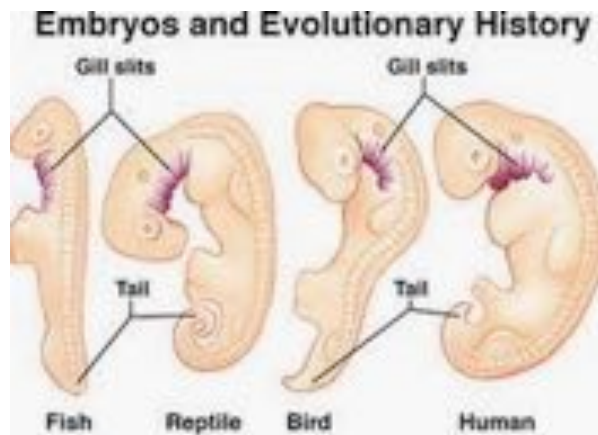


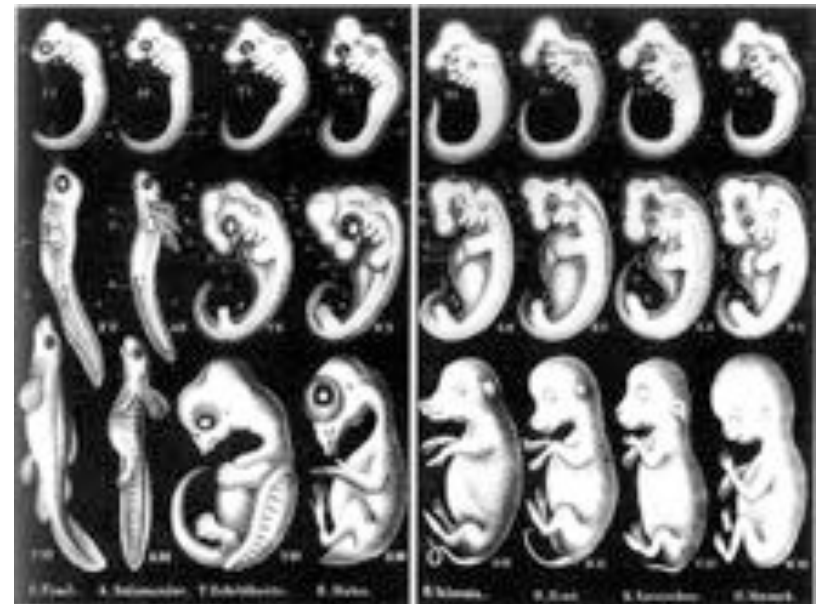
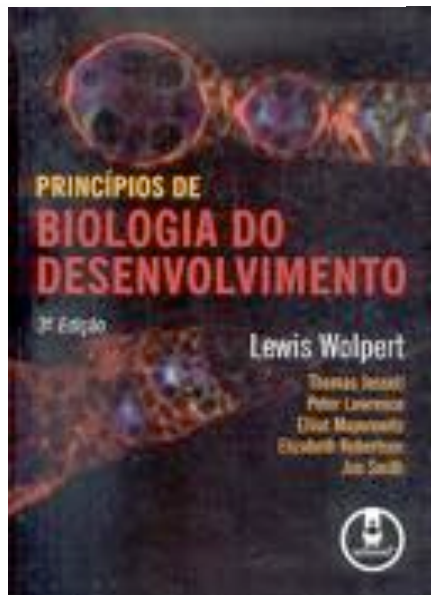
# O qué é a biología do desenvolvemento???

busqueda de imaxes en google (6-3-17): 'biología del desarrollo'



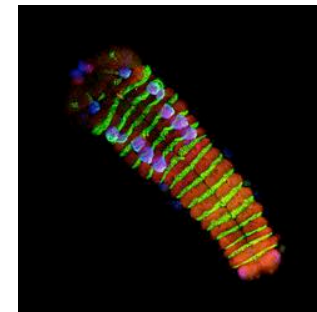
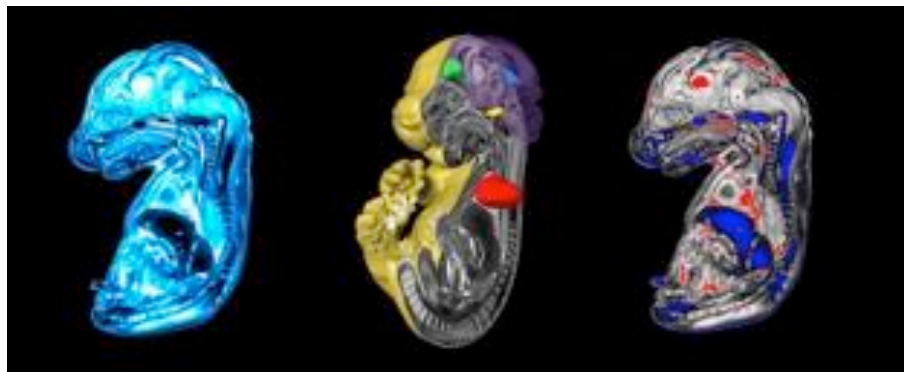
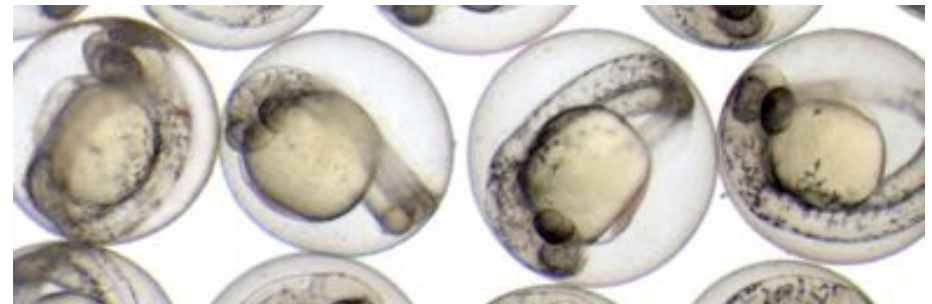
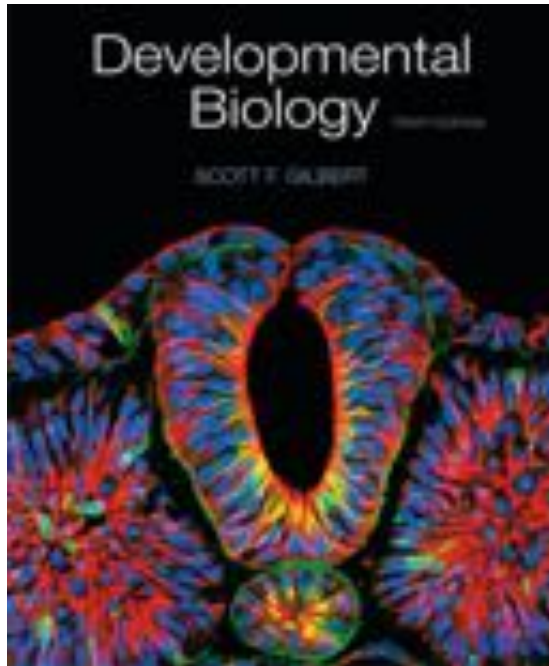
# O qué e a biologia do desenvolvemento???

pesquisa de imaxes no google (6-3-17): 'biologia do desenvolvemento'



# O qué e a biologia do desenvolvemento???

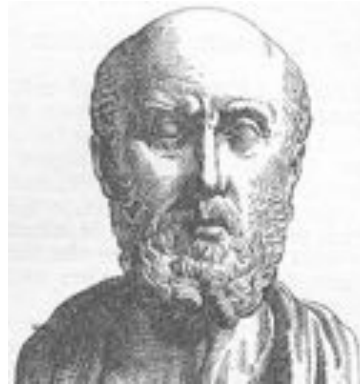
google image search em ingles (6-3-17): developmental biology:





# Historia do pensamento da Biologia de desenvolvimento

V AC Hipócrates define ao desenvolvimento como interações entre calor, humedade e solidificação.



IV AC

Aristóteles propõe duas formas de desenvolver o orgânico:

a) preformação

b) epigénese (em formação ou nova formação), usó como metáfora el tecer uma rede

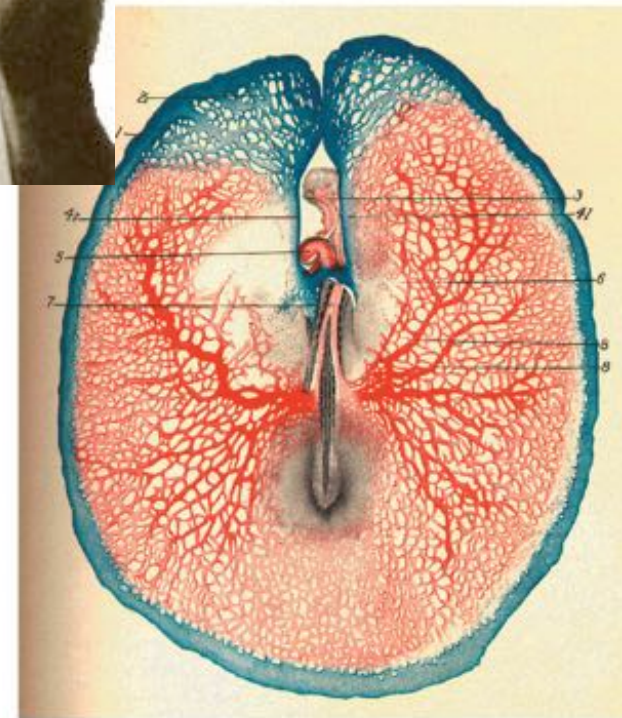
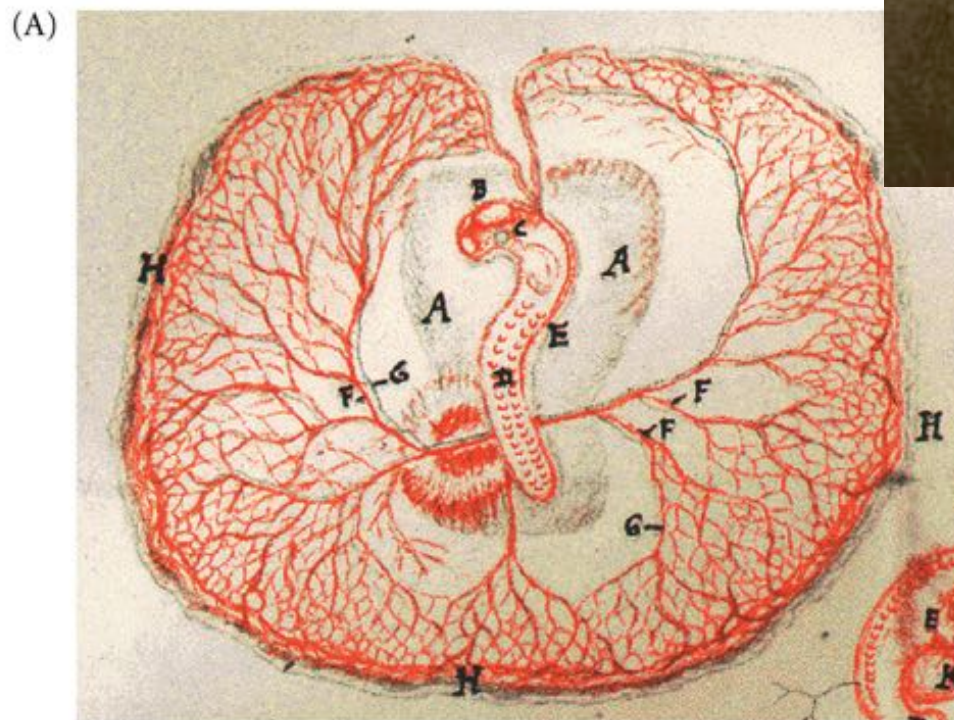


