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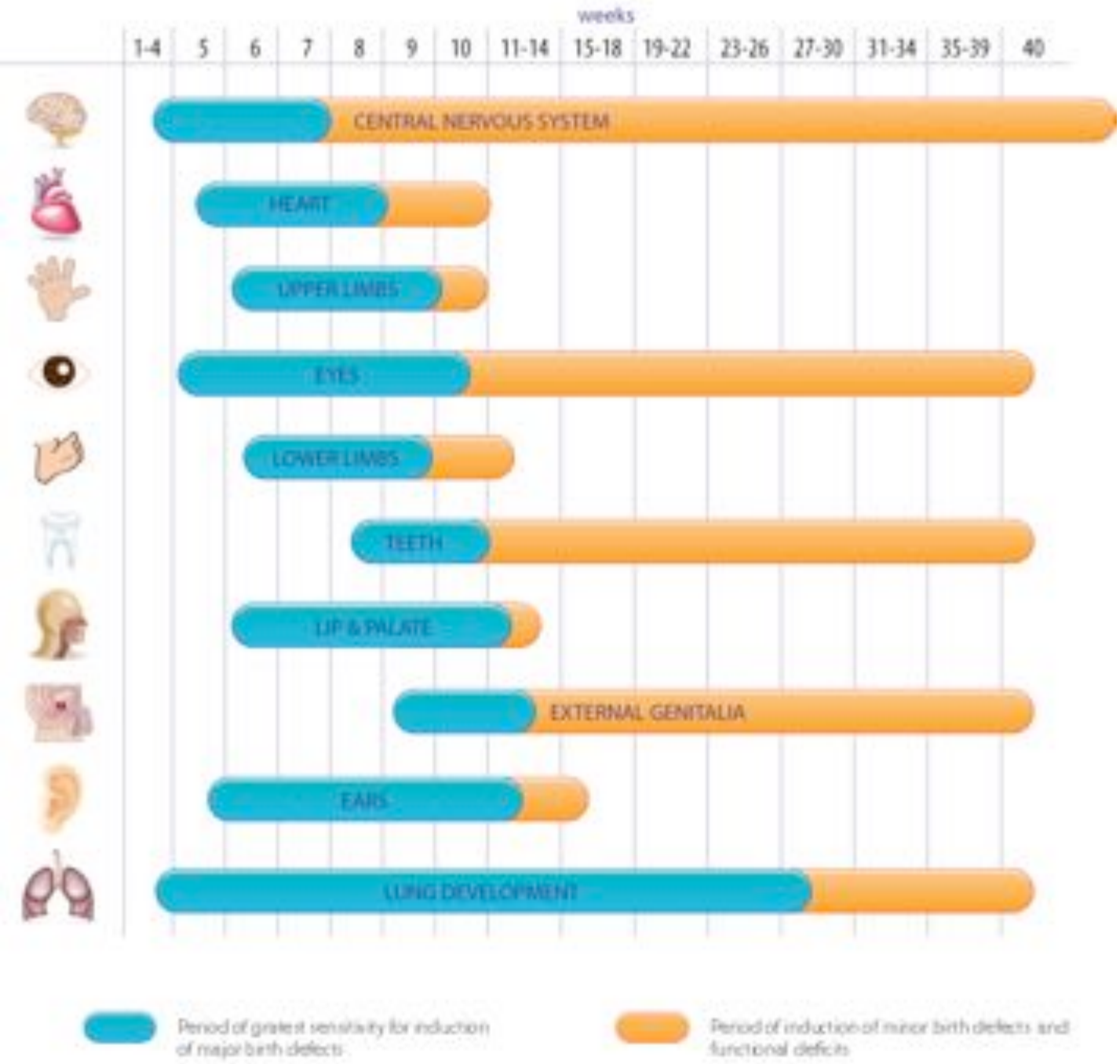

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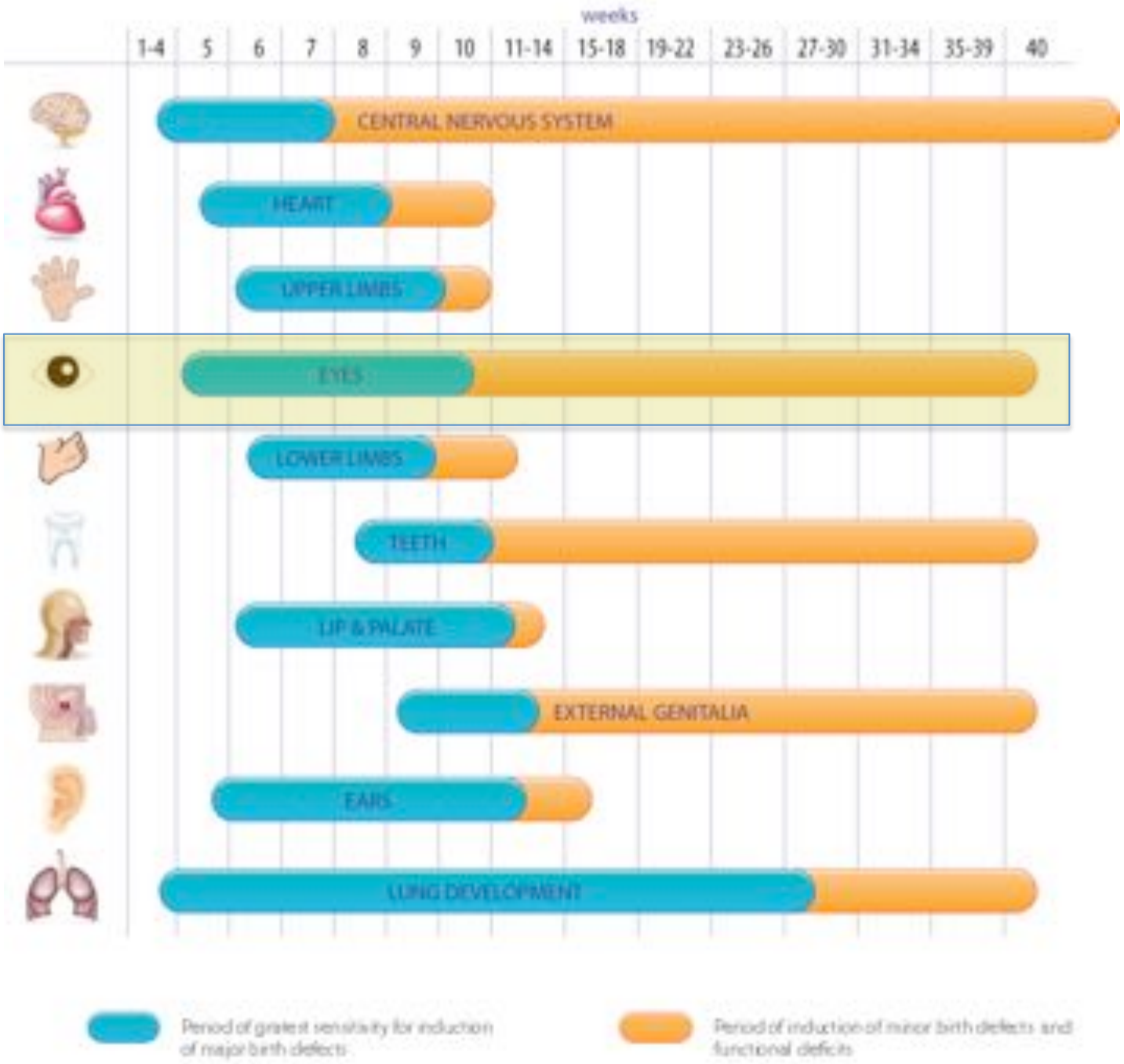
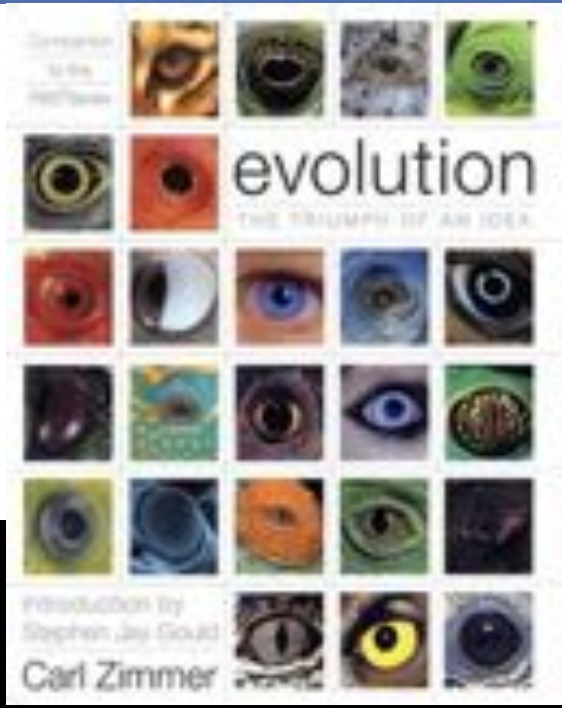
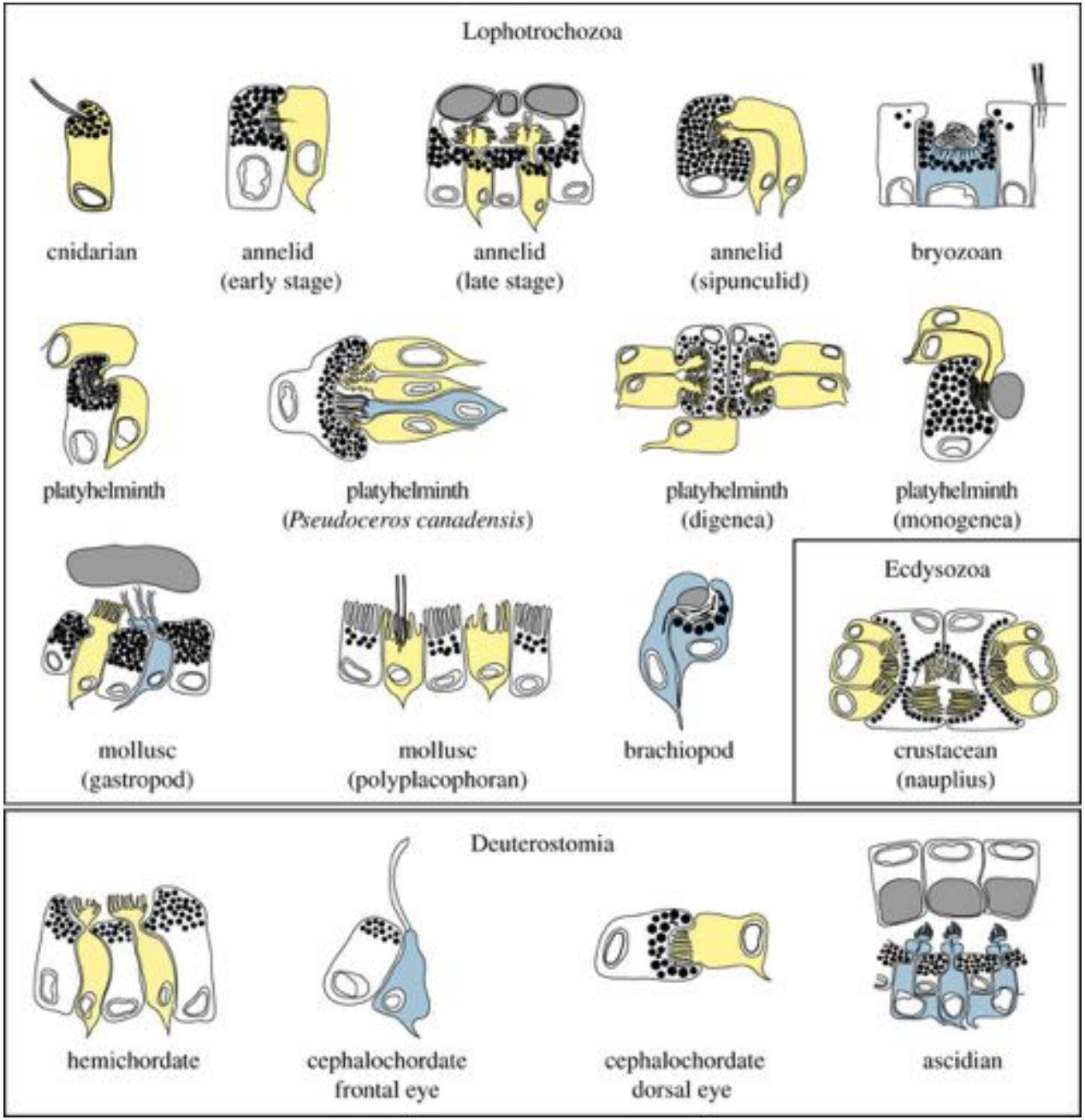


Tipos de OlhOs



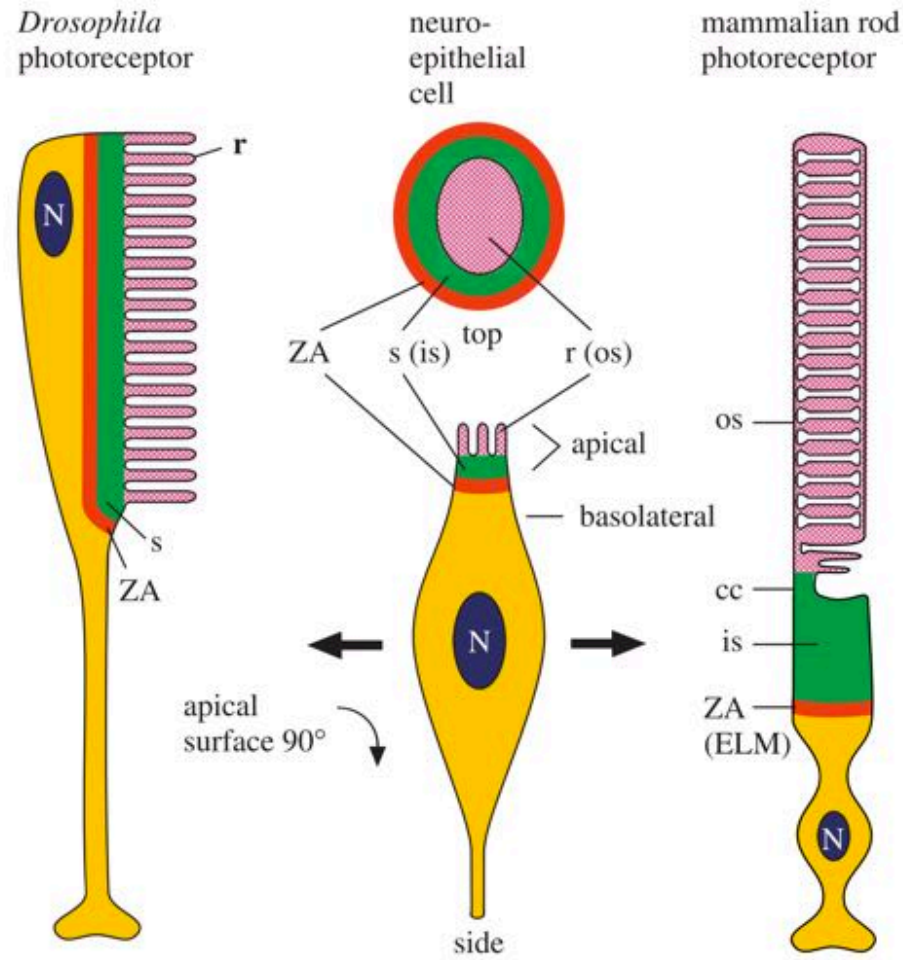
Diversity of simple eyes in planktonic larvae (Randel & Jékely, 2016)

