

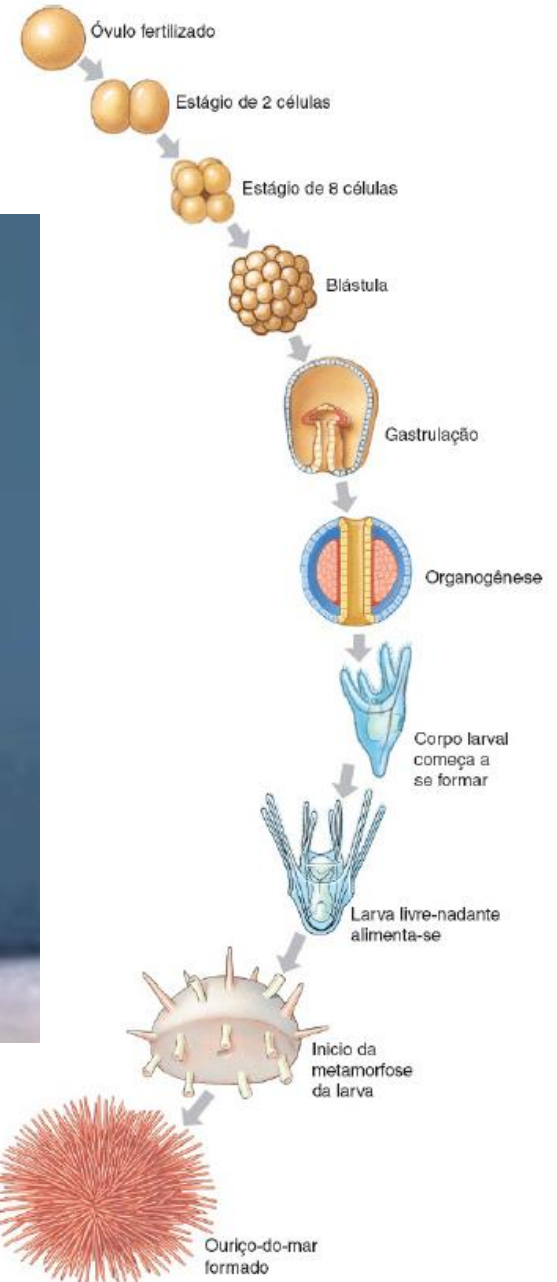
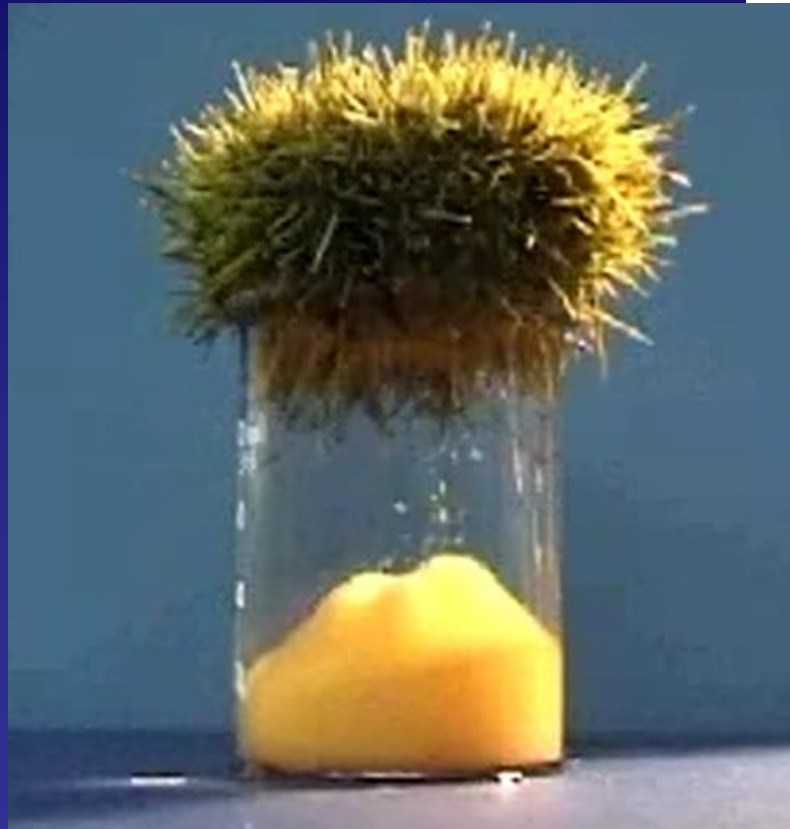
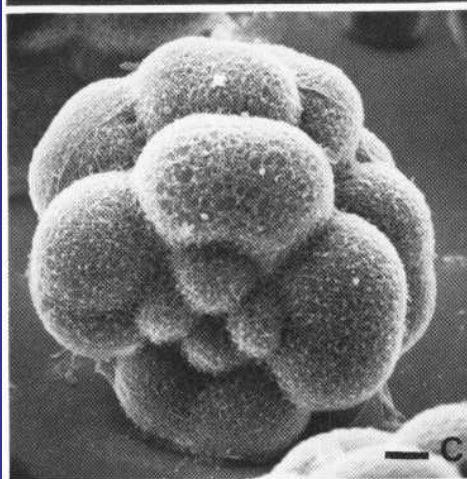
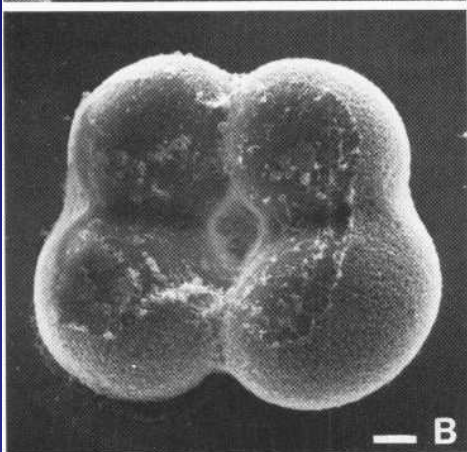
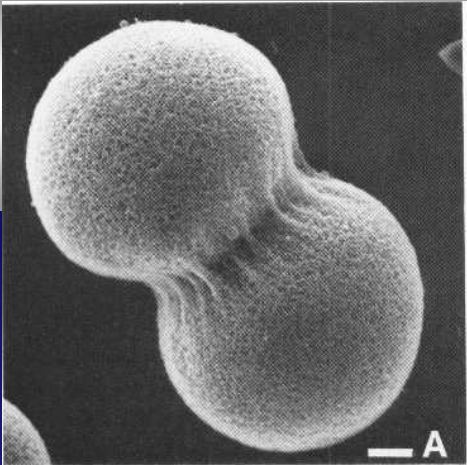
DEPARTAMENTO DE BIOLOGIA- FFCLRP

UNIVERSIDADE DE SÃO PAULO

EMBRIOLOGIA E MORFOGÊNESE

**Clivagem e gastrulação
em equinodermas e
anfíbios**

Ouriço-do-mar



Larva pluteus

0,1 - 1,0 mm, campo escuro, cebimar-usp, larva, planctônico, planctotrófica



Alvaro E. Migotto

Táxon: Echinoidea

Especialista: Alvaro E. Migotto

Data: 30 de Setembro de 2005 às 12:36

Local: Canal de São Sebastião, São Sebastião, SP, Brasil

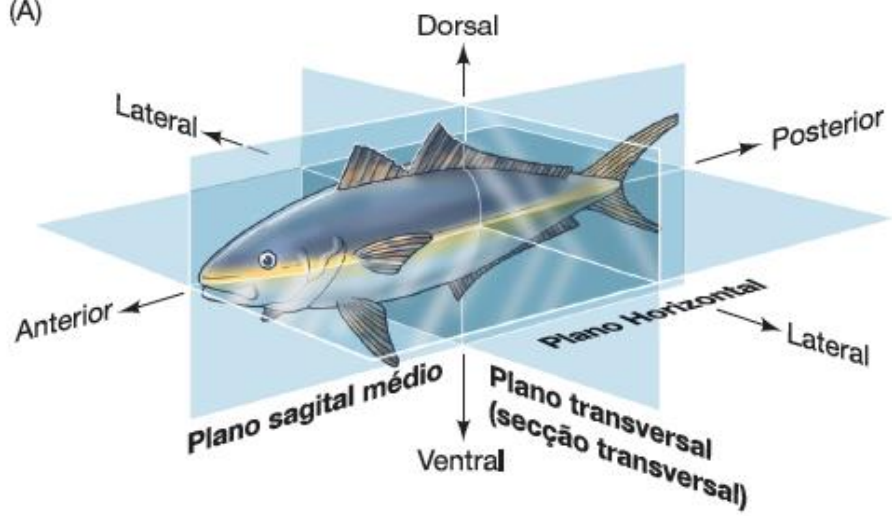
Geolocalização: S 23°50'11" W 45°24'54"

GBIF
EoL
ITIS
BHL
OBIS
WoRMS
CoL
GenBank
BOLD
uBio
MSIP
Wikispecies
BHL SciELO

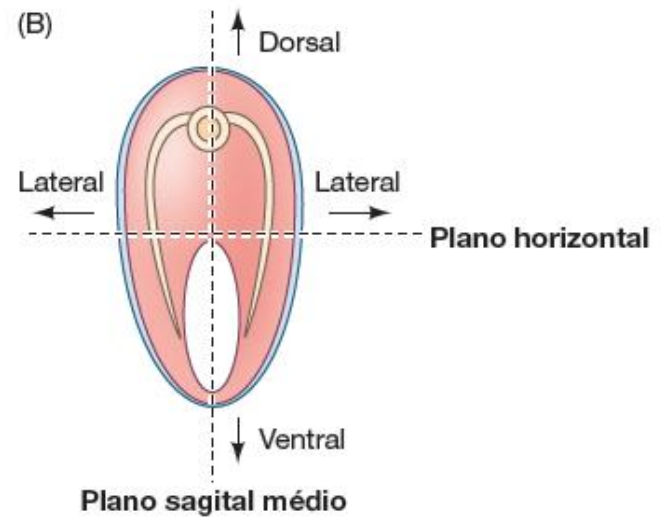
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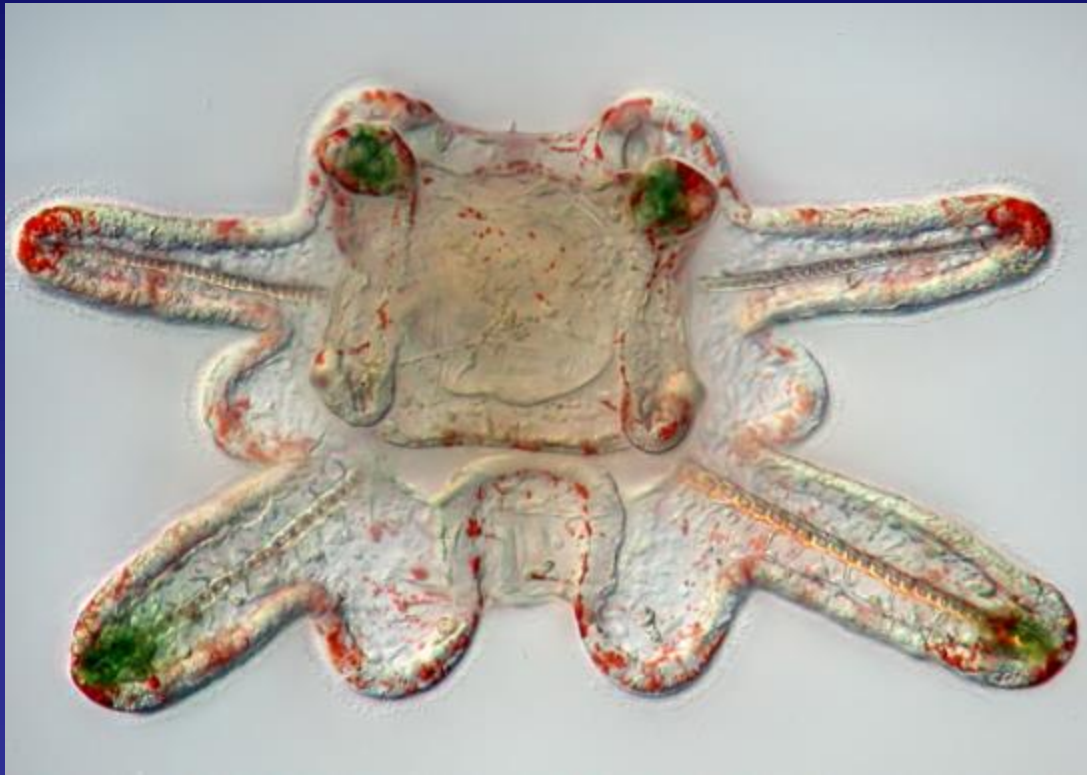


(A)



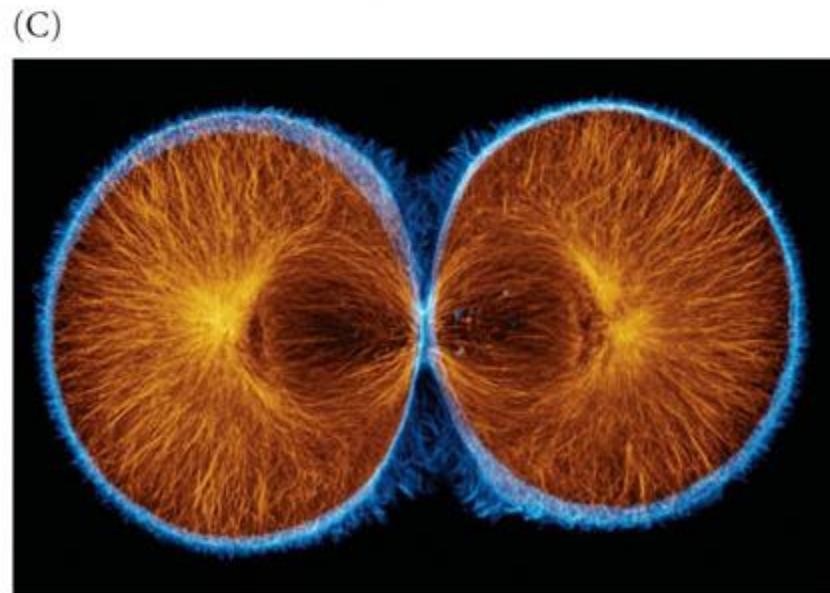
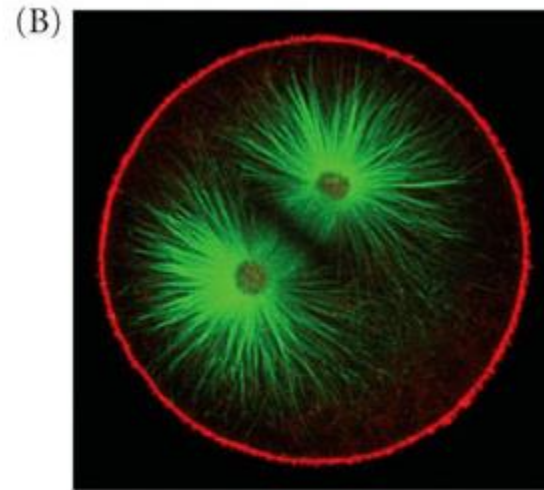
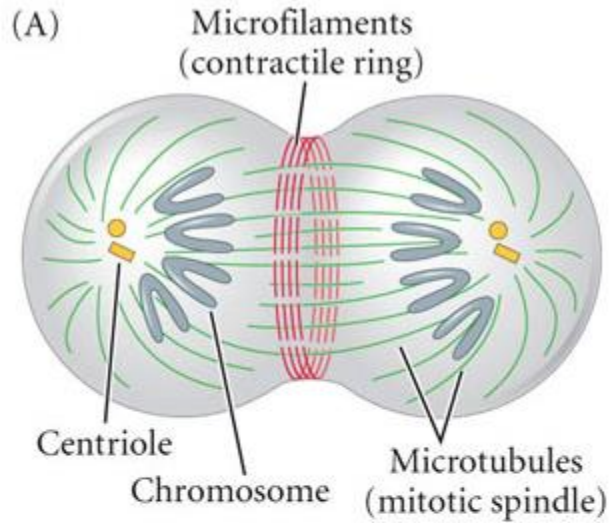
(B)





Larva pluteus em vista frontal

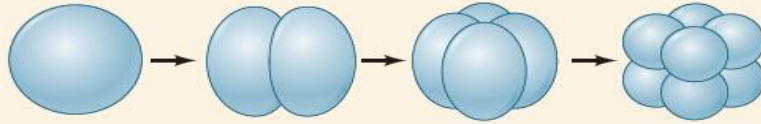
Clivagem



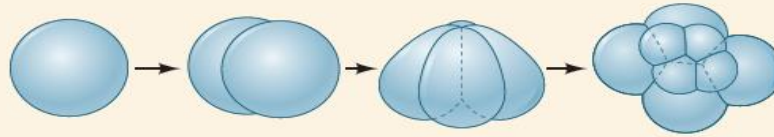
I. CLIVAGEM HOLOBLÁSTICA (COMPLETA)