XVII DC William Harvey propõe como regra geral para os animais, o desenvolvimento a partir de um ovo (1651)

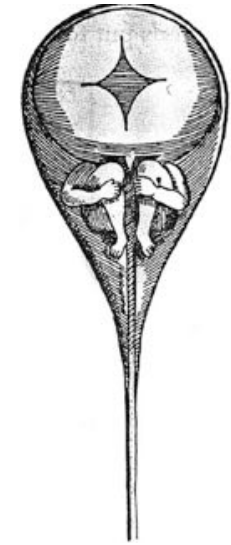


XVII DC O excelente microscopista Marcelo Malpighi observa e descreve com muito detalhe o desenvolvimento da galinha (1672). É influenciado pelo período histórico e descreve/afirma que os estágios iniciais do desenvolvimento da galinha não podem ser observados porque são muito pequenos.

O pensamento da criação divina do cristianismo em ocidente estabeleceu o pensamento generalizado da preformação para explicar o desenvolvimento



XVIII DC Começa novamente o debate da preformação e a epigénese com observações detalhadas do embrião da galinha. N. Hartsoeker escreve ter reconhecido o homúnculo/animalculo no espermatozoide de humanos (1694).



**K. Friedrich Wolff** amostra que os tecidos embrionários desenvolvem-se de precursores distintos aos observados no adulto favorecendo pela primeira vez a visão da epigénese (1767)



C. Pander

1817 **Christian Pander** define as camadas germinais e a indução no embrião da galinha (e ideia é expandida a todos os vertebrados por **Karl Ernst von Baer** quem define a blástula e a notocorda, e descubre o ovo nos humanos)

1820-80 Síntese da teoria celular (com a contribuição do botânico Matthias Schleiden e o fisiólogo Theodor Schwann)

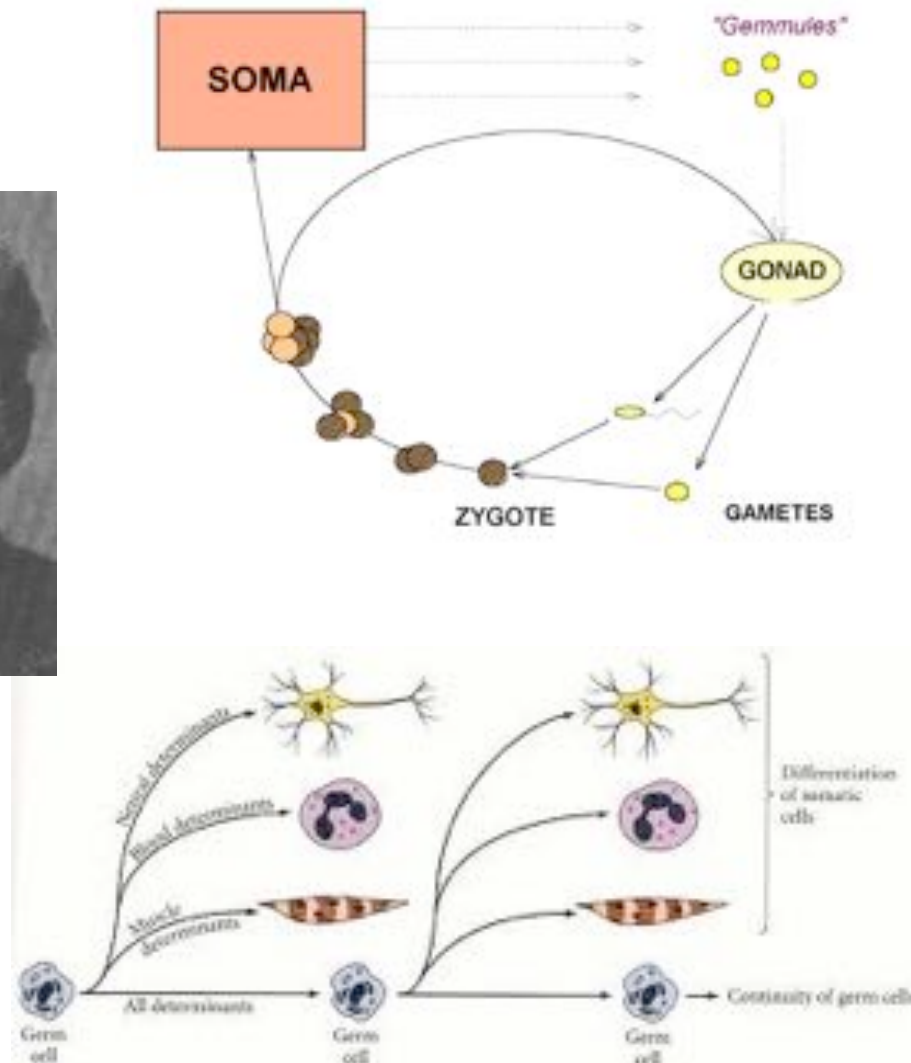


Schleiden

Schwann



XIX-XX August Weismann diferencia as células do corpo (soma) das células germinais (esperma e ovo); se descubre que os gametos tem a metade do conteúdo cromosómico (haploide) e que ele duplica-se com a fertilização (diploide); descrevem-se os procesos de mitosis e meiosis; e desenvolvem-se os trabalhos da herencia e a genética do Gregor Mendel

