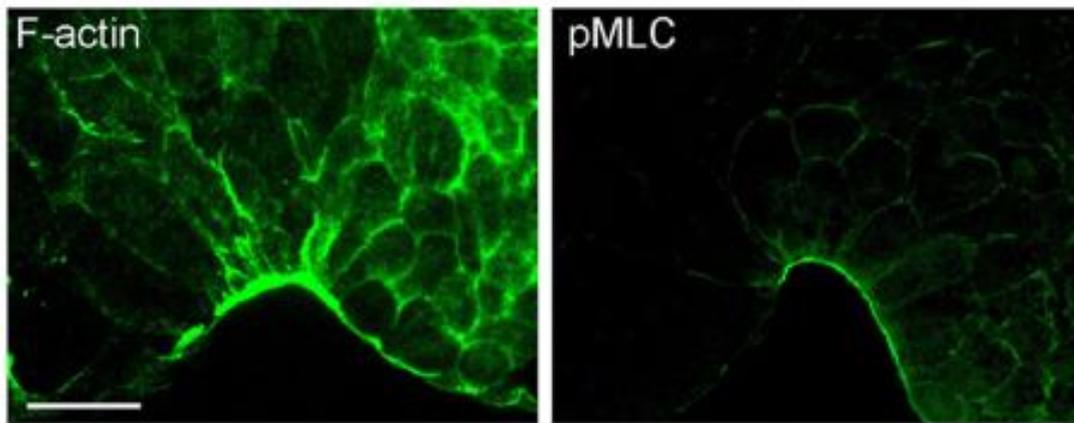
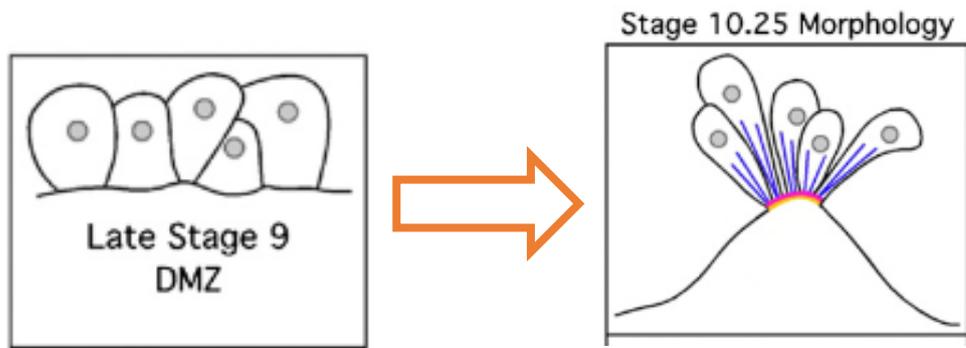
# Rotación vegetal



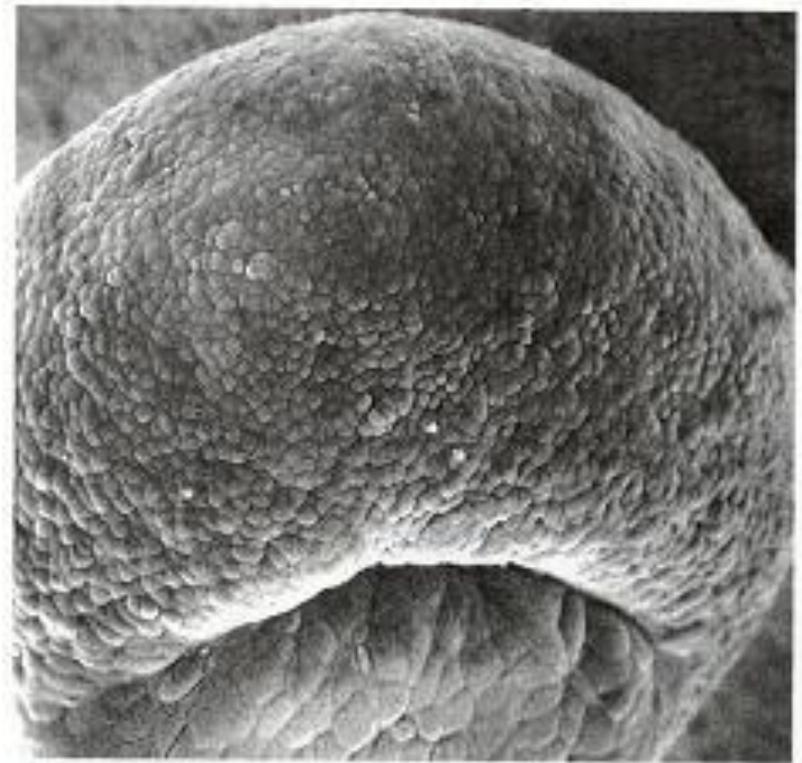
Coloca al endodermo faríngeo adyacente al blastocele, migrando hacia la futura región anterior del embrión



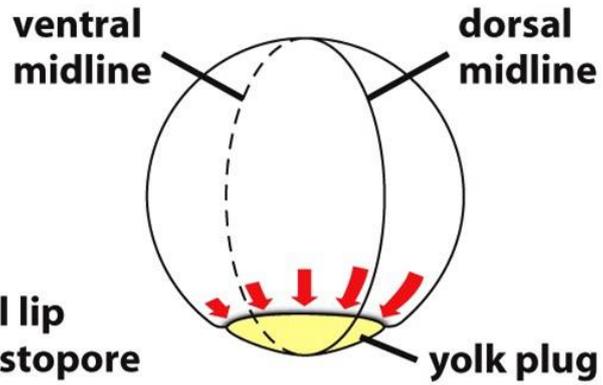
# Células en botella



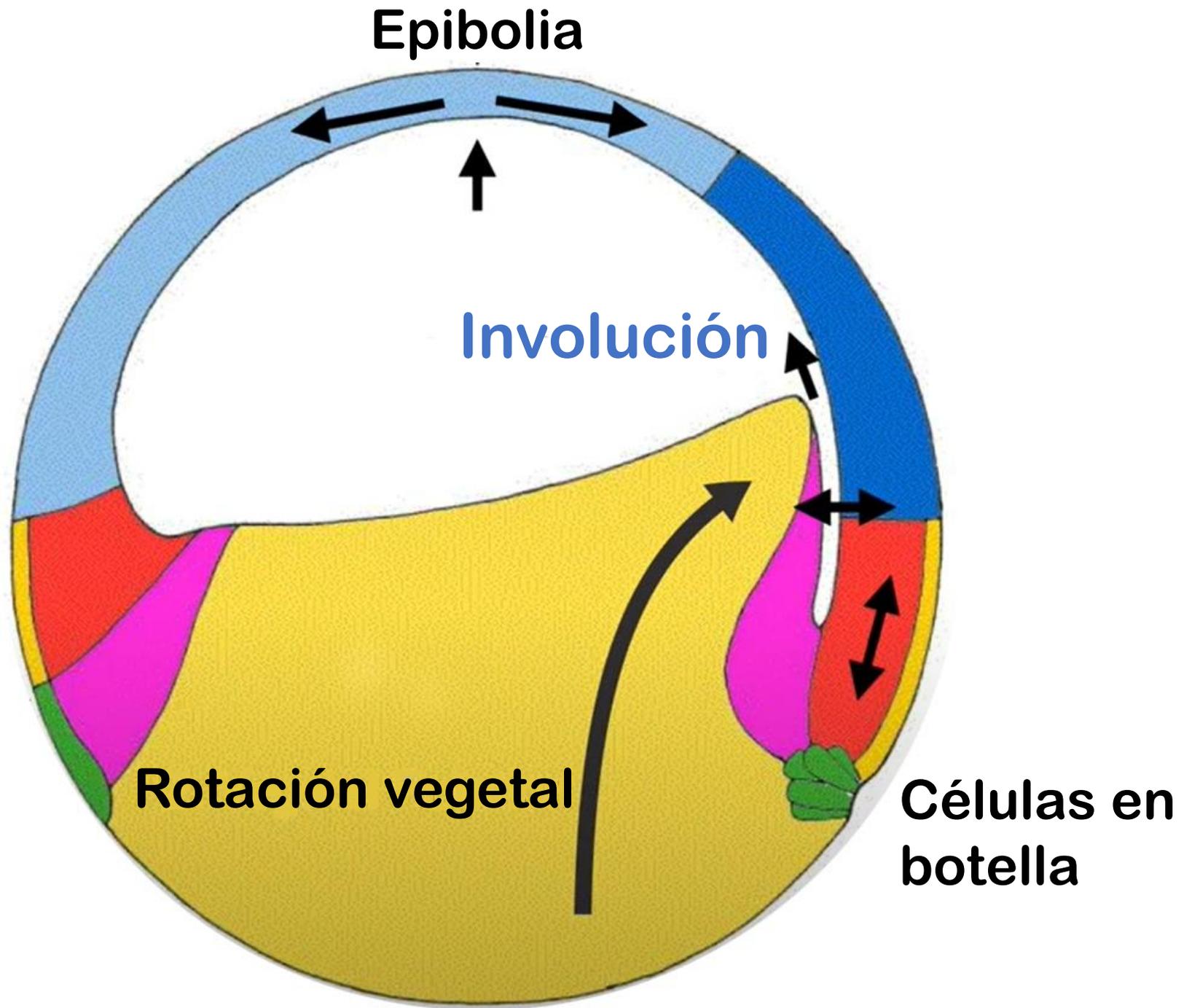
# Blastoporo



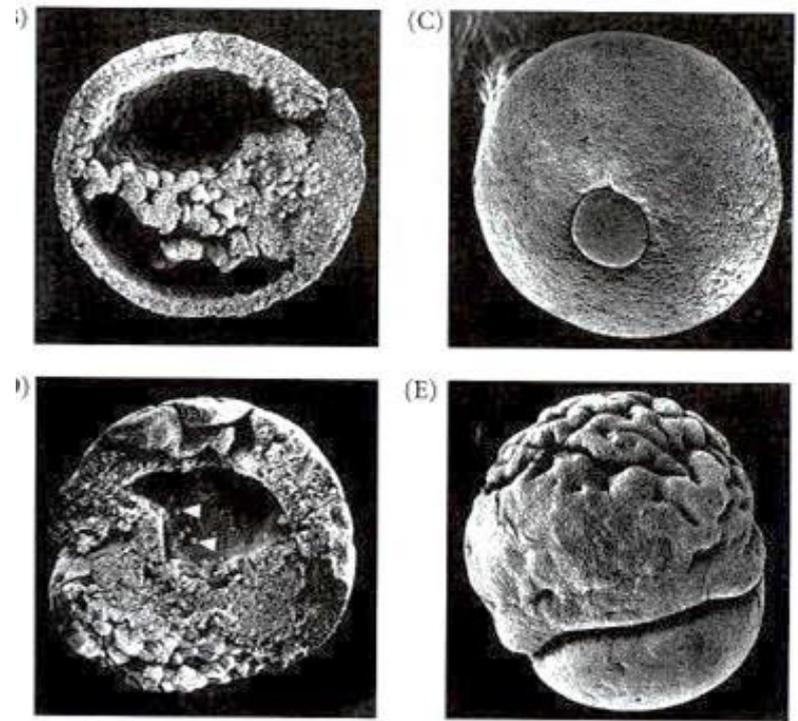
**ANIMAL POLE**



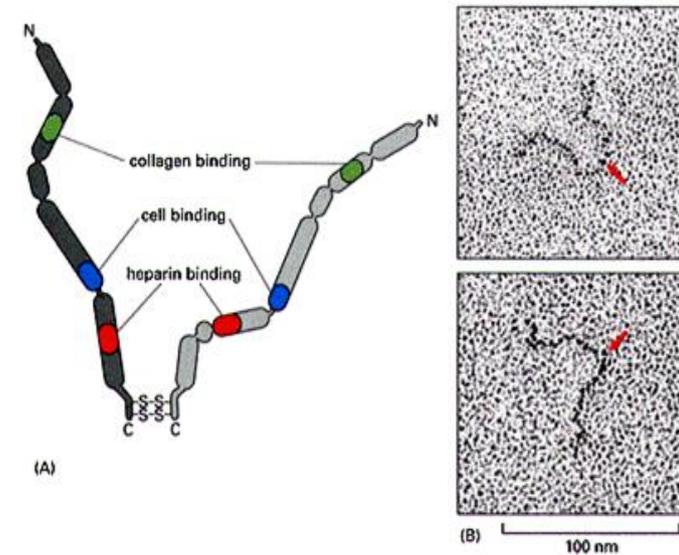
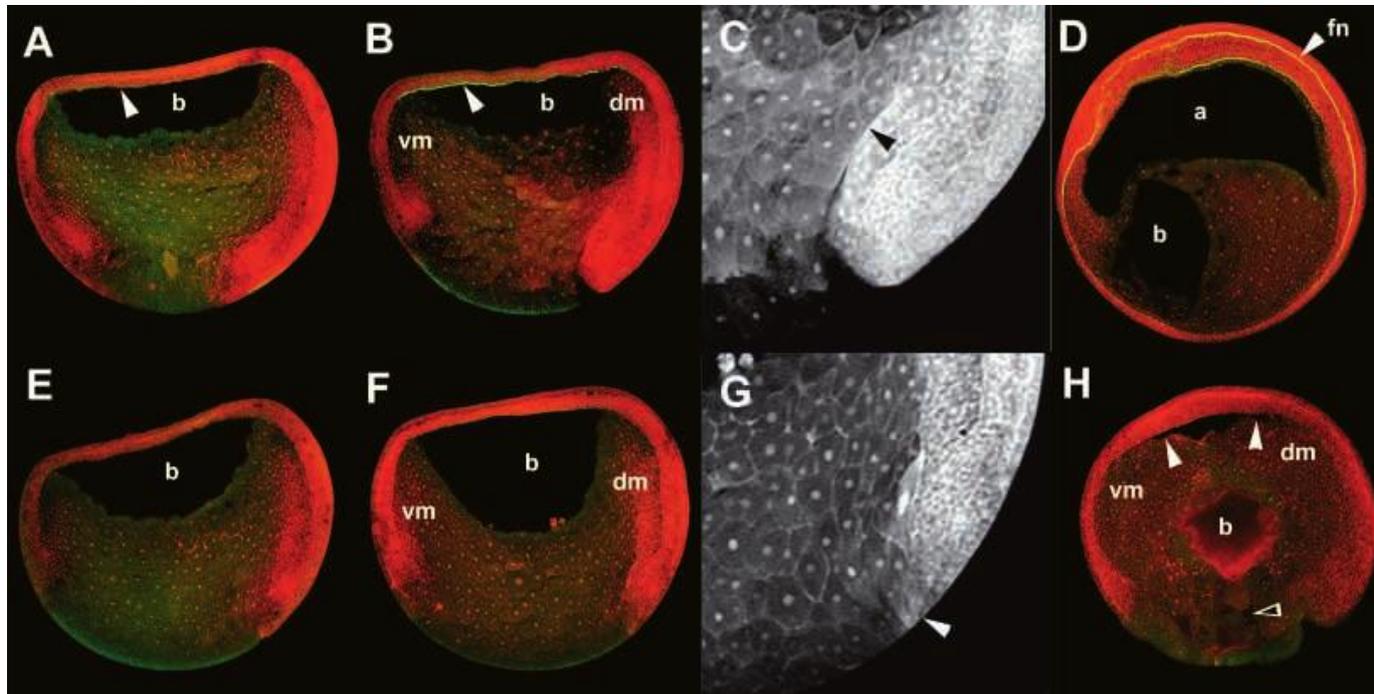
**VEGETAL POLE**