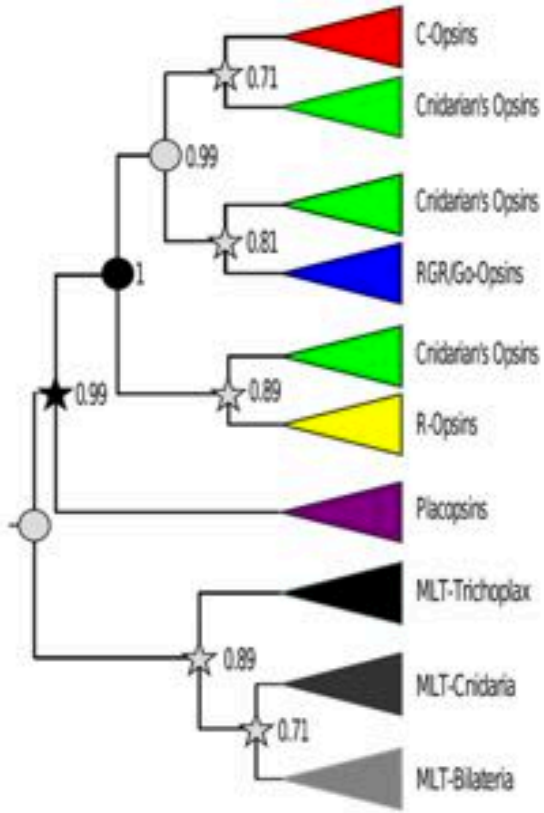


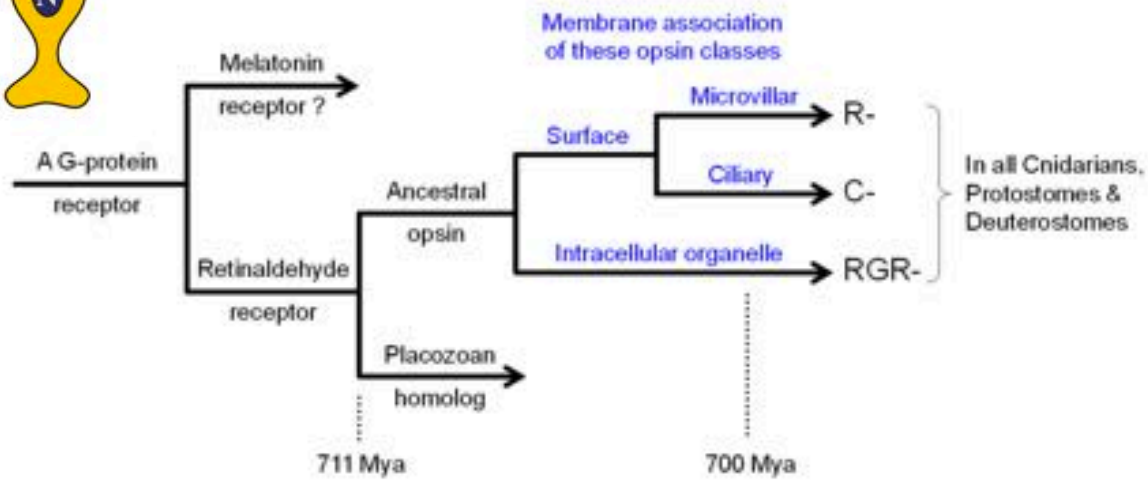
Evolução das opsinas e células fotoreceptoras:

Rhabdomerico (IP3):

Ciliar (PDE):

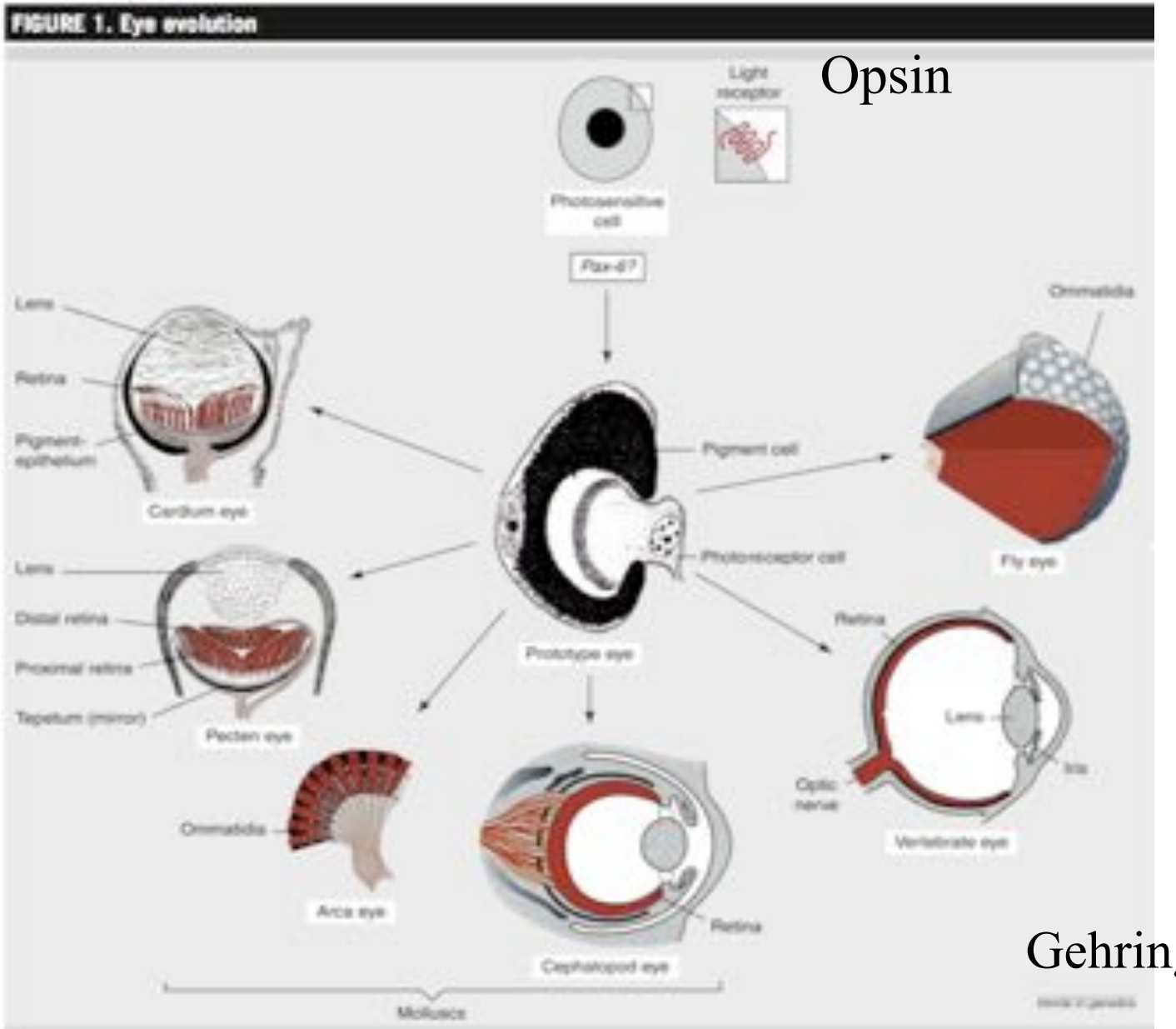






Lamb, 2013

OlhOs, estruturas homólogas?

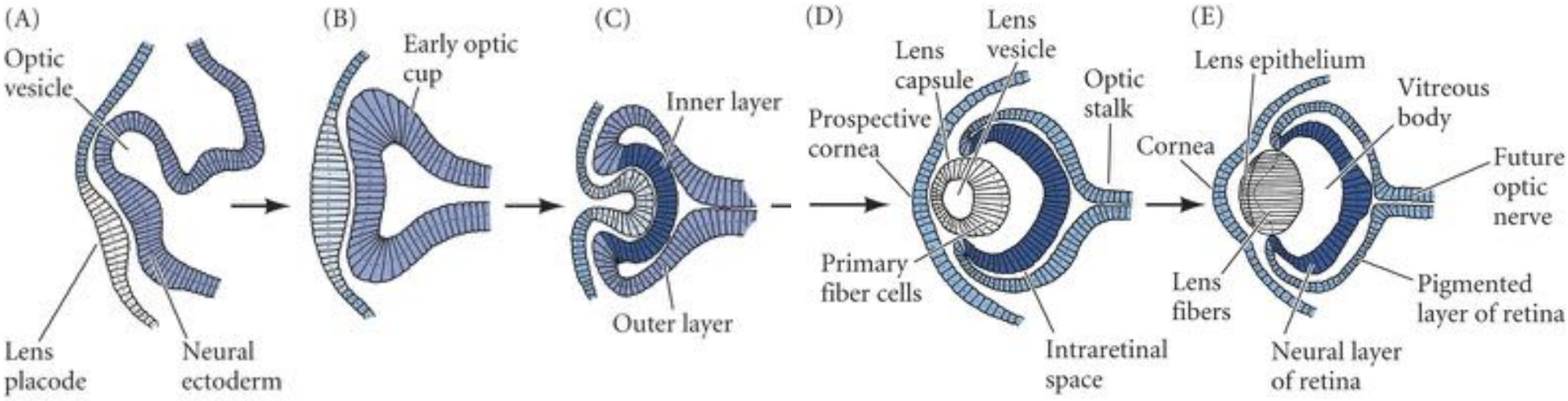


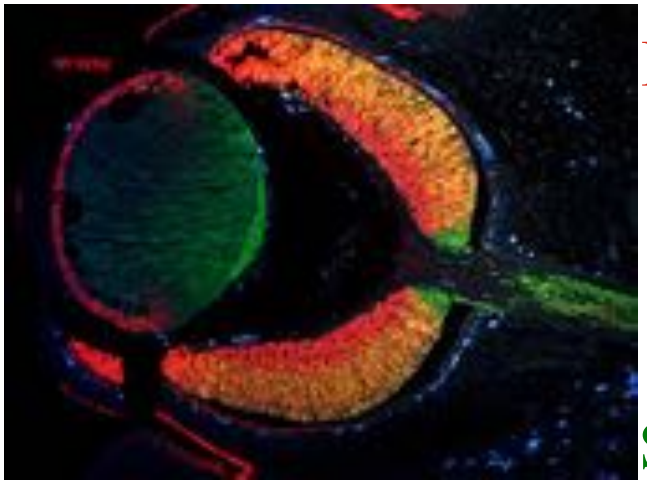
Gehring 1999

CASO DE ESTUDO: PAX6 E OLHOS

“Master Control Gene of Eye Development”

Desenvolvimento do olho no camondongo



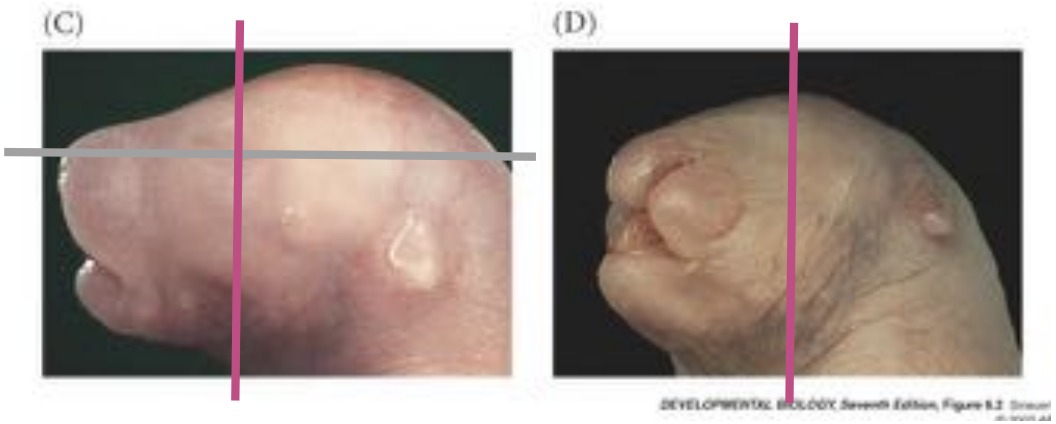


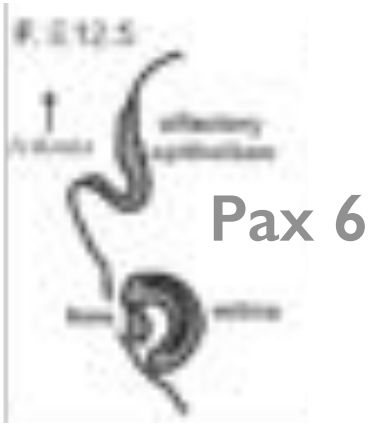
Pax6

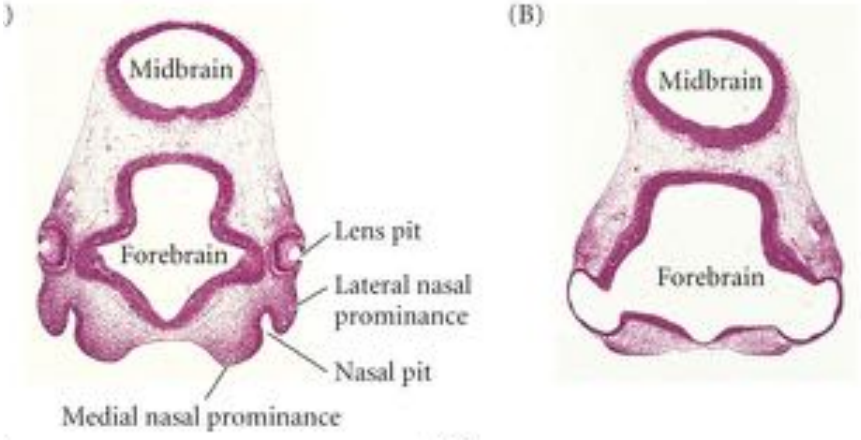
Sox2

Van Heyningen, MRC

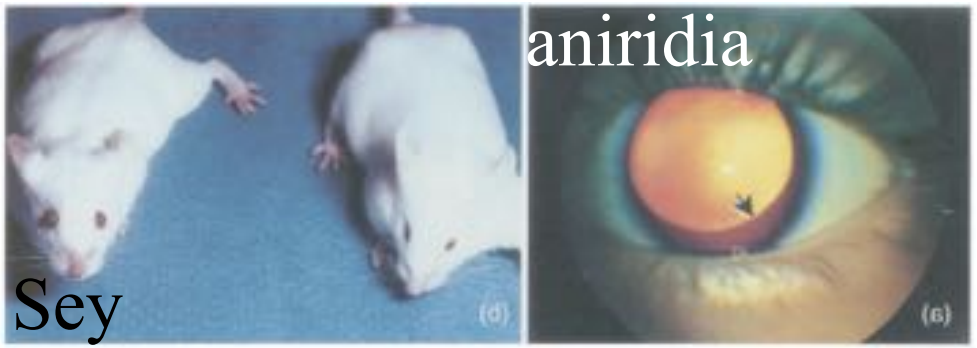
Y por que Pax 6?