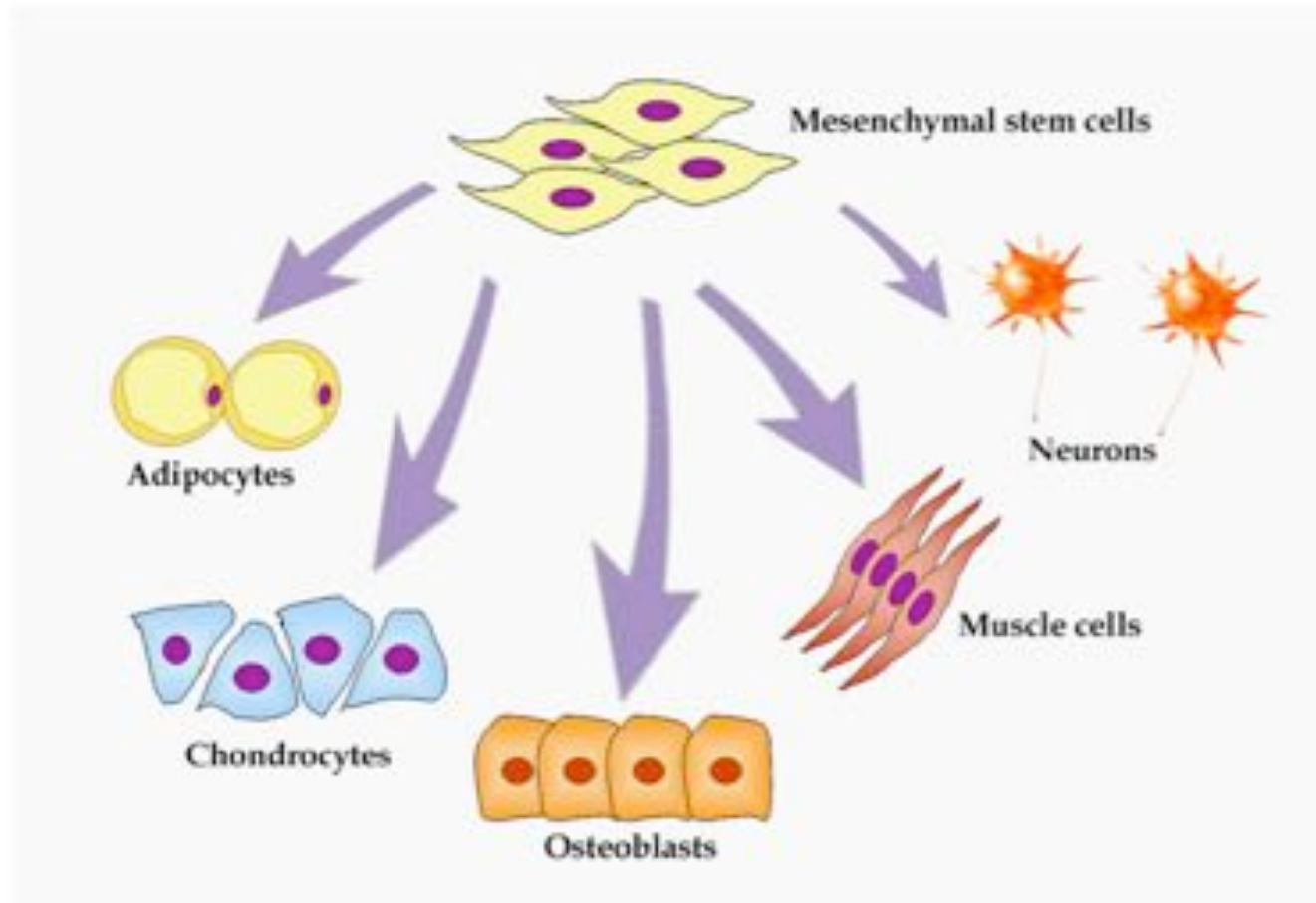


## Seculo XX-XXI

### Principios contemporaneos da biologia do desenvolvimento:

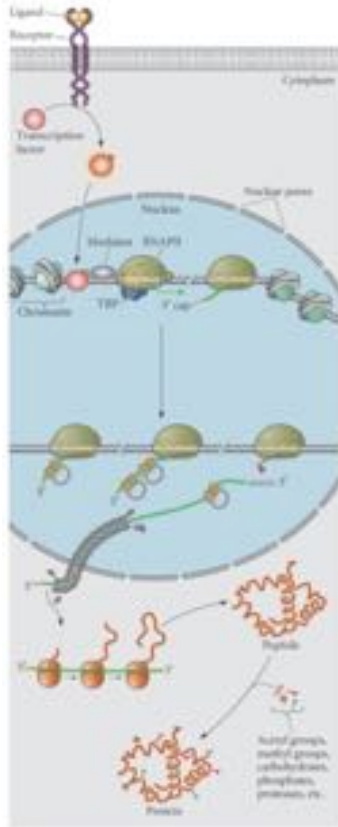
- a) O desenvolvimento de linhagens celulares é progressivo e restritivo
- b) A expressão dos genes é regulada diferencialmente por células e tecidos: INDUÇÃO
- c) Os genes codificam informação importante que dirige comportamentos temporais e espaciais das células: MORFOGENESE
- d) Comunicação intercelular (e.g. processos de indução e morfogênese)

# Cellular specification: external and intrinsic factors

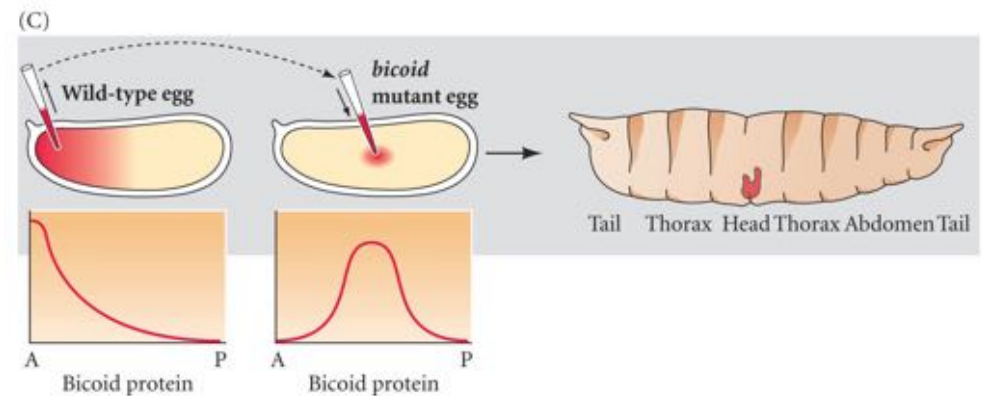
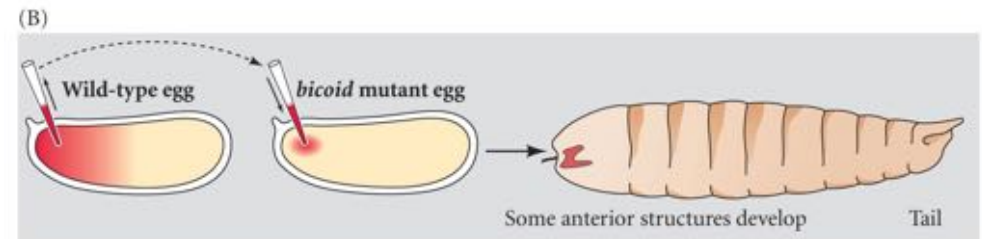
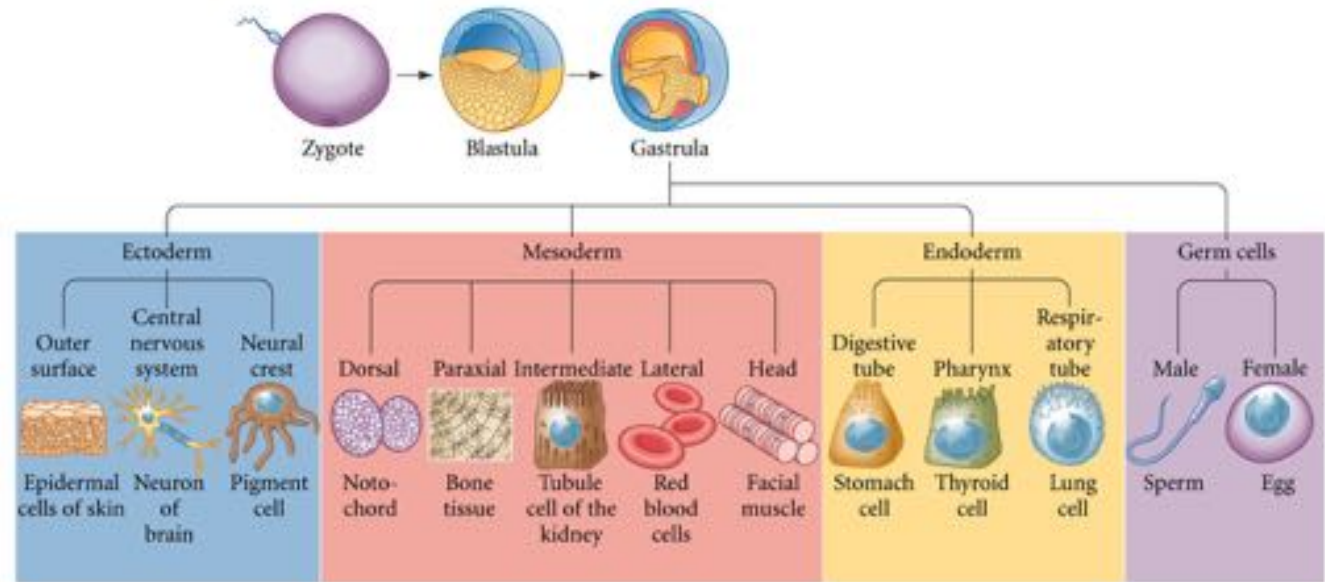


# General principles of development:

Gene regulation

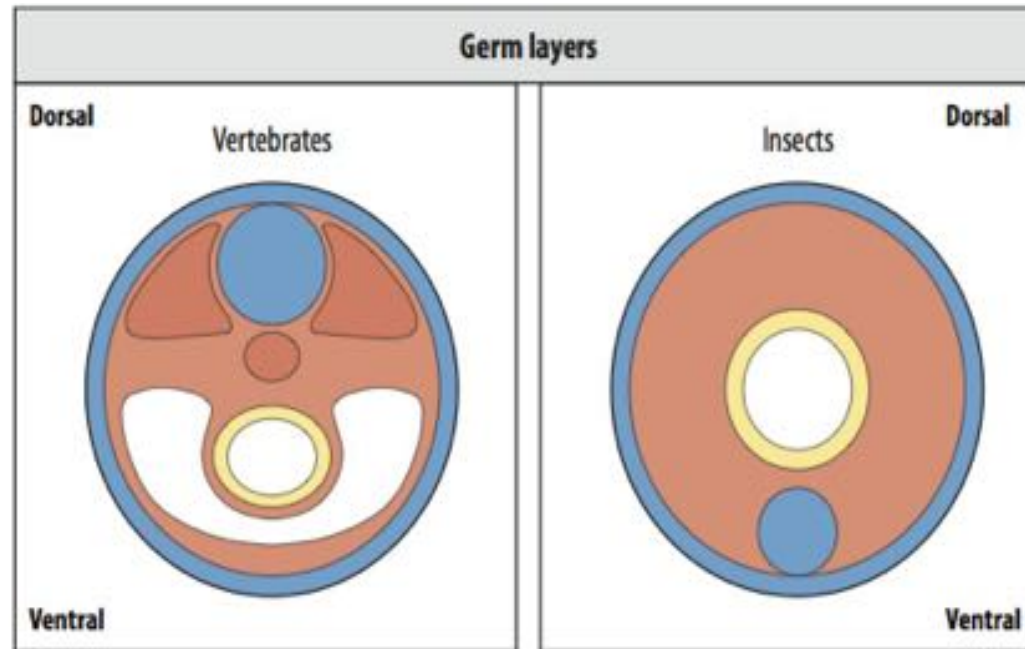


Specification & differentiation



Morphogens and gradients

# Camadas germinativas



Germ layers	Organs	
Endoderm	gut, liver, lungs	gut
Mesoderm	skeleton, muscle, kidney, heart, blood	muscle, heart, blood
Ectoderm	skin, nervous system	cuticle, nervous system

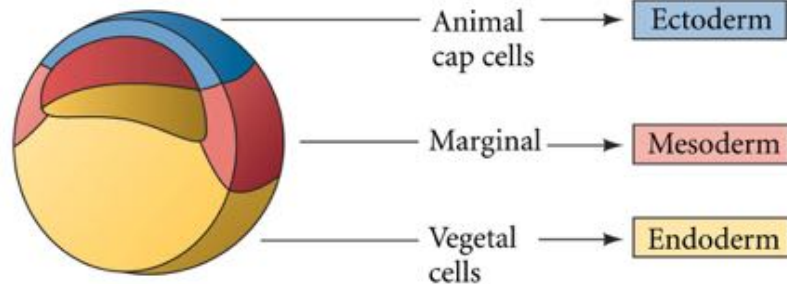
# INDUCTION (1924)