A. Isolécito (vitelo esparsos, uniformemente distribuído)

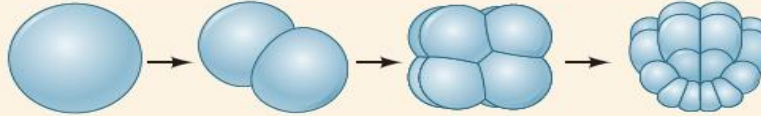
1. Clivagem radial
Equinodermas, anfioxo



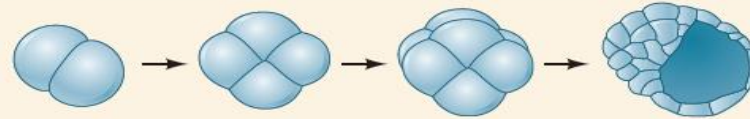
2. Clivagem espiral
Anelídeos, moluscos, platelmintos



3. Clivagem bilateral
Tunicados

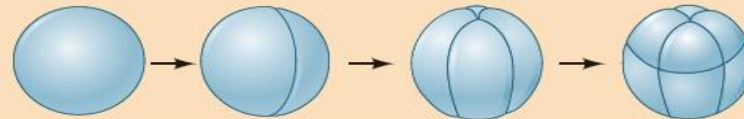


4. Clivagem rotacional
Mamíferos, nematódeos



B. Mesolécito (Disposição de vitelo vegetal moderada)

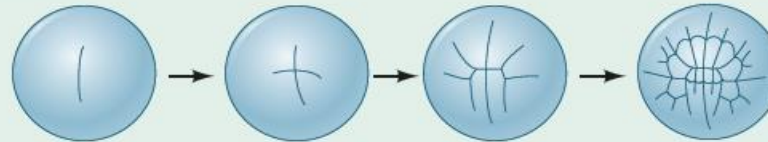
Clivagem radial deslocada
Anfíbios



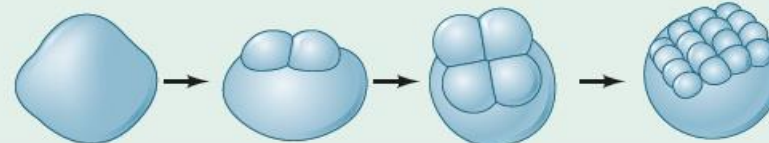
II. CLIVAGEM MEROBLÁSTICA (INCOMPLETA)

A. Telolécito (vitelo denso na maior parte da célula)

1. Clivagem bilateral
Moluscos cefalópodes



2. Clivagem discoidal
Peixes, répteis, aves



B. Centrolécito (vitelo no centro do ovo)

Clivagem superficial
A maioria dos insetos

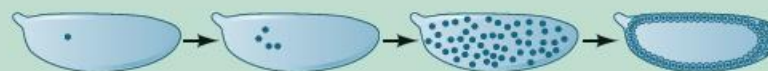


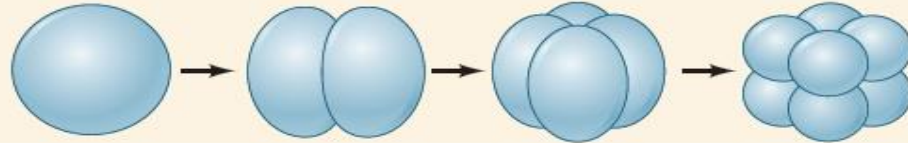
FIGURA 1.5 Resumo dos principais padrões de clivagem.

Ovo isolécito – Clivagem holoblástica radial

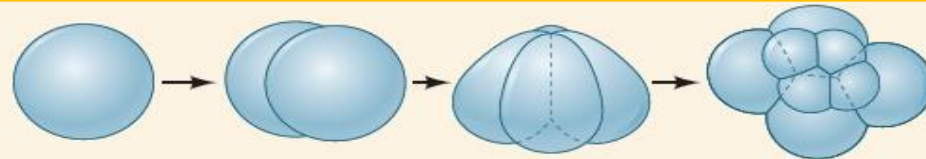
I. CLIVAGEM HOLOBLÁSTICA (COMPLETA)

A. Isolécito (vitelo esparso, uniformemente distribuído)

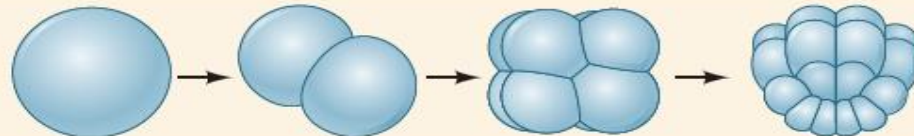
1. Clivagem radial
Equinodermas, anfíoxo



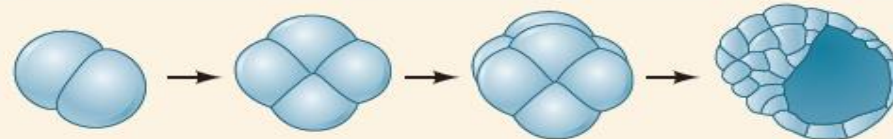
2. Clivagem espiral
Anelídeos, moluscos, platelmintos



3. Clivagem bilateral
Tunicados

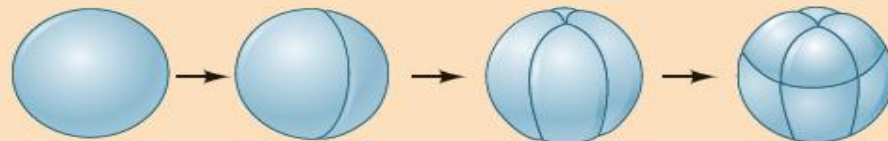


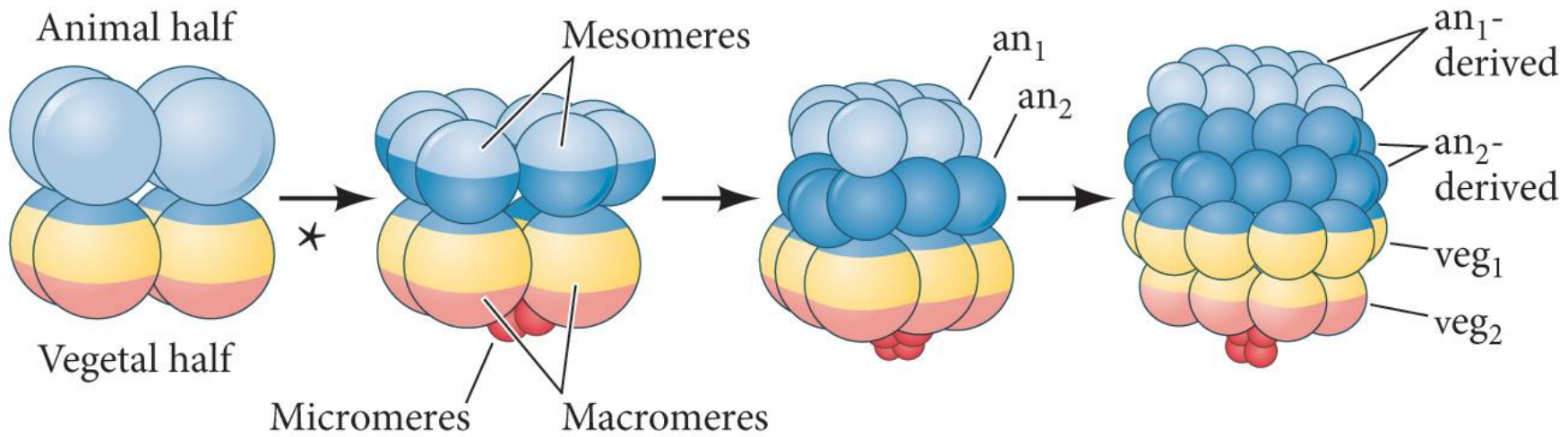
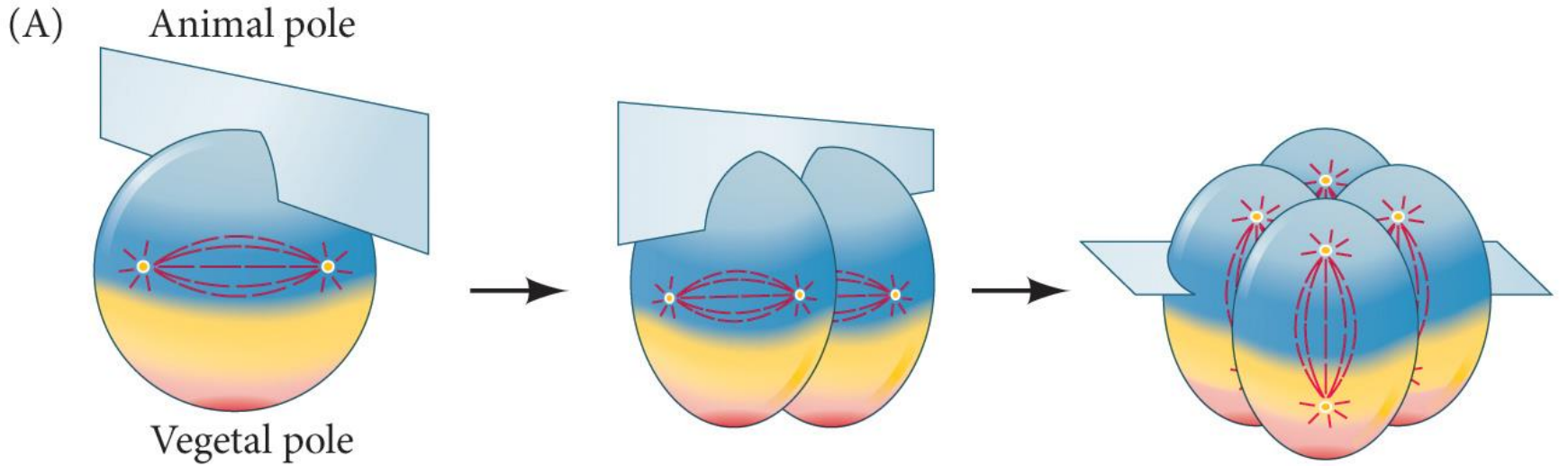
4. Clivagem rotacional
Mamíferos, nematódeos

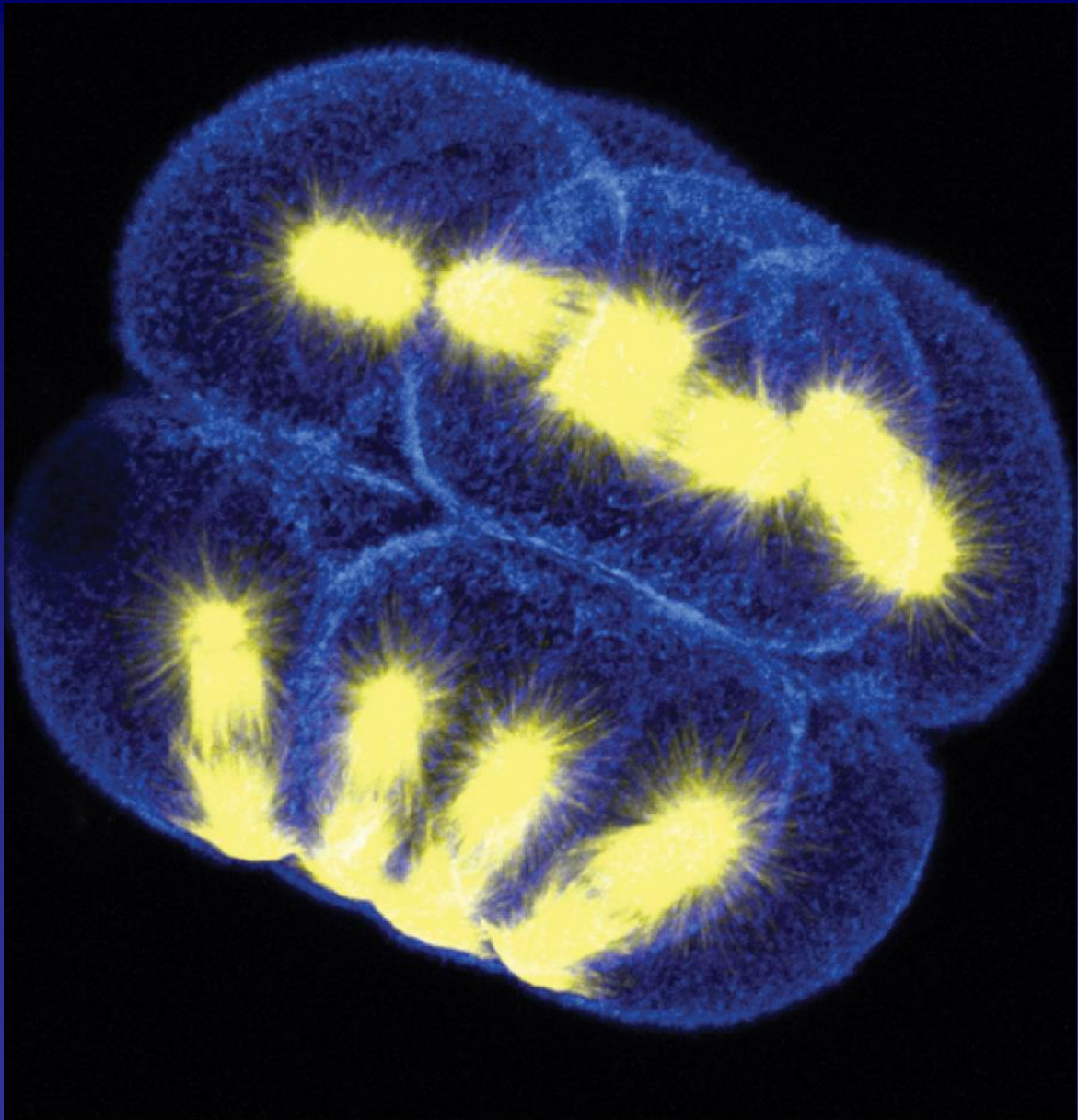


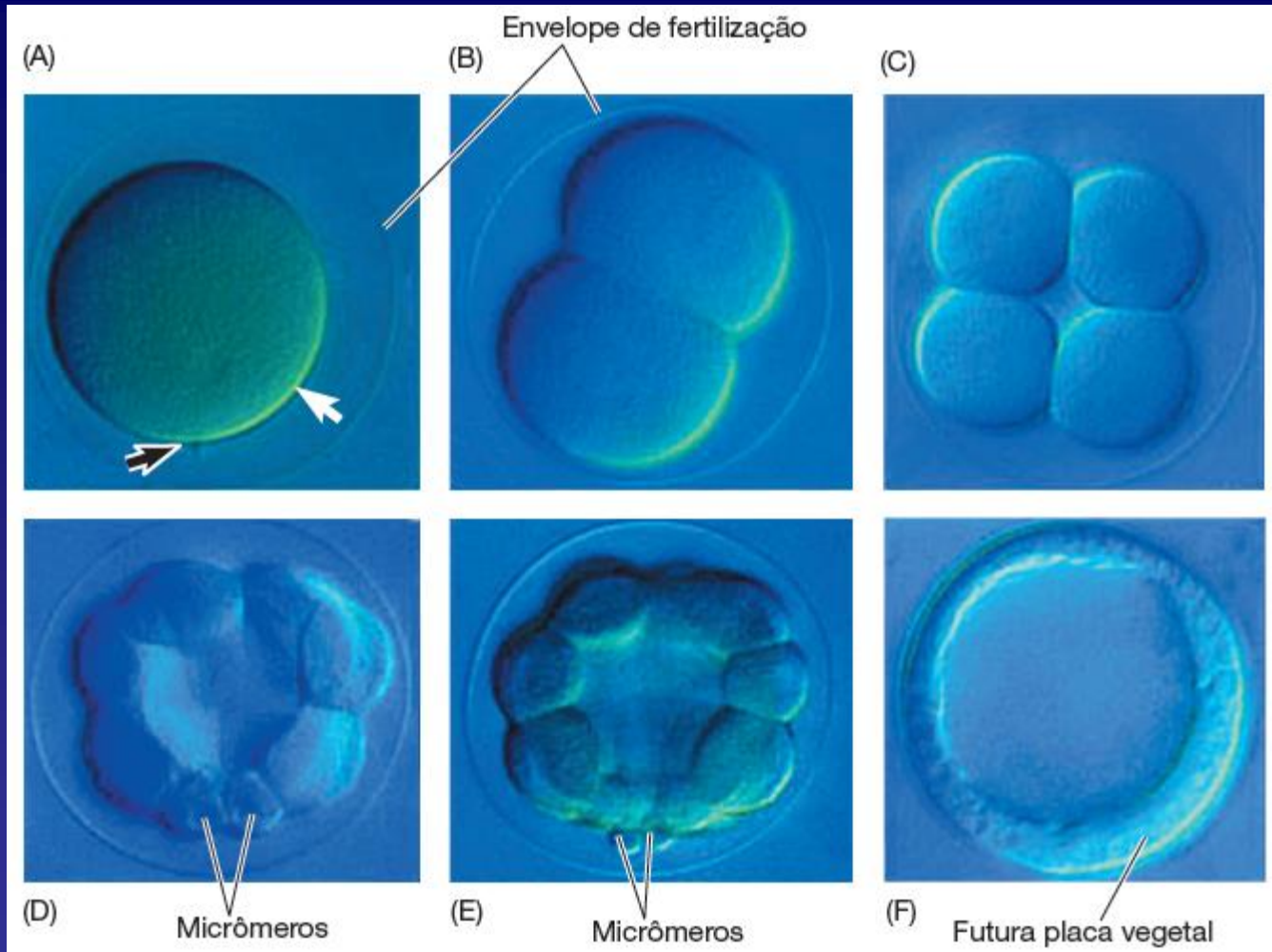
B. Mesolécito (Disposição de vitelo vegetal moderada)