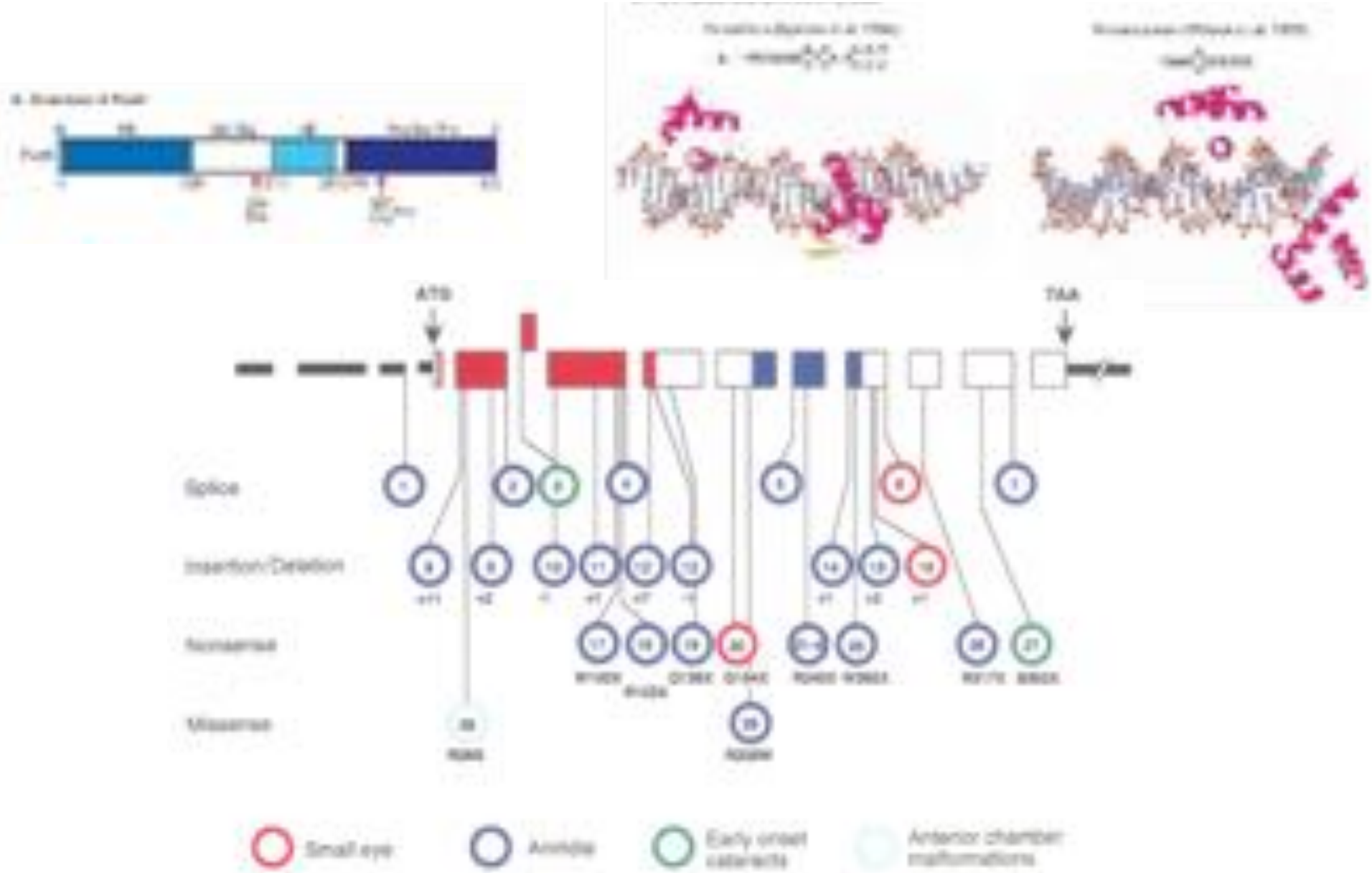


Simpson & Price, 2002



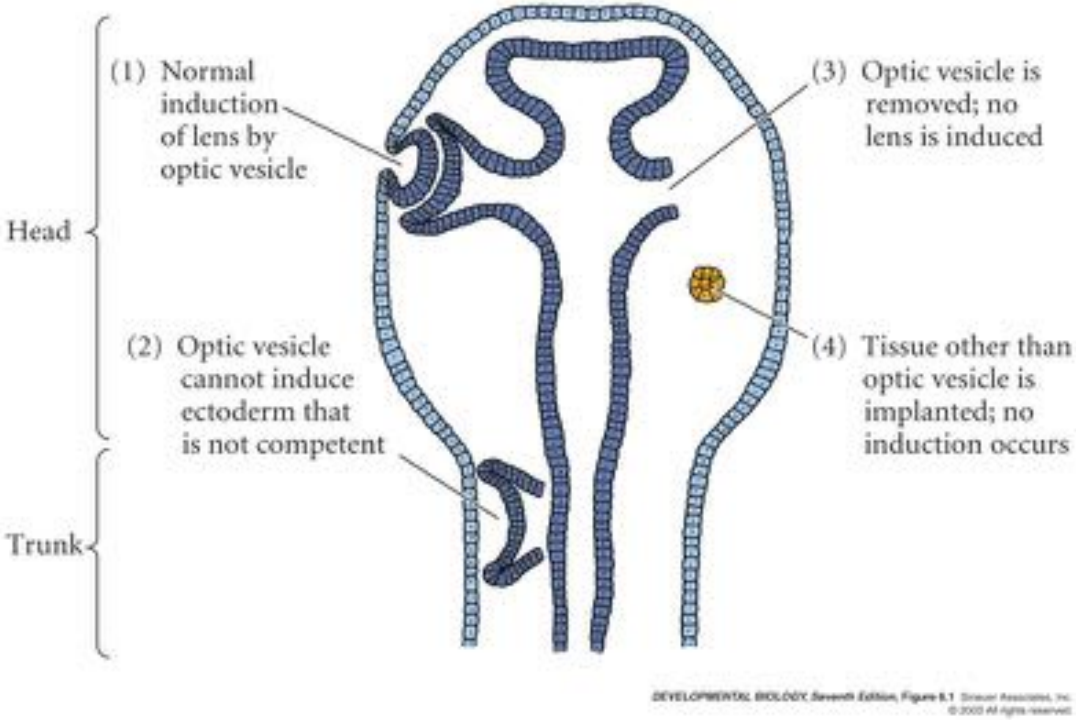
Hanson1995

Malformacões nos olhos por mutacões em *pax 6*

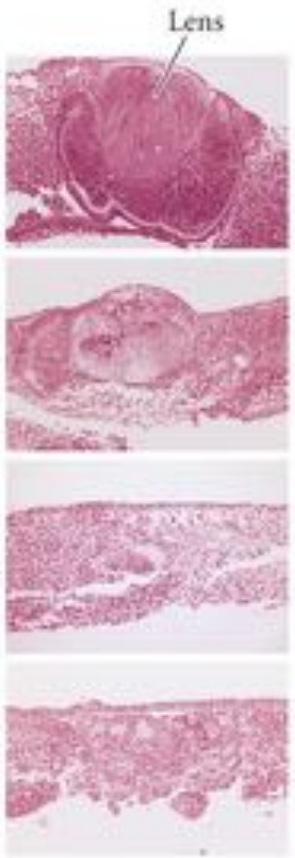


Hanson1995

Indução do lente: experimentos de transplante

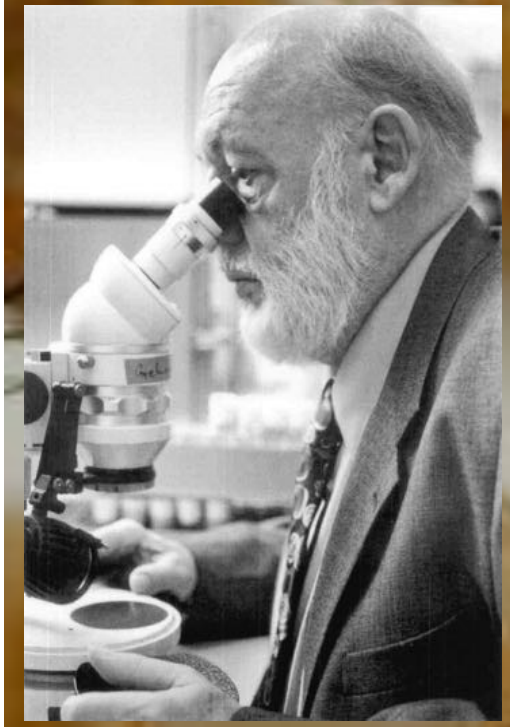


Surface ectoderm	Optic vesicles	Lens induction
Wild-type	Wild-type	Yes
Wild-type	*Pax6*⁻/*Pax6*⁻	Yes
Pax6⁻/*Pax6*⁻	Wild-type	No
Pax6⁻/*Pax6*⁻	*Pax6*⁻/*Pax6*⁻	No



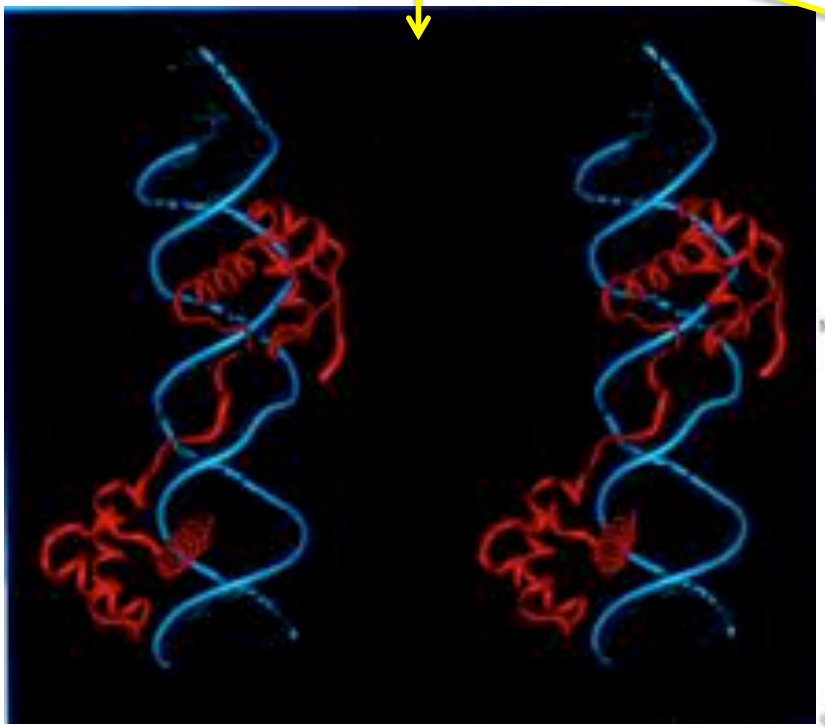
La formación del lente a partir del **ectodermo** requiere la acción de Pax 6

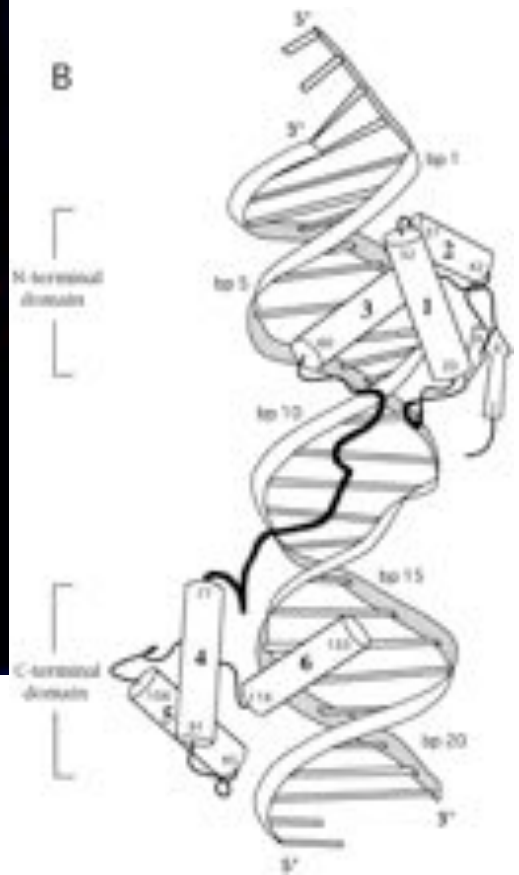
Walter Gehring
Pax 6 em *Drosophila melanogaster*