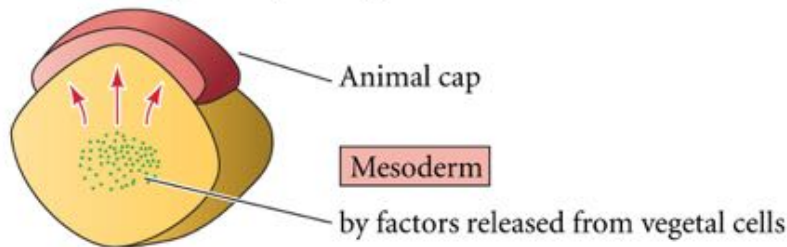
- Spemann & Mangold: embryonic induction
- Hilde Mangold: Hans Spemann's doctoral student in Freiburg
- Spemann wins Nobel in 1935

# Mesoderm induction (1969)

(A) Dissected blastula fragments give rise to different tissue in culture:

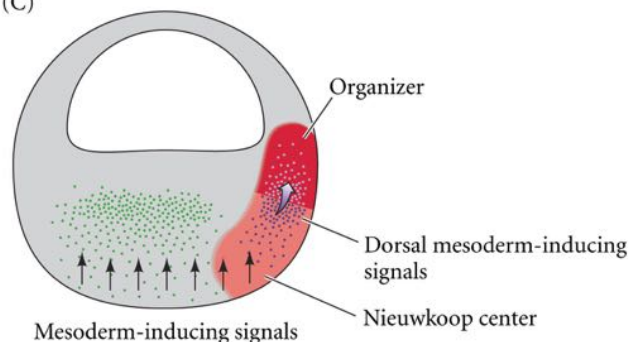


(B) Animal and vegetal fragments give rise to mesoderm



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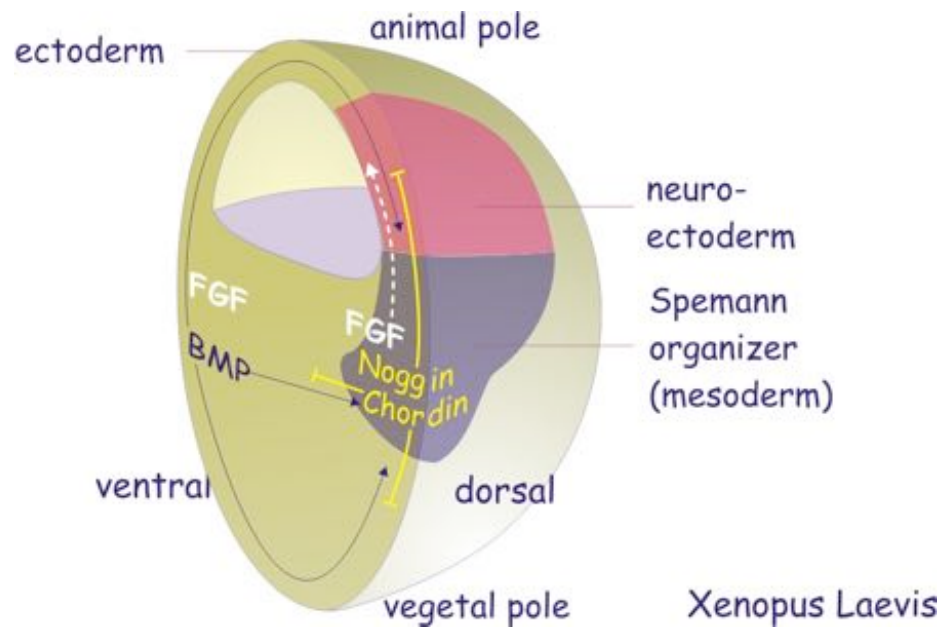
(C)



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- Nieuwkoop find that endoderm signals the ectoderm to specify mesoderm in the axolotl.
- J.M.W. Slack finds FGF signaling is responsible for induction in *X. laevis*
- D. Kimmelman & M. Kirschner find that FGF is present in early embryos. They and J.C. Smith find that TGF- $\beta$  signaling is also important for mesoderm induction.

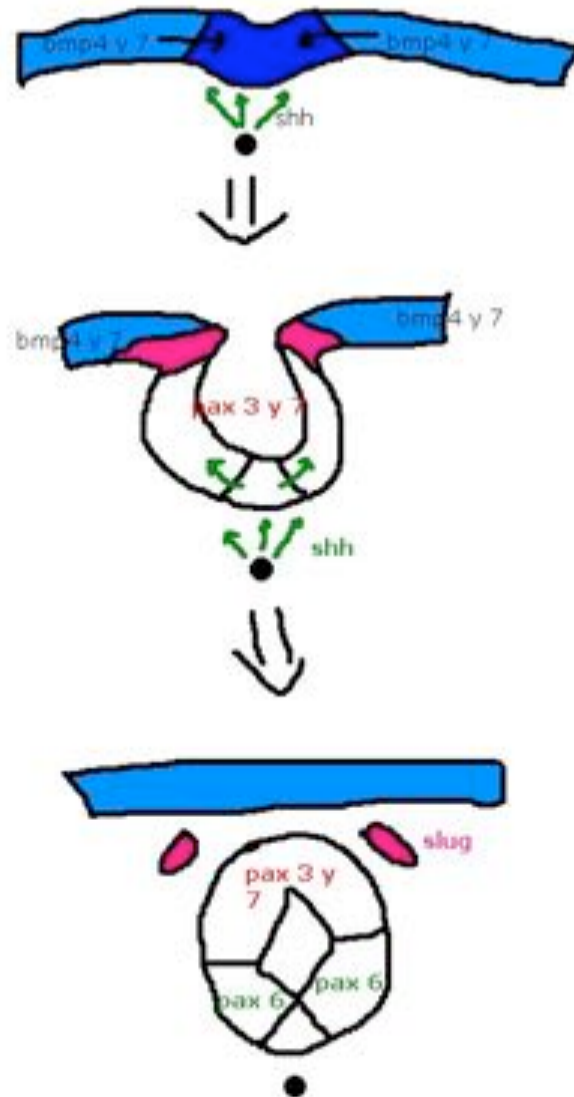
# Neural induction (1989)



- Grunz & Tacke find that ectodermal cells form neural tissue when kept dissociated for long (without signaling of other molecules); i.e. ectoderm default is neural tissue



# Neural plate floor and sonic hedgehog *shh* (1991)



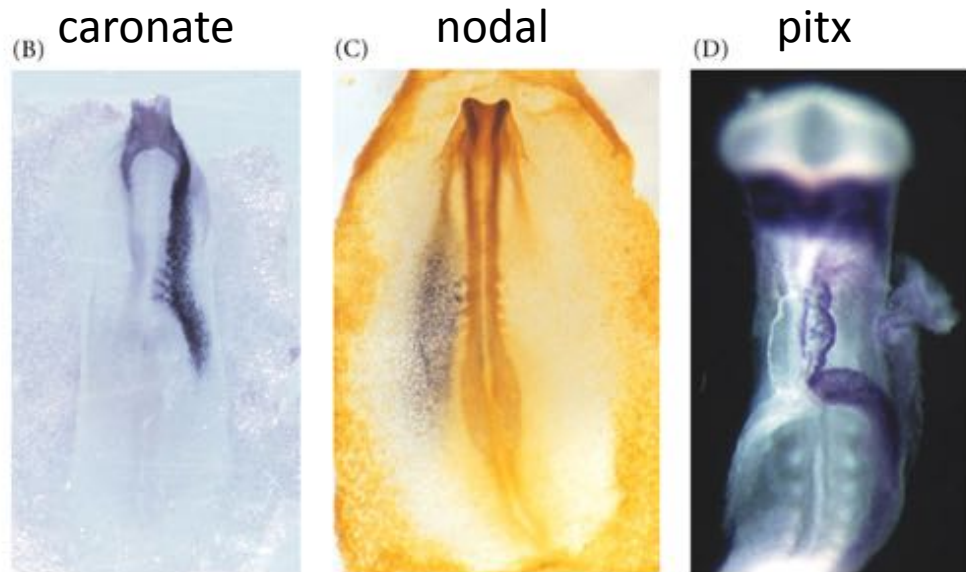
Defecto en Shh



Figura 3. Foto del recién nacido. Se observa ojo único central, con probóscide, confirmando la etmocefalia.