Clivagem radial deslocada
Anfíbios



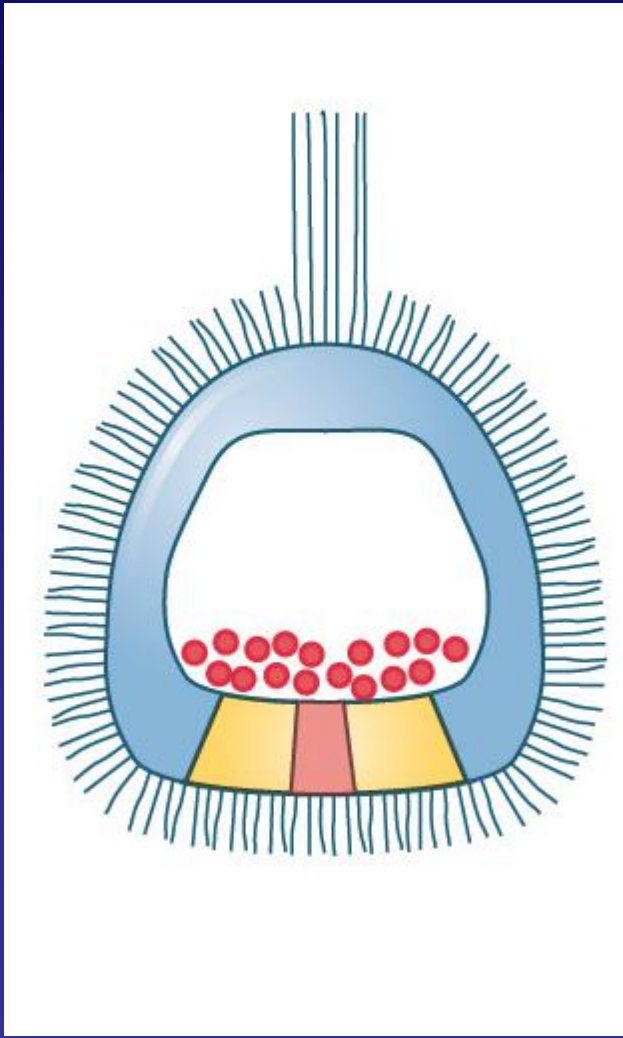




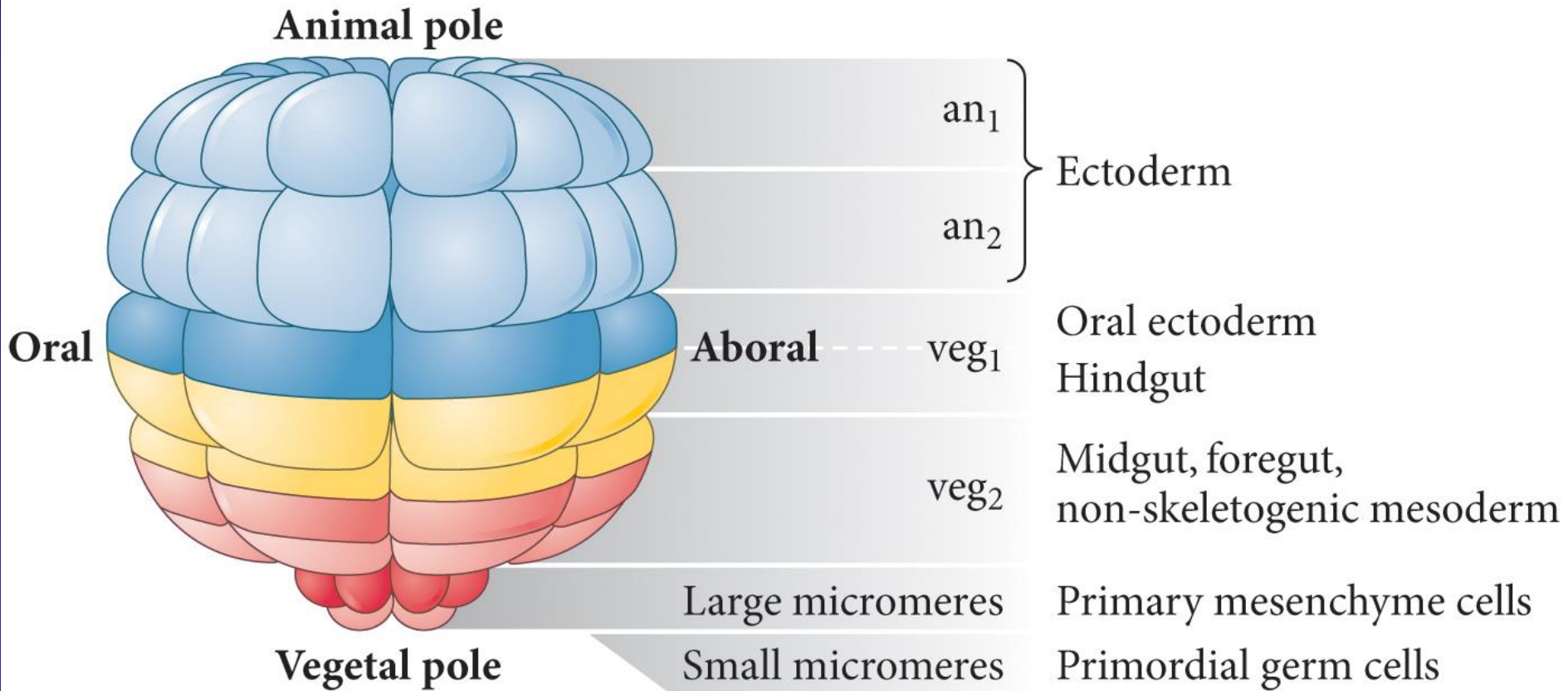


Clivagem em *Lytechinus variegatus*. **A-** Seta preta mostra local de entrada do espermatozoide, seta branca marca o polo vegetal. **B-** 2 células. **C-** 8 células. **D-** 16 células. Os micrômeros se formam no polo vegetal. **E-** 32 células. **F-** A blástula ciliada eclodiu da membrana de fertilização. A placa vegetal está começando a espessar. **Observe:** A blastocele se formou no centro, cheia de líquido, sem células em seu interior.

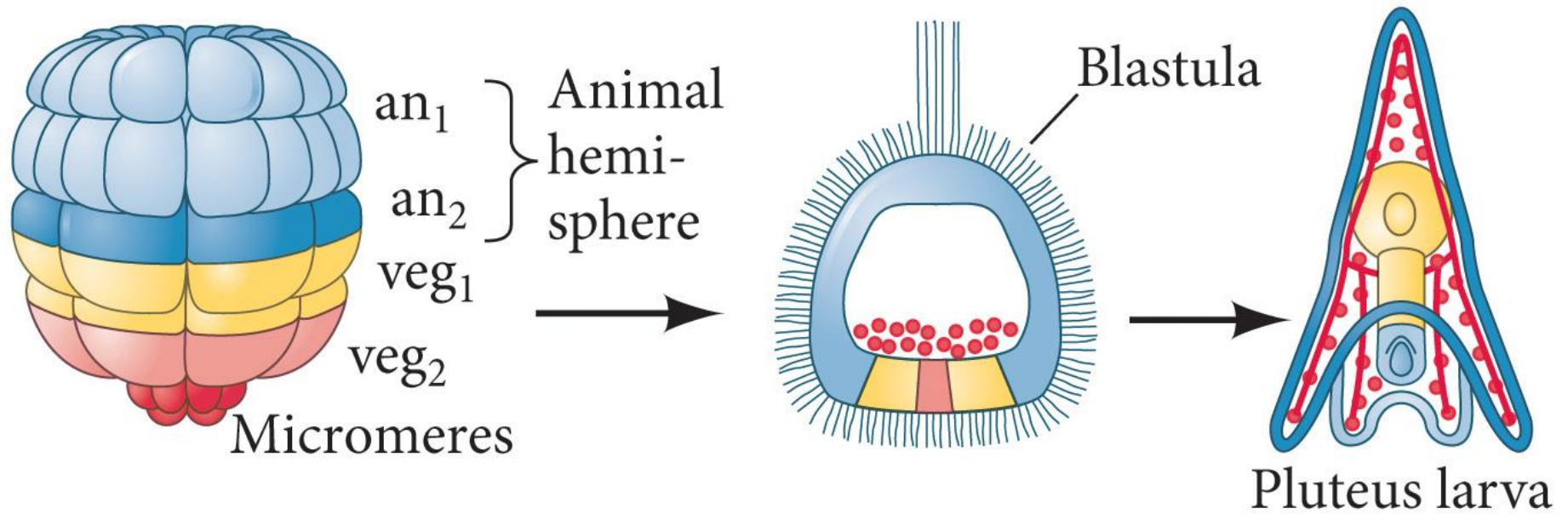
Discosia ceciliaria n.sp. Br



MAPA DE DESTINO

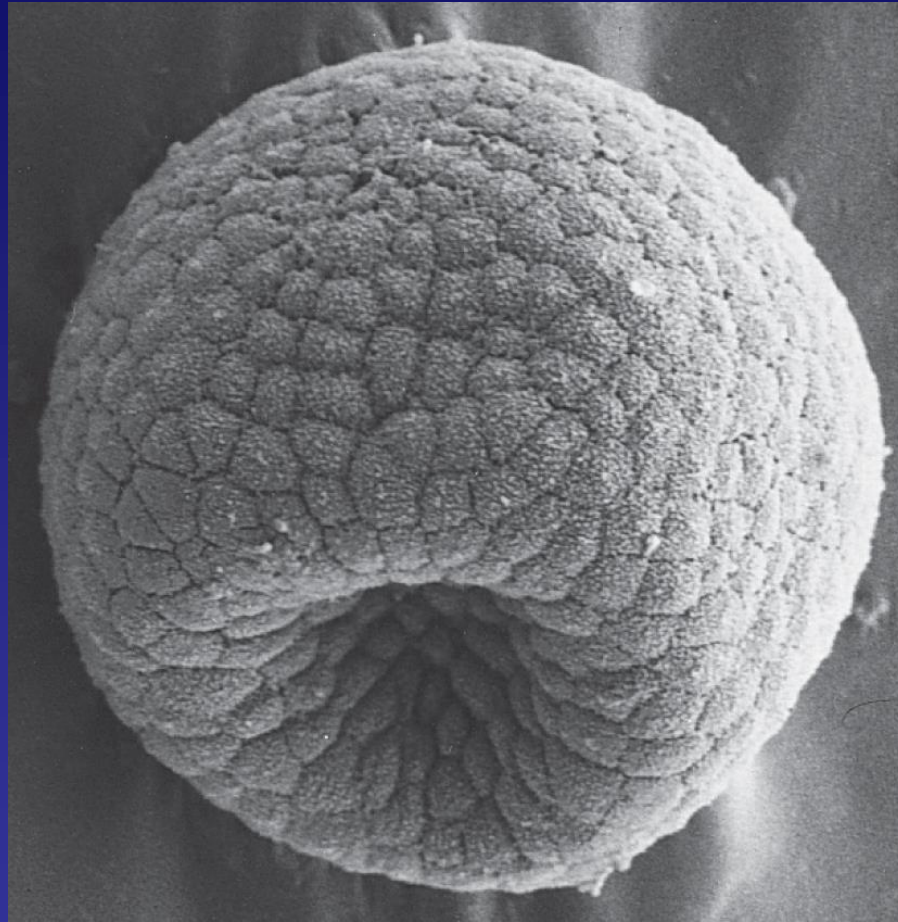


(A) Normal development



After S. Hörstadius, 1939, *Biol Rev* 14: 132-179.

Gastrulação



Movimento celular

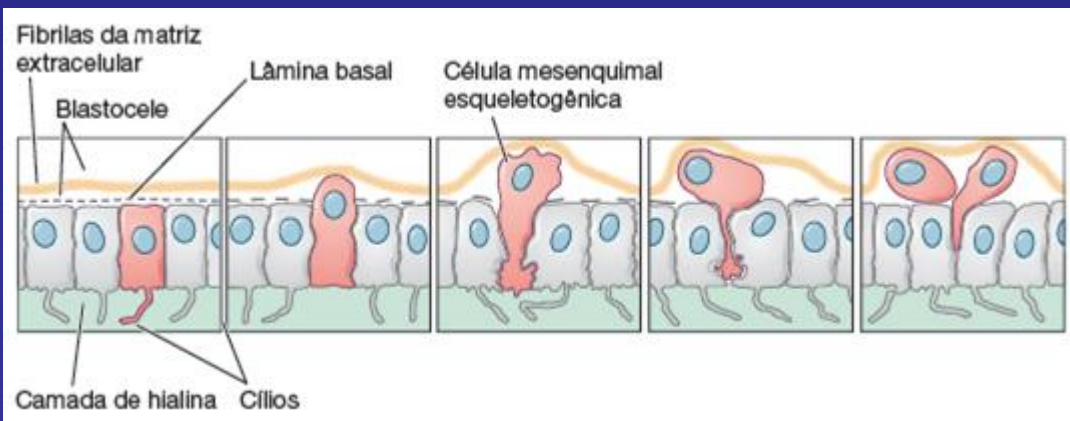
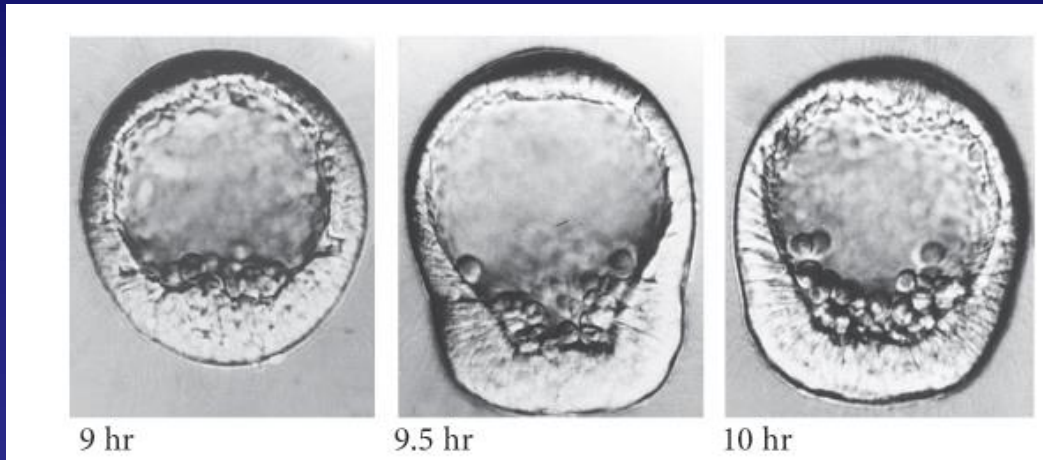
Ingressão

Ingressão

Migração de células individuais da superfície para o interior do embrião. As células individuais tornam-se mesenquimais (i.e., separam-se umas das outras) e migram independentemente.