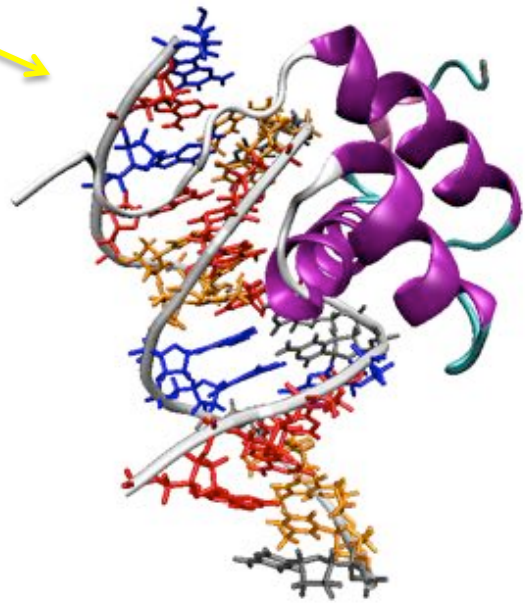


Kowalevsky Award 2003
Kyoto Award 2000

eyeless/pax6 na mosca

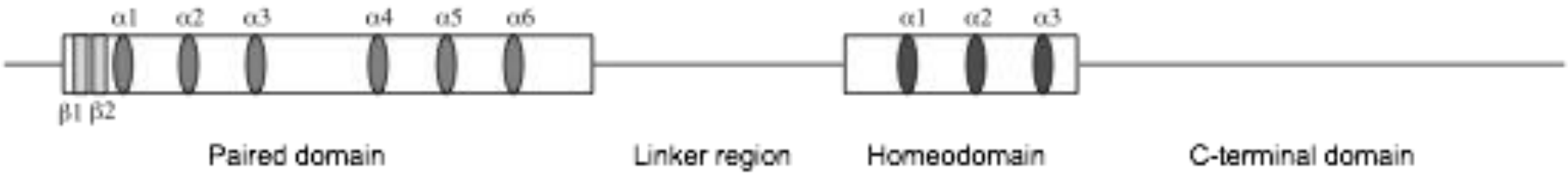






(Xu, et al. 1999)