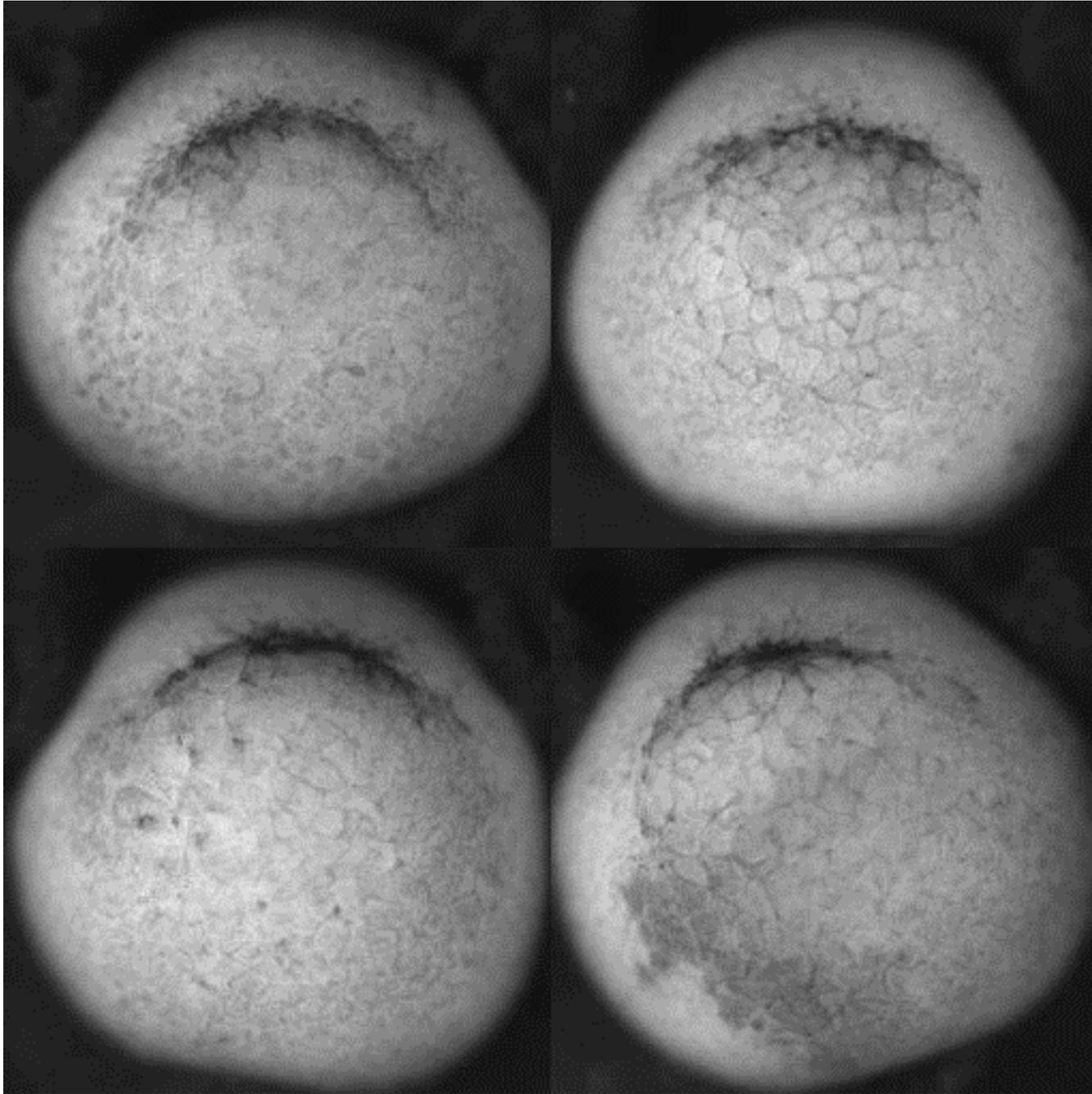


# Rol de la fibronectina en la gastrulación de anfibios



## Bloqueo funcional con mAb





<https://youtu.be/QAQdGhe92yo>

DORSAL

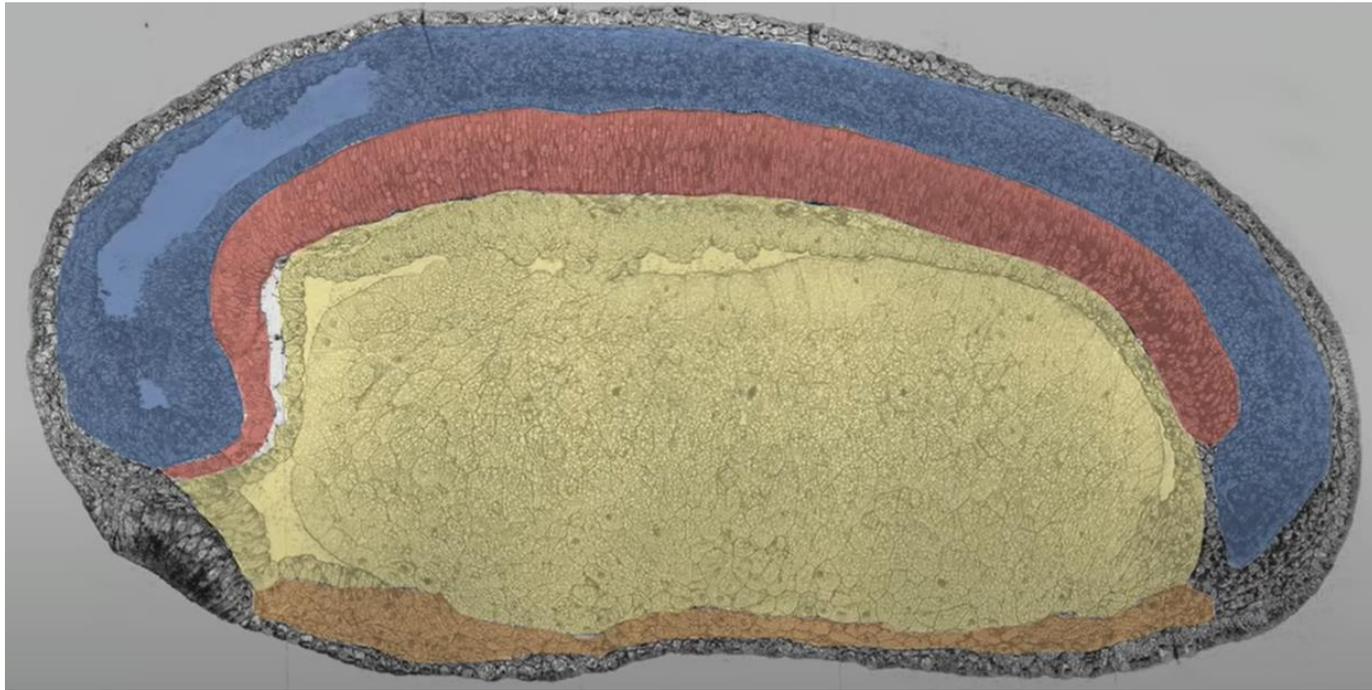
Sistema nervioso

Sistema digestivo

ANTERIOR Cabeza

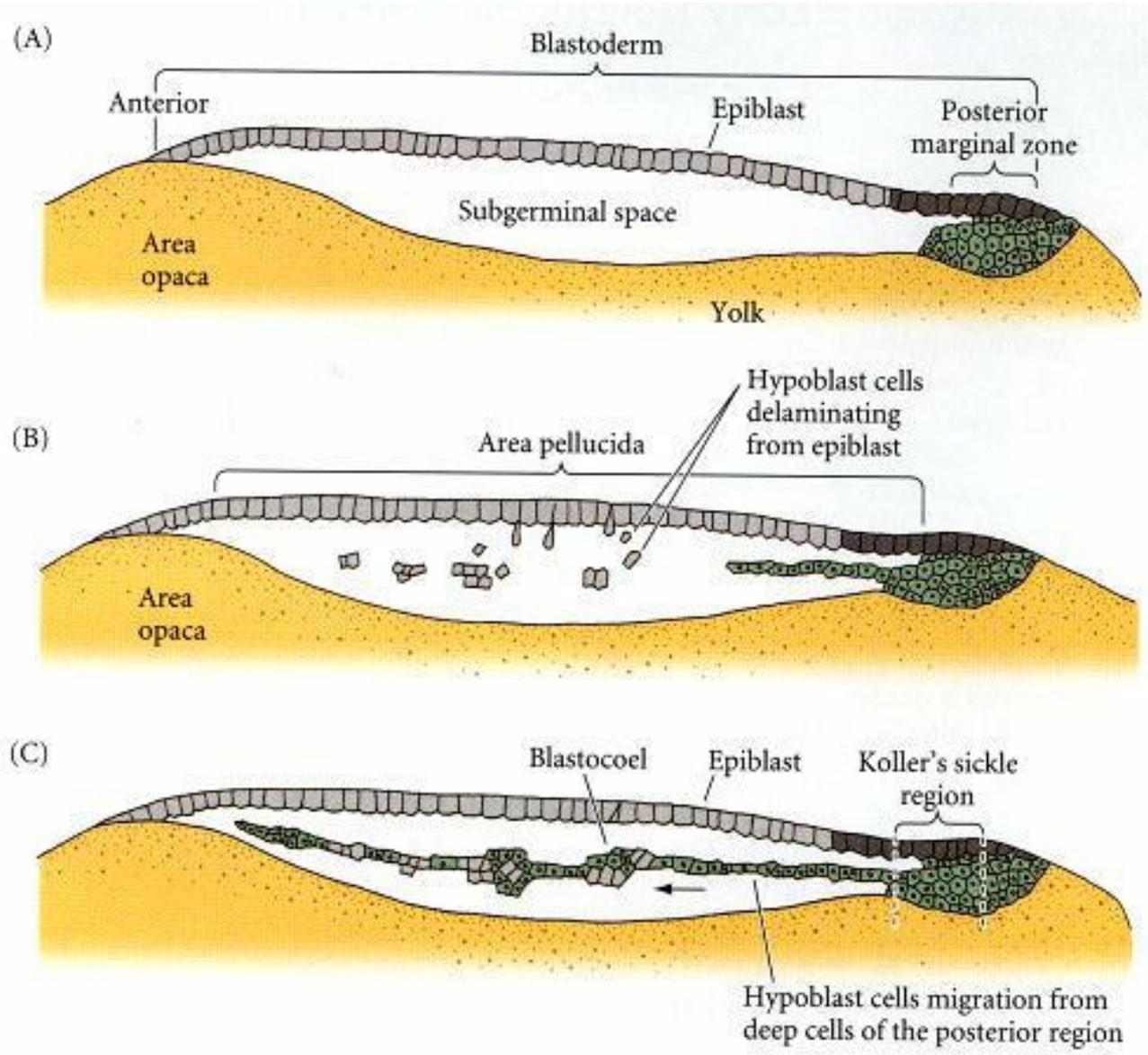
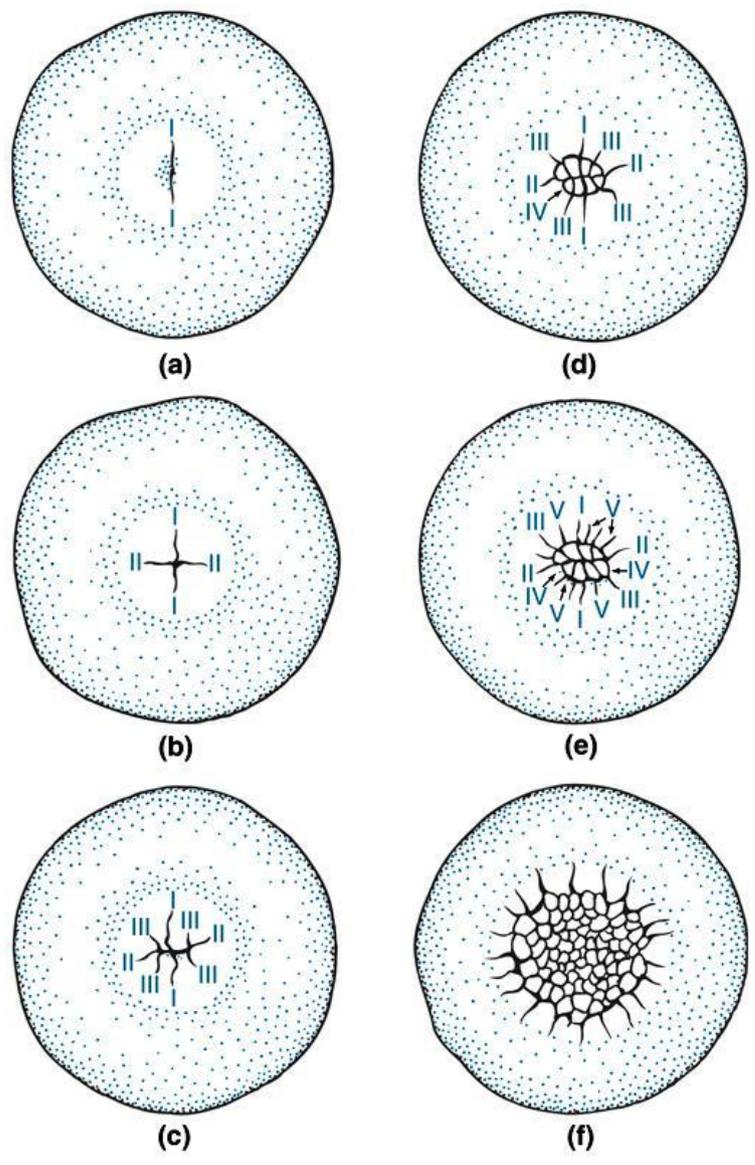
Ano POSTERIOR