Mesoderma de ouriço-do-mar, neuroblastos de *Drosophila*

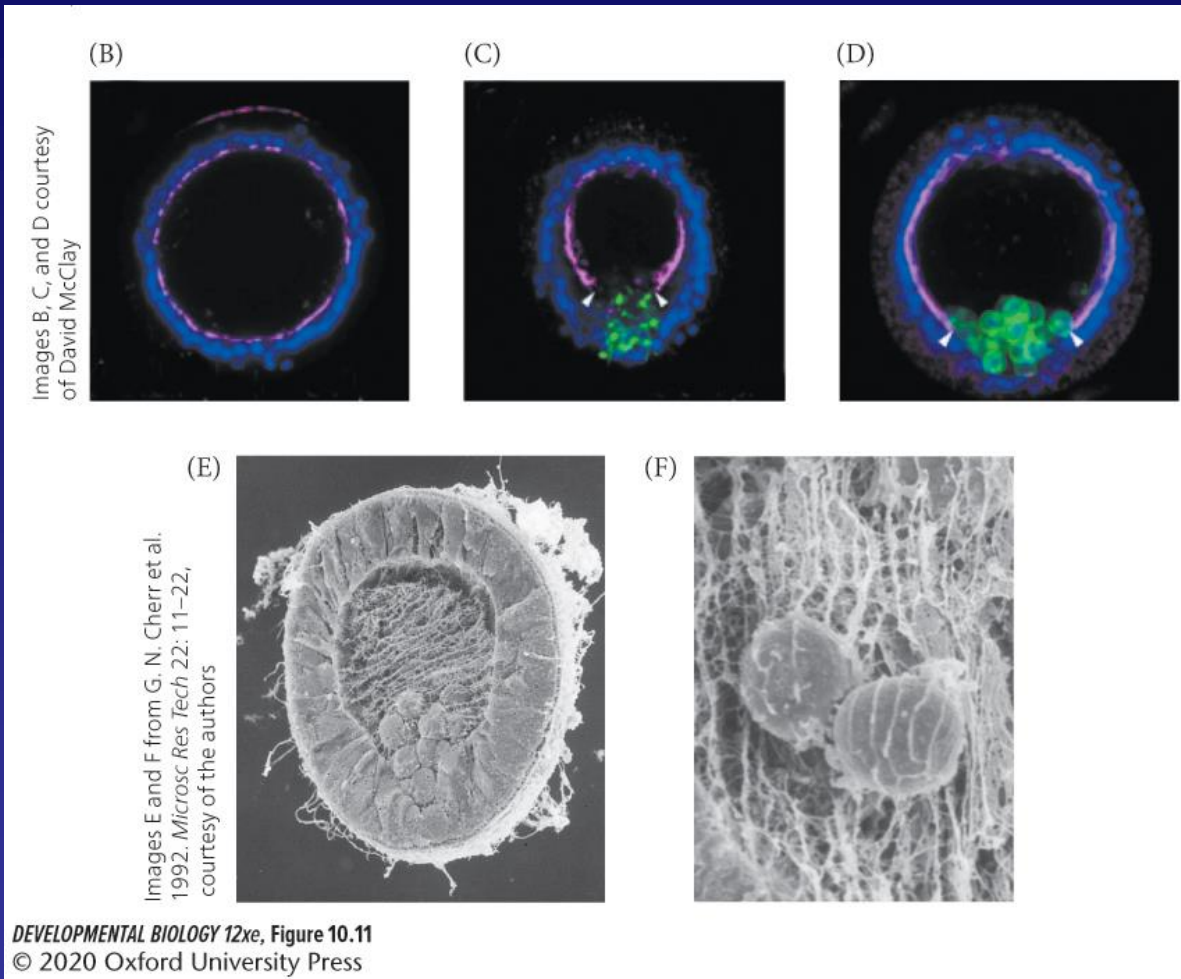


Ingresso dos micrômeros na blastocele.

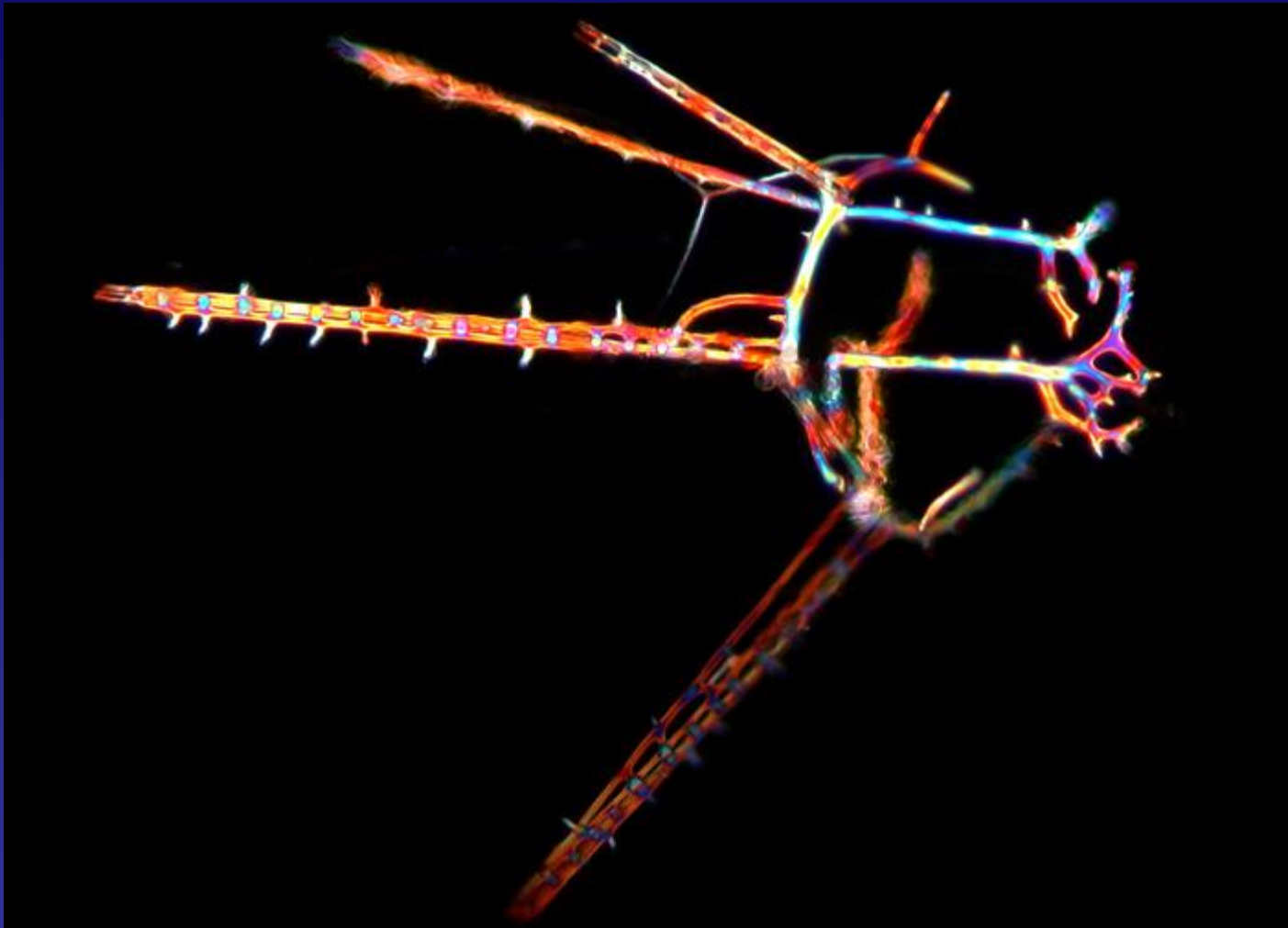
Observe que o micrômero perde o cílio e sua aderência à camada hialina, aumenta sua afinidade pela lâmina basal, muda a forma e ingressa na blastocele.

Transição epitélio-mesenquimal – MESÊNQUIMA PRIMÁRIO

B-D- Observe que a lâmina basal reveste de maneira uniforme a blastocele. A lâmina é interrompida (laminina) e os micrômeros esqueléticos ingressam na blastocele.



E-F- Observe que as fibras no interior da blastocele têm uma organização e estão intimamente associadas às células mesenquimais esqueléticas.

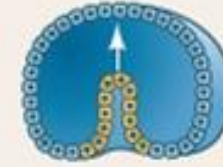


<https://brunovellutini.com/posts/esqueleto-larva-pluteos/>

Invaginação

Invaginação

Dobramento para dentro de uma camada (epitélio) de células, como o recuo de uma bola de borracha macia quando um dedo entra.



Endoderma de ouriço-do-mar



10.5 hr



11 hr



11.5 hr

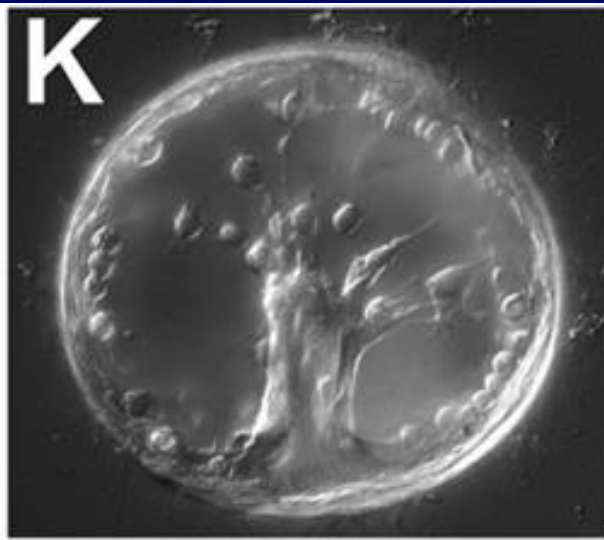
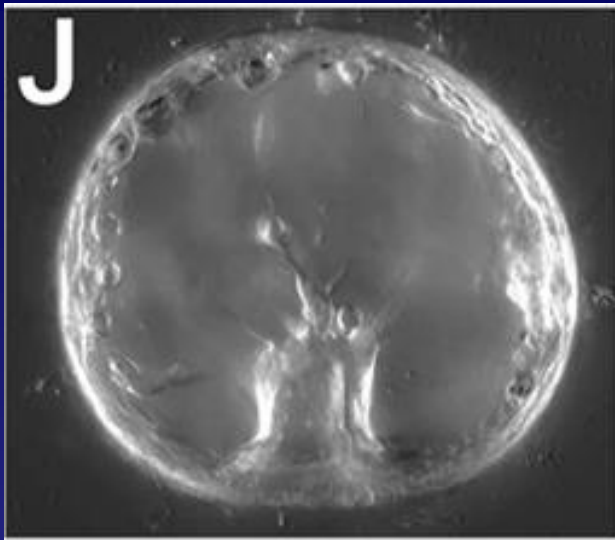
Blastopore



Images B and C courtesy of C. Ettensohn

MESÊNQUIMA SECUNDÁRIO

Arquêntero



12 hr



13 hr



13.5 hr

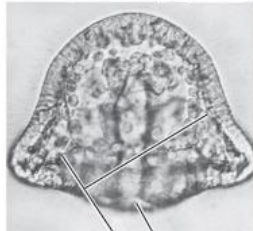
Syncytial cables



15 hr

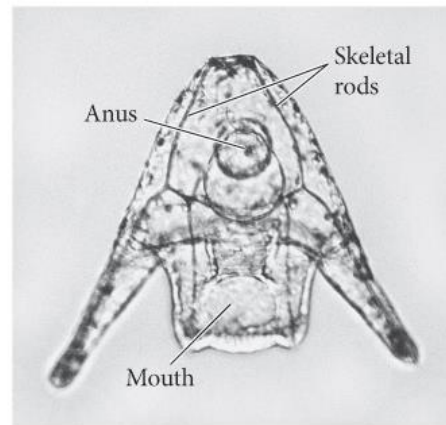


17 hr



18 hr

Blastopore
Syncytial cables



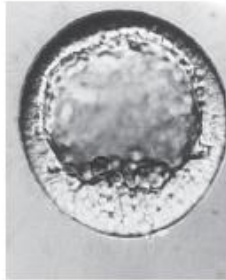
Anus
Skeletal rods

Mouth

24 hr

Courtesy of J. Morrill

© ISM/ Michel Delarue/ Medical Images



9 hr



9,5 hr



10 hr



10,5 hr



11 hr



11,5 hr Blastóporo



12 hr



13 hr



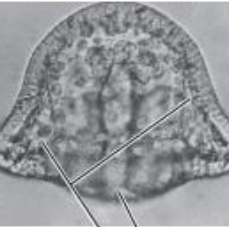
13,5 hr Cabos sinciais



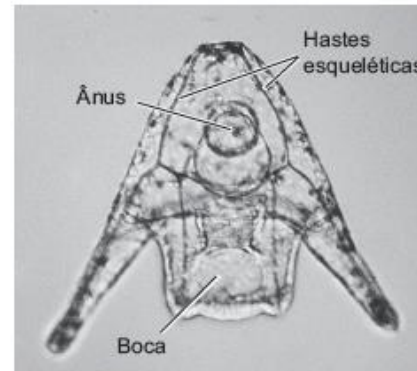
15 hr



17 hr



18 hr Blastóporo
Cabos sinciais



24 hr

Metamorfose



Imaginal rudiment

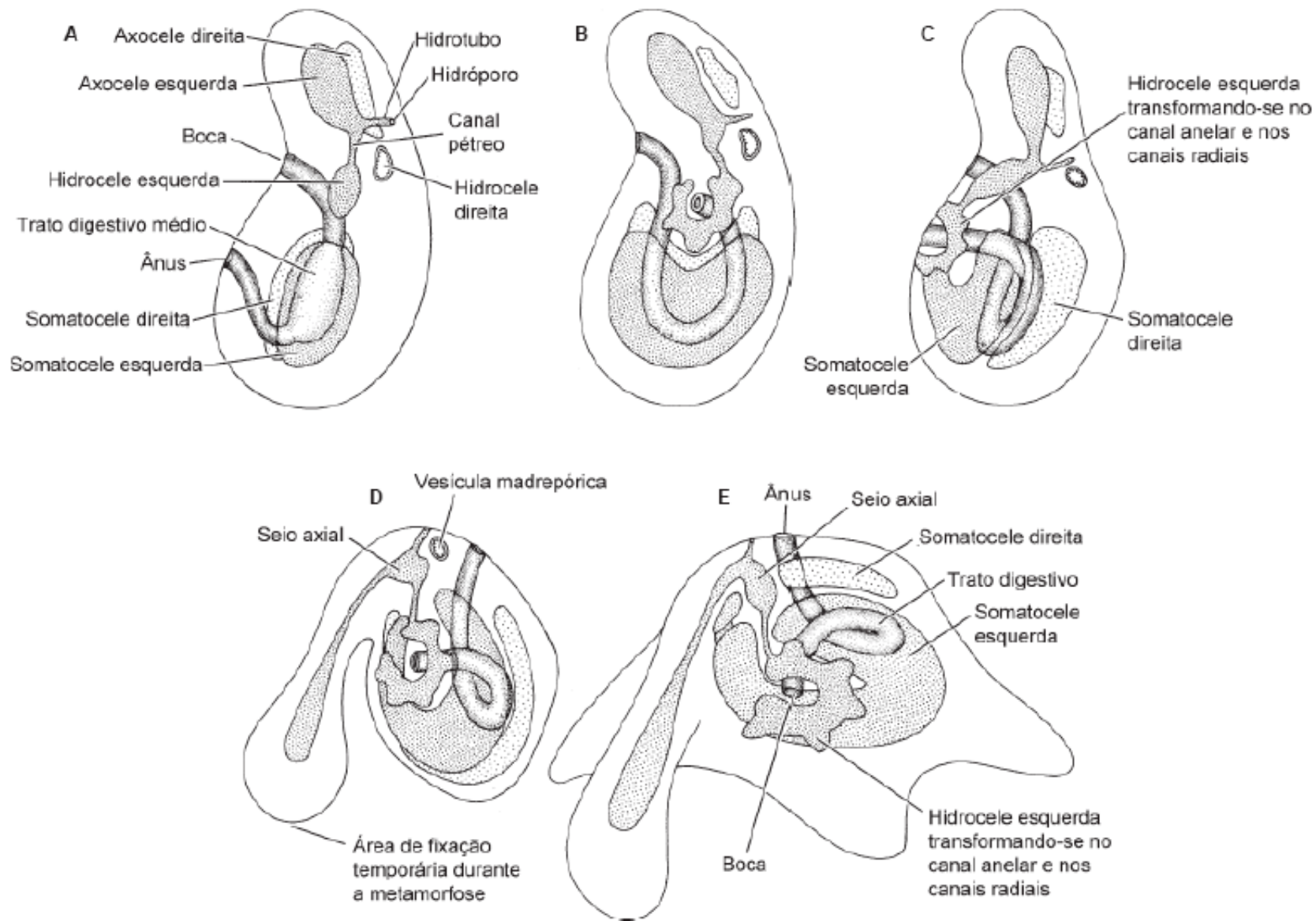
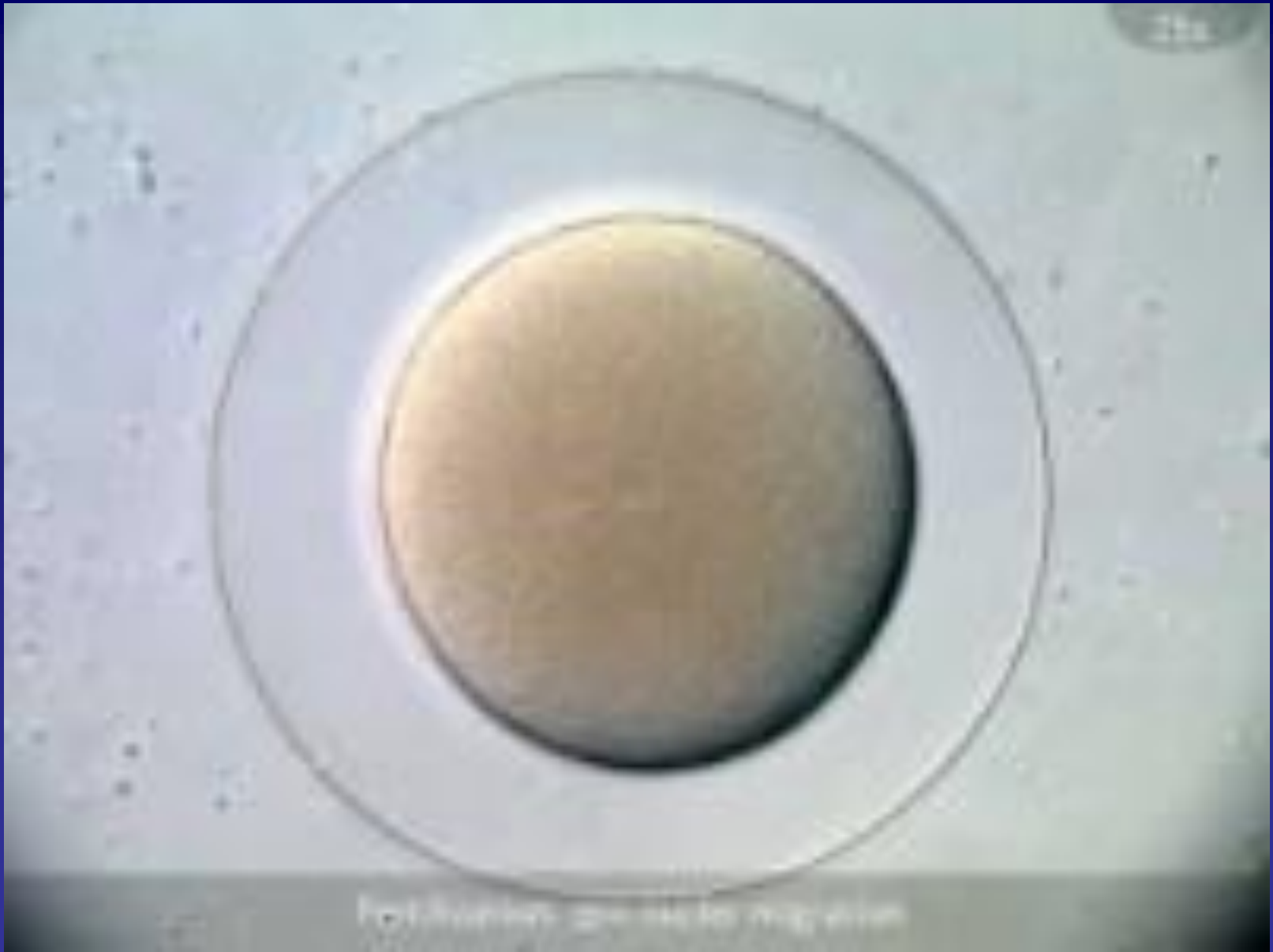