eyeless/pax6 na mosca

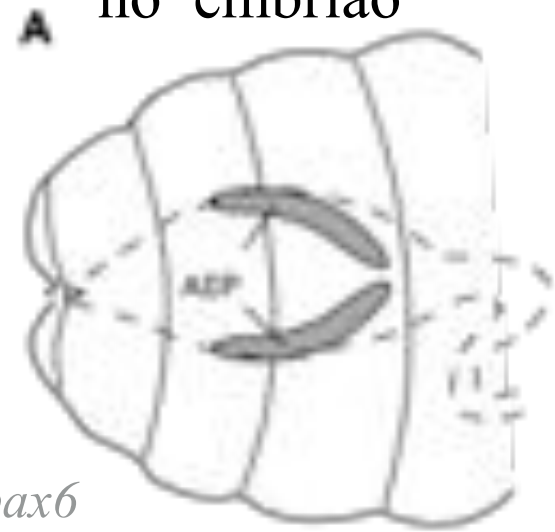


Expressão de *pax6* no primordio de antena e olho

primordio de antena-olho no embrião

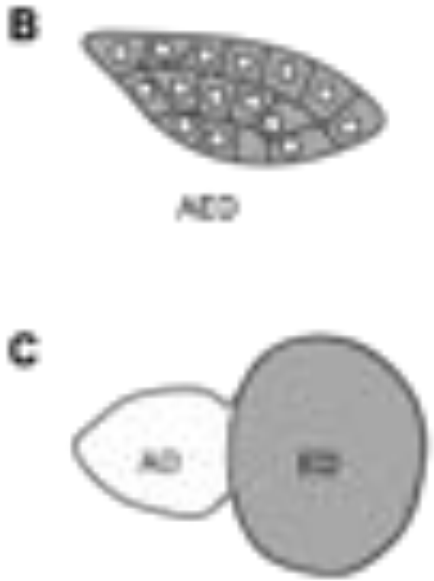
disco de antena-olho no estágio L1

disco de antena e disco de olho no estágio L3

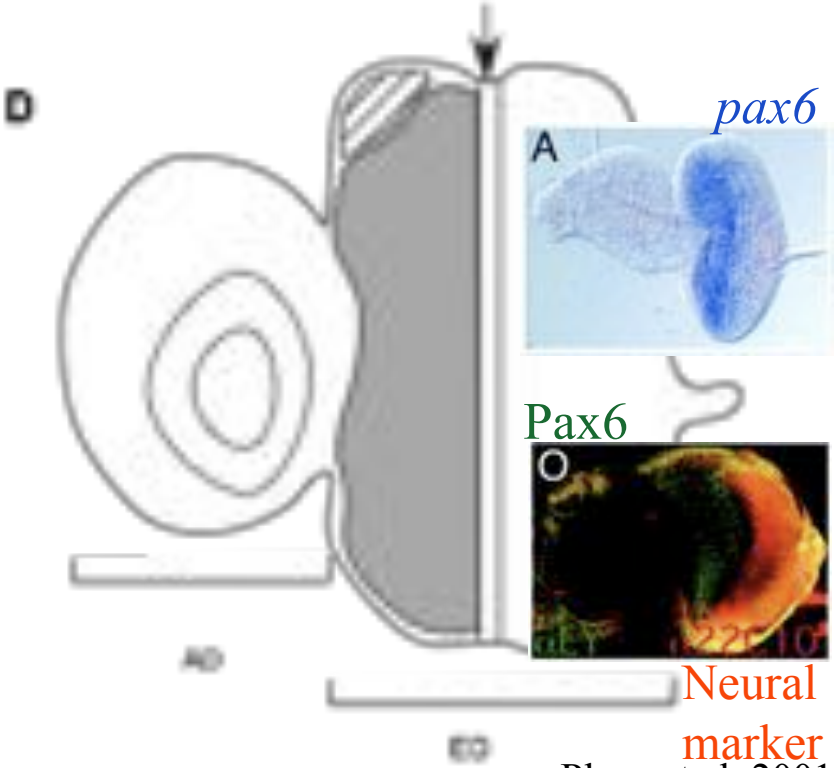


pax6 mARN

Callaerts et al. 2006

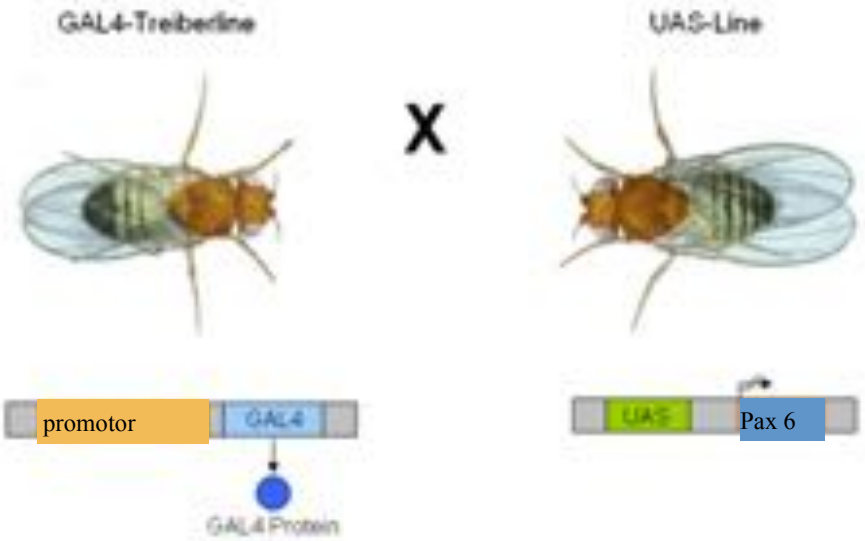


disco de antena y disco de ojo L2



Plaza et al. 2001

Sistema GAL4/UAS na *Drosophila melanogaster*

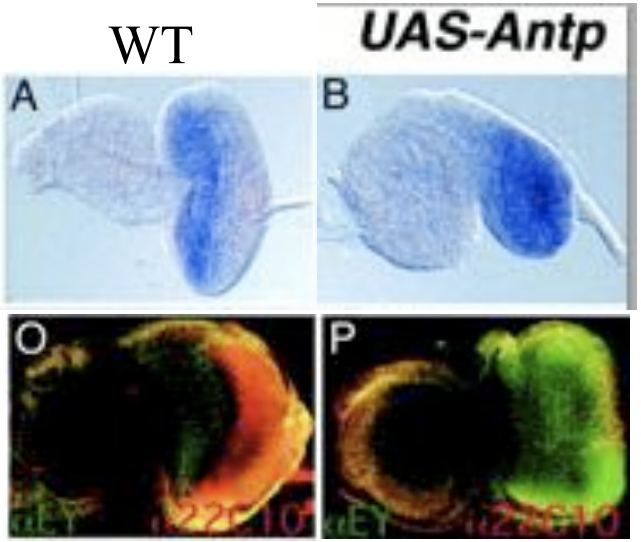


disco de antena e disco de olho em L3

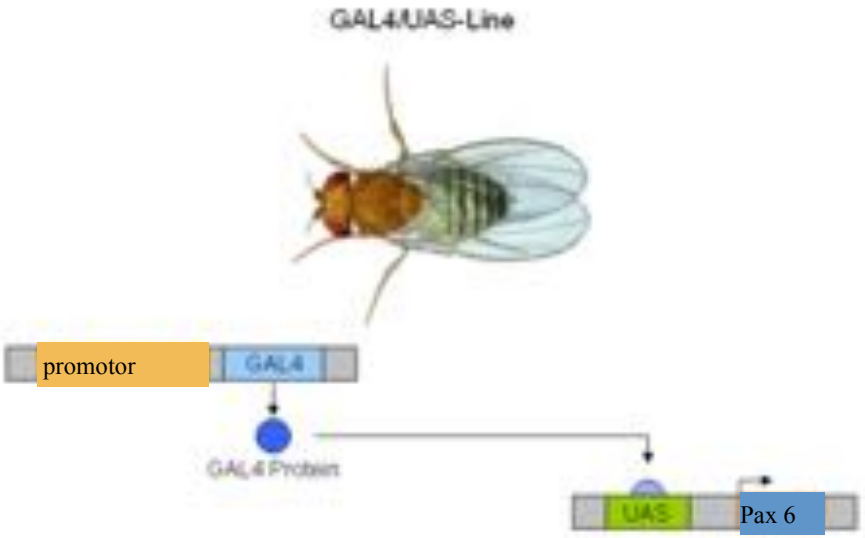
pax6

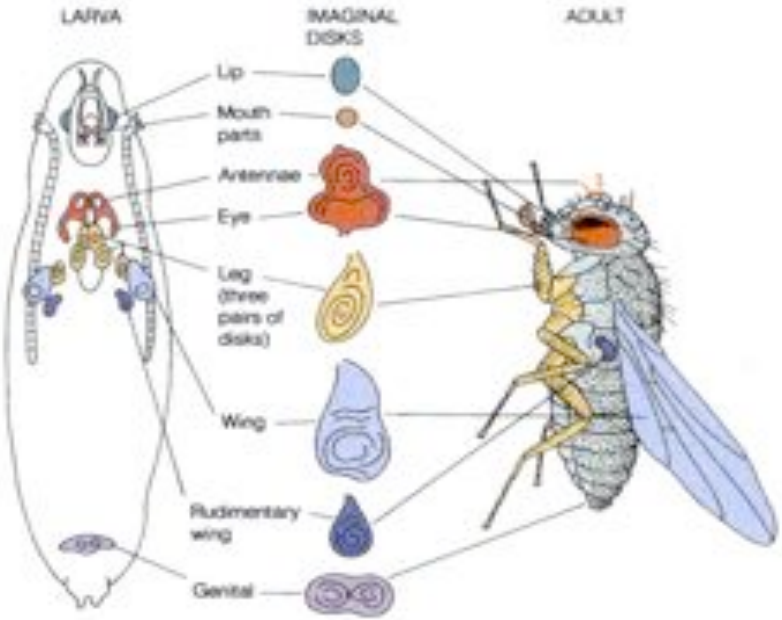
Pax6

Neural marker



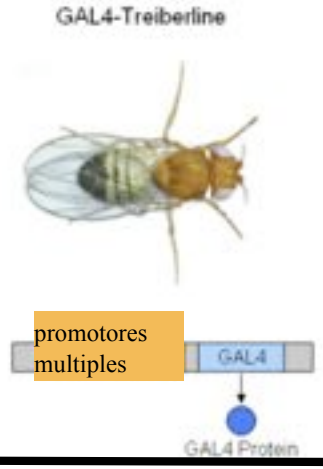
Plaza et al. 2001





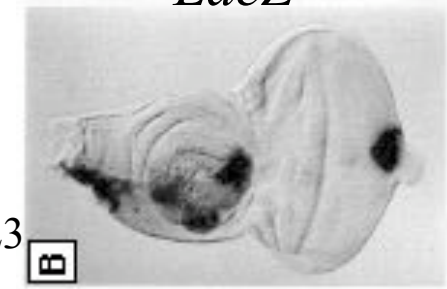
MASTER gen: *pax6*

Halder et al. 1995

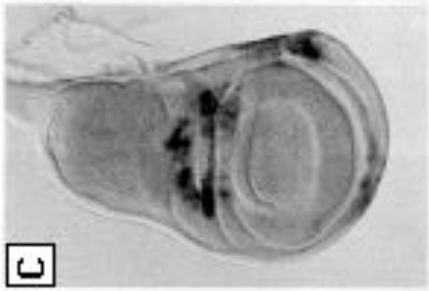


LacZ

disco de antena e disco de olho em L3



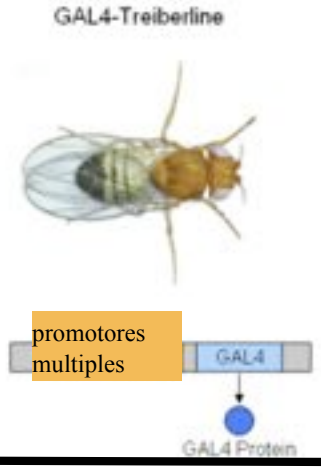
disco de aça em L3

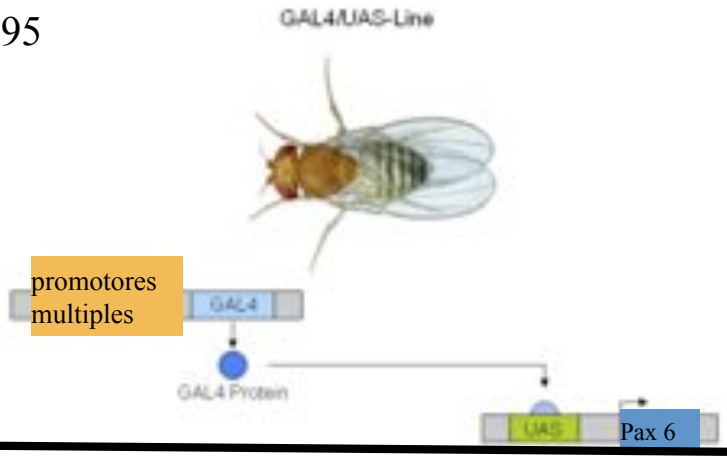


disco de perna em L3

MASTER gen: *pax6*

Halder et al. 1995

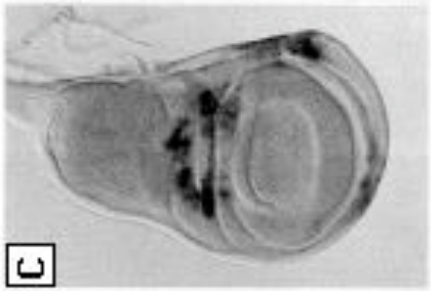




LacZ

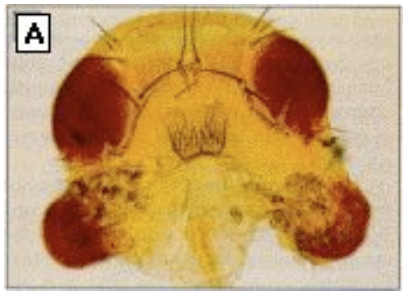
disco de antena e disco de olho em L3

disco de aça em L3



disco de perna em L3

cabeza



antena

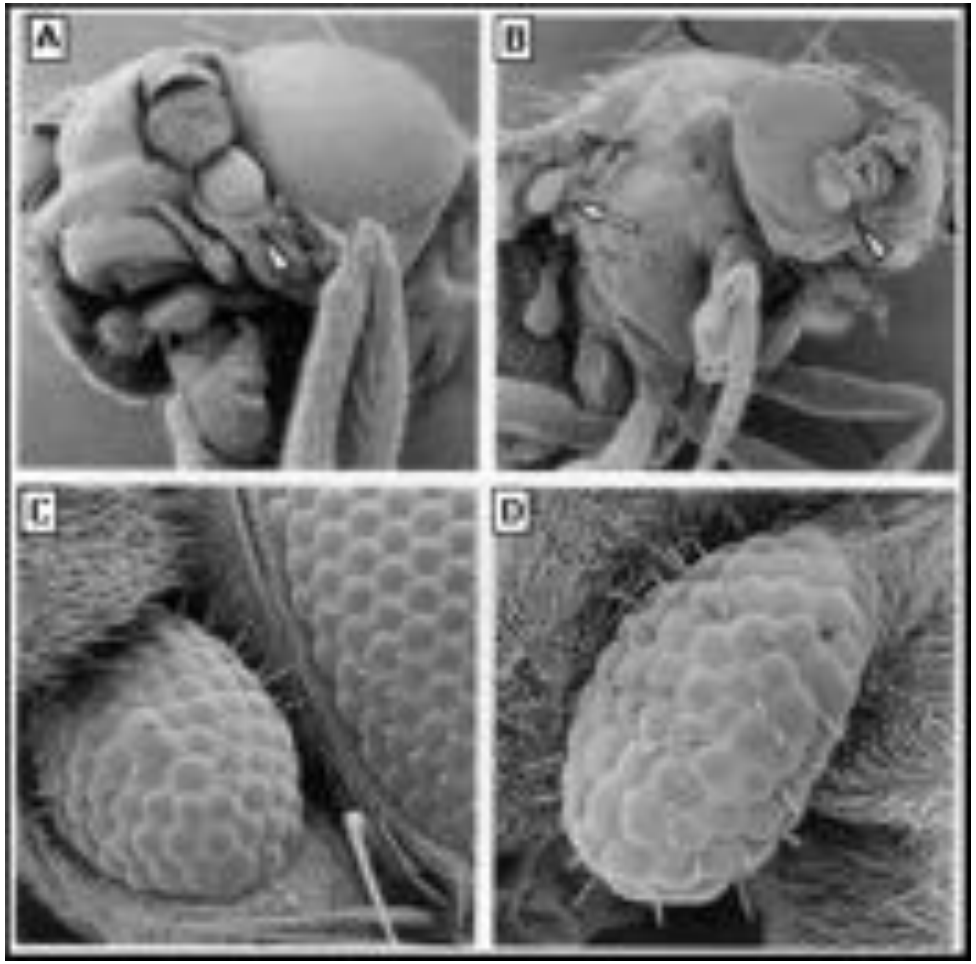
ala

patas

pata

Halder et al. 1995

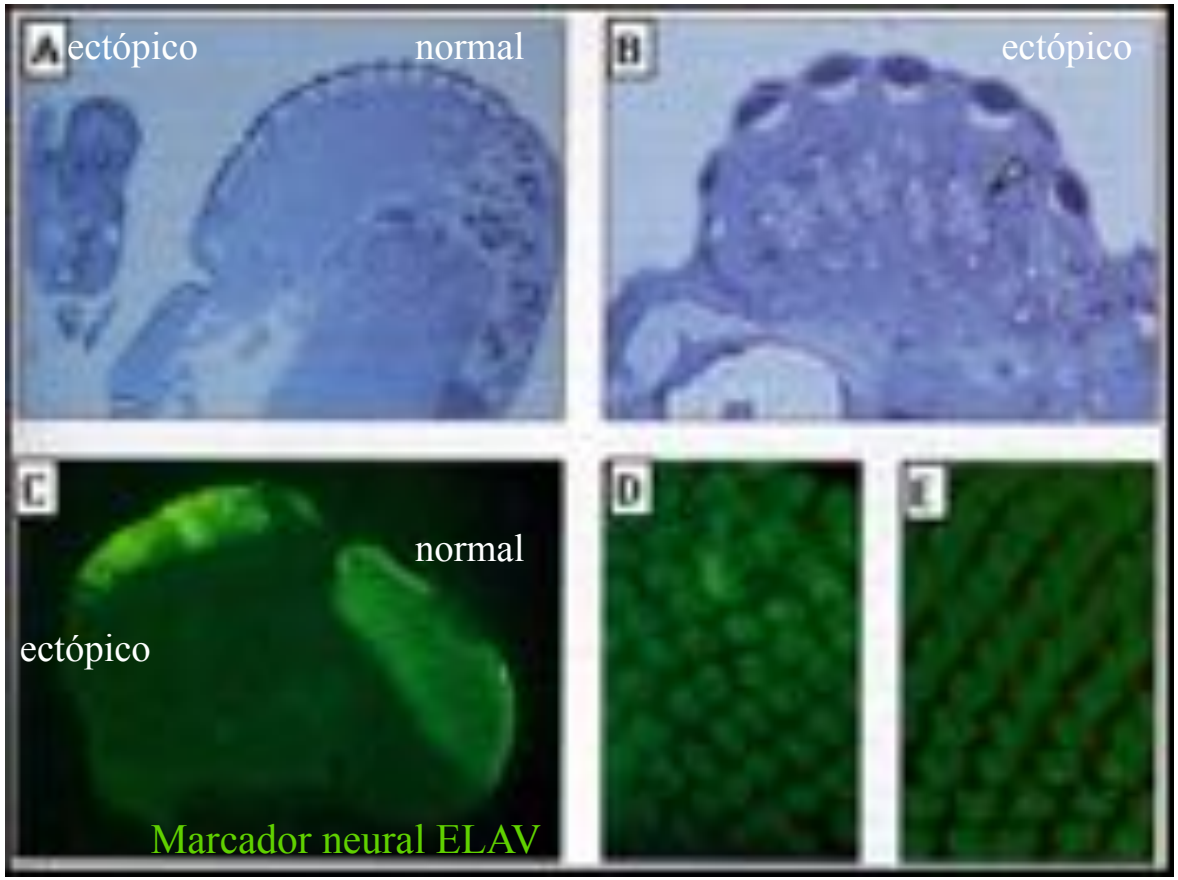
Microscopia electrónica de olhos ectópicos