# Left-right asymmetry (1995)

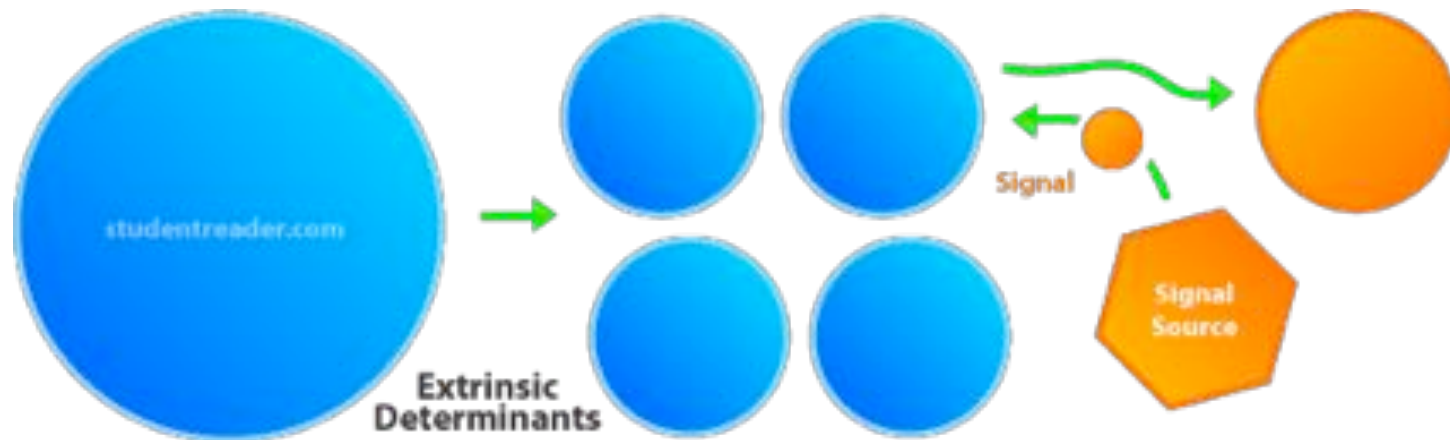
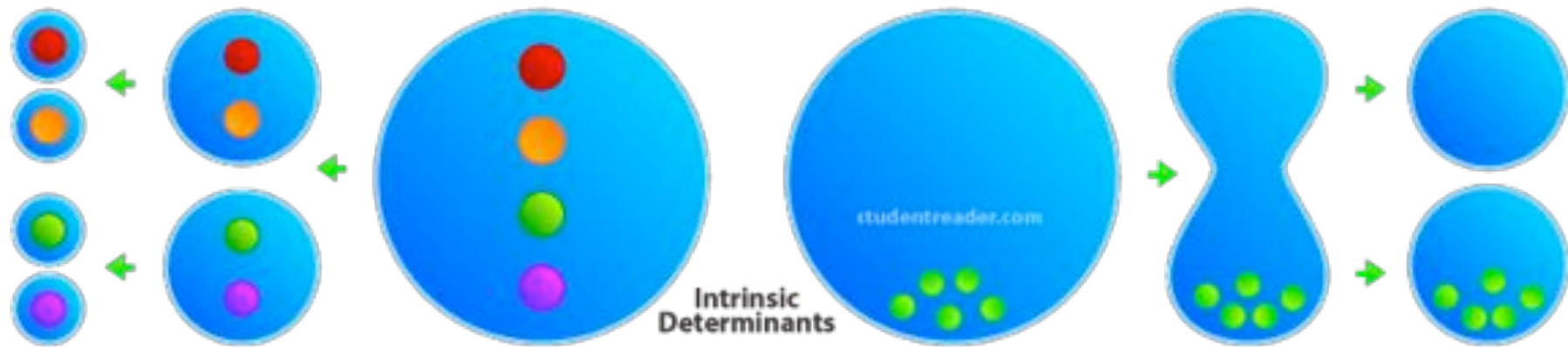
Chick:



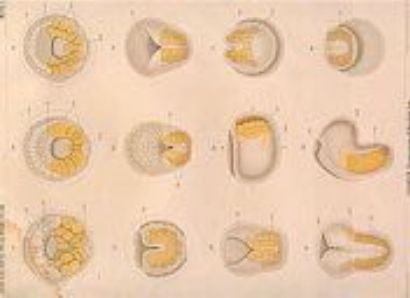
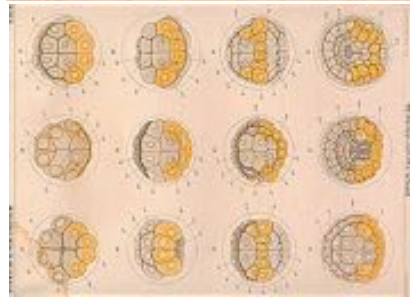
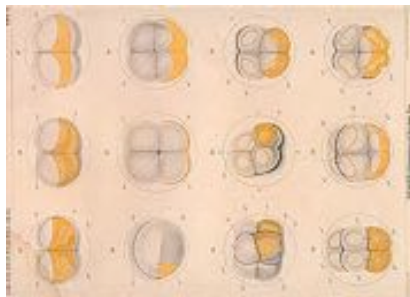
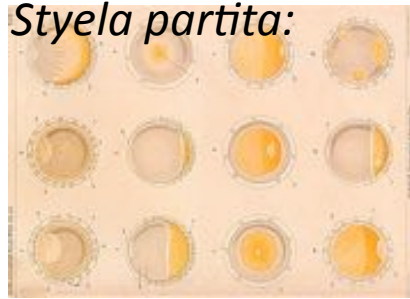
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- Mike Levin and Cliff Tabin study L-R asymmetry, and find that Nodal is expressed on the left, next to the asymmetrical and temporal expression of *shh*. It then regulates expression of *Pitx* on the left side.
- Hiroshi Hamada *et al.* discover Lefty-1 and Lefty-2. Lefty-1 maintains the identity of Right. Nobutaka Hirokawa (1998) found that cilia beating in circles to the left on the ventral surface of Hensen's nodule also regenerate L-R asymmetries.

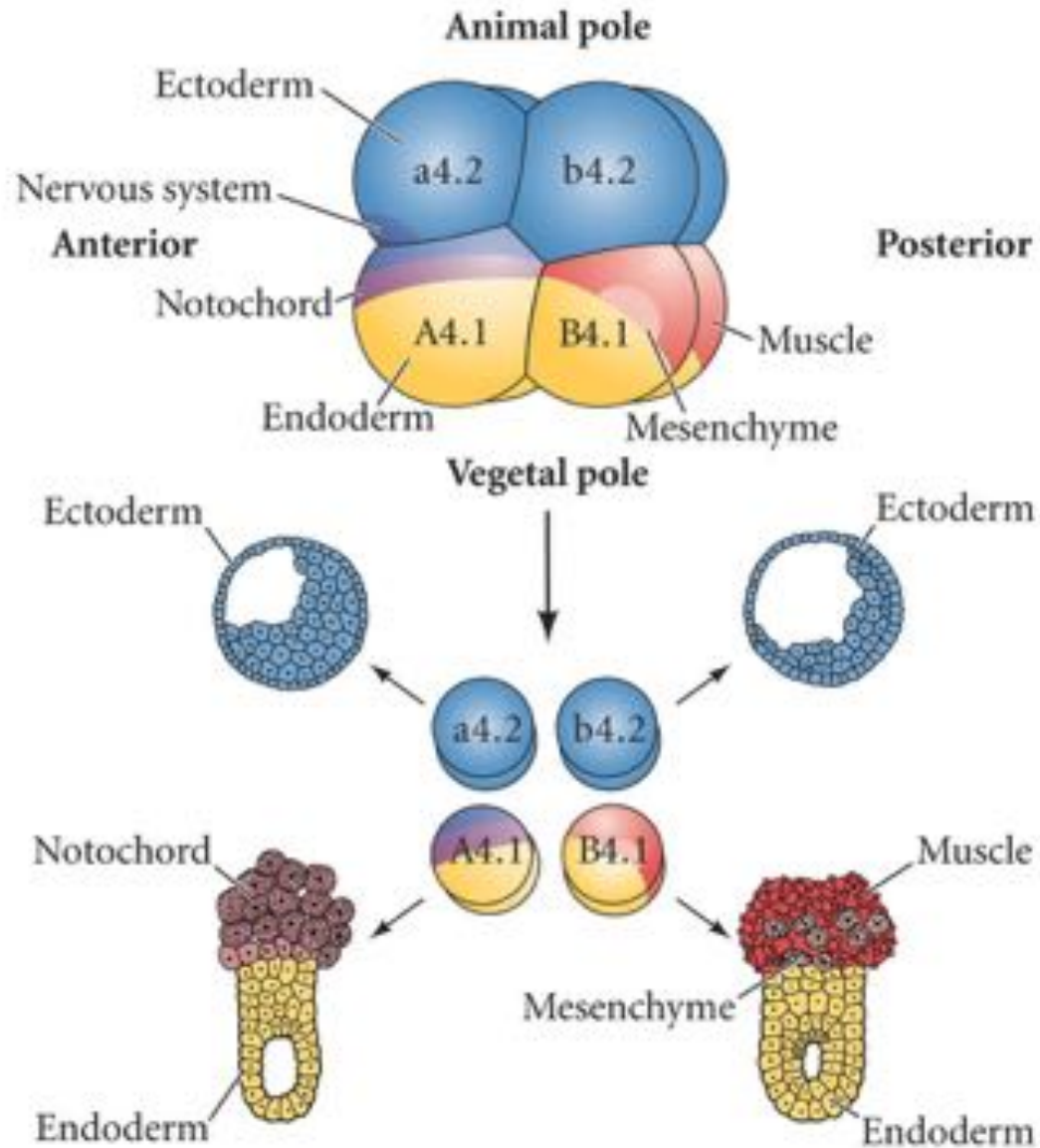
# Determinants during early embryogenesis



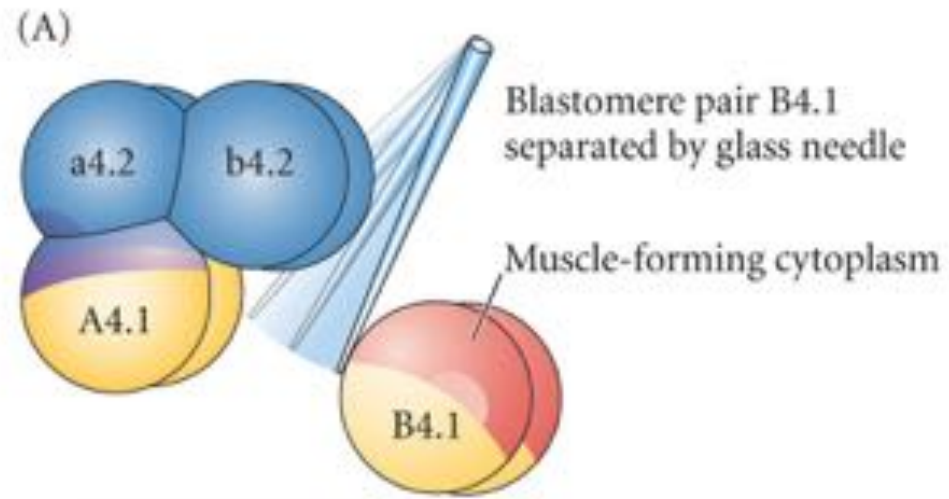
*Styela partita*:



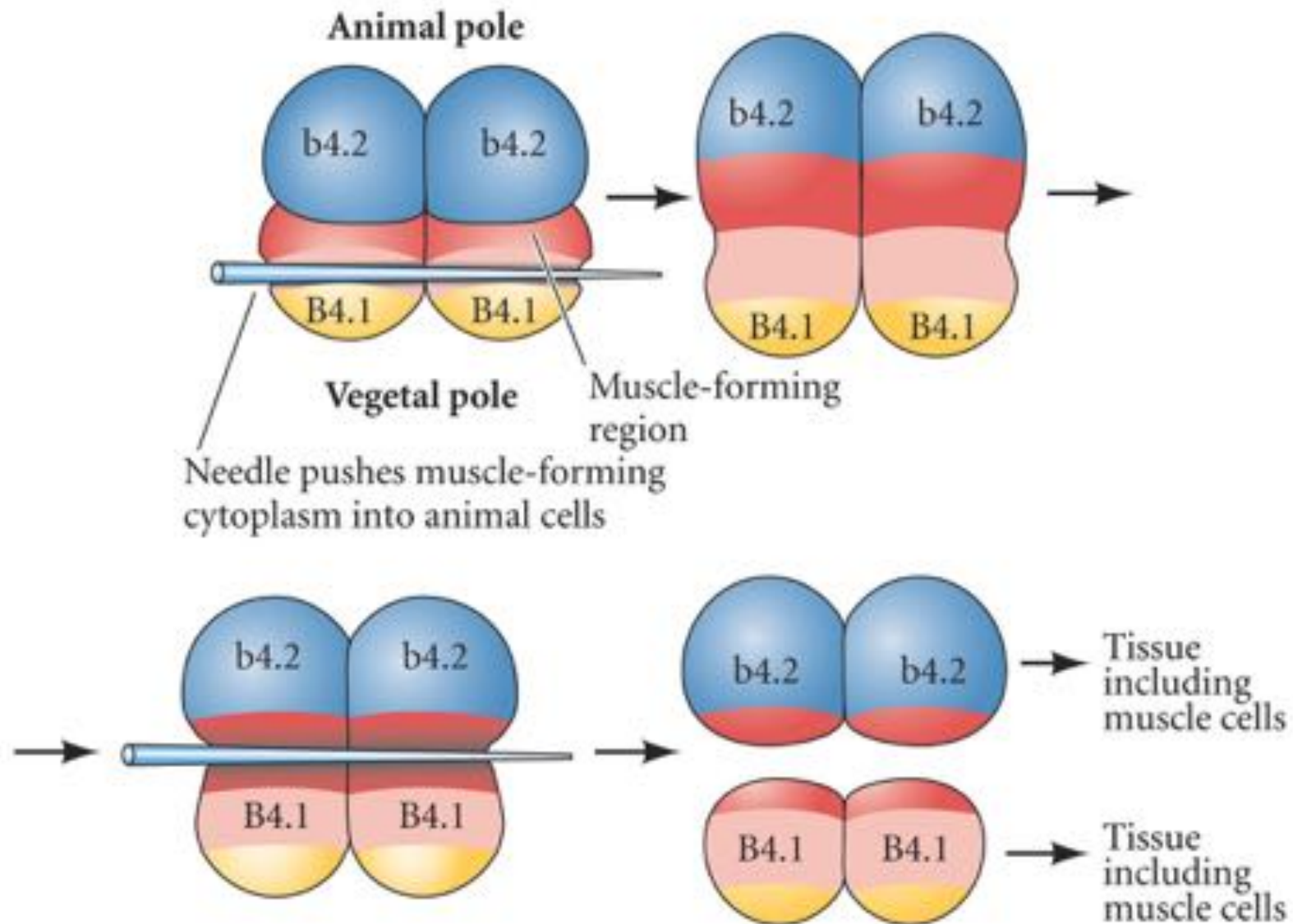
# Autonomous specification in ascidians



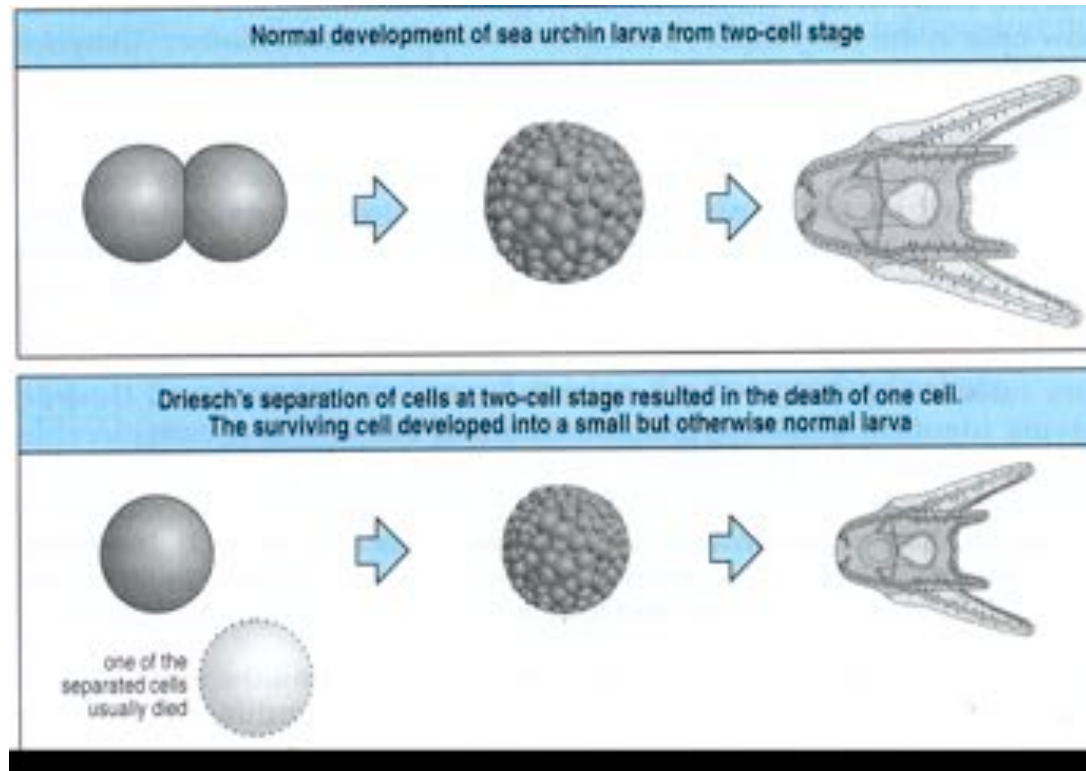
# Muscle development in ascidians



# Yellow crescent in the cytoplasm determines the destiny of muscle cells

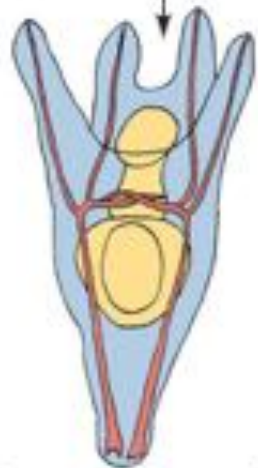


# Conditional specification: Regulative development in urchins

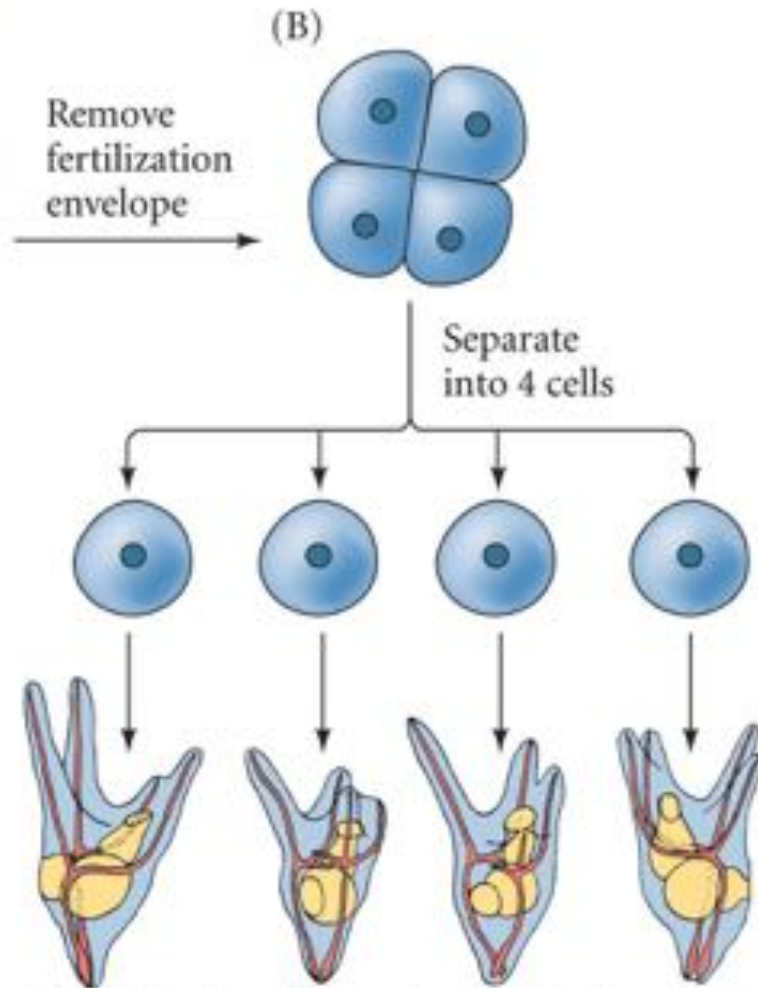


# Conditional specification: regulative development in the urchin

(A) Fertilization envelope



Normal pluteus larva



Plutei developed from single cells of 4-cell embryo

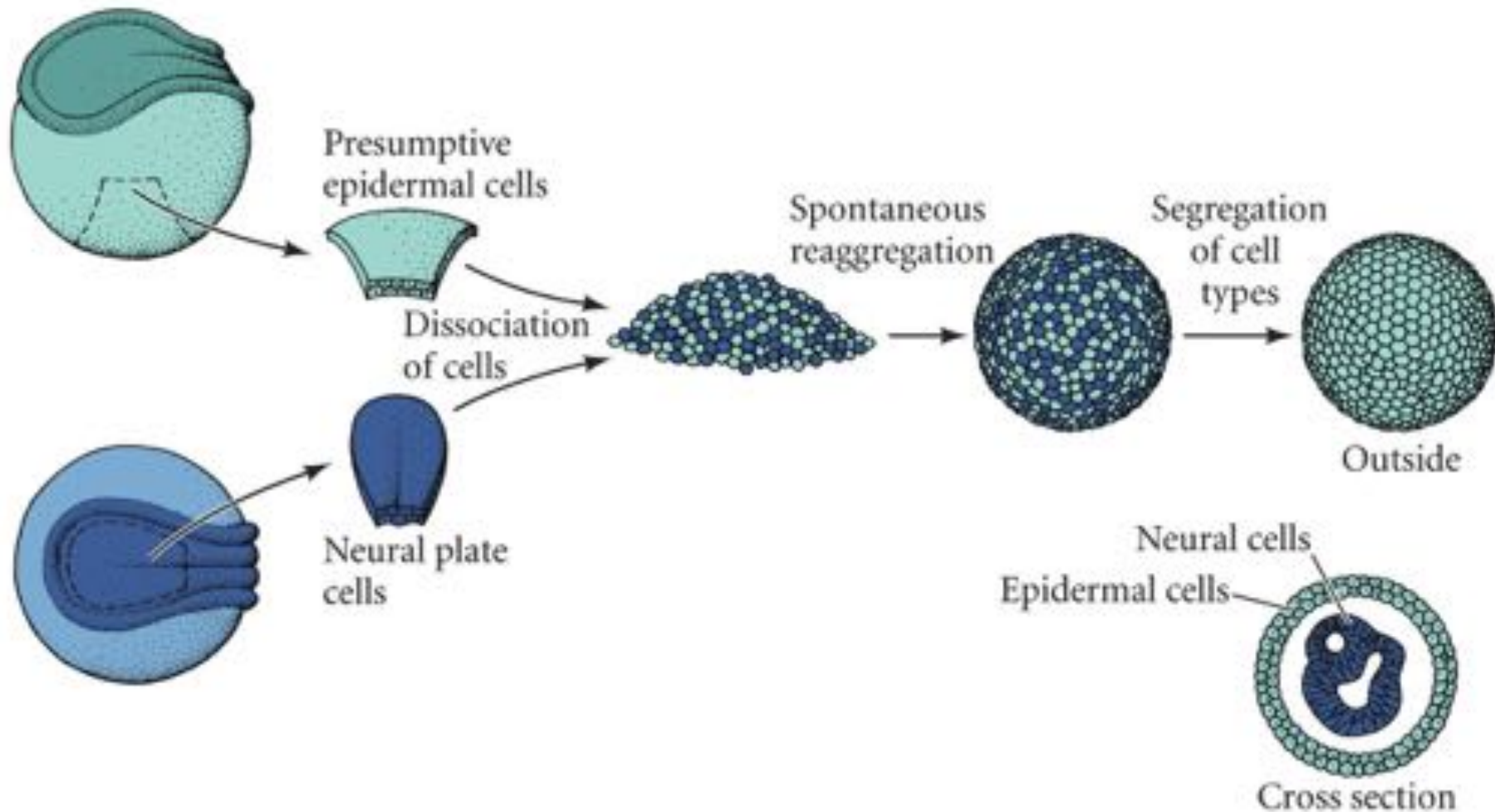