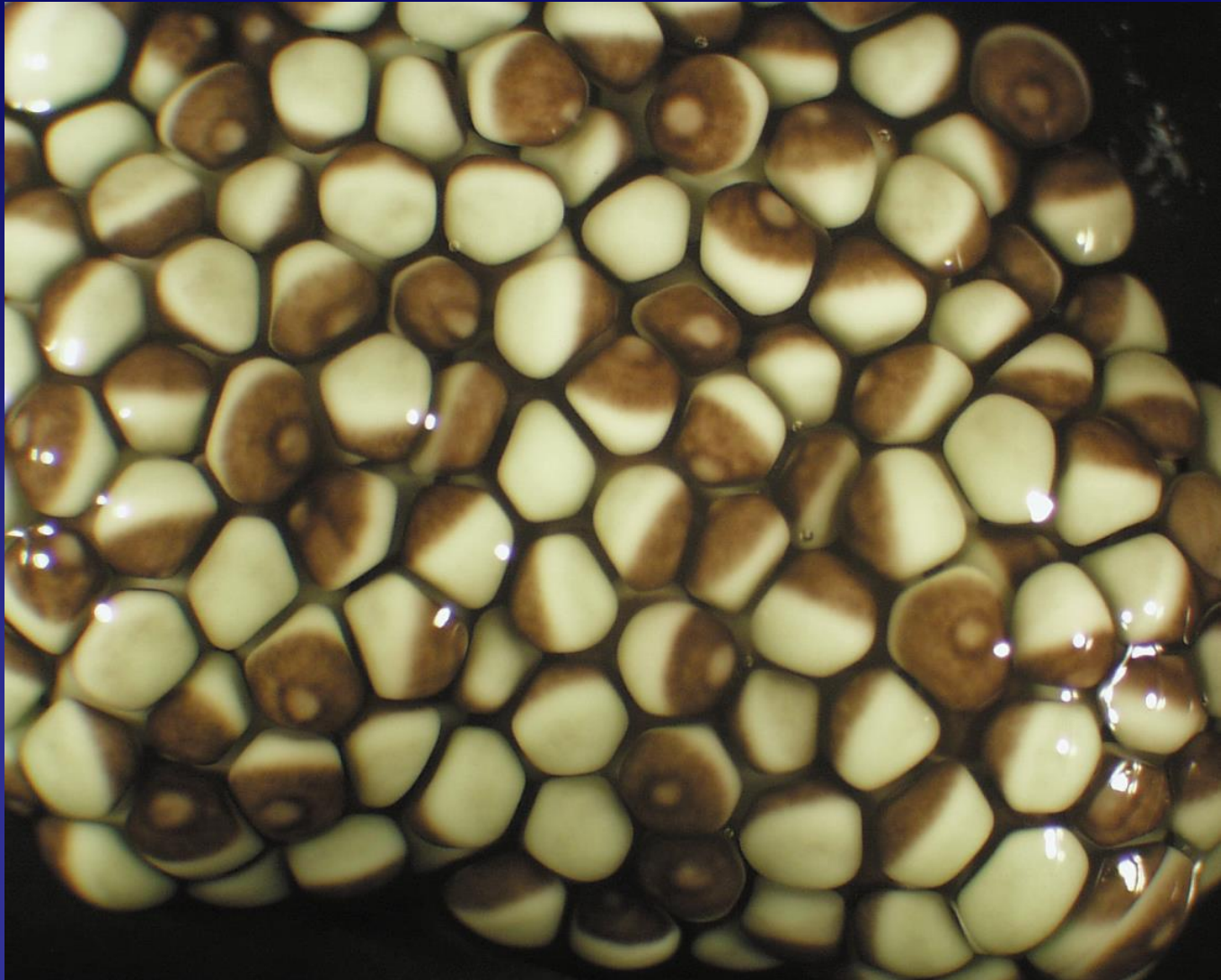
Figura 25.18 A a E. Desenvolvimento do celoma e dos seus derivados em uma estrela-do-mar (Asteroidea).