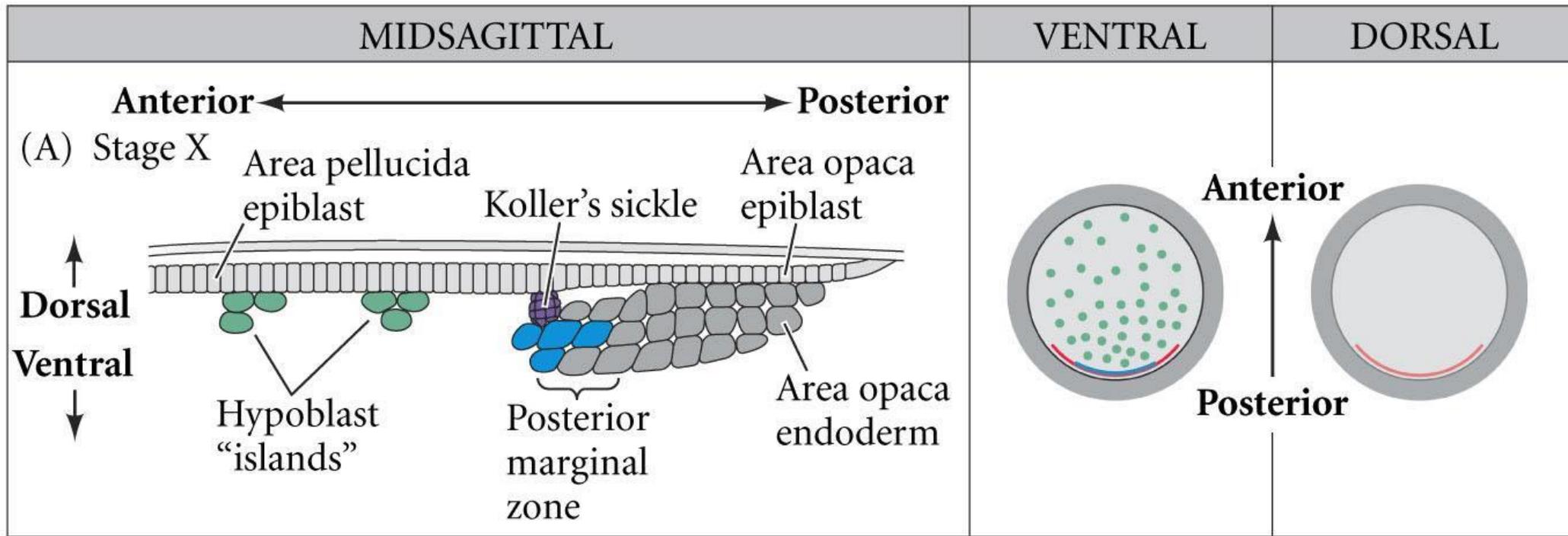
VENTRAL



# Gastrulación

## Embriones con clivaje meroblástico: aves



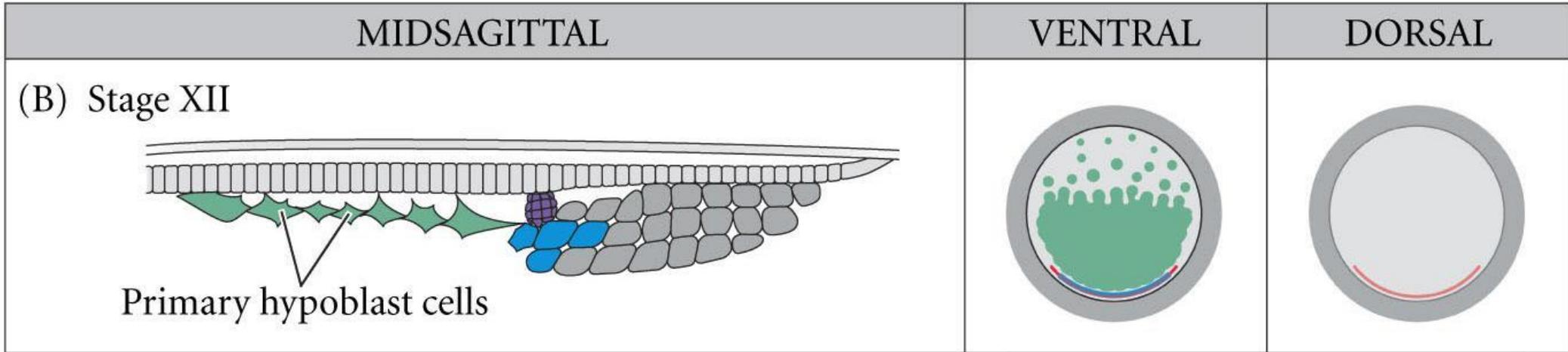


Entre 5-6 capas de células del blastodisco se sueltan y mueren

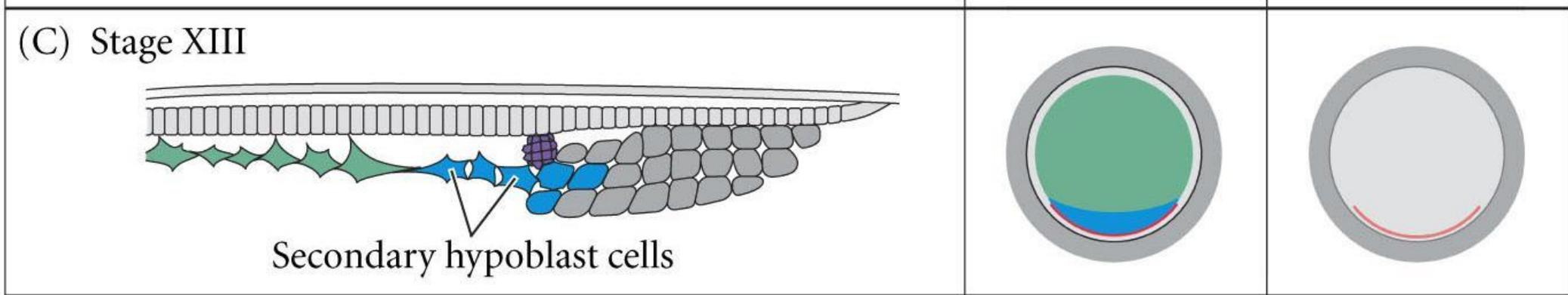
Se mantiene una única capa: **área pelúcida (epiblasto)**

Bordes: **área opaca**

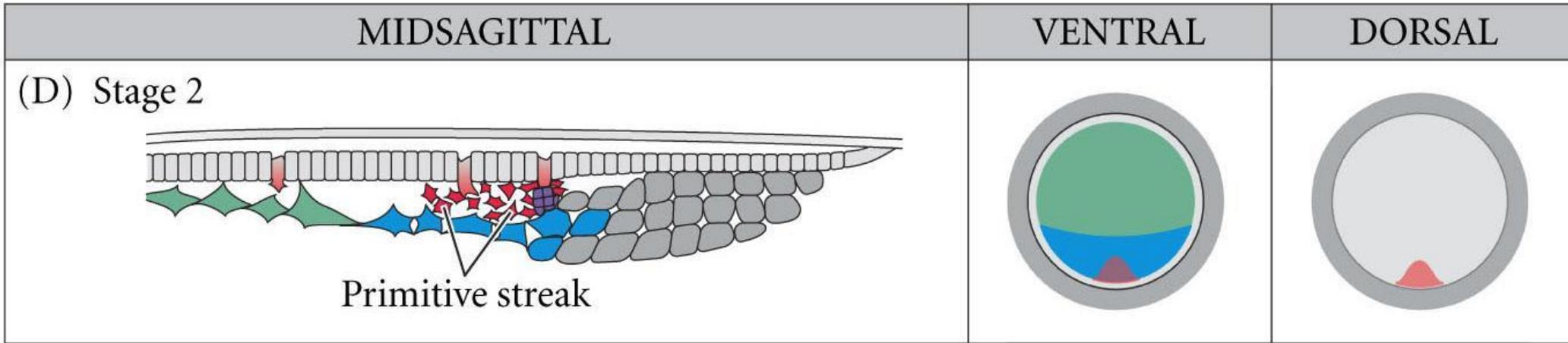
Algunas células del área pelúcida se sueltan: **islas de poli-invaginación**



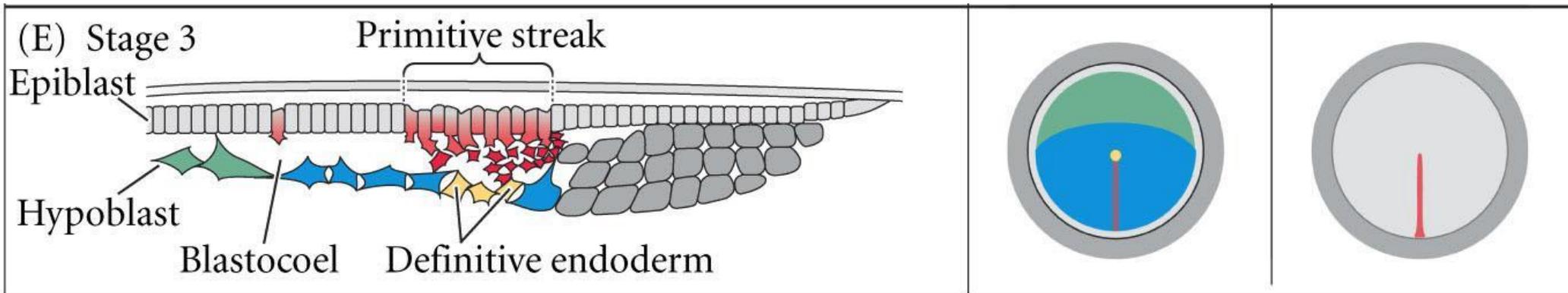
Las islas de poli-invaginación se unen: **hipoblasto primario**



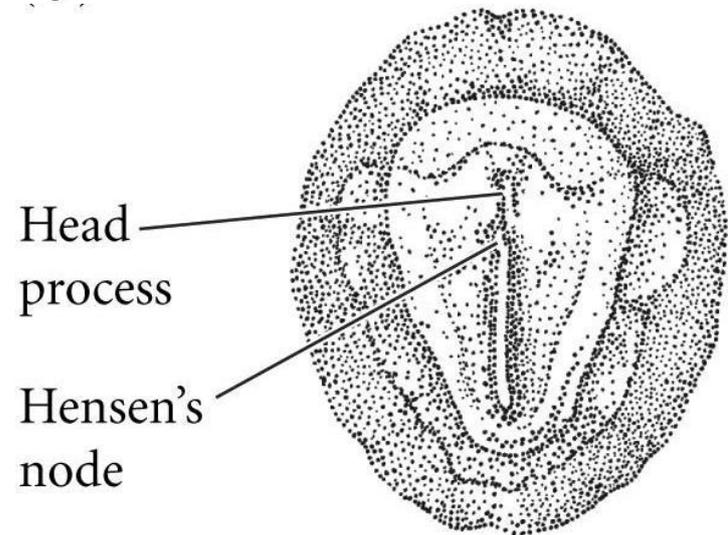
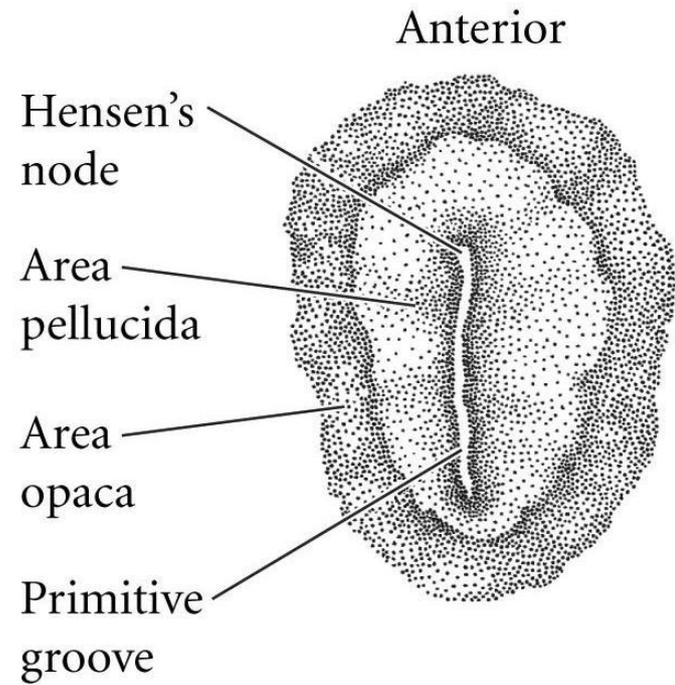
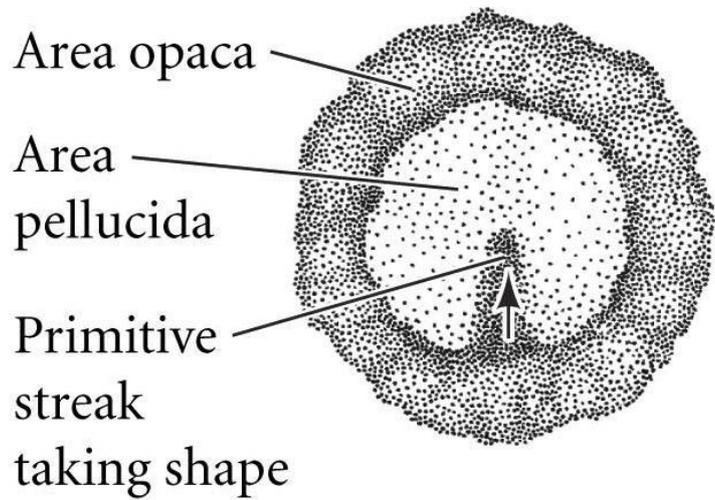
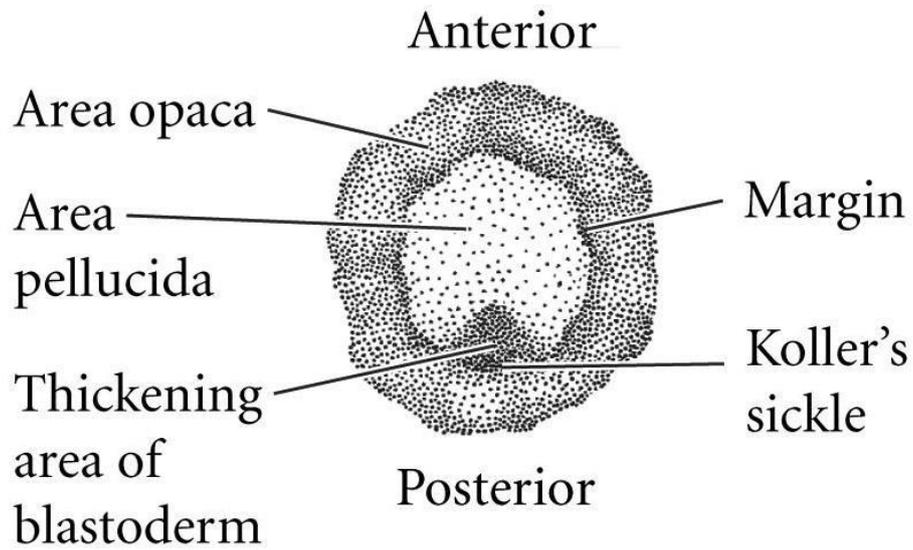
Desde la **Hoz de Koller** migra una capa de células formando el **hipoblasto secundario**