Histologia e fotoreceptores em olhos ectópicos

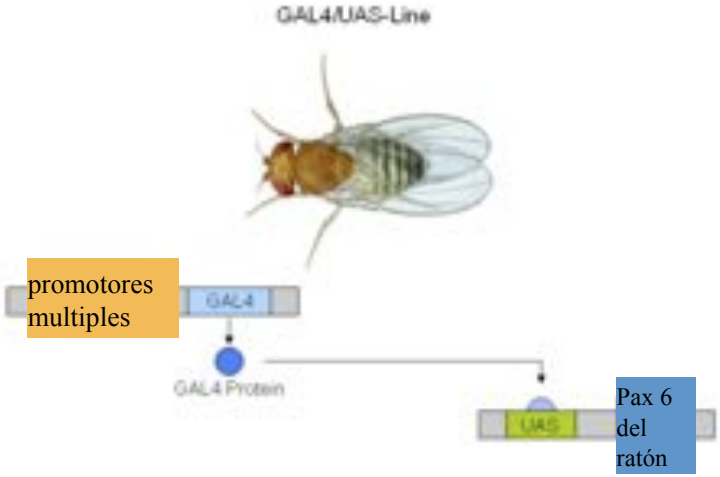
Olhos adultos

Disco de antena e olho em L3



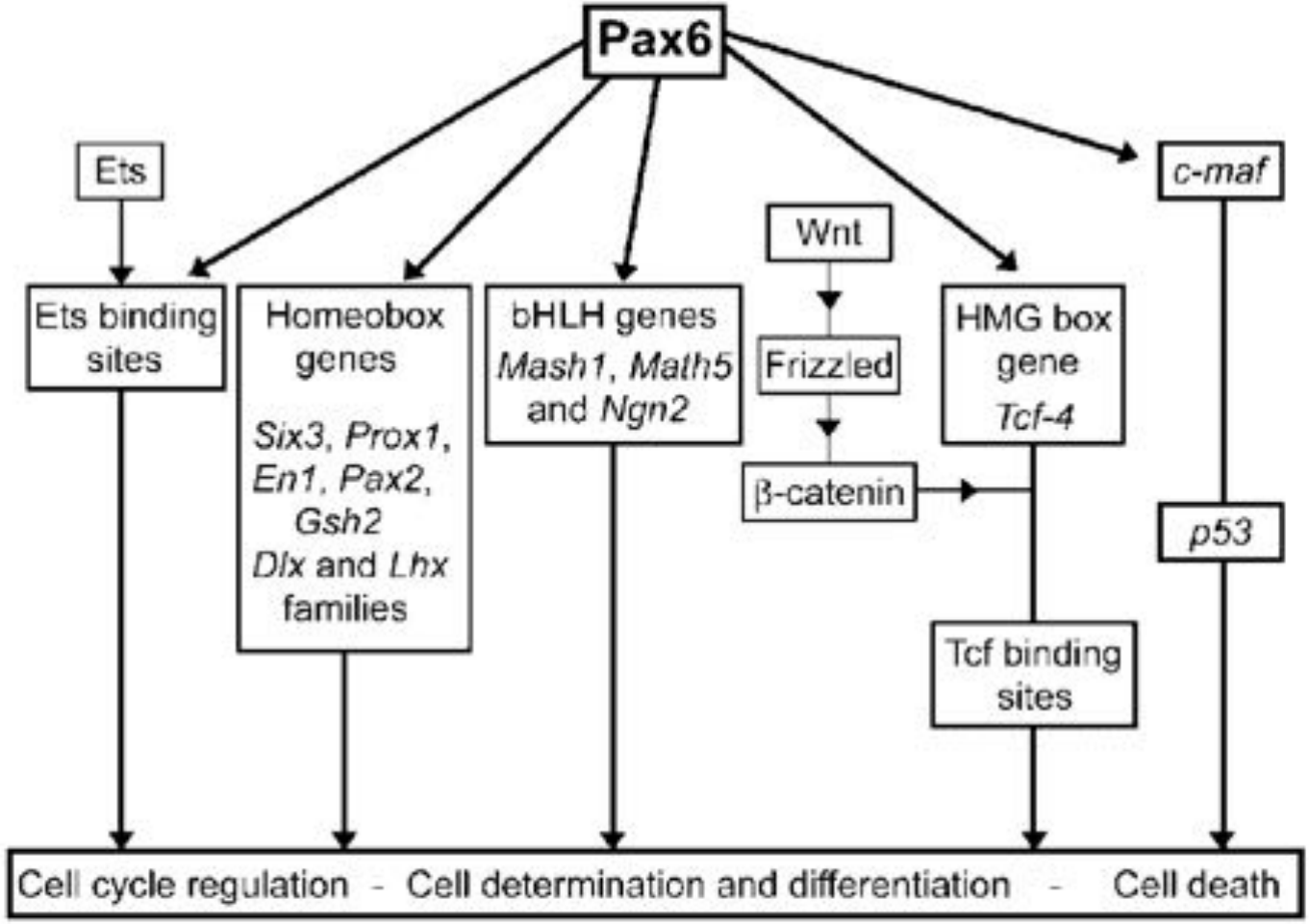
Azur II y azul de metileno

Pax6 do camondongo tambem gera olhos ectópicos



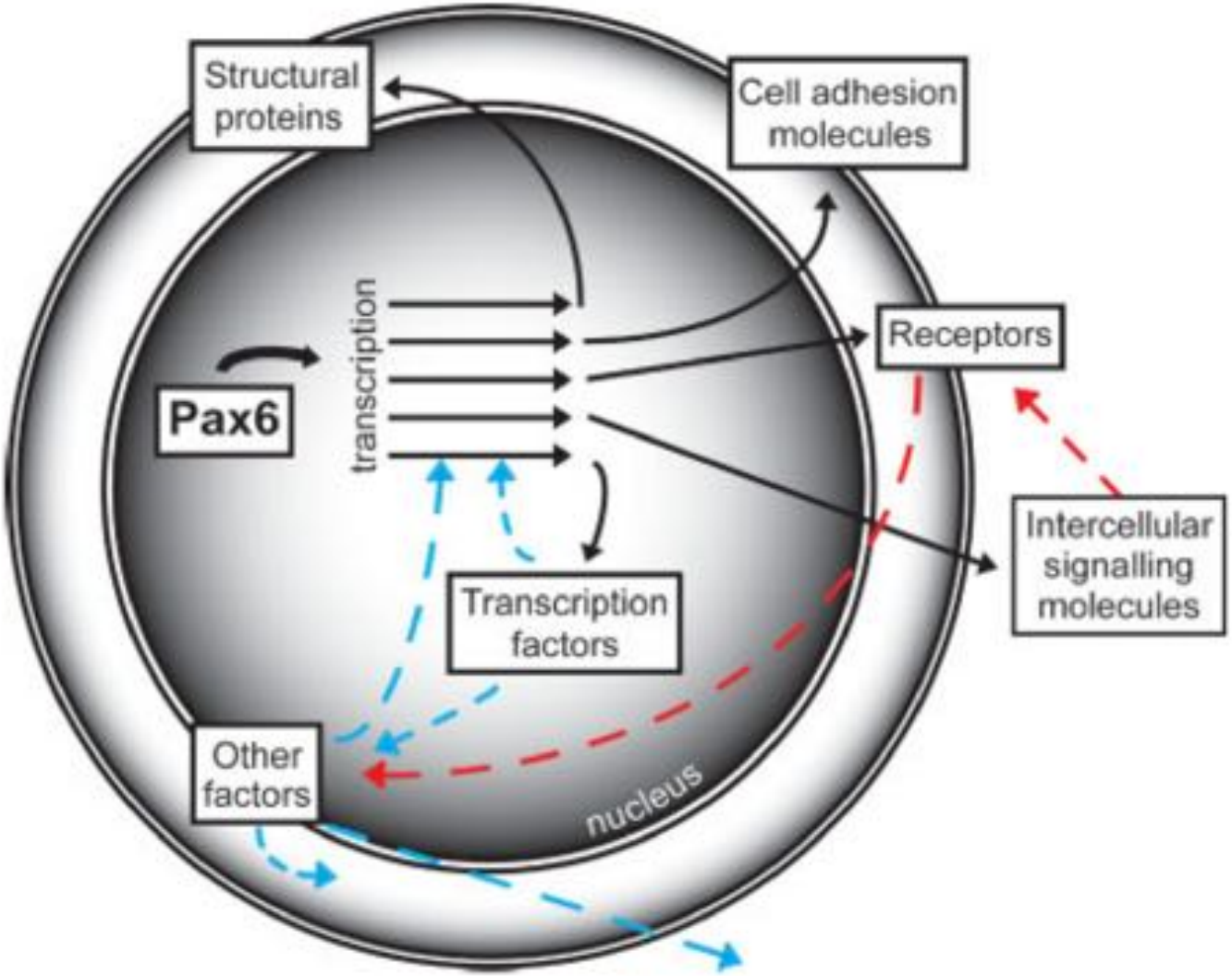
Efectos pleiotrópicos de Pax6

(MASTER ya no es tan MASTER, sino SUBMASTER)



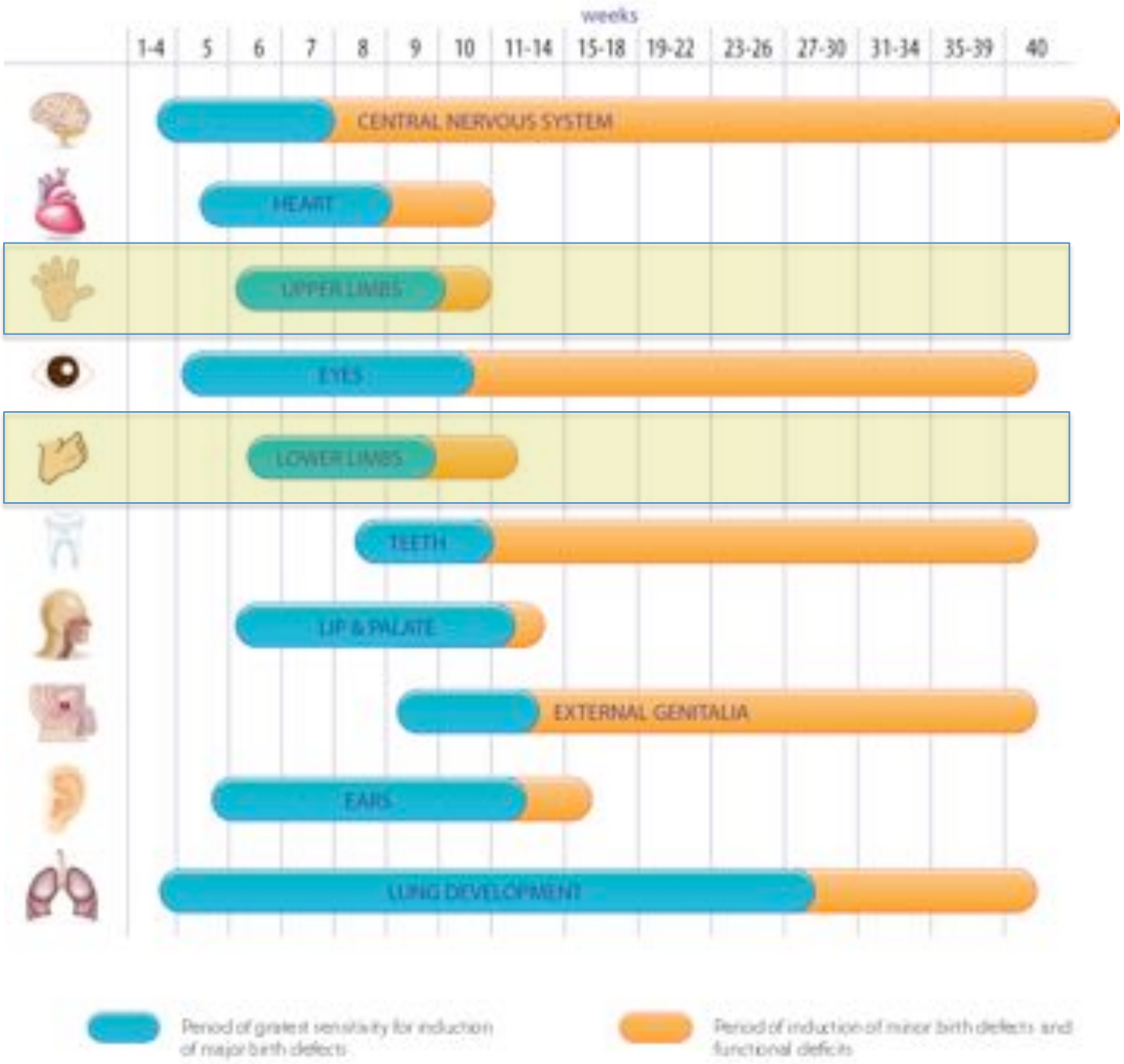
Simpson & Price, 2002

Efectos pleiotrópicos de Pax6

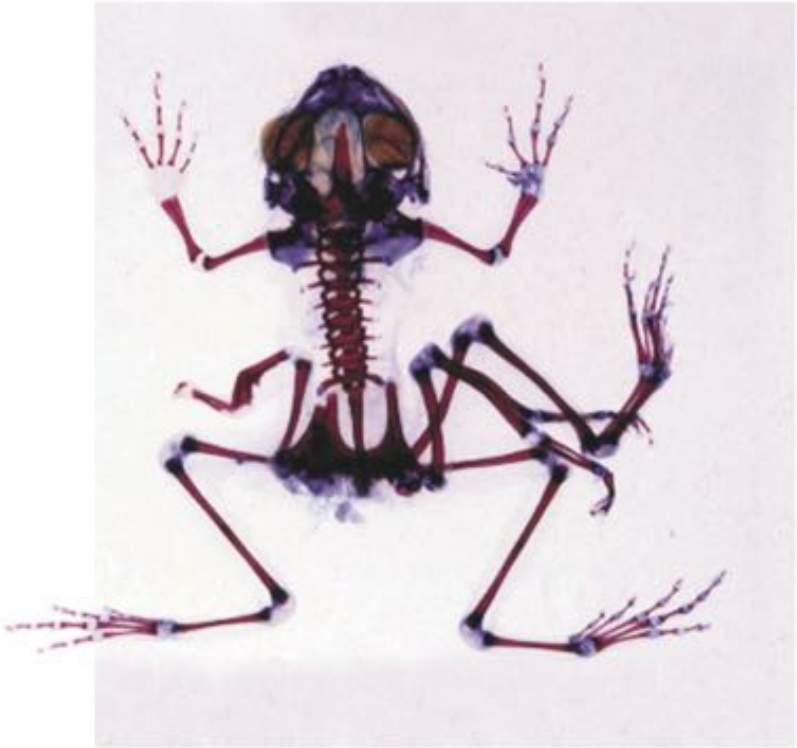


Simpson & Price, 2002

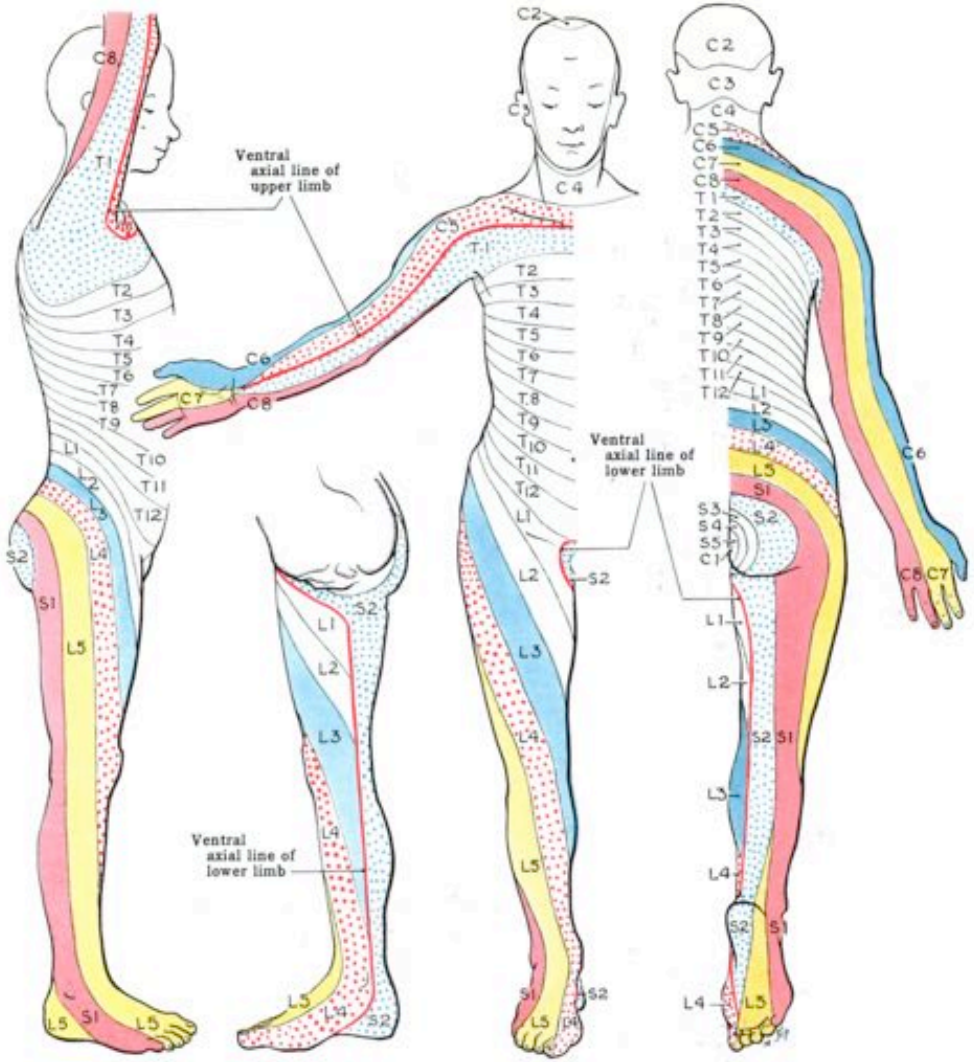
ORGANOGENESE:



Dermatomas:

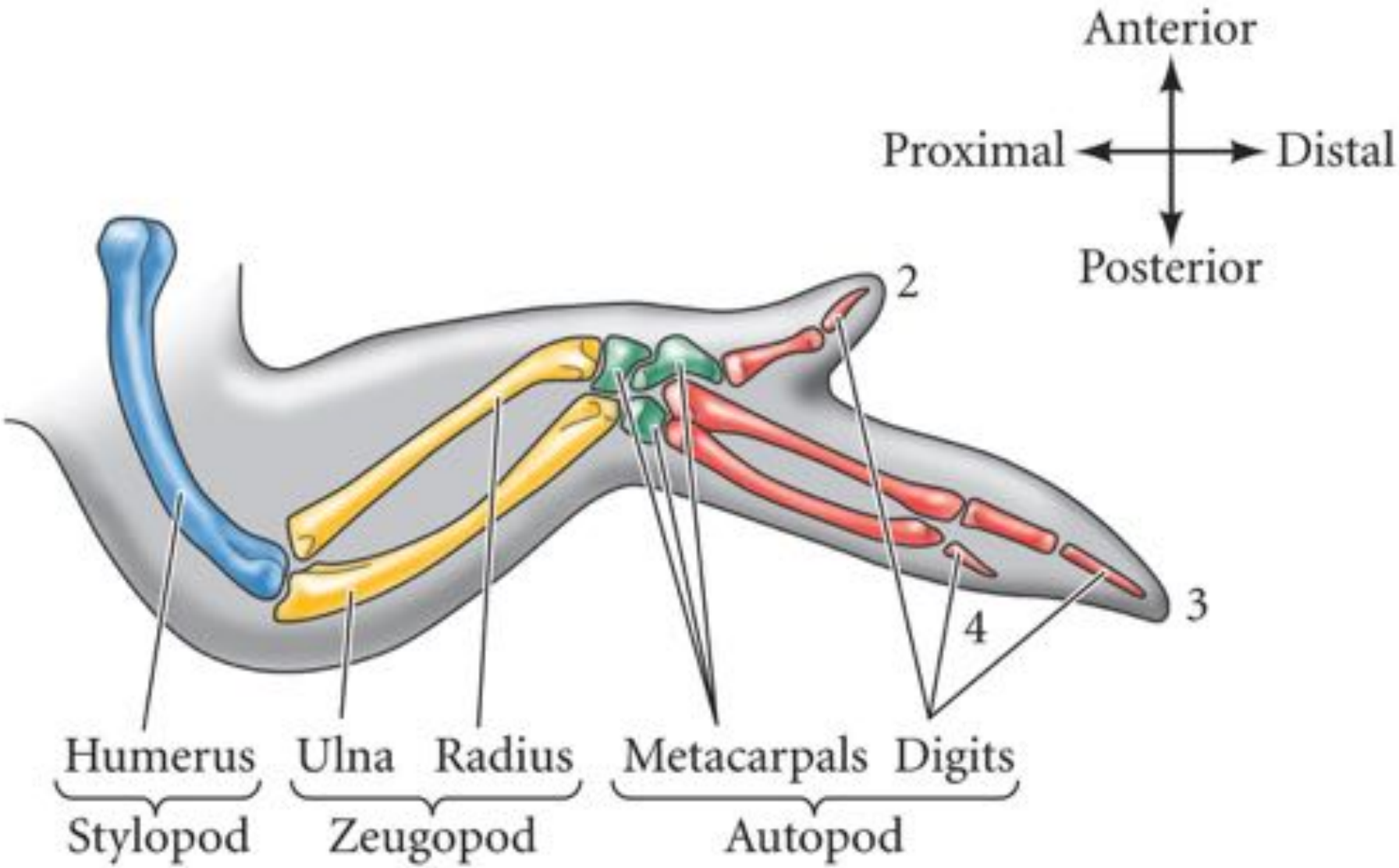


DEVELOPMENTAL BIOLOGY, Eighth Edition, Chapter 16, Opener © 2006 Sinauer Associates