<https://youtu.be/KelvSE5S2yQ>

Anfíbios

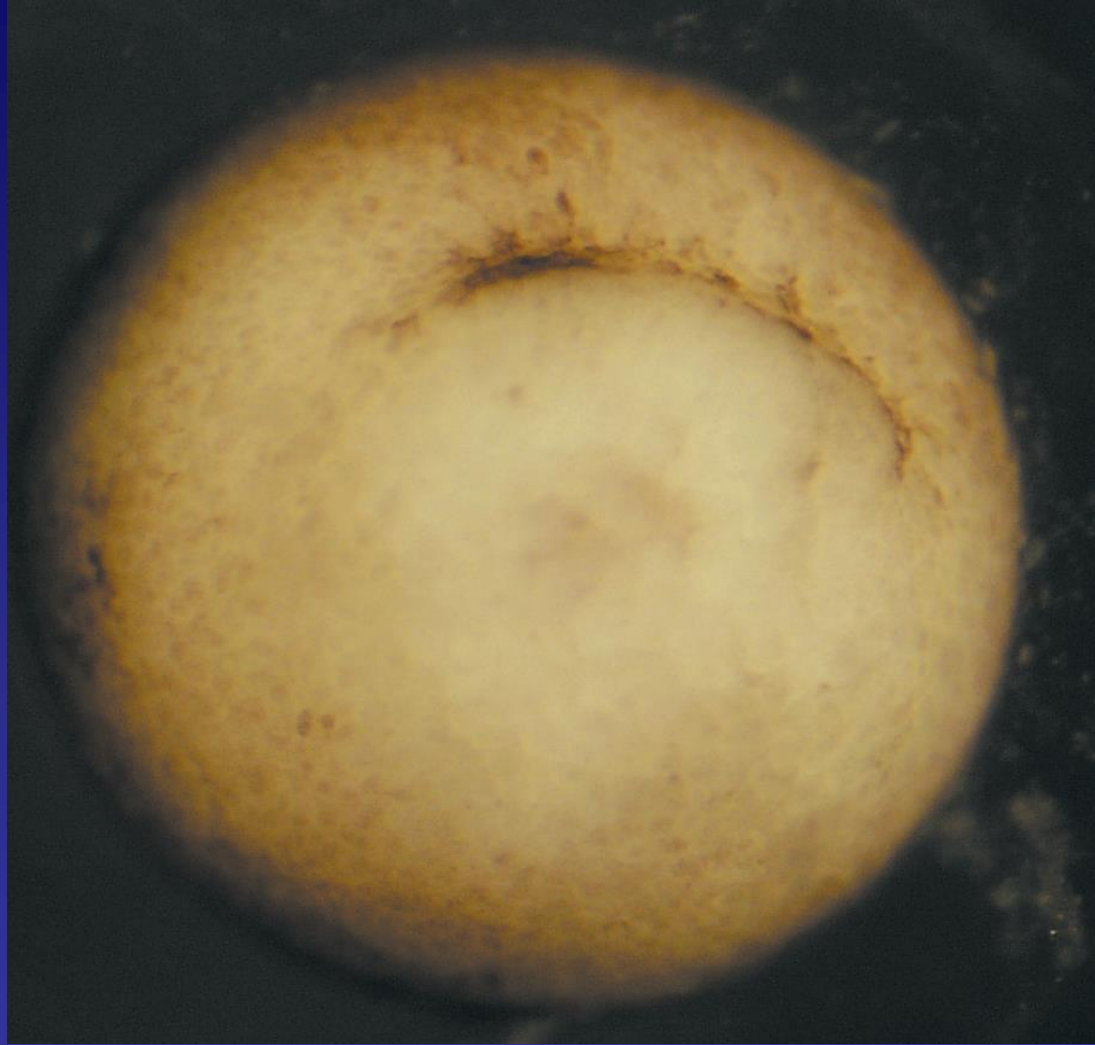


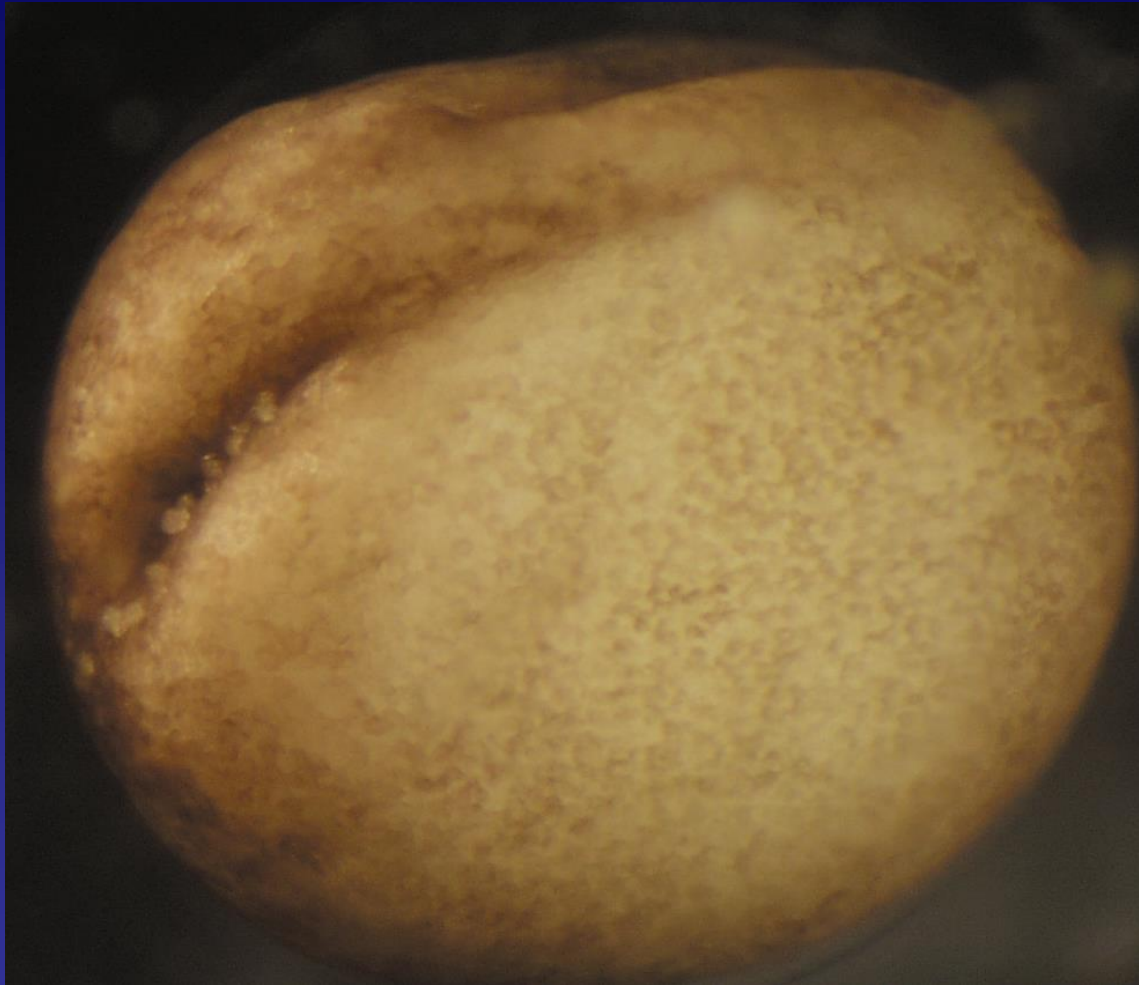


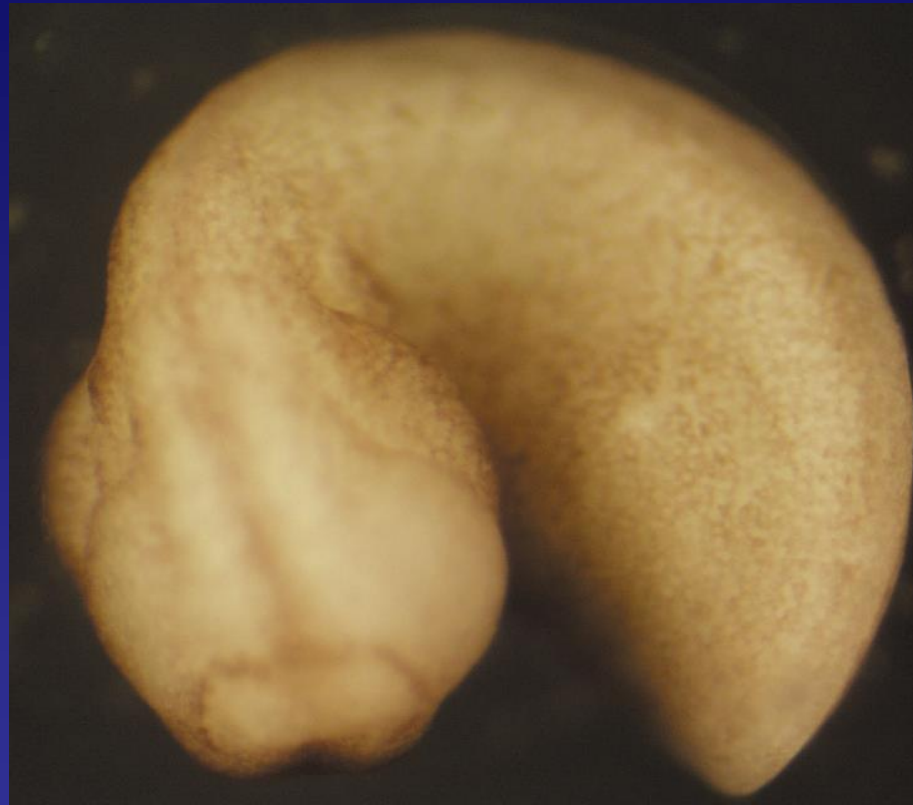


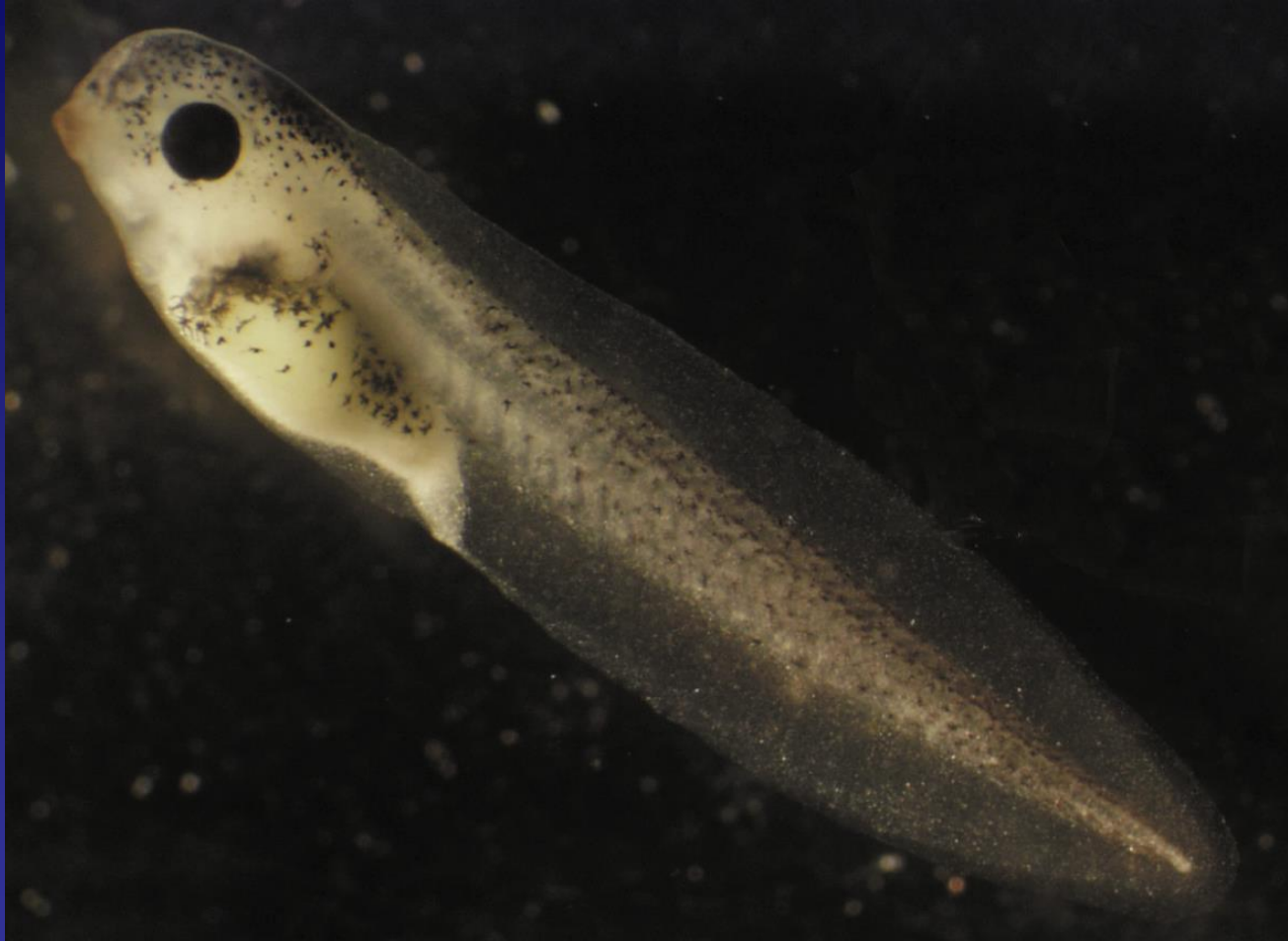




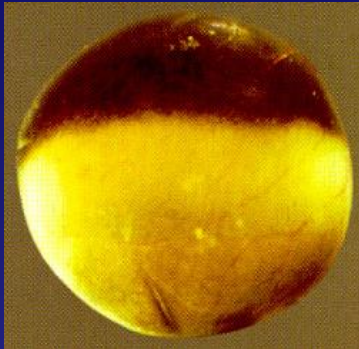




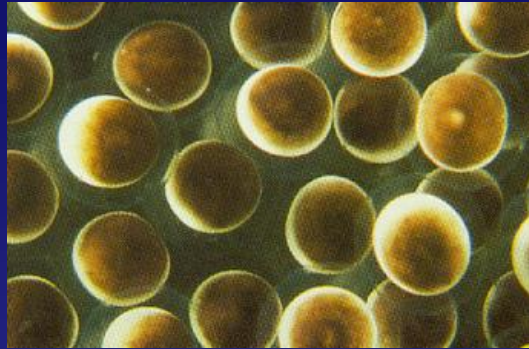




Desenvolvimento inicial de *Xenopus laevis*



Ovócito



Ovos fecundados



8 blastômeros



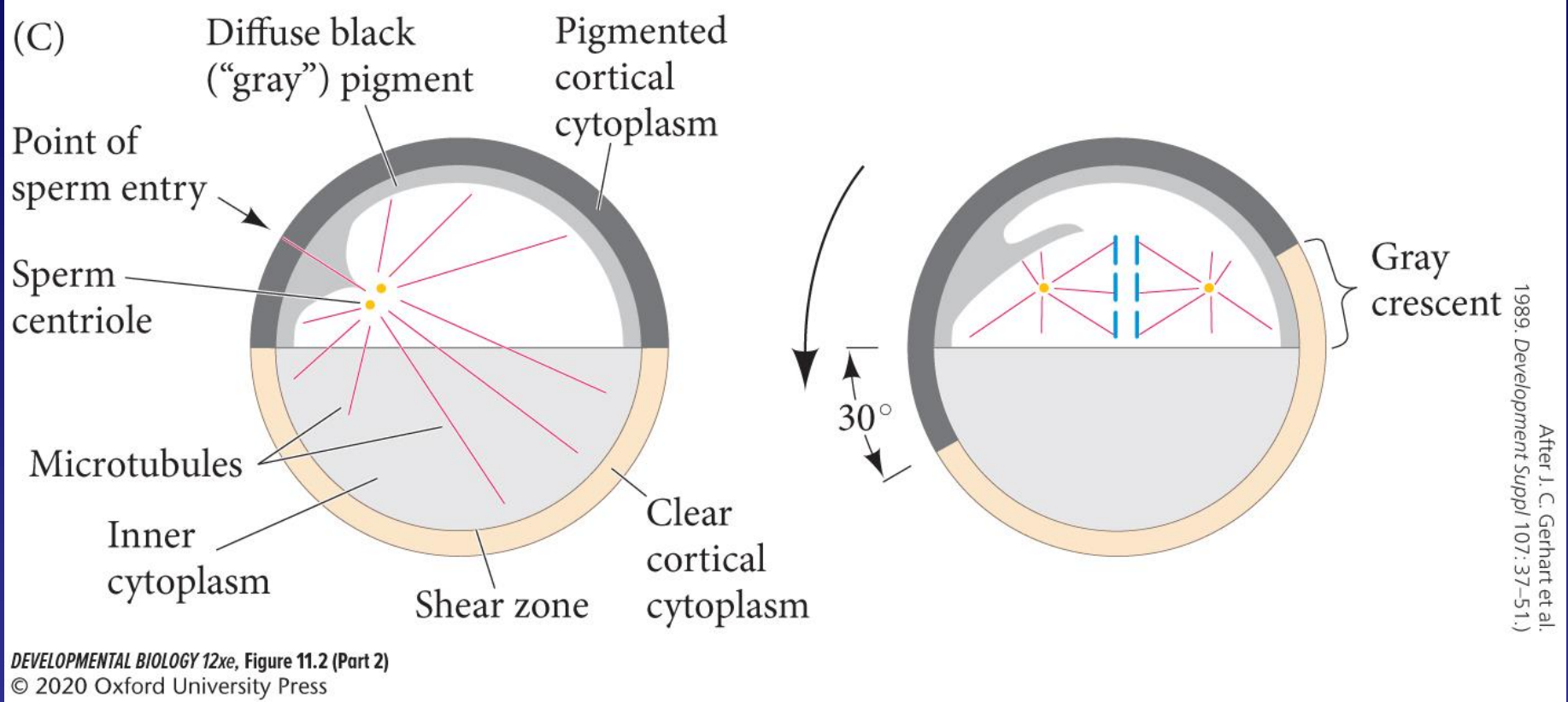
in vivo



MEV

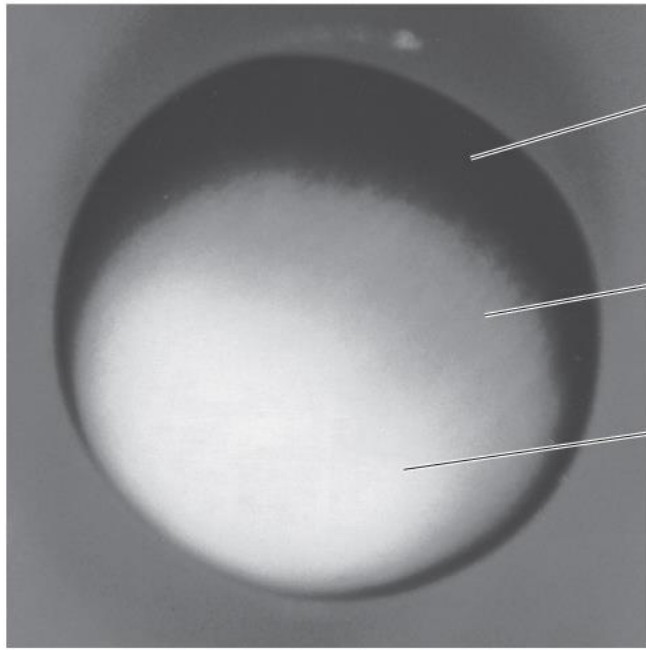
Lábio dorsal do blastóporo

Rotação cortical após a fecundação



- Microtúbulos e proteínas associadas causam deslocamento do córtex e a formação da crescente-cinzenta.
- Definição dos eixos dorso-ventral e antero-posterior

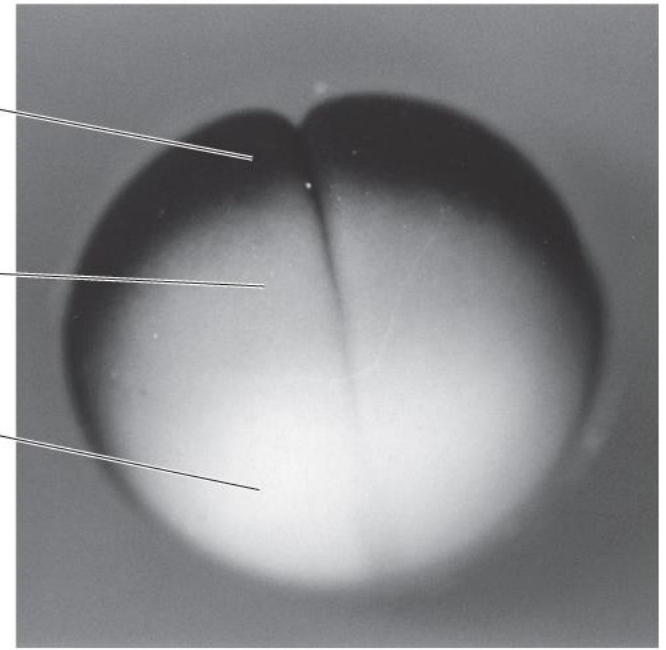
(D)



Pigmented animal region

Gray crescent

Vegetal region



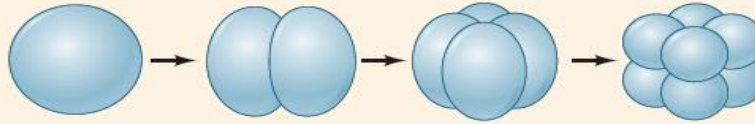
From R. P. Elinson and B. Rowning, 1988. *Dev Biol* 128: 185-197, courtesy of R. P. Elinson

From R. P. Elinson, 1997. In *Embryology: Constructing the Organism*, S. F. Gilbert and A. M. Raunio (Eds.), pp. 409-436. Sinauer Associates: Sunderland, MA, courtesy of R. P. Elinson

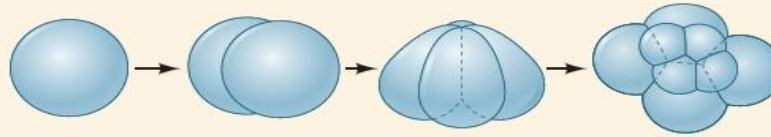
I. CLIVAGEM HOLOBLÁSTICA (COMPLETA)

A. Isolécito (vitelo esparsa, uniformemente distribuído)

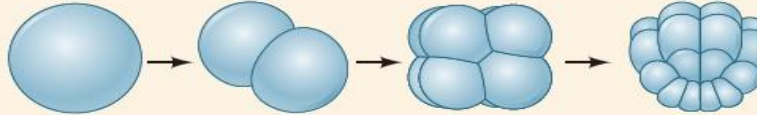
1. Clivagem radial
Equinodermas, anfíoxo



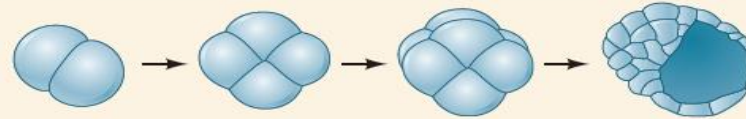
2. Clivagem espiral
Anelídeos, moluscos, platelmintos



3. Clivagem bilateral
Tunicados

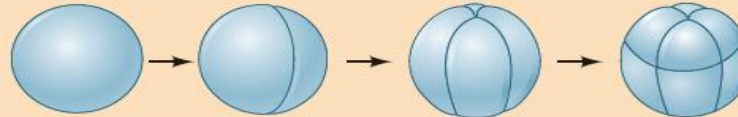


4. Clivagem rotacional
Mamíferos, nematódeos



B. Mesolécito (Disposição de vitelo vegetal moderada)

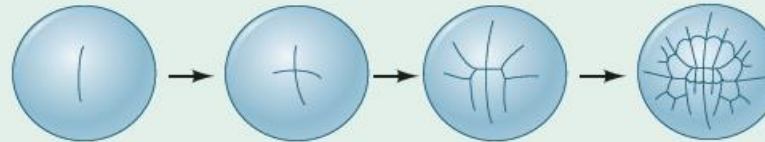
Clivagem radial deslocada
Anfíbios



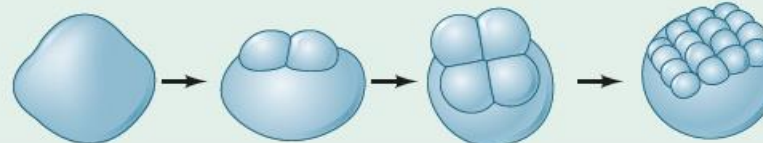
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A. Telolécito (vitelo denso na maior parte da célula)

1. Clivagem bilateral
Moluscos cefalópodes



2. Clivagem discoidal
Peixes, répteis, aves



B. Centrolécito (vitelo no centro do ovo)

Clivagem superficial
A maioria dos insetos

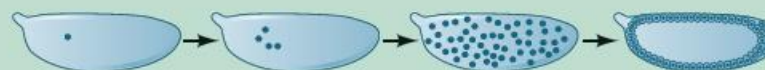


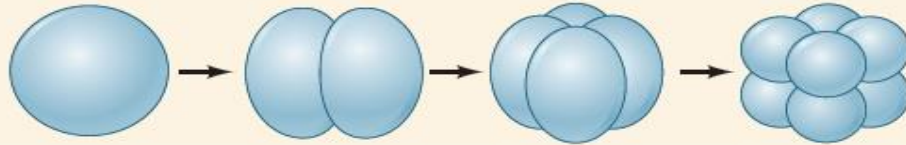
FIGURA 1.5 Resumo dos principais padrões de clivagem.