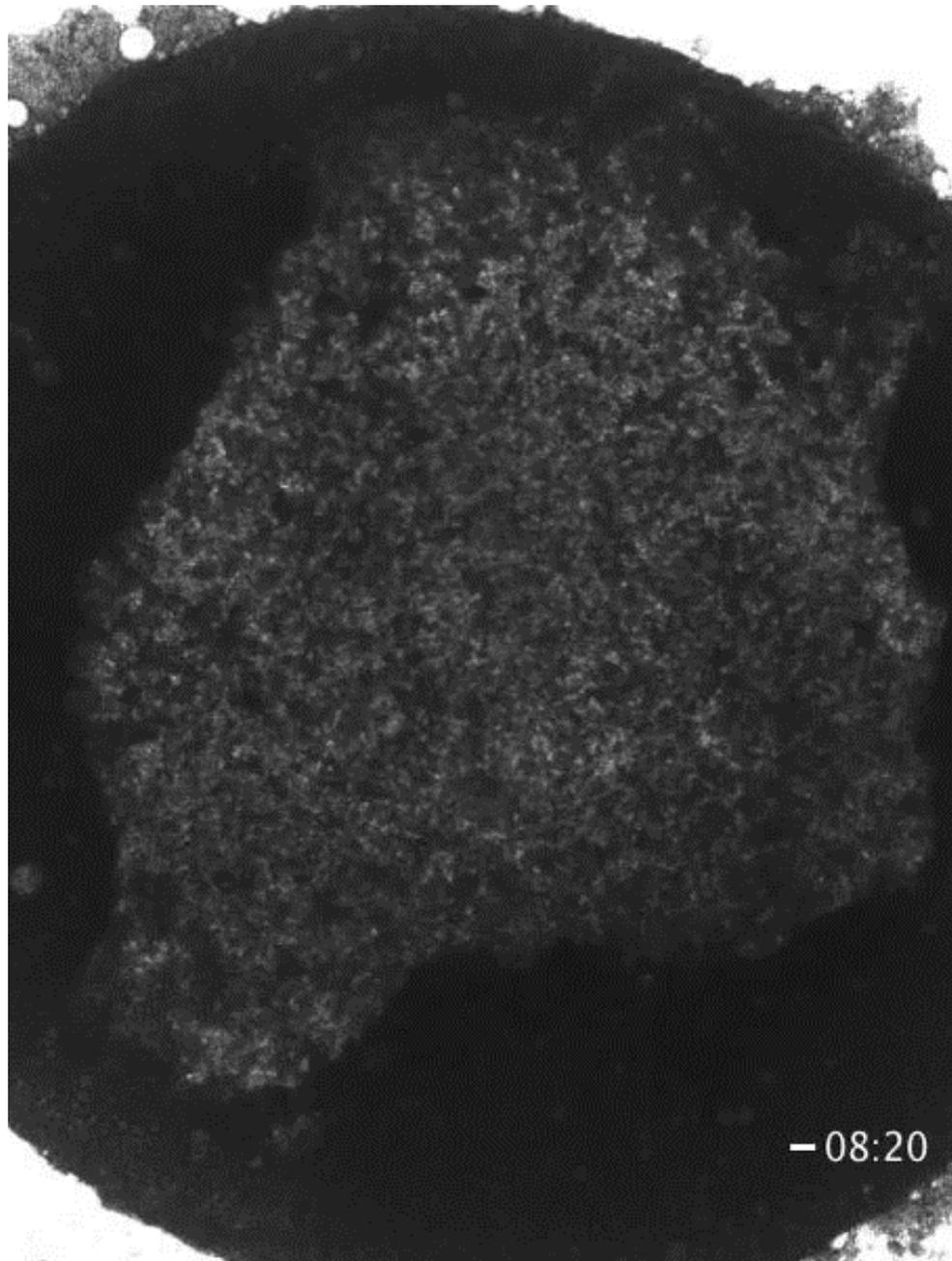


Células del centro del epiblasto se engrosan formando la **línea primitiva**

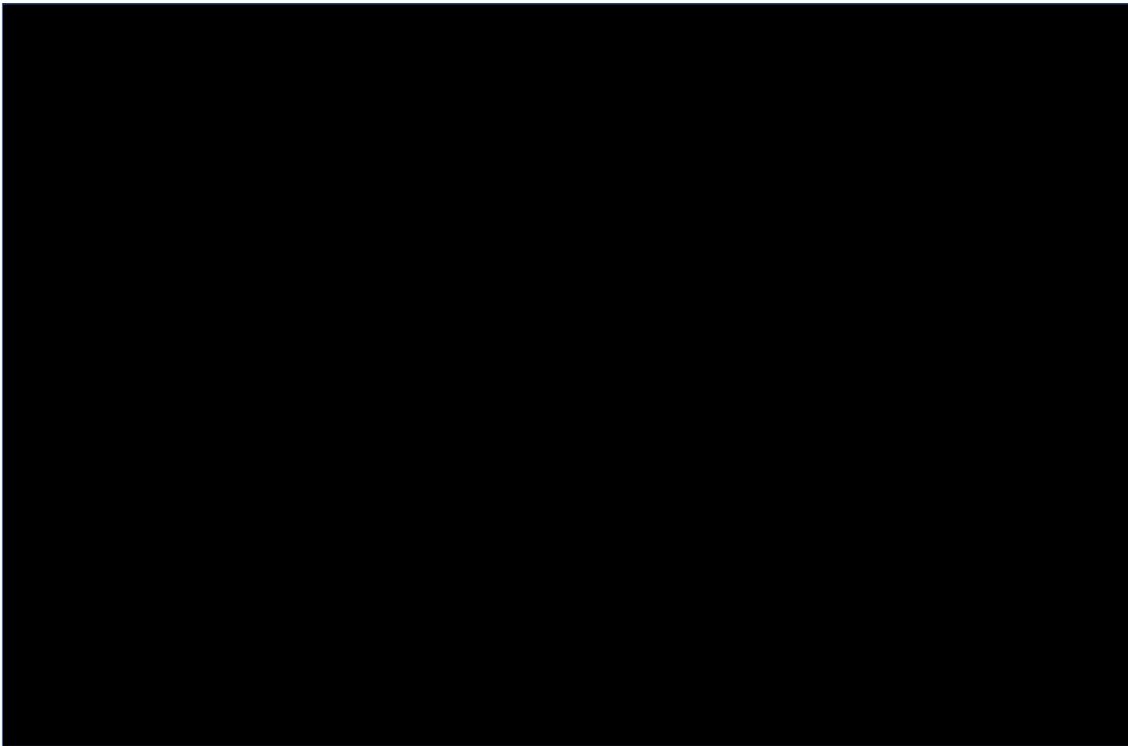


Depresión formada en la línea primitiva: **surco primitivo**  
 Células ingresan a través del surco primitivo