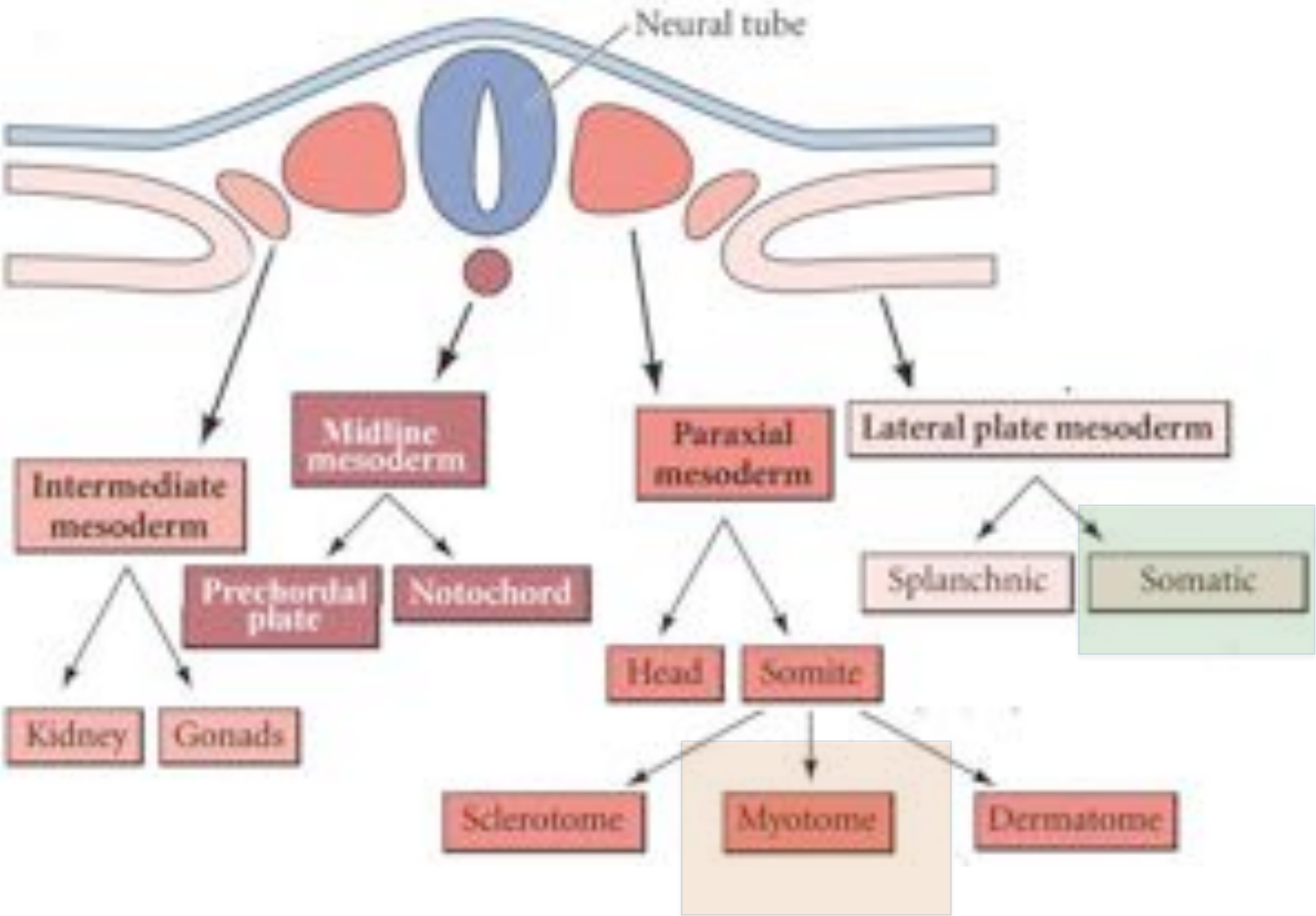
http://www.youtube.com/watch?v=VpbdqGJ9LWk

Skeletal pattern of the chick wing (limb axes)

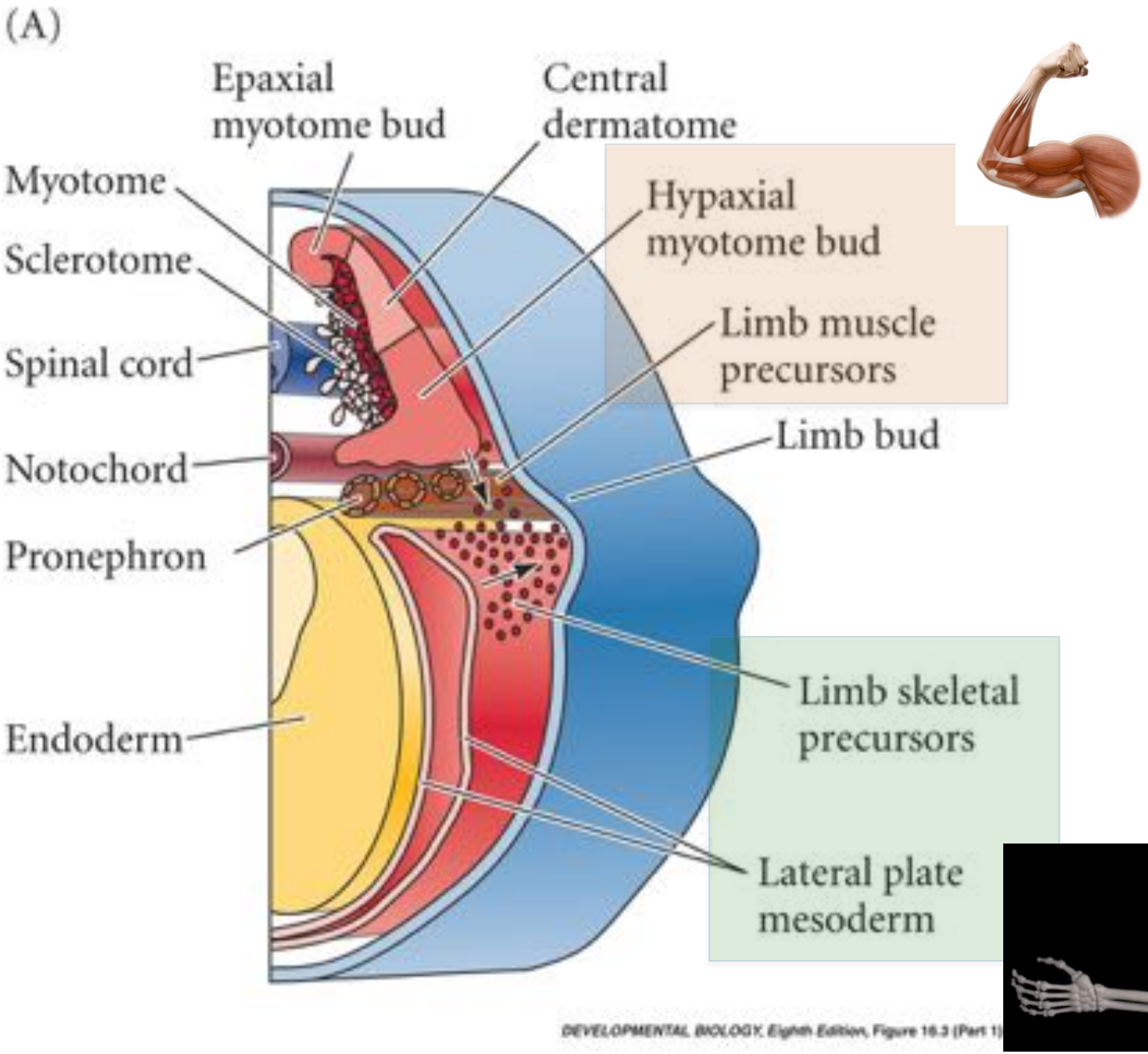


DEVELOPMENTAL BIOLOGY, Eighth Edition, Figure 16.1 © 2006 Sinauer Associates, Inc.

Mesoderm derivatives and limb bud precursors

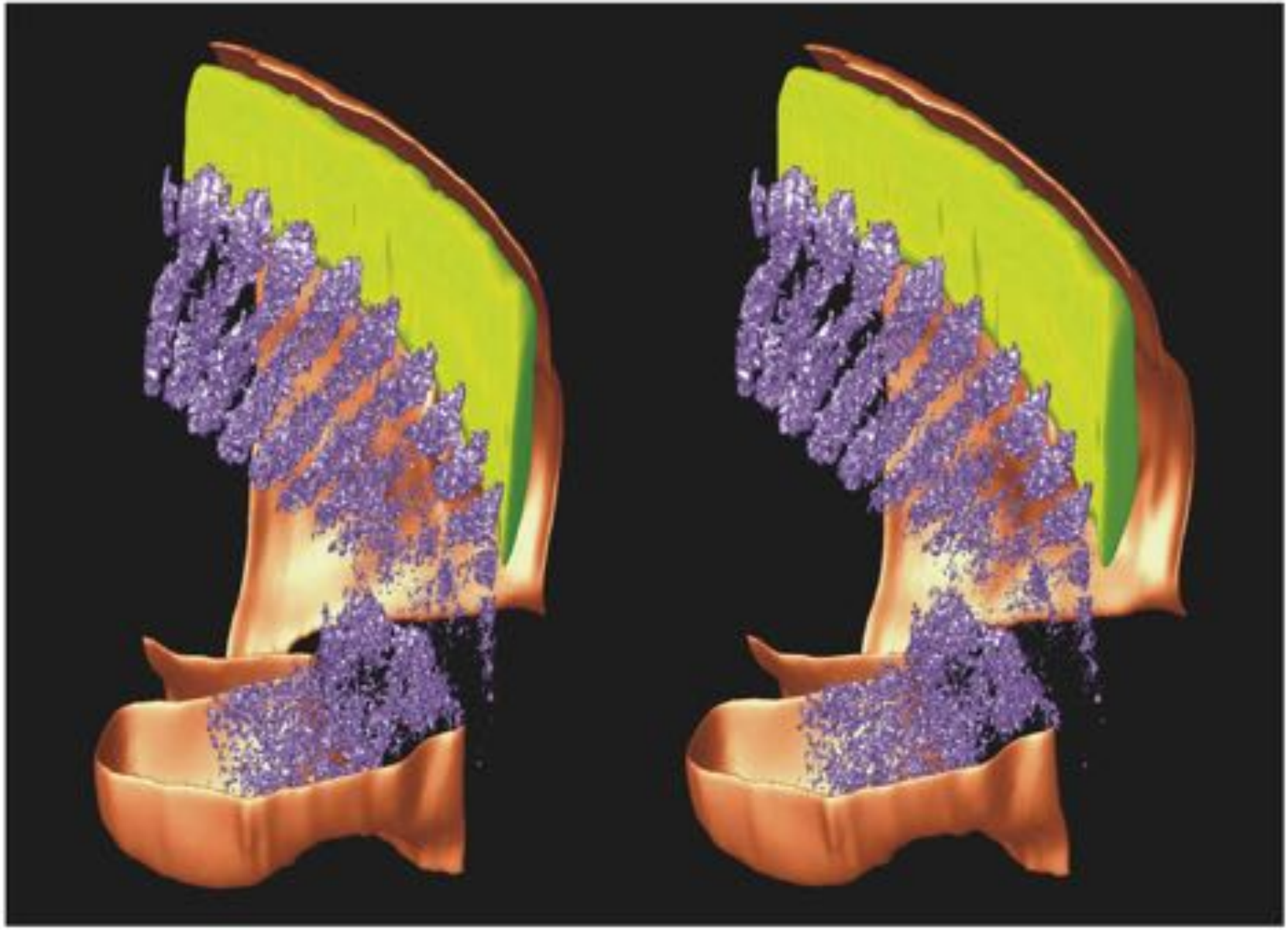


Proliferation of mesenchymal cells from the somatic region of the lateral plate mesoderm (skeleton) and the hypaxial myotome (muscle) causes the limb bud in the amphibian embryo to bulge outward



Proliferation of mesenchymal cells from the somatic region of the lateral plate mesoderm (skeleton) and the hypaxial myotome (muscle) causes the limb bud in the amphibian embryo to bulge outward