Ovo mesolécito – Clivagem holoblástica radial desigual

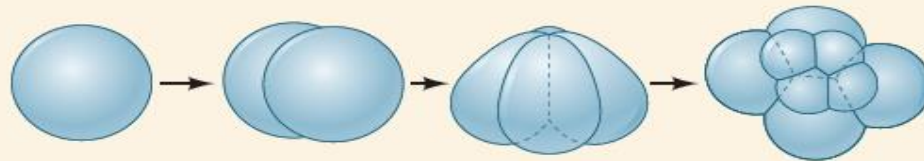
I. CLIVAGEM HOLOBLÁSTICA (COMPLETA)

A. Isolécito (vitelo esparso, uniformemente distribuído)

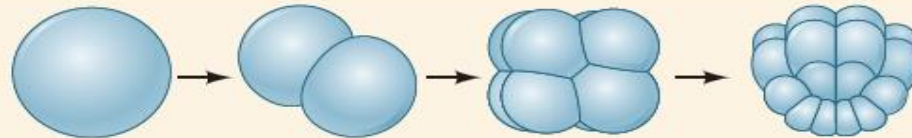
1. Clivagem radial
Equinodermas, anfioxo



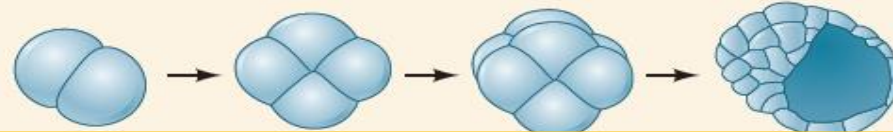
2. Clivagem espiral
Anelídeos, moluscos, platelmintos



3. Clivagem bilateral
Tunicados

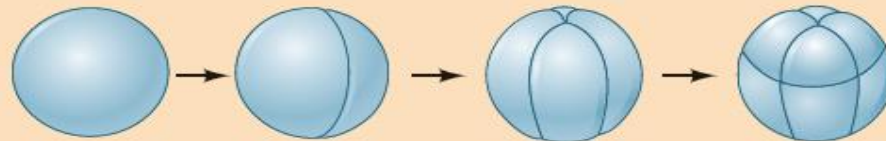


4. Clivagem rotacional
Mamíferos, nematódeos



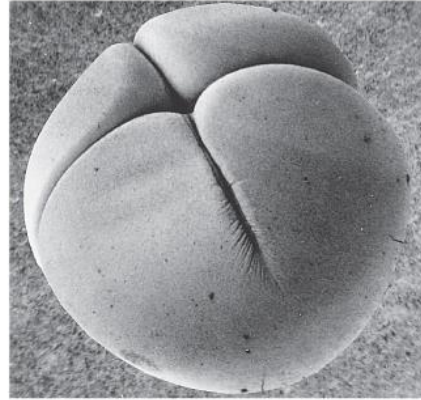
B. Mesolécito (Disposição de vitelo vegetal moderada)

Clivagem radial deslocada
Anfíbios

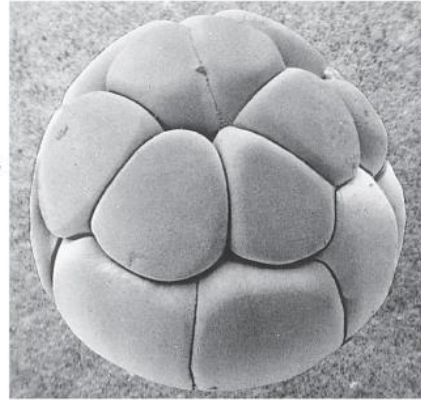


(D)

From H. W. Beams and R. G. Kessel,
1976. *Am Sci* 64: 279-290, courtesy of
the authors and L. Biedler



Center and bottom Courtesy of L. Biedler





1ª divisão

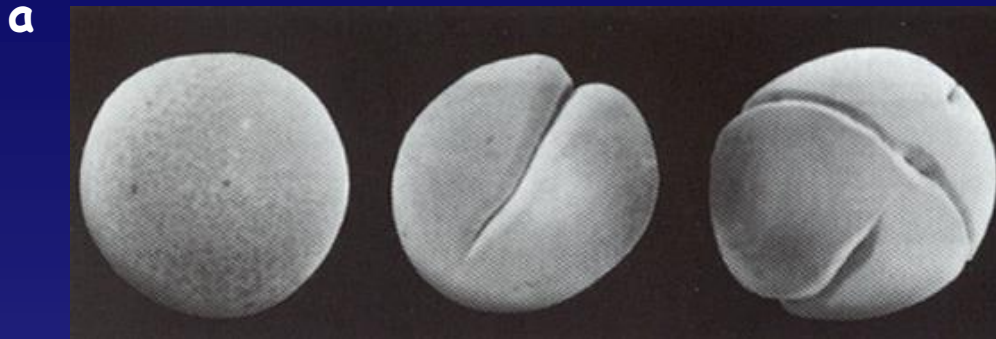




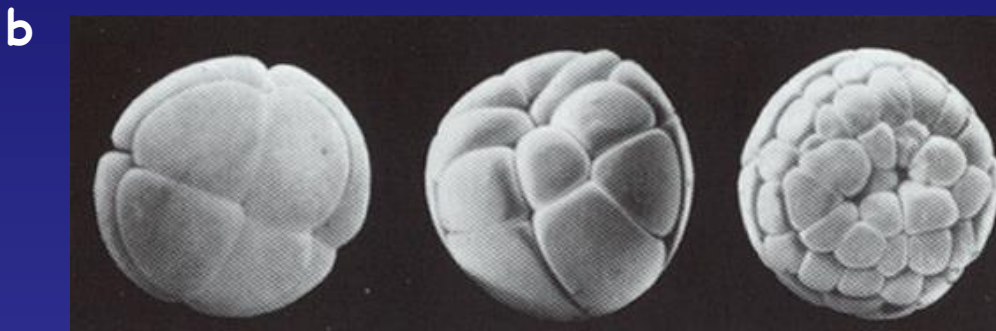
blastocoele



Início do desenvolvimento de embrião de anfíbio



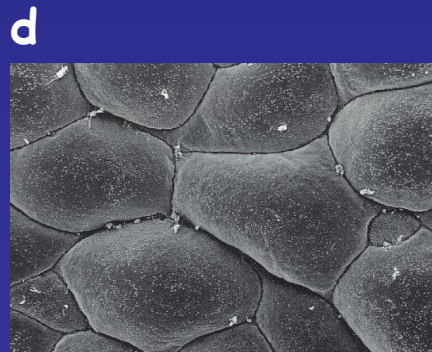
a- ovo e primeiras clivagens



b- fases da clivagem, de 8 blastômeros até início da gástrula

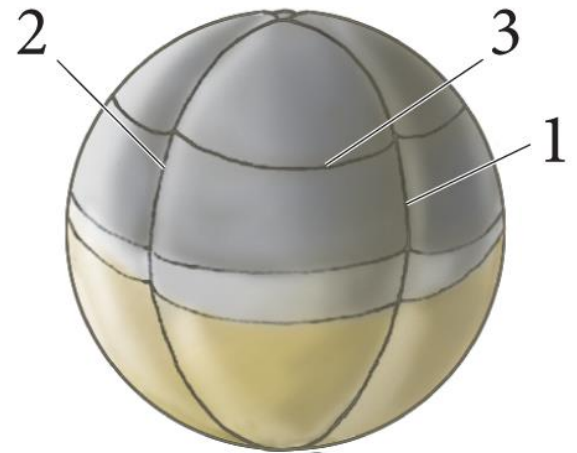
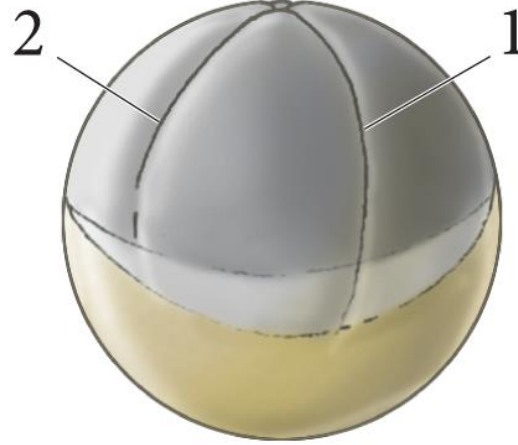
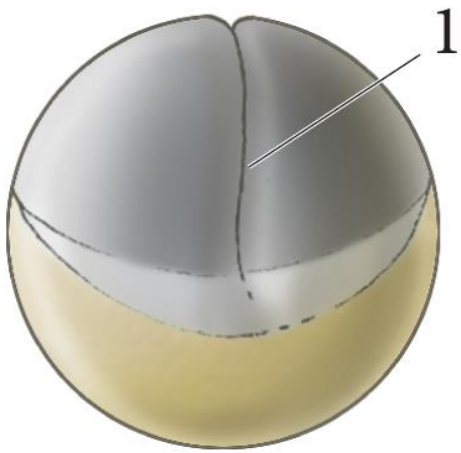


c-blástula - observe o tamanho dos blastômeros



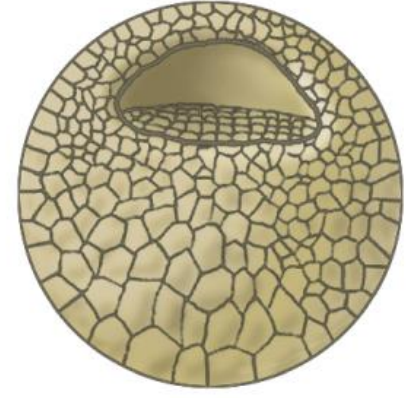
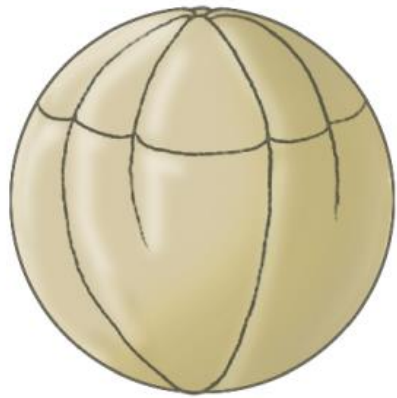
d- detalhe das células da blástula

Animal



Vegetal

After B. M. Carlson. 1981. *Patten's Foundations of Embryology*. McGraw-Hill, New York;



After B. M. Carlson. 1981. *Patten's Foundations of Embryology*. McGraw-Hill, New York