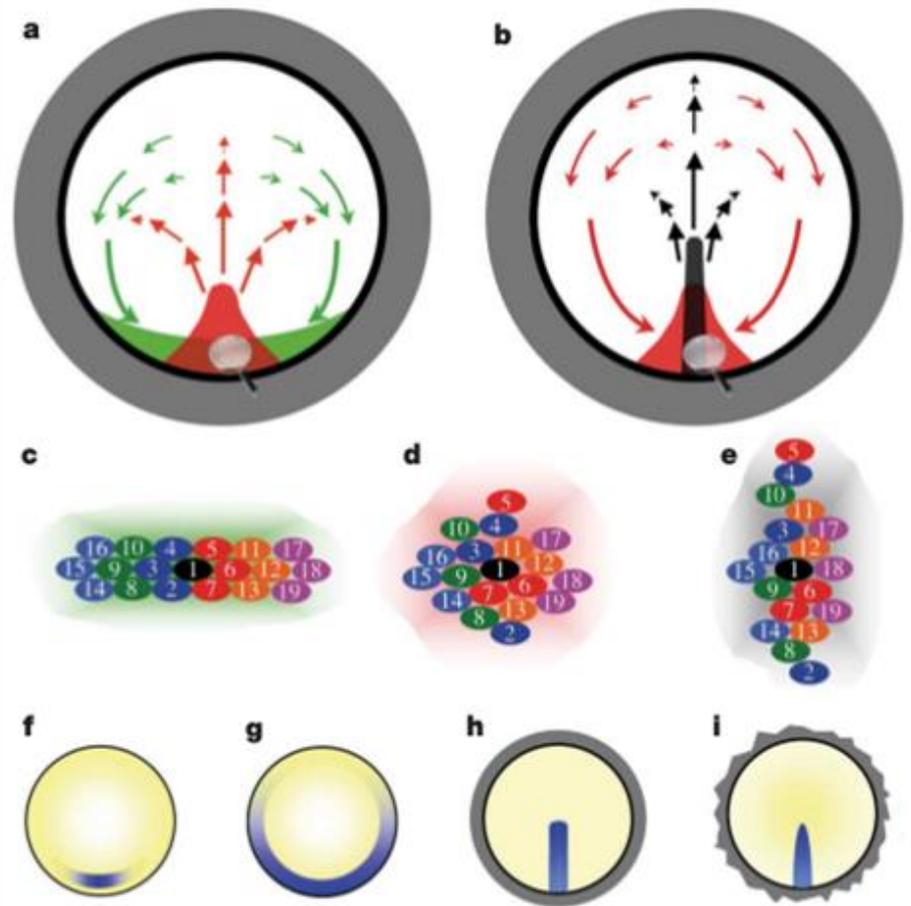




<https://youtu.be/ZPsnVNiOjsU>

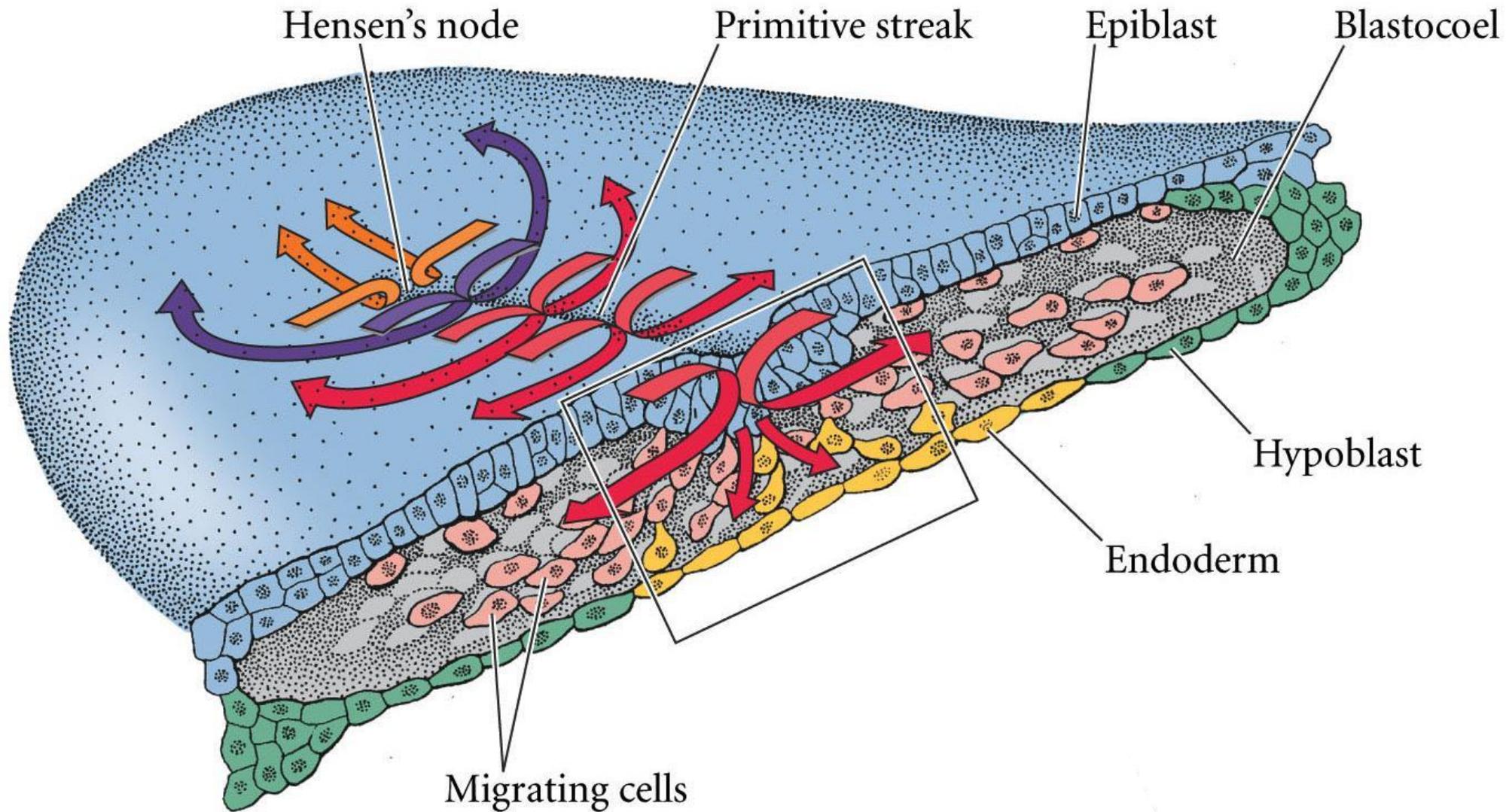


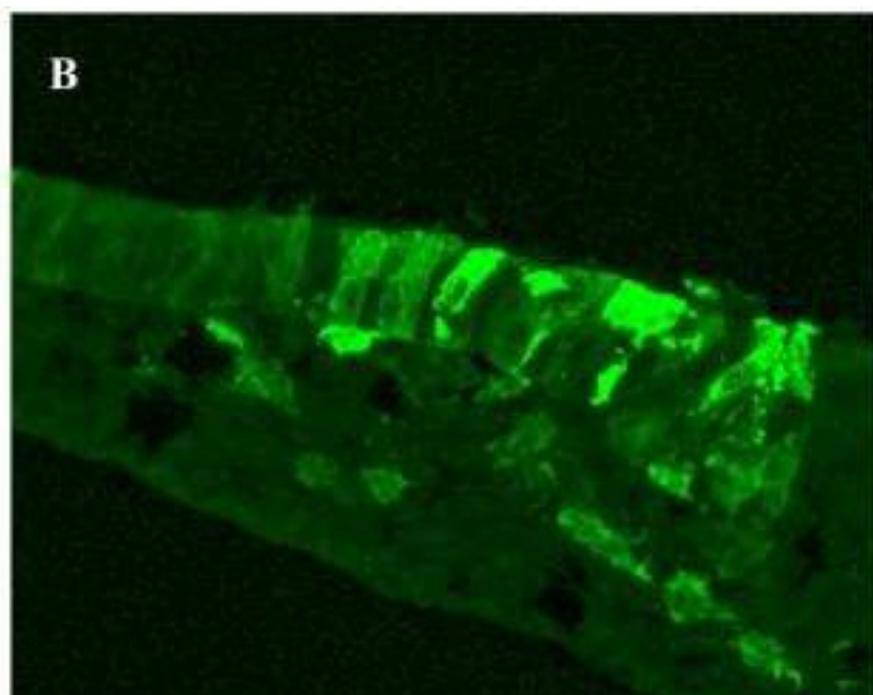
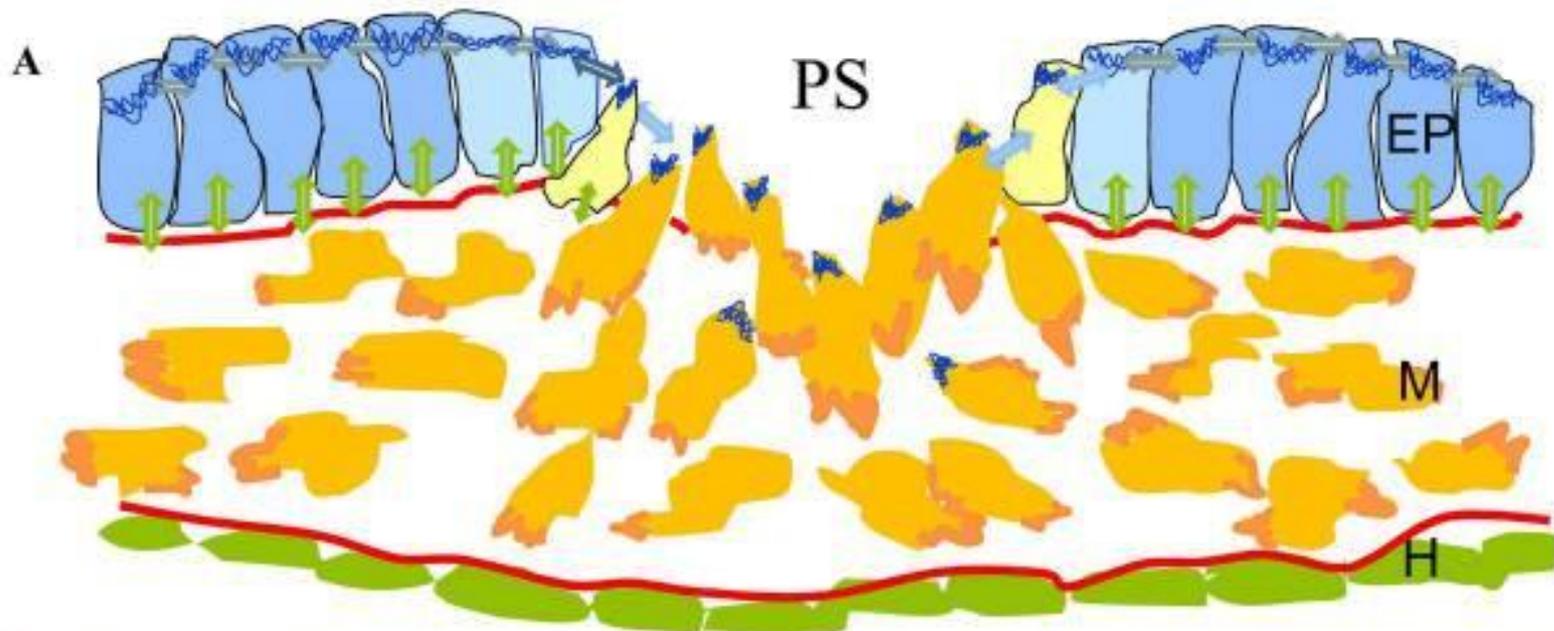
<https://youtu.be/KgJcFpGC0xg>



**Extensión de la línea primitiva: intercalación celular**

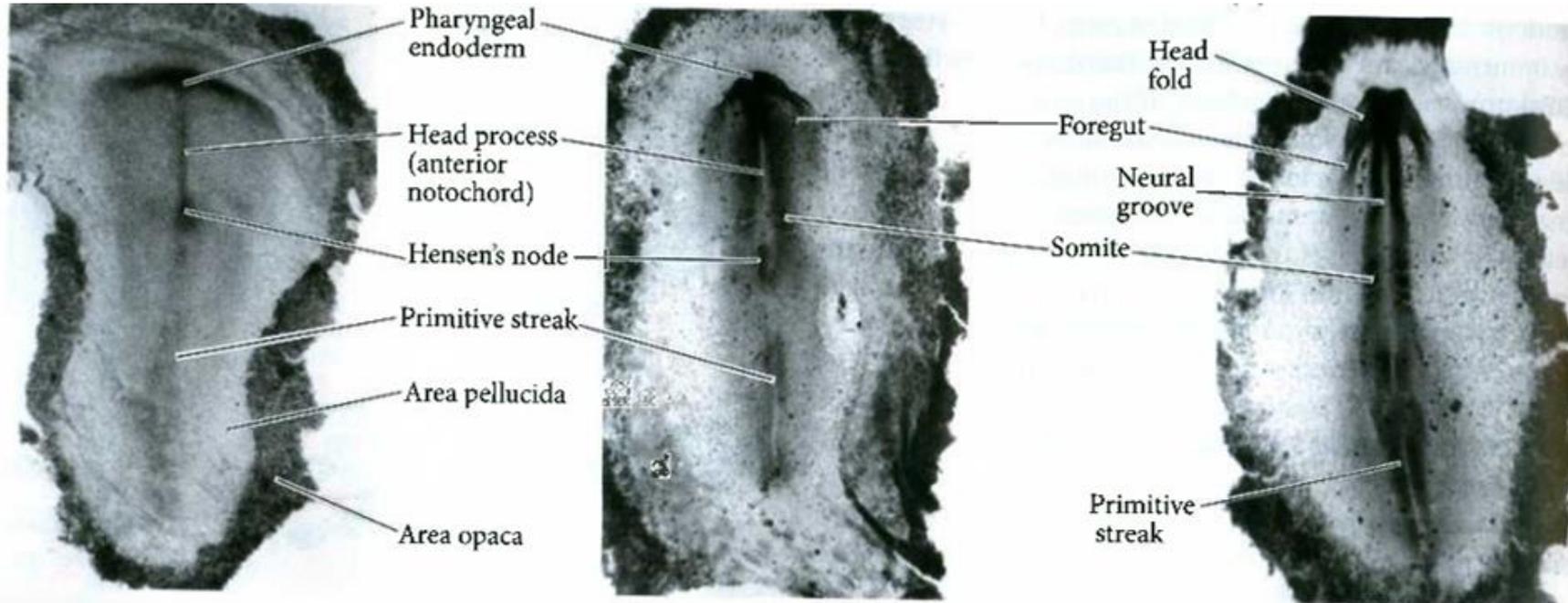
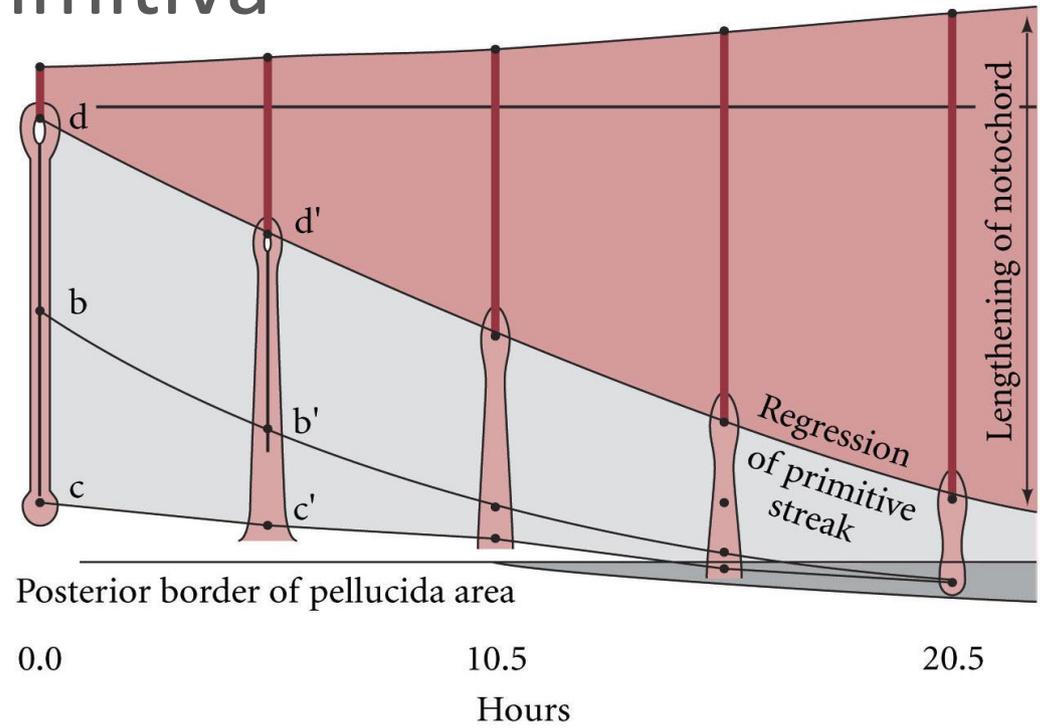
# Migración a través de la línea primitiva





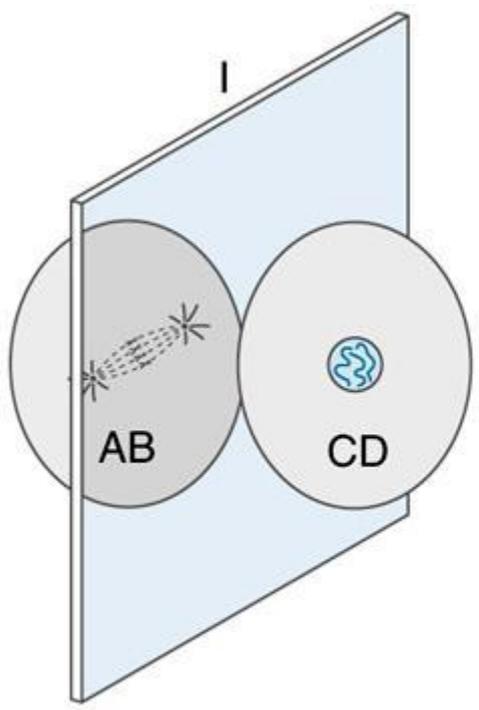
GFP

# Regresión de la línea primitiva

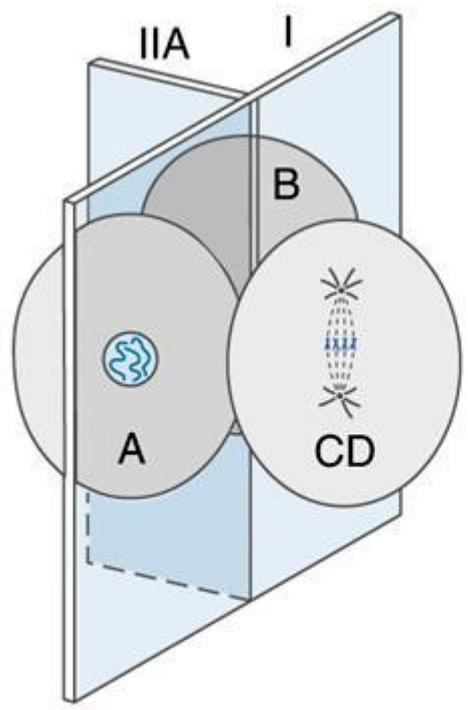


# Gastrulación

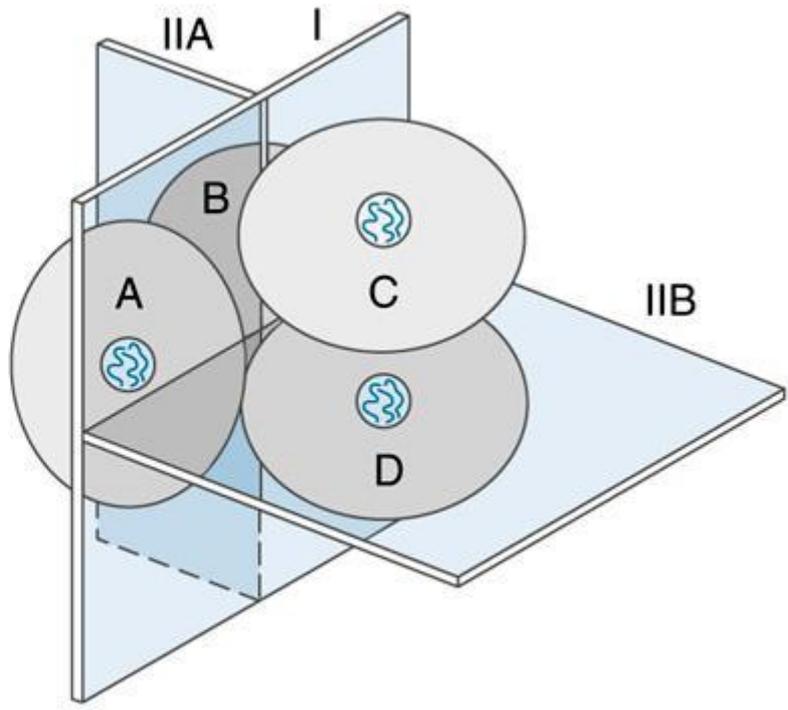
Embriones con clivaje holoblástico: mamíferos



(a)