*“Development starts with a few ordered manifoldnesses; but the manifoldnesses create, by interactions, new manifoldnesses, and these are able, by acting back on the original ones, to provoke new differences, and so on. With each new response, a new cause is immediately provided, and a new specific reactivity for further specific responses. We derive a complex structure from a simple one given in the egg.”*



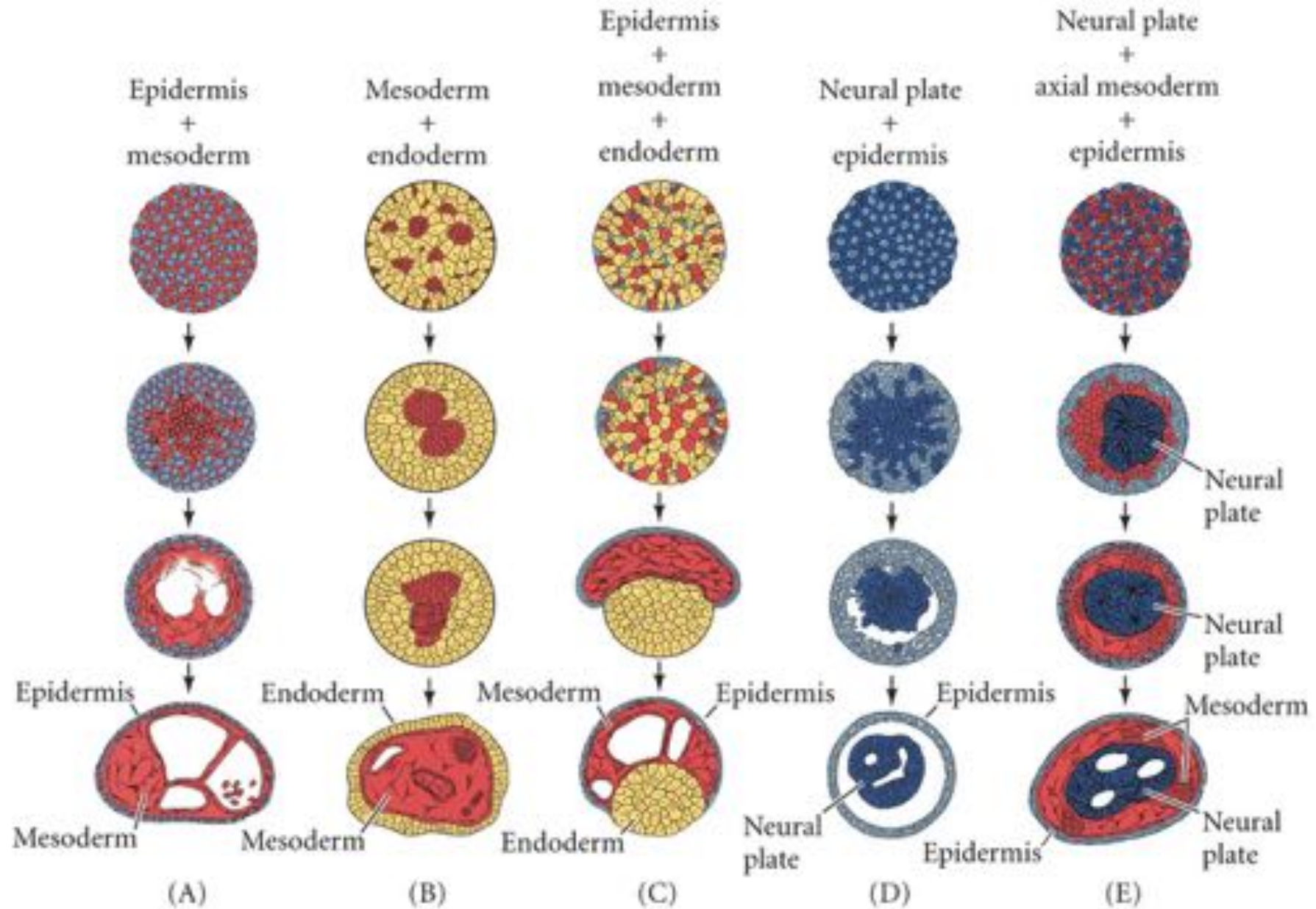


# MORPHOGENESIS and the formation of tissues

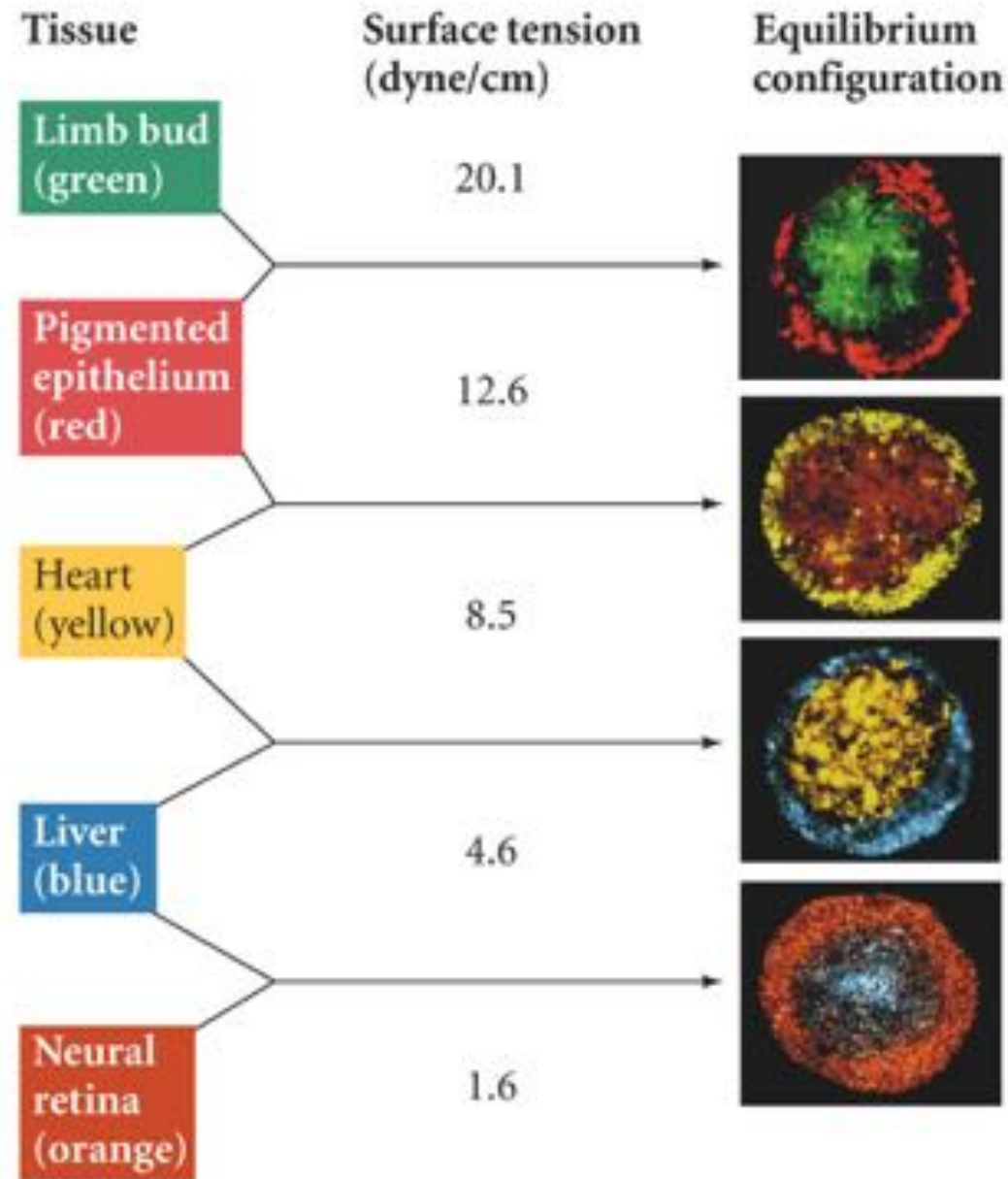
Cell aggregation of the amphibian neurula:



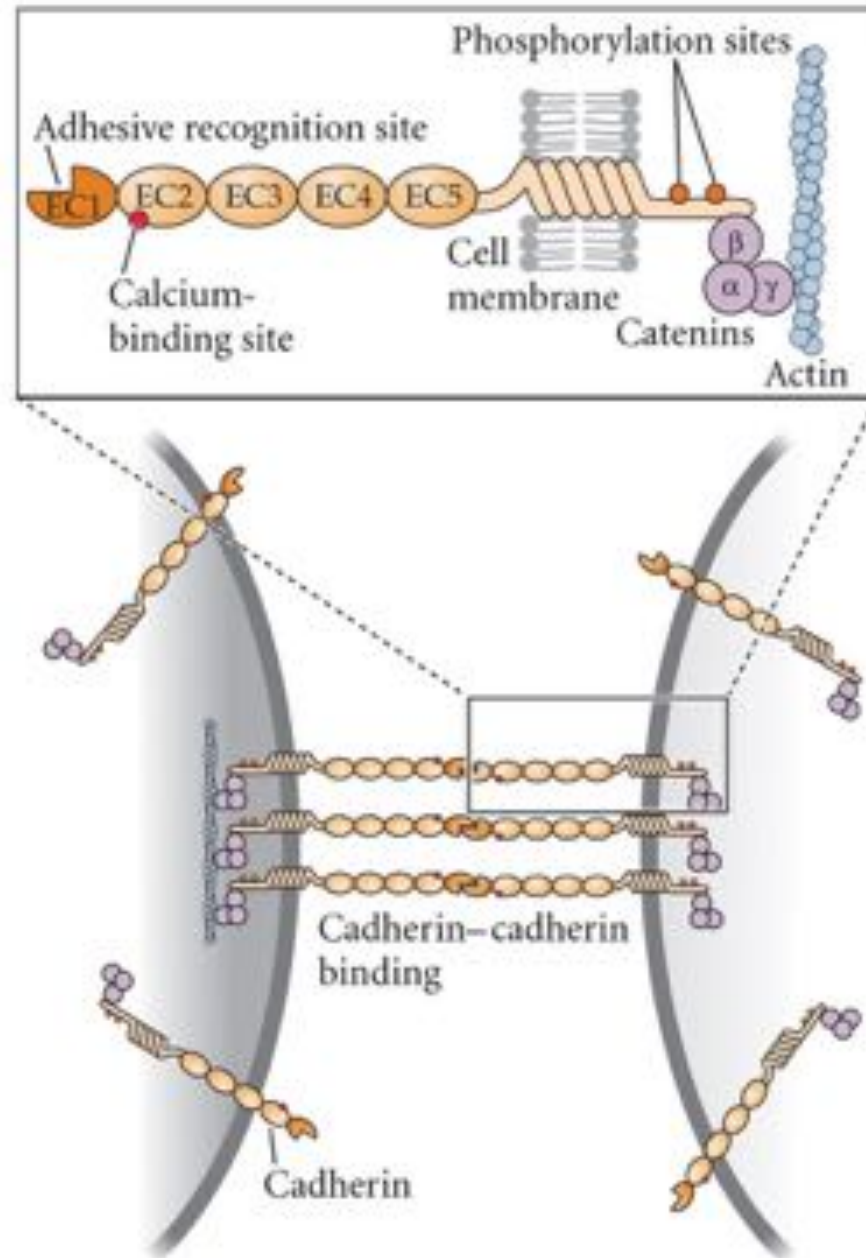
# Spatial relationships in amphibian cell aggregates



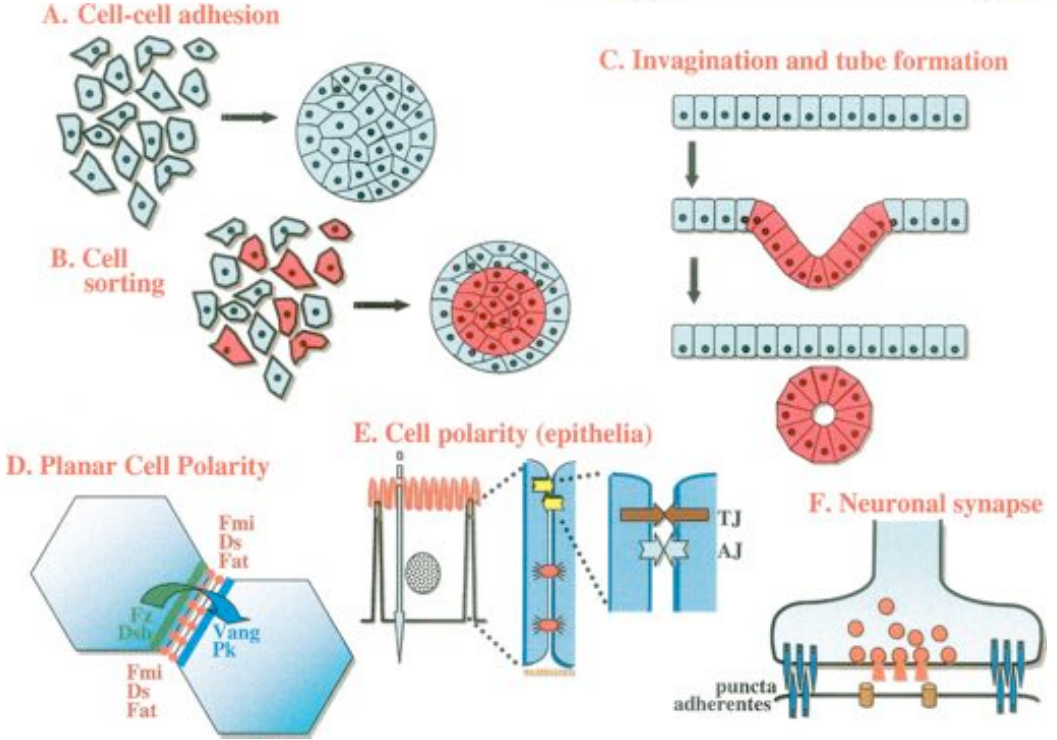
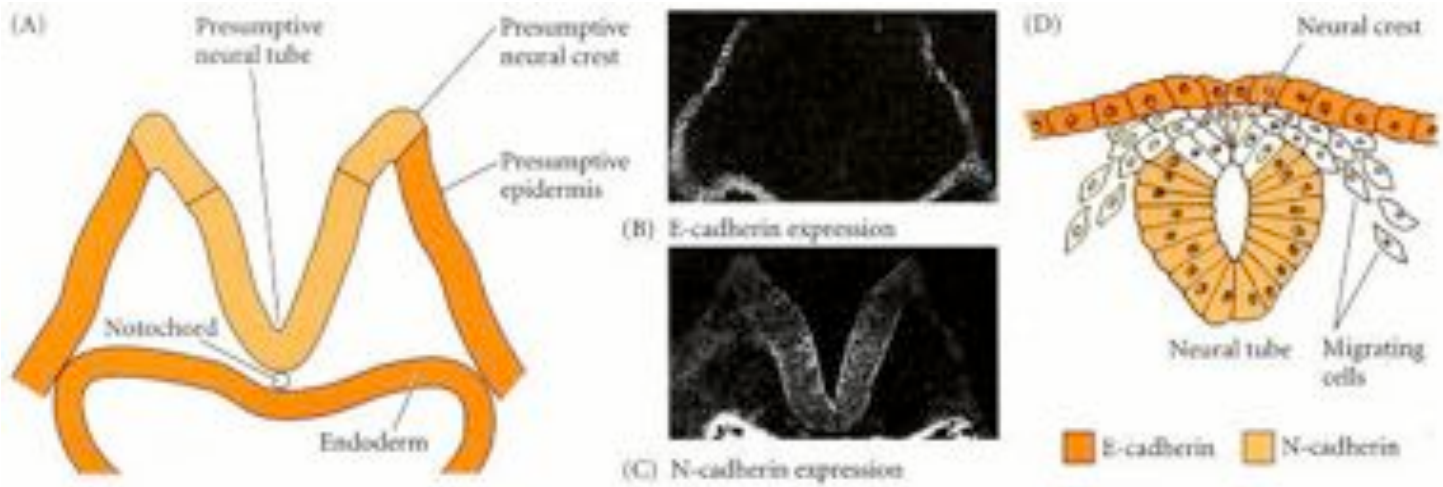
# Hierarchies in the cellular order in relation to the different superficial tensions.



# Cellular adhesion is mediated by cadherins



# Morphogenetic movements mediated by different cadherins



# ATIVIDADE:

## XX-XI Ideias Contemporâneas do desenvolvimento

Instruções:

- 1) Formar grupos de 2-3 alunos com interesses similares da biologia
- 2) Como pensa que a biologia do desenvolvimento pode ajudar no entendimento do seu tema de interesse?
- 3) Pensa num trabalho científico (descubrimento ou artigo em particular) relacionado à biologia do desenvolvimento que pode contribuir no entendimento ou progresso na sua disciplina de interesse.
- 4) Pensa numa grande pergunta (i.e. mistério ou enigma) que ainda não foi resolvida na sua área de interesse, e pensa como a biologia do desenvolvimento pode contribuir na resolução dela.

# ATIVIDADE:

## XX-XI Ideias Contemporâneas do desenvolvimento

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