Polo animal

PLATE 17

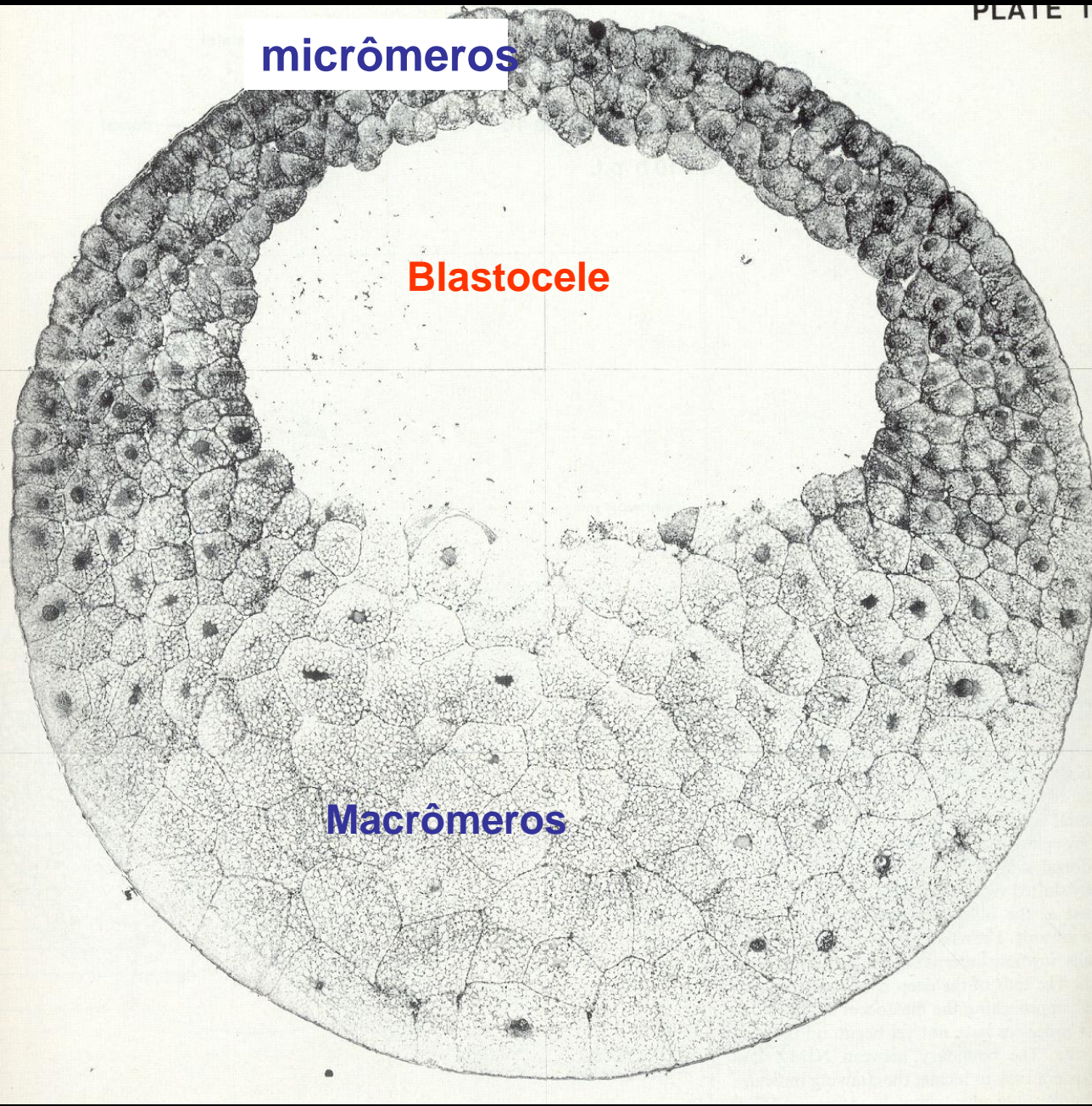
micrômeros

Blastocele

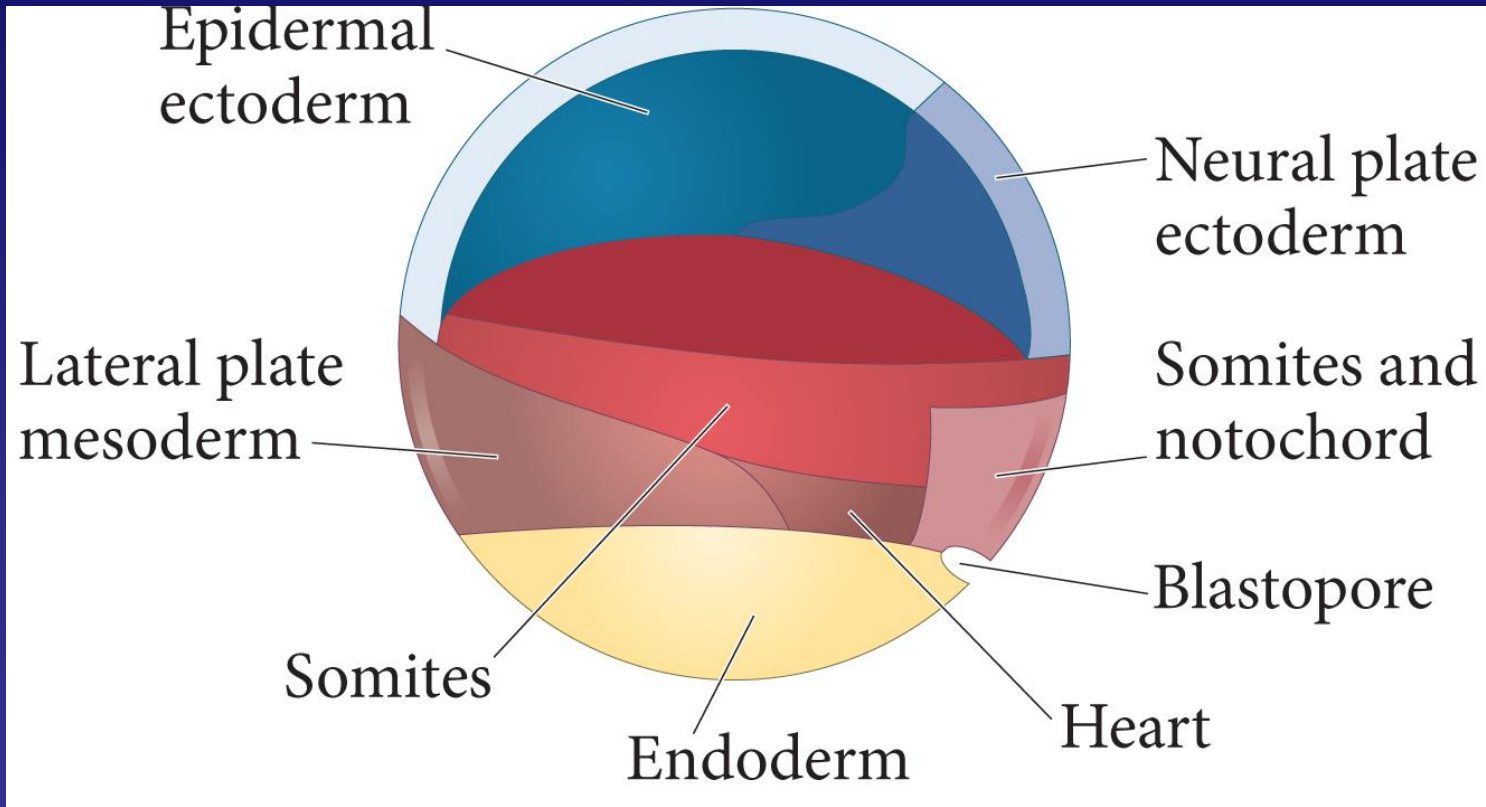
Macrômeros

Polo vegetativo

**Blástula de
anfíbio**



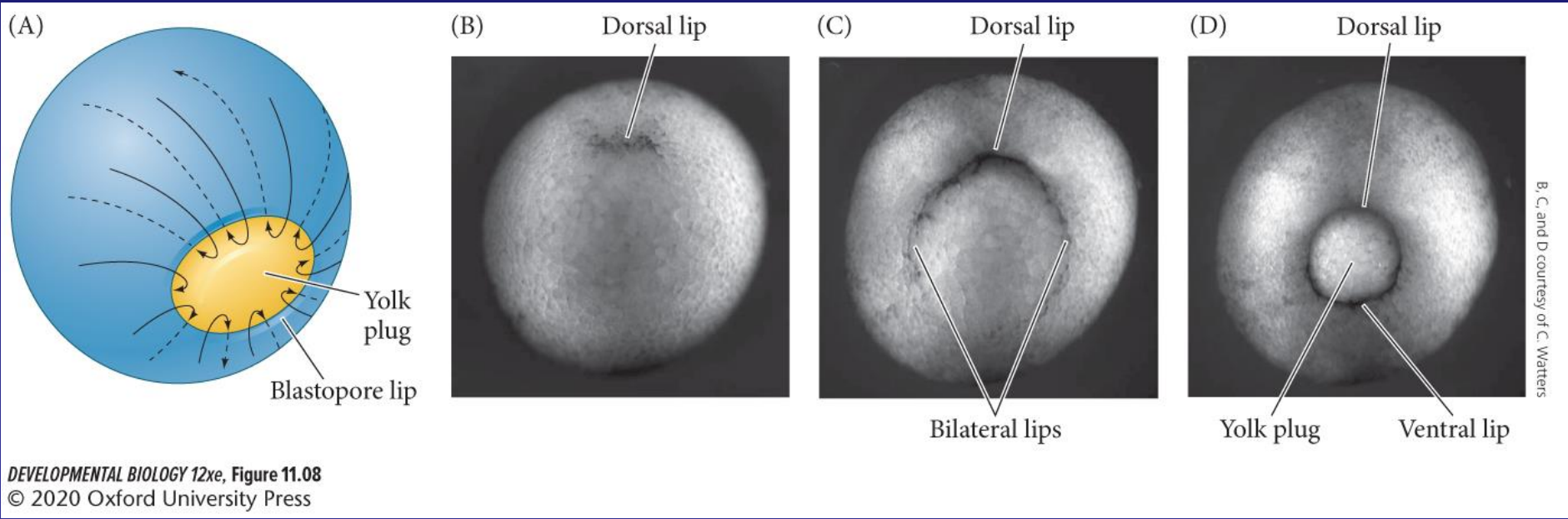
MAPA DE DESTINO



A. C. Lane and W. C. Smith. 1999. *Development* 126: 423-434 and C. S. Newman and P. A. Krieg. *Cell Lineage and Fate Determination*, S. A. Moody (Ed.), pp. 341-351. Academic Press: New York.

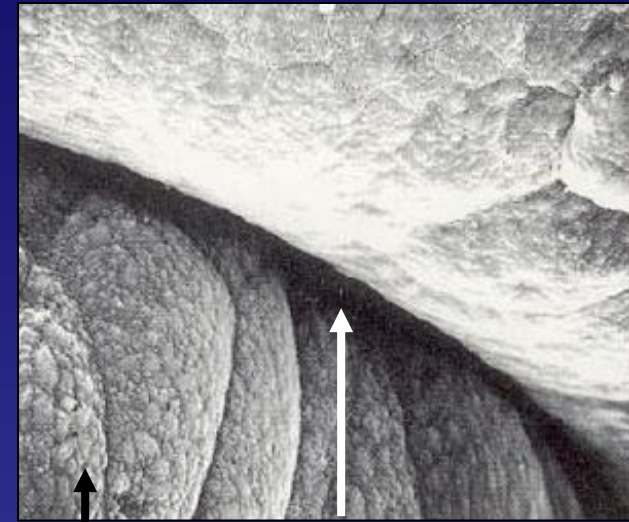
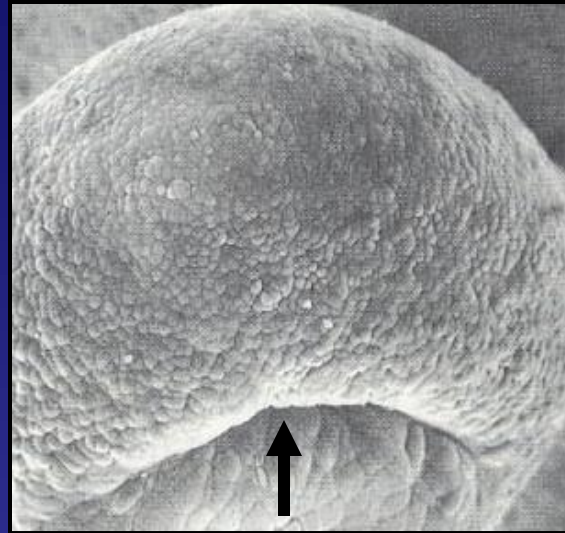
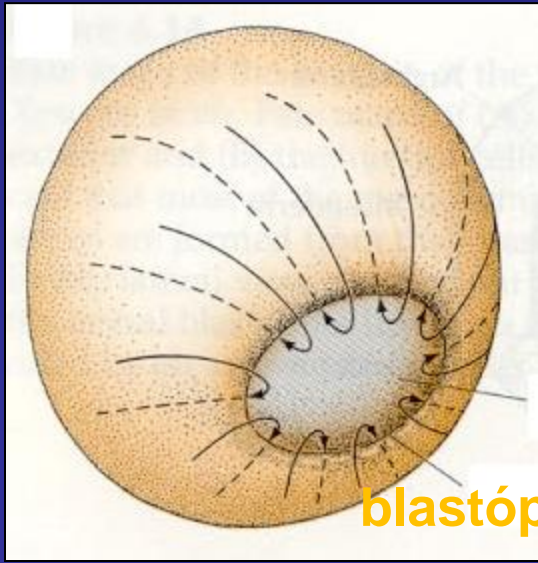
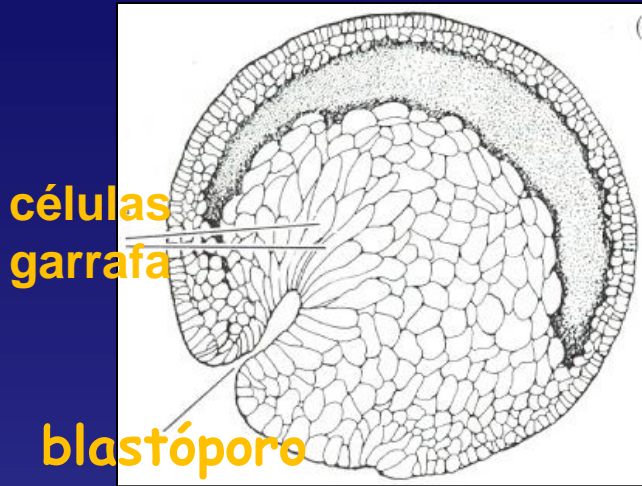
Epibolia da ectoderme (A)

Formação dos lábios dorsal, laterais e ventral do blastóporo (B-D)

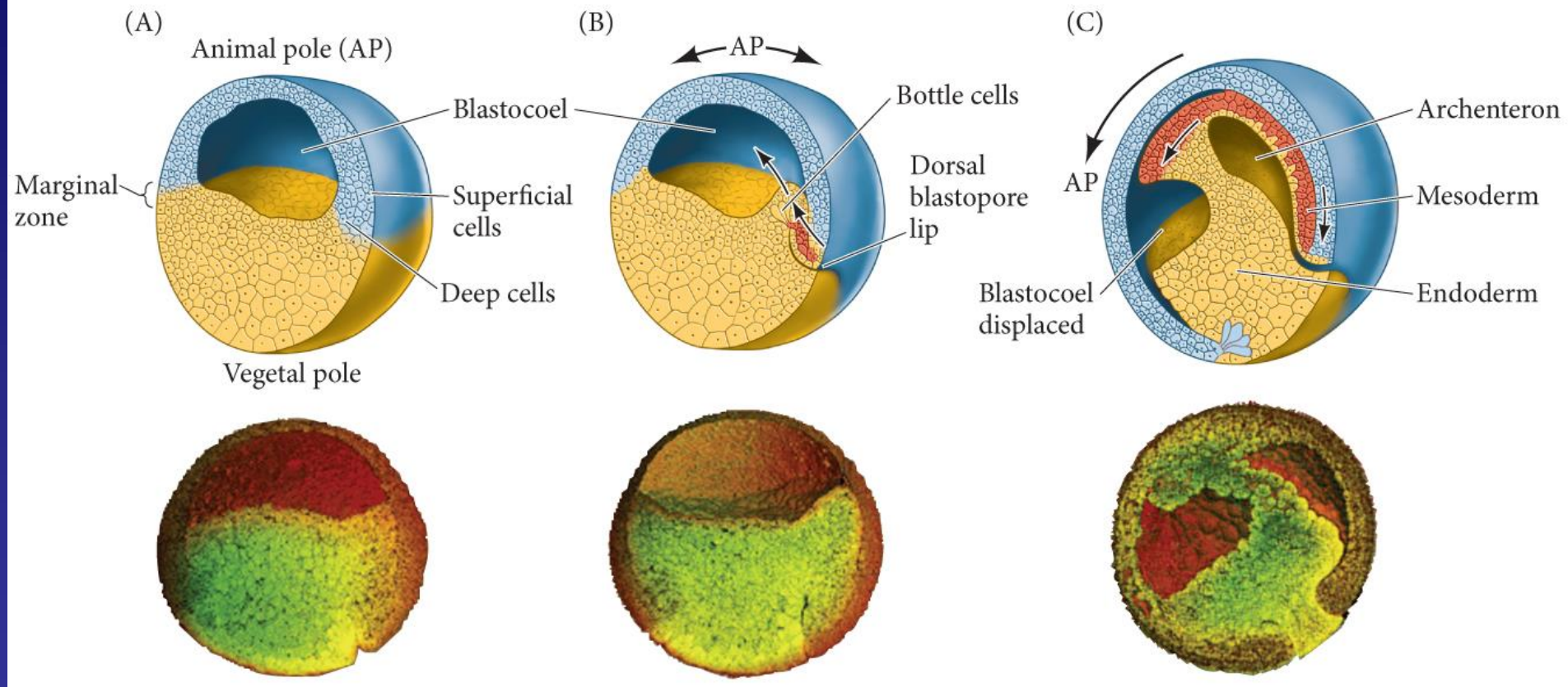


Embriões de ANFÍBIO

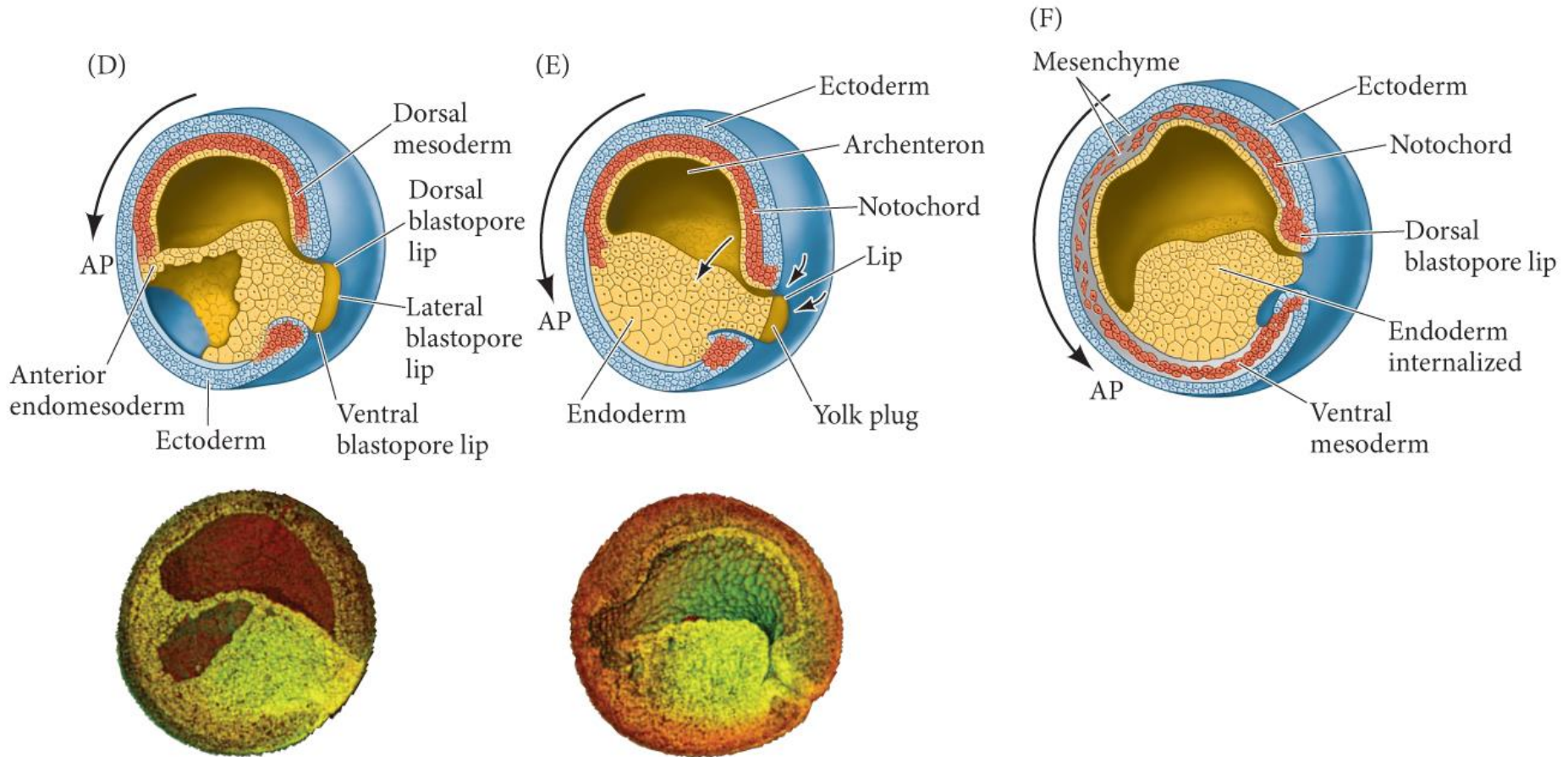
Formação do BLASTÓPORO



Gastrulação em *Xenopus laevis*



Gastrulação em *Xenopus laevis*







Bibliografia complementar

- <http://cifonauta.cebimar.usp.br/>
- <https://depts.washington.edu/vurchin/>
- Barresi, J.F. & Gilbert, S.F. &, 2020. *Developmental biology*. Sinauer Associates, Sunderland.
- Brusca, R.; Moore, W. & S.M. Shuster. 2016. *Invertebrates*. 3rd Edition, Sinauer Associates, Inc.
- Ruppert, E.E.; Fox, R.S. & R.D. Barnes. 2005. *Zoologia dos Invertebrados*. Uma Abordagem Funcional-evolutiva. 7ª ed. Editora Roca, São Paulo.