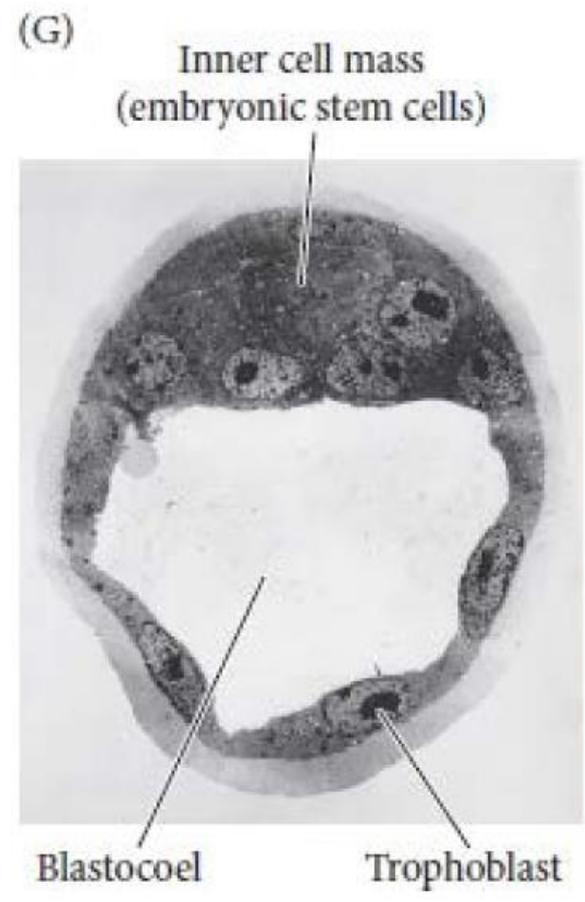
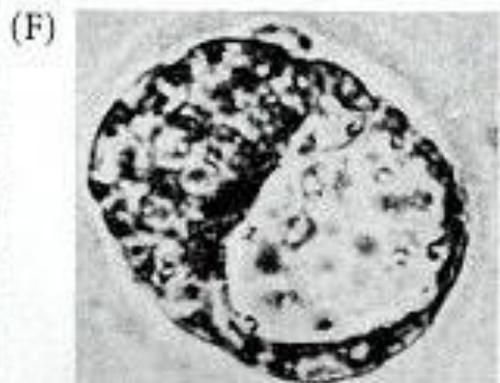
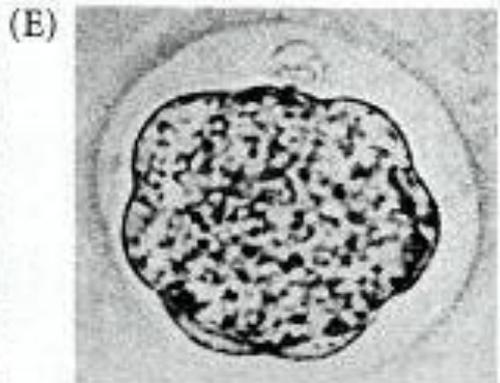
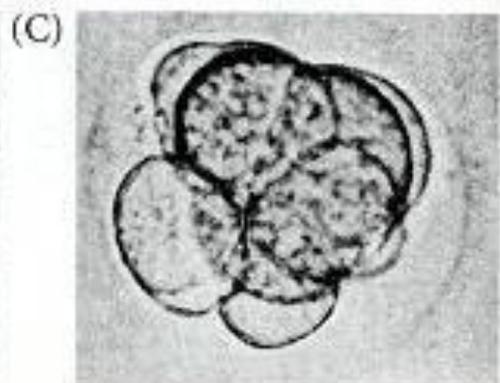
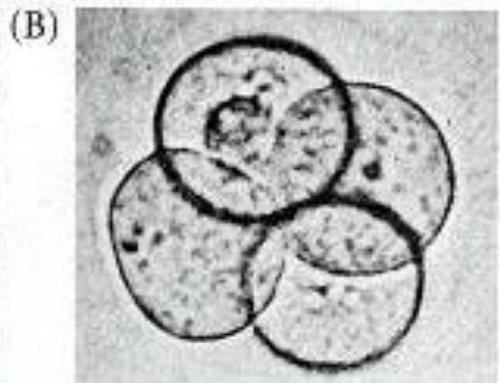
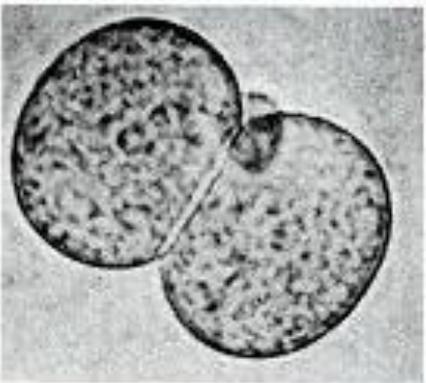
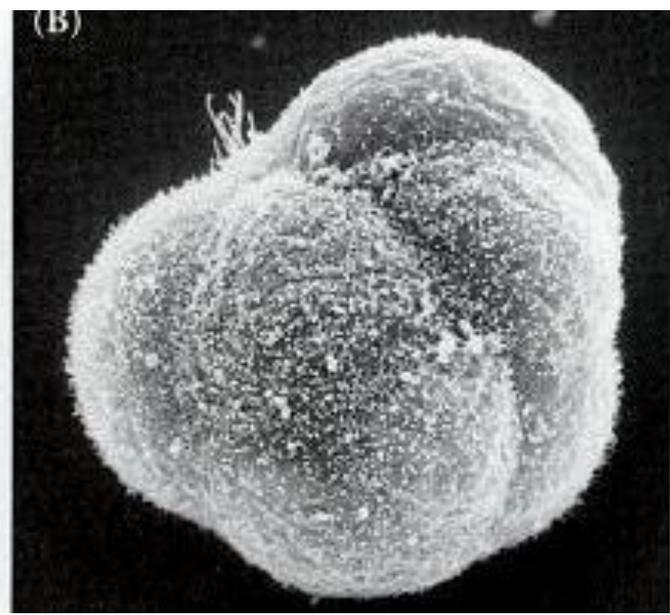


(b)

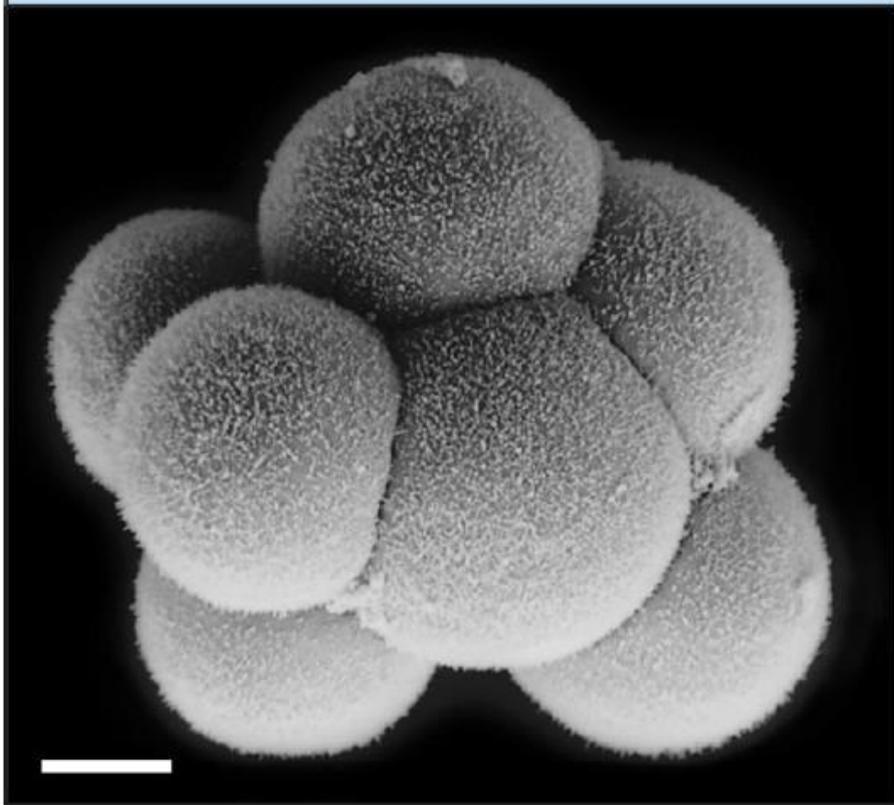


(c)

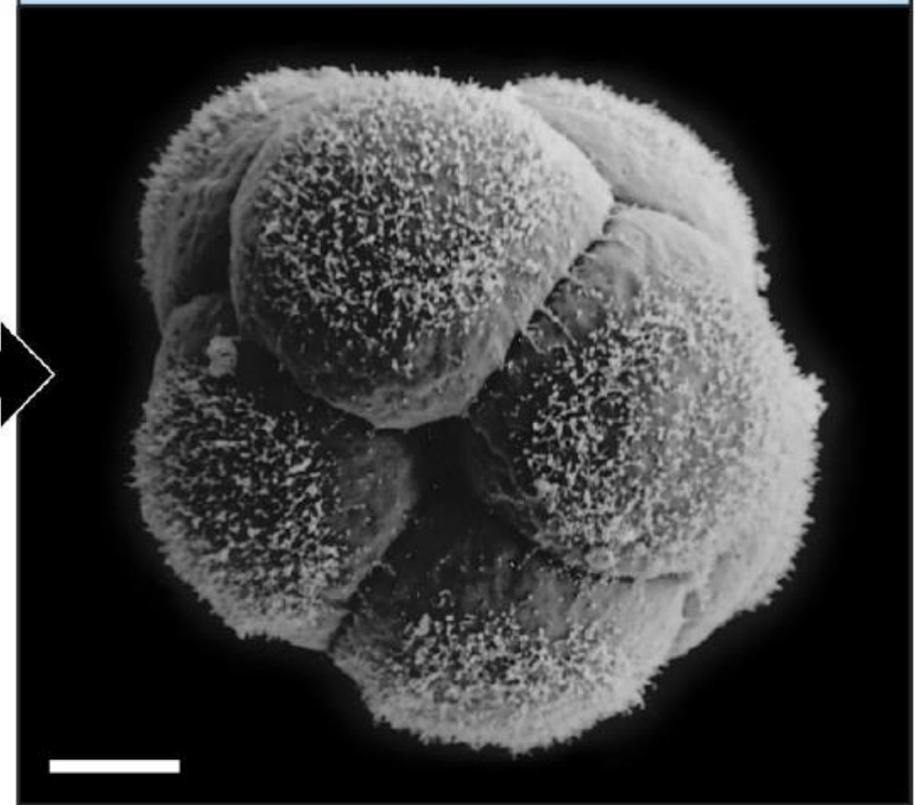
12-24 horas duración cada ciclo



**Eight-cell stage**

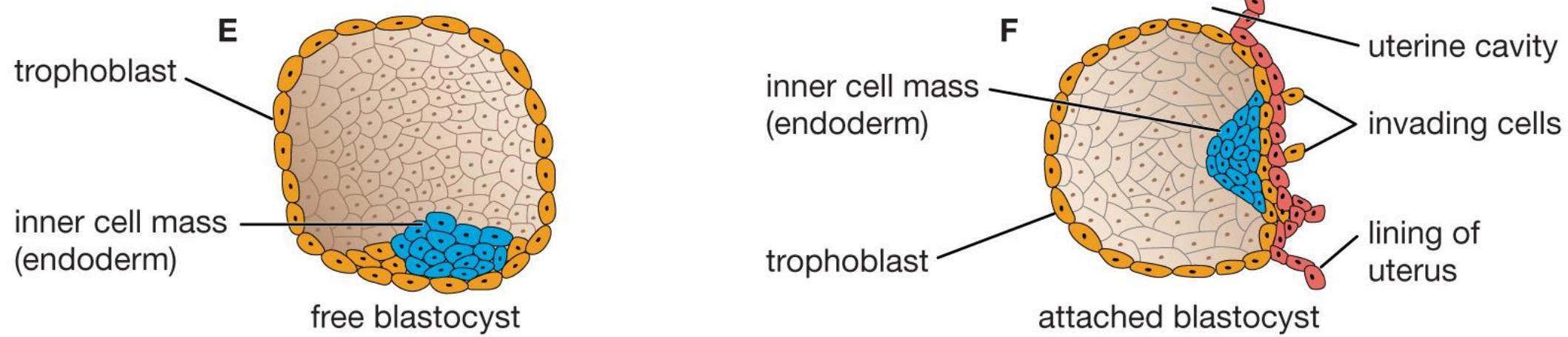


**Compaction**



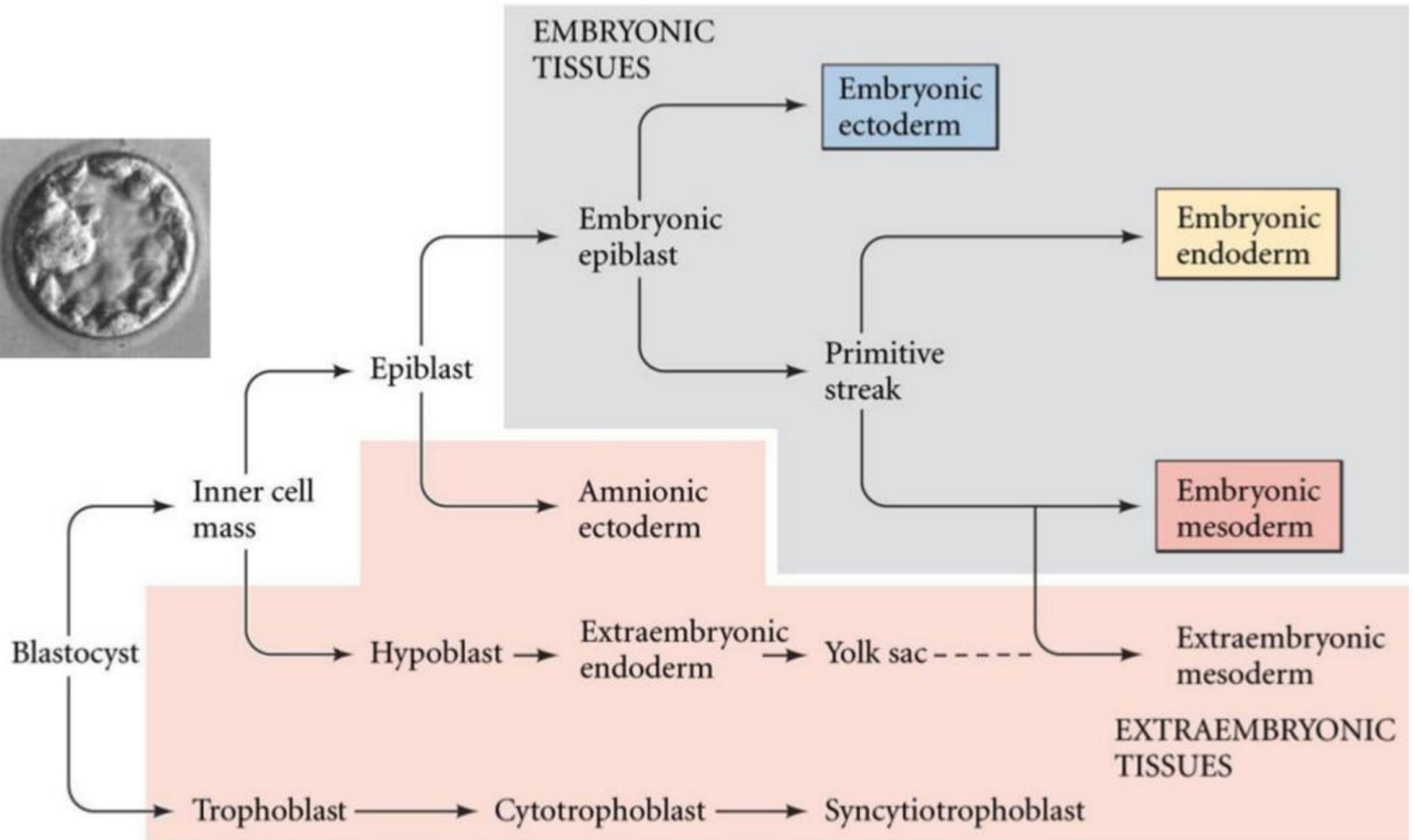


### Blastocyst development

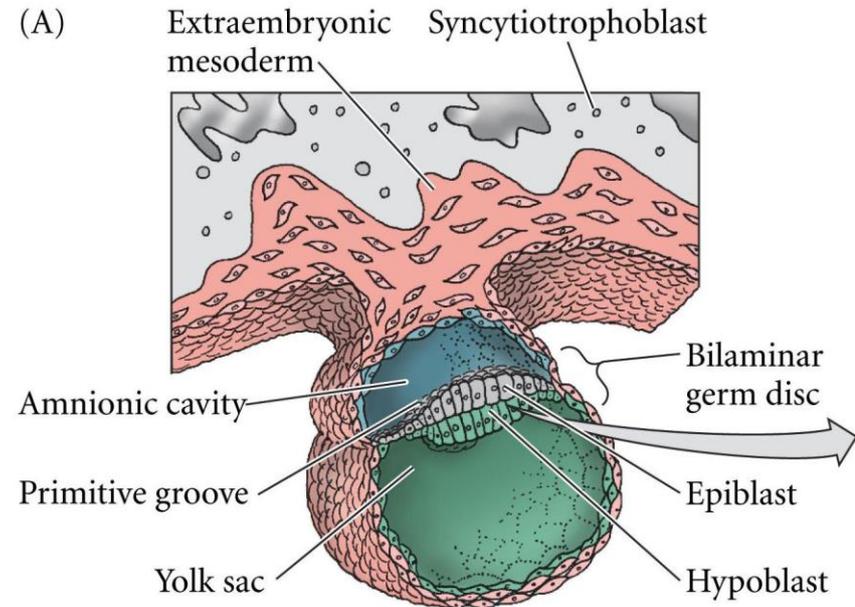
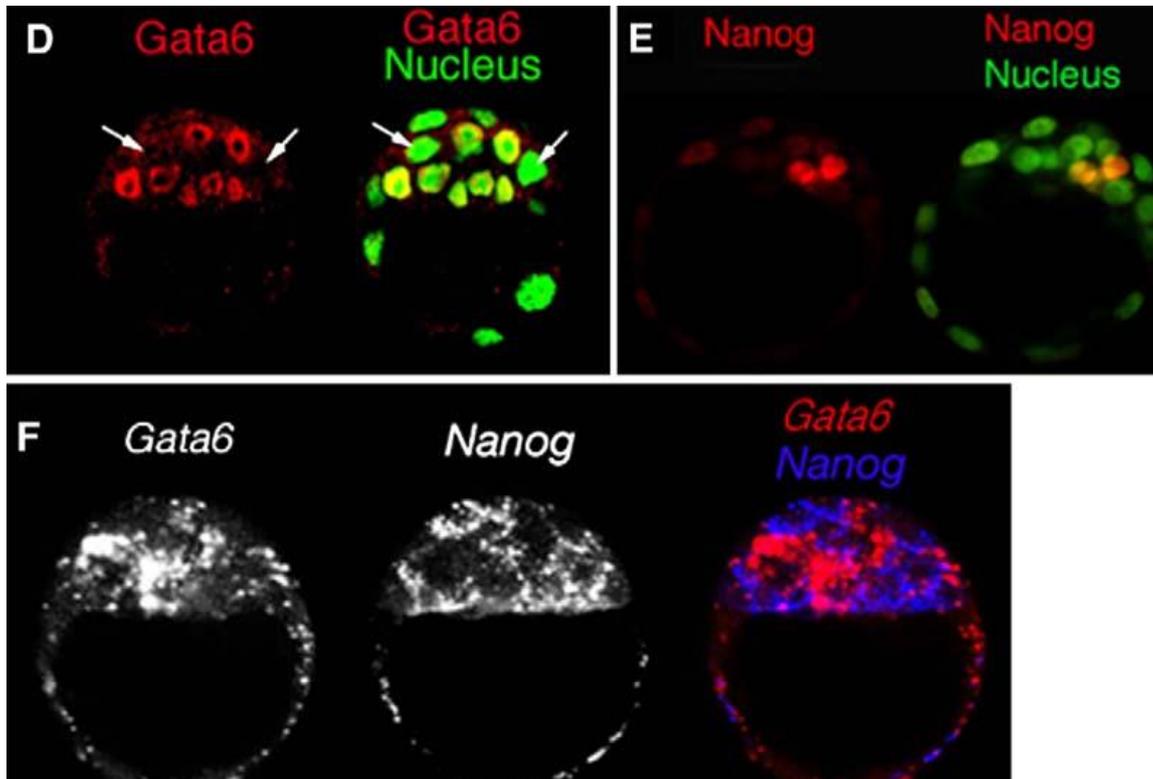


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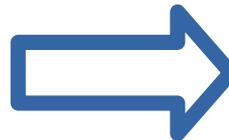
**Totipotentes (primeras blastómeras)**  
**Pluripotentes (macizo celular interno)**



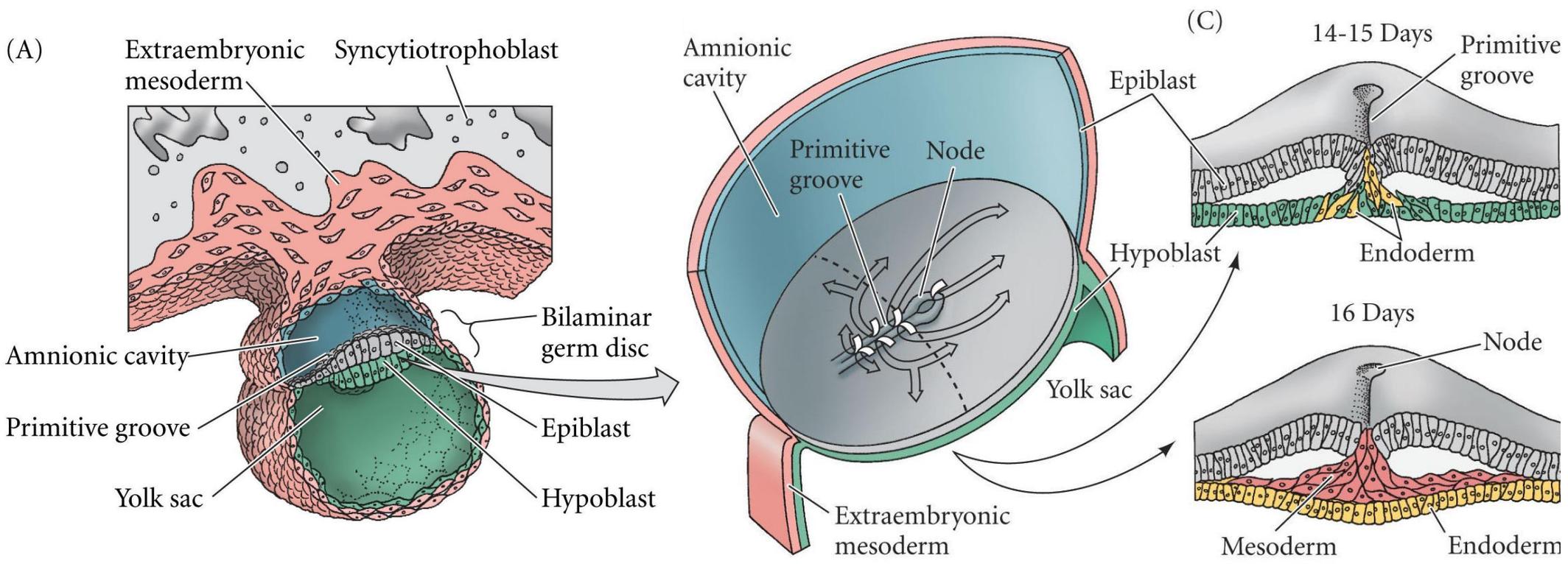
# El endodermo primitivo: hipoblasto de mamíferos



**Gata6** endodermo primitivo  
**Nanog** epiblasto



Disco bilaminar germinal

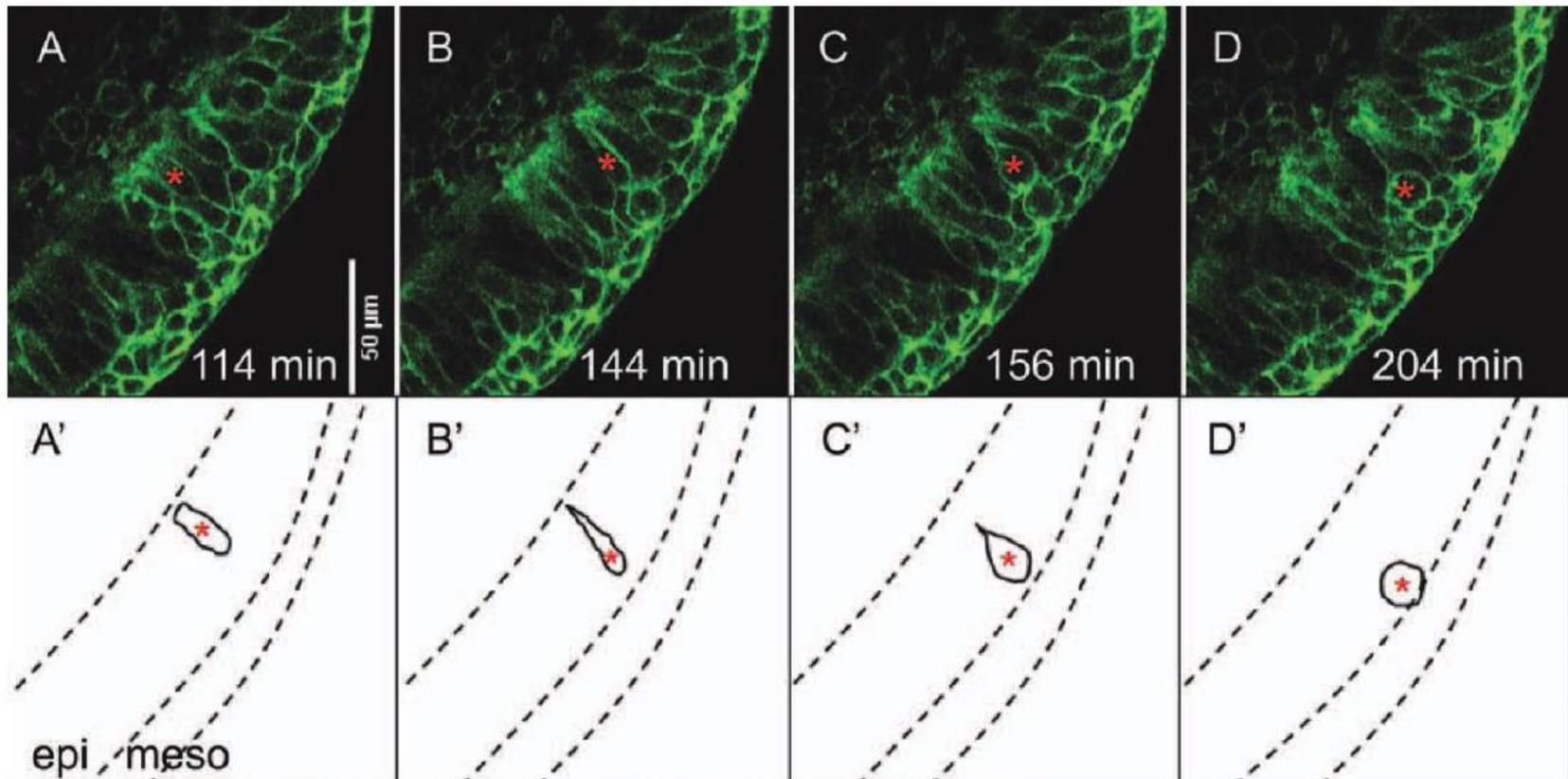
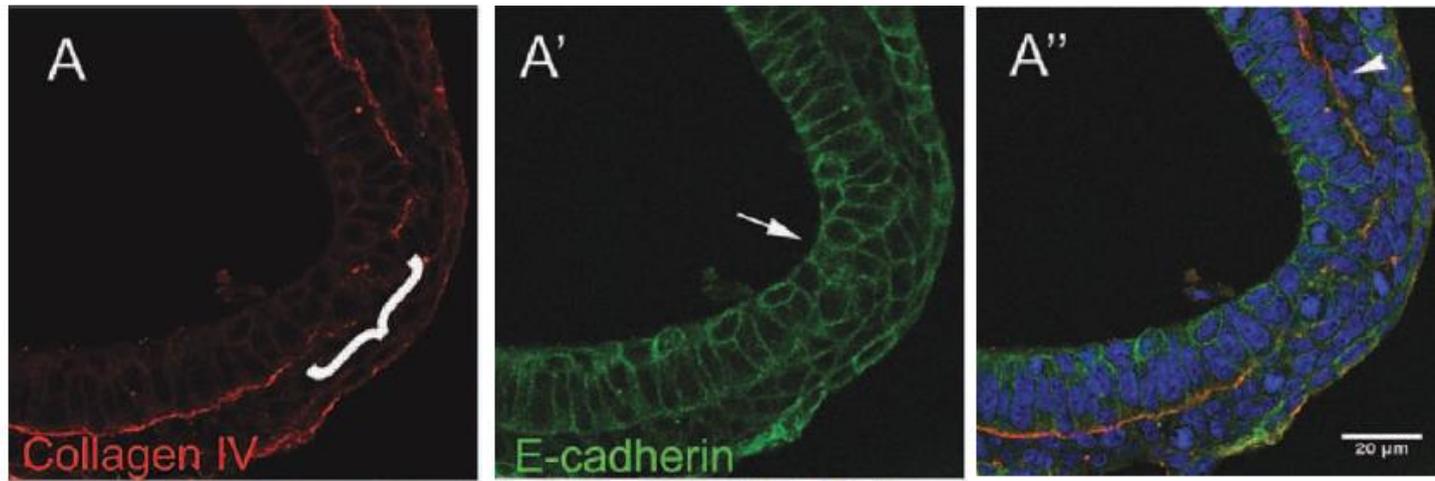


(A)

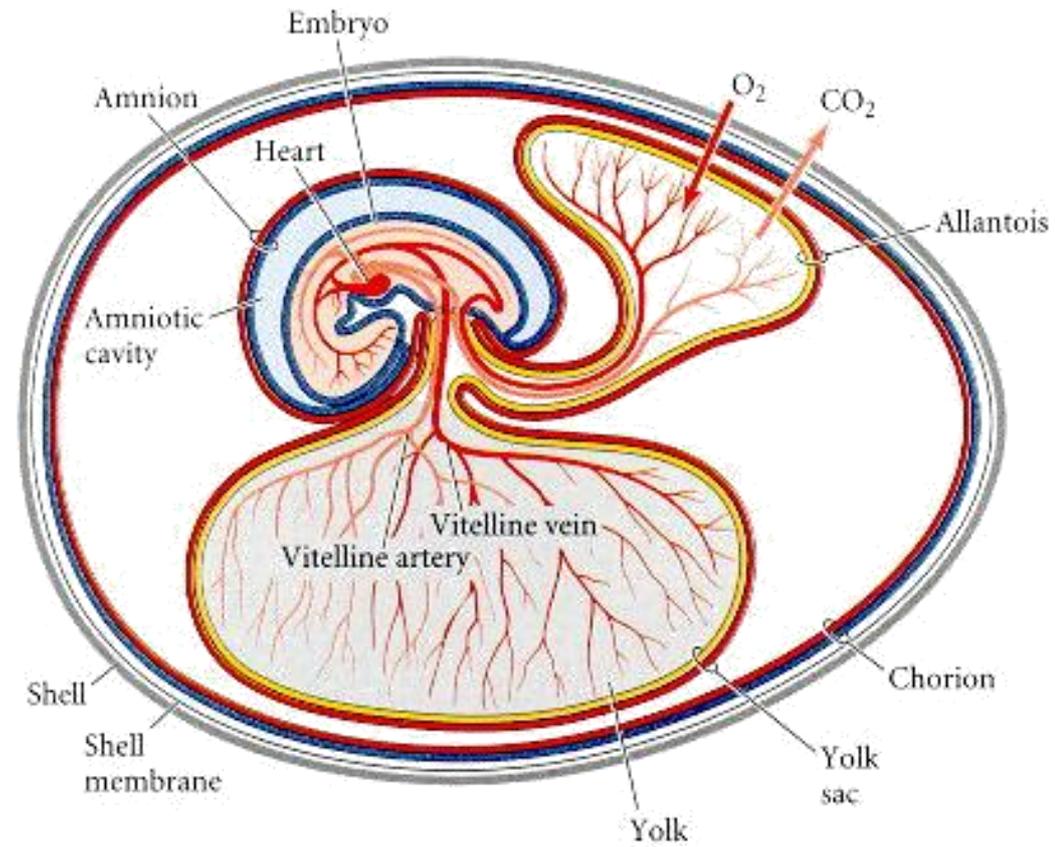
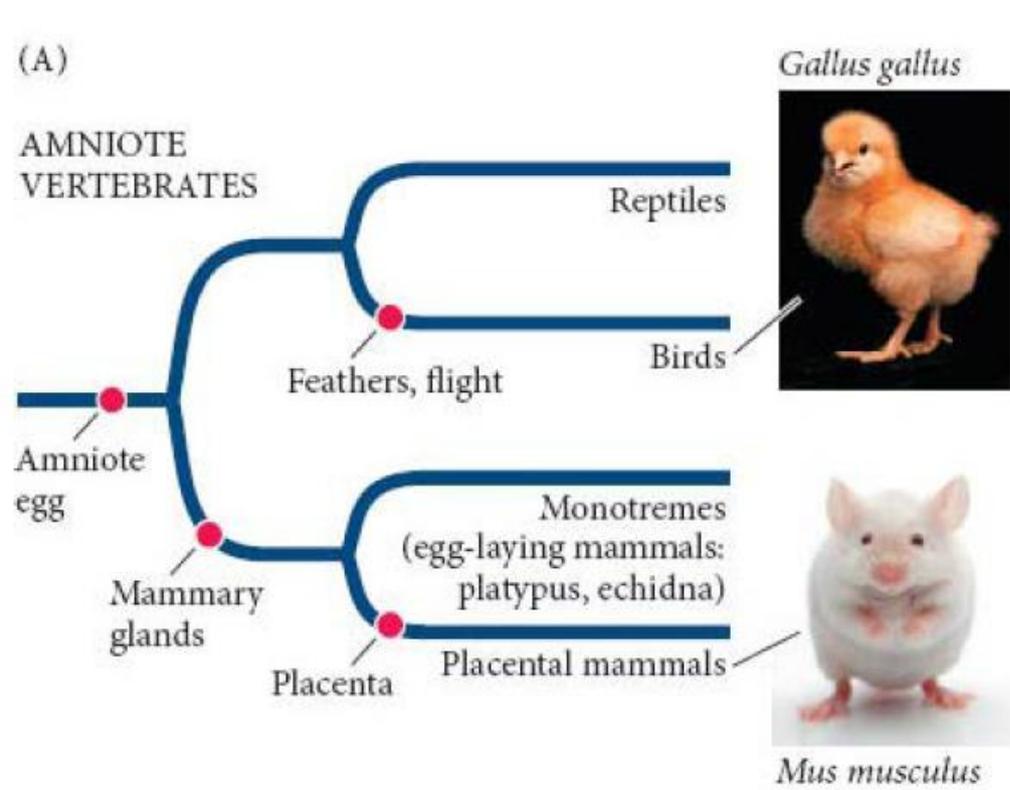
(C)

14-15 Days

16 Days

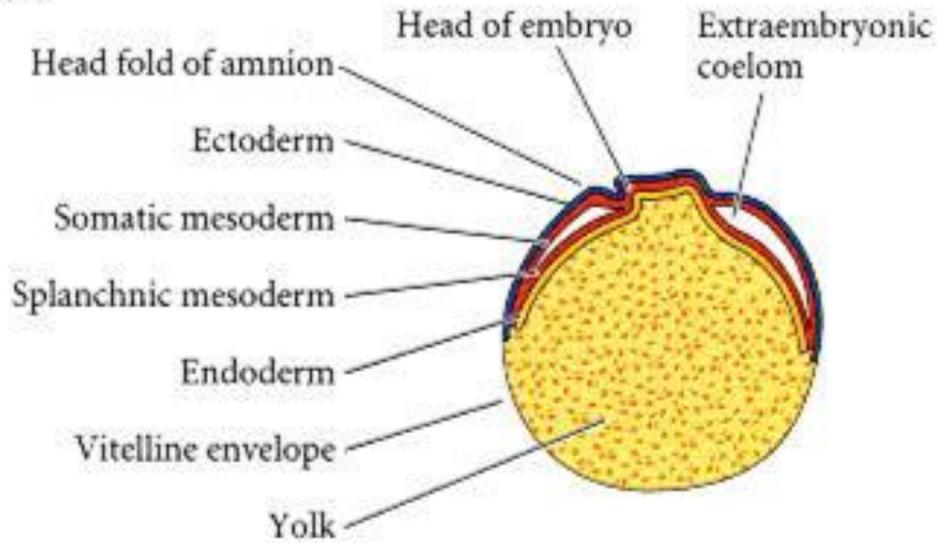


# Anexos extraembrionarios

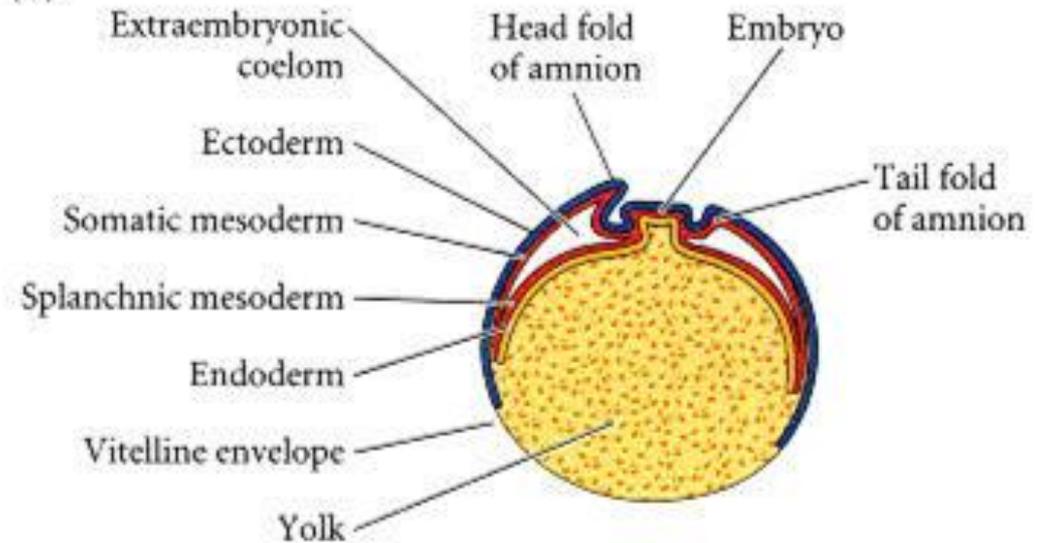


# Anexos extraembrionarios

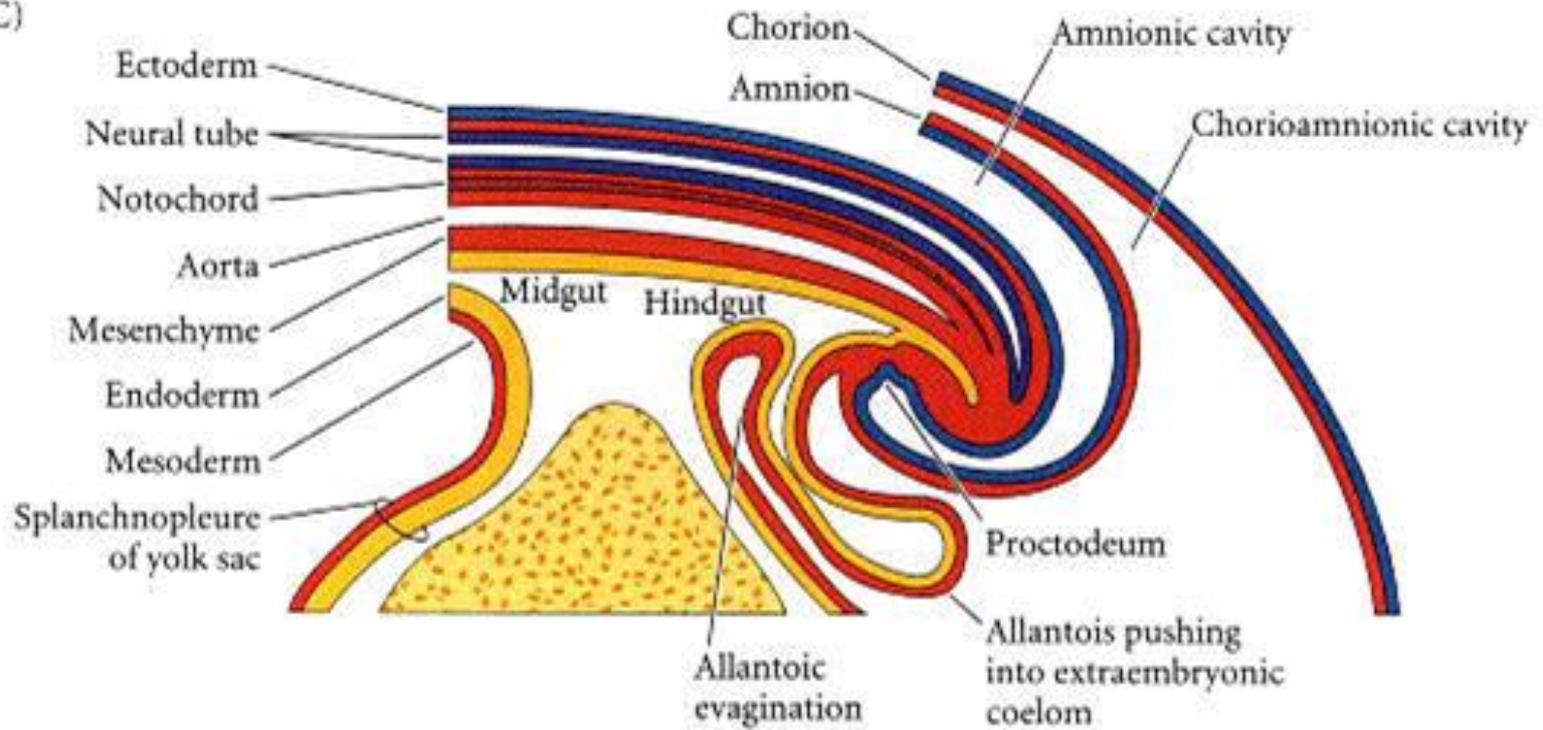
(A)



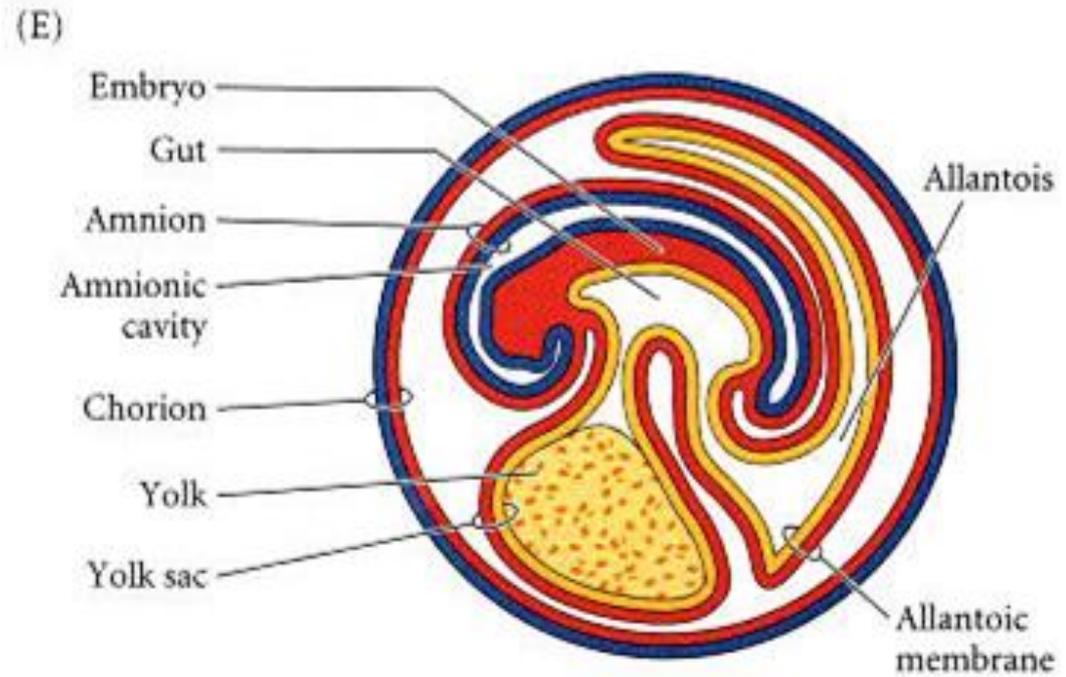
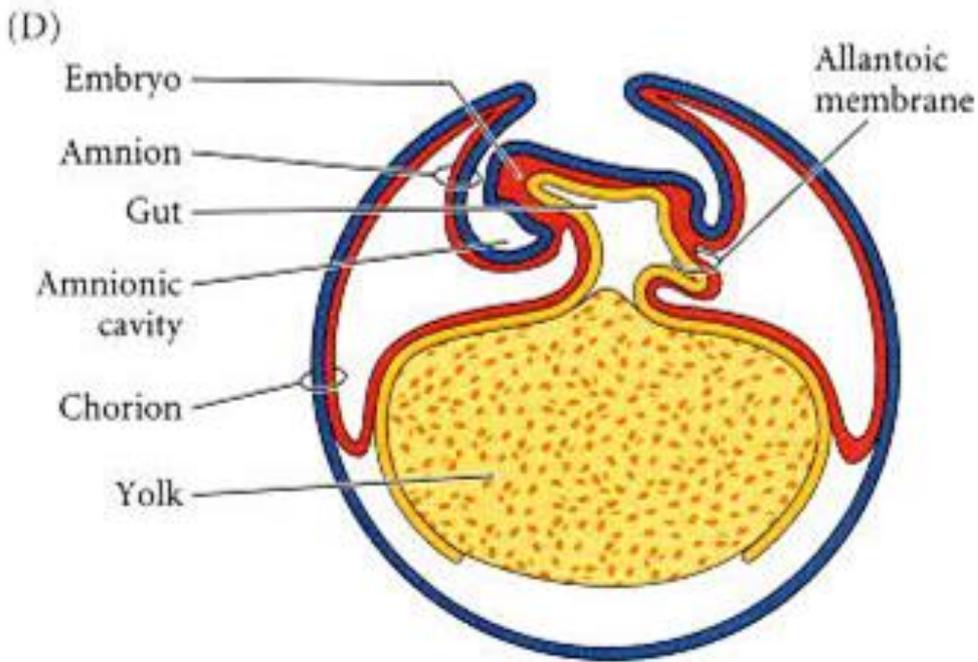
(B)



(C)



# Anexos extraembrionarios



(A)

AMNIOTE  
VERTEBRATES