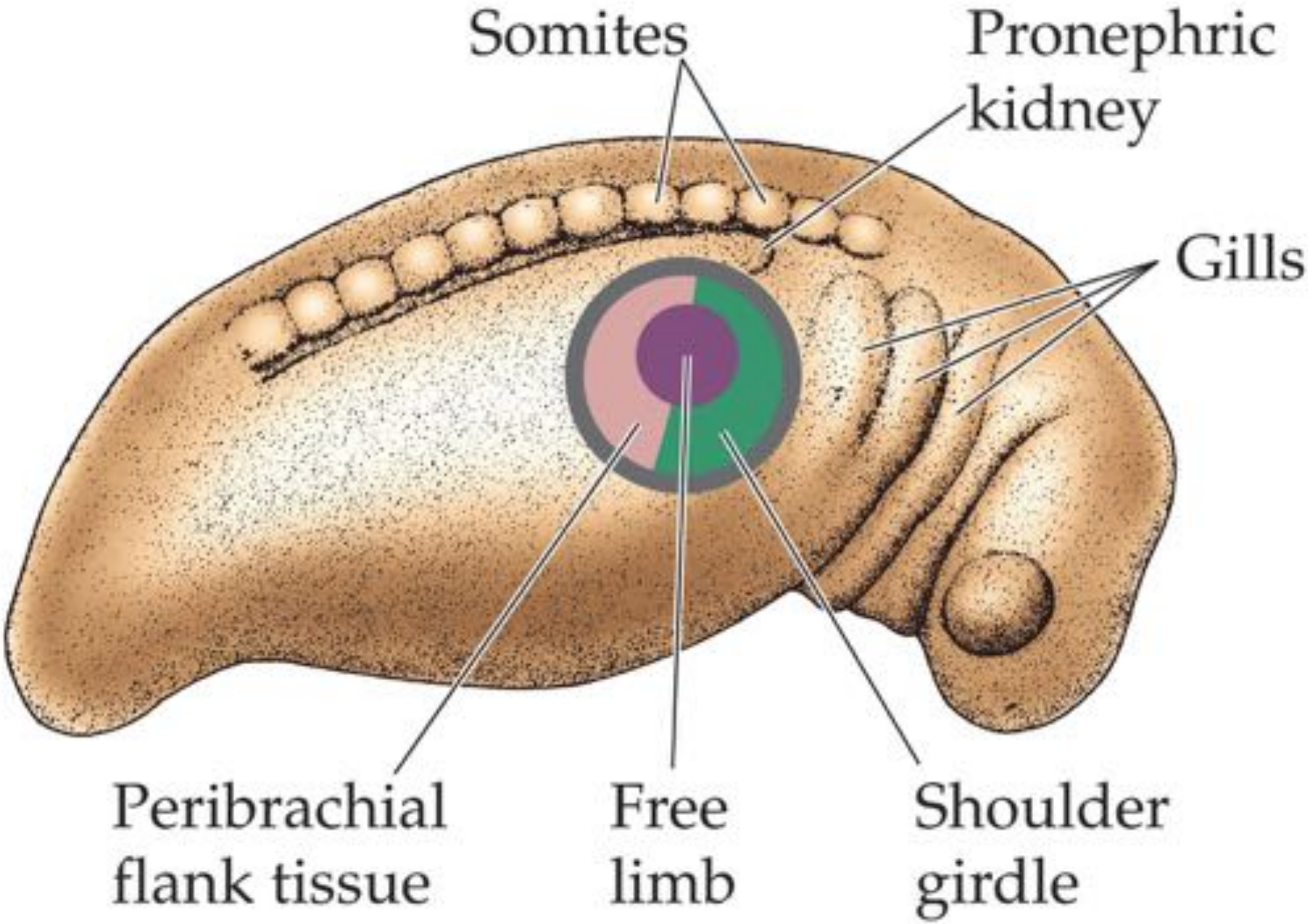
(B)



myf5 (developing muscle) cells in purple

DEVELOPMENTAL BIOLOGY, Eighth Edition, Figure 16.3 (Part 2) © 2006 Sinauer Associates, Inc.

Prospective forelimb field of the salamander *Ambystoma maculatum*



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The regulative nature of the limb field:
A multilimbed *Hyla regilla* and other frogs are the result of ????

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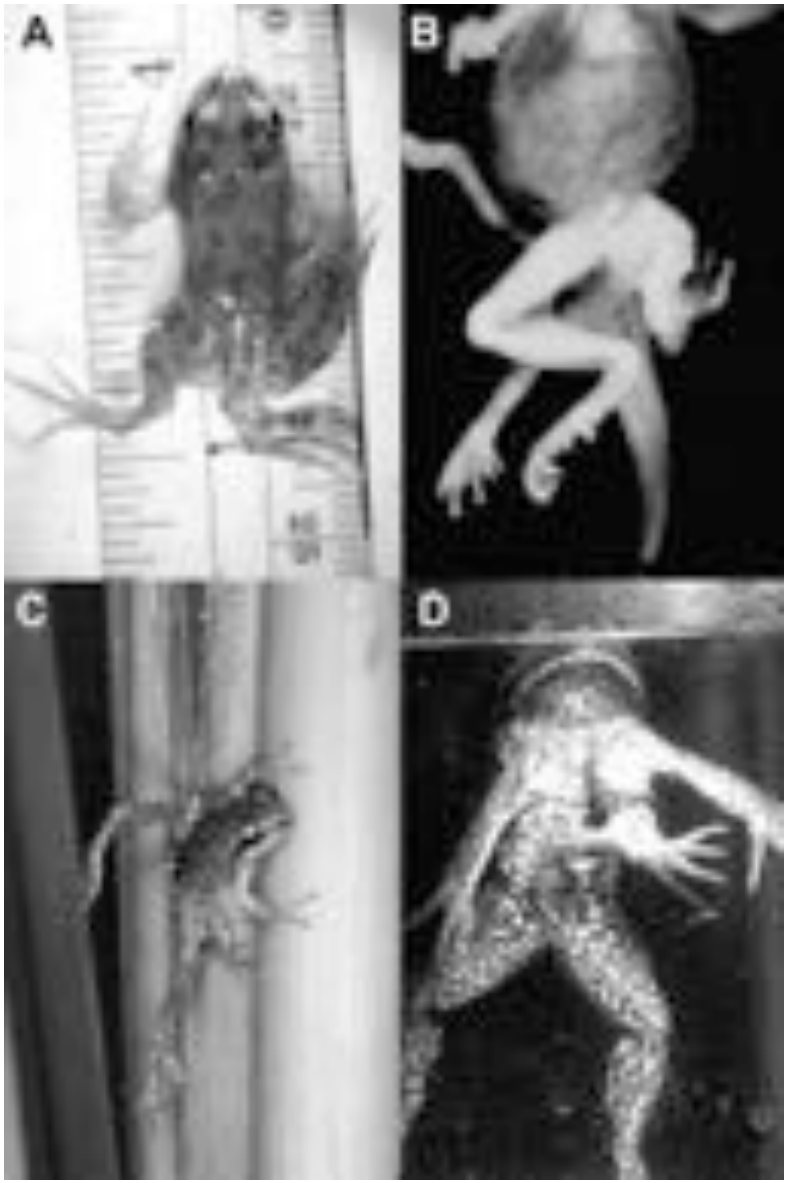

?

ANSWER: A multilimbed *Hyla regilla* is the result of infestation of the tadpole-stage developing limb buds by trematode cysts

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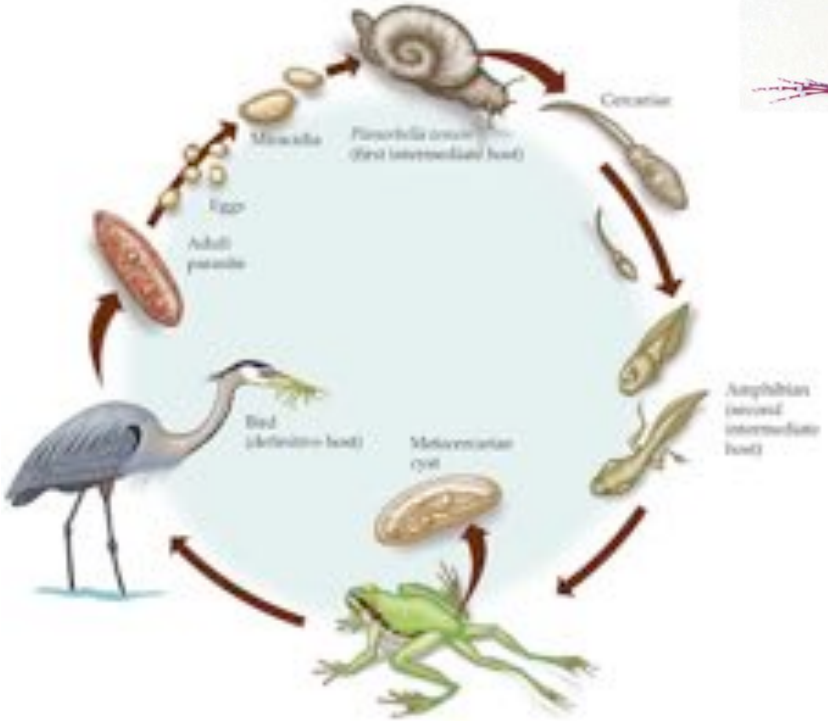
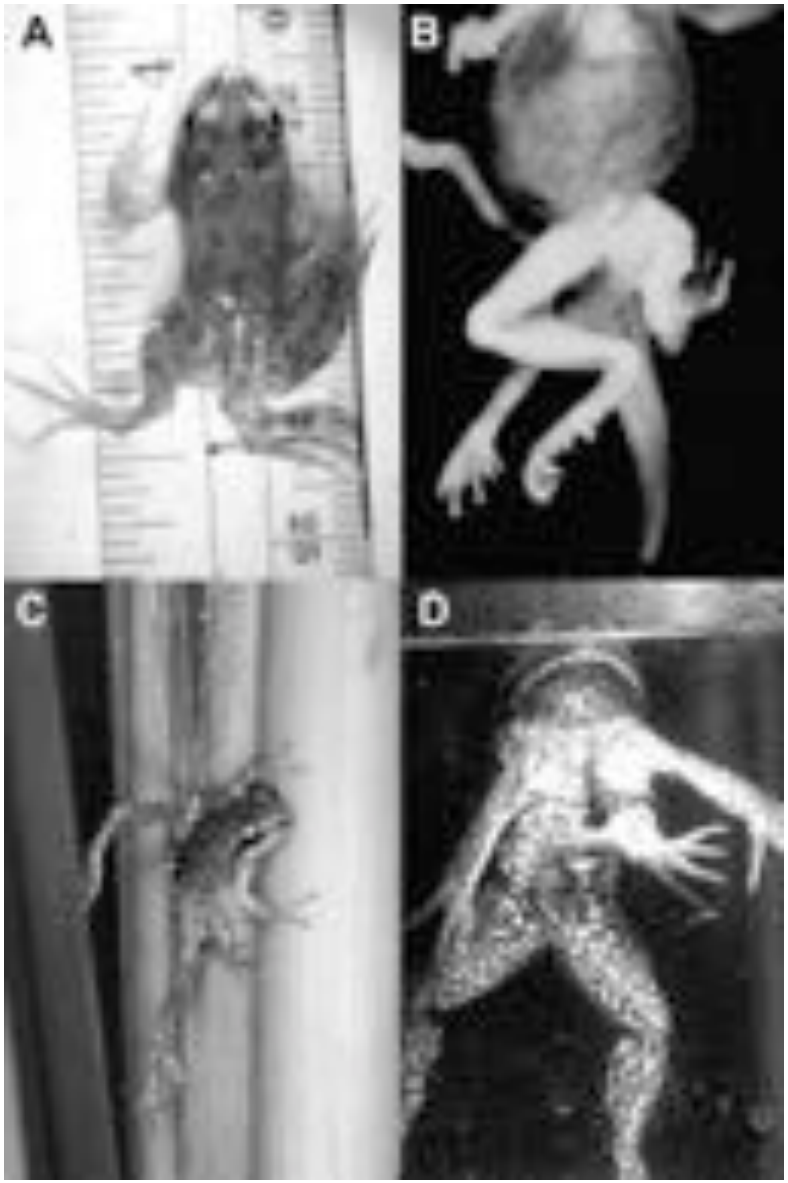


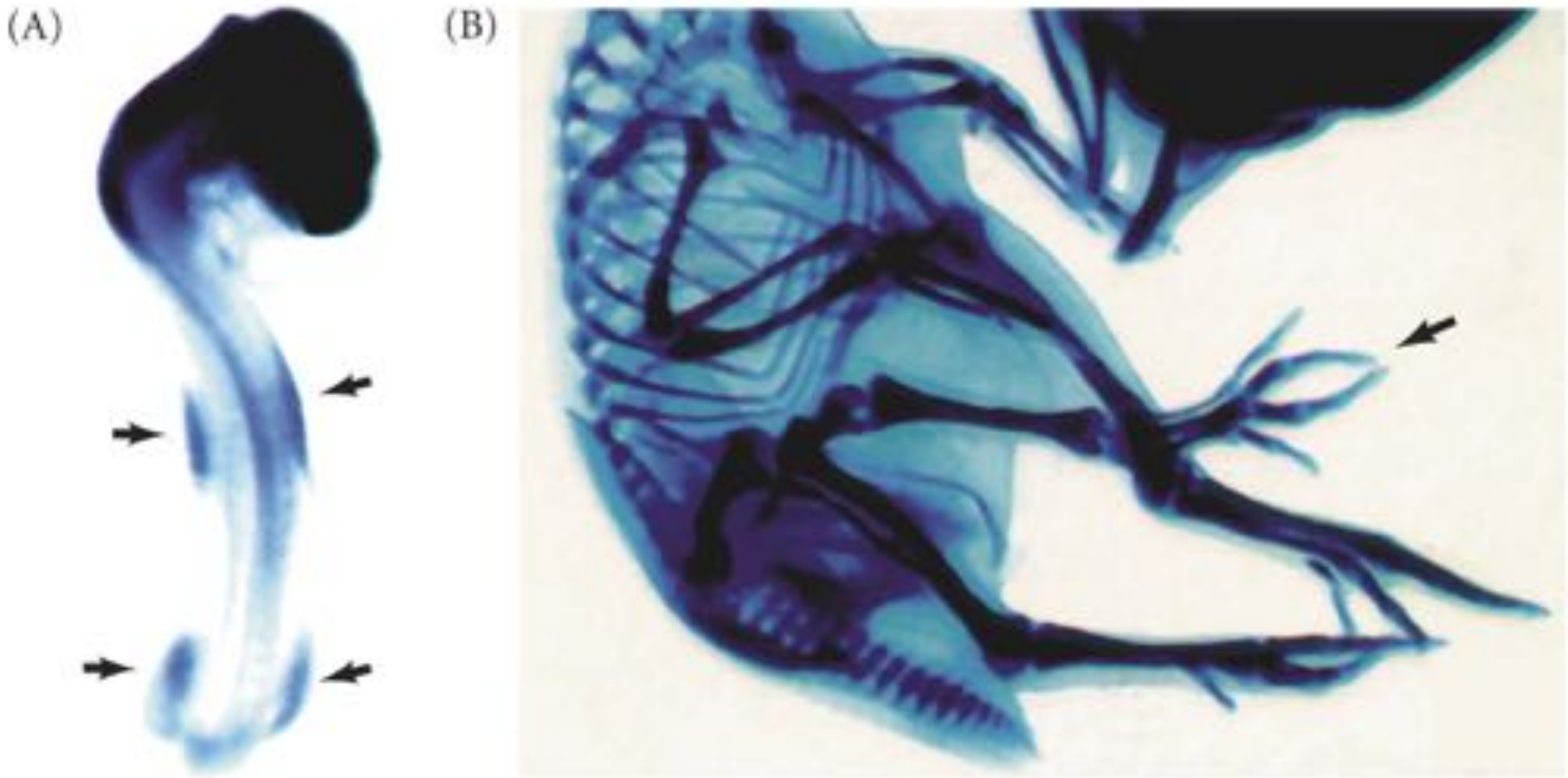


Highlight work by John Saunders (Vade Mecum 3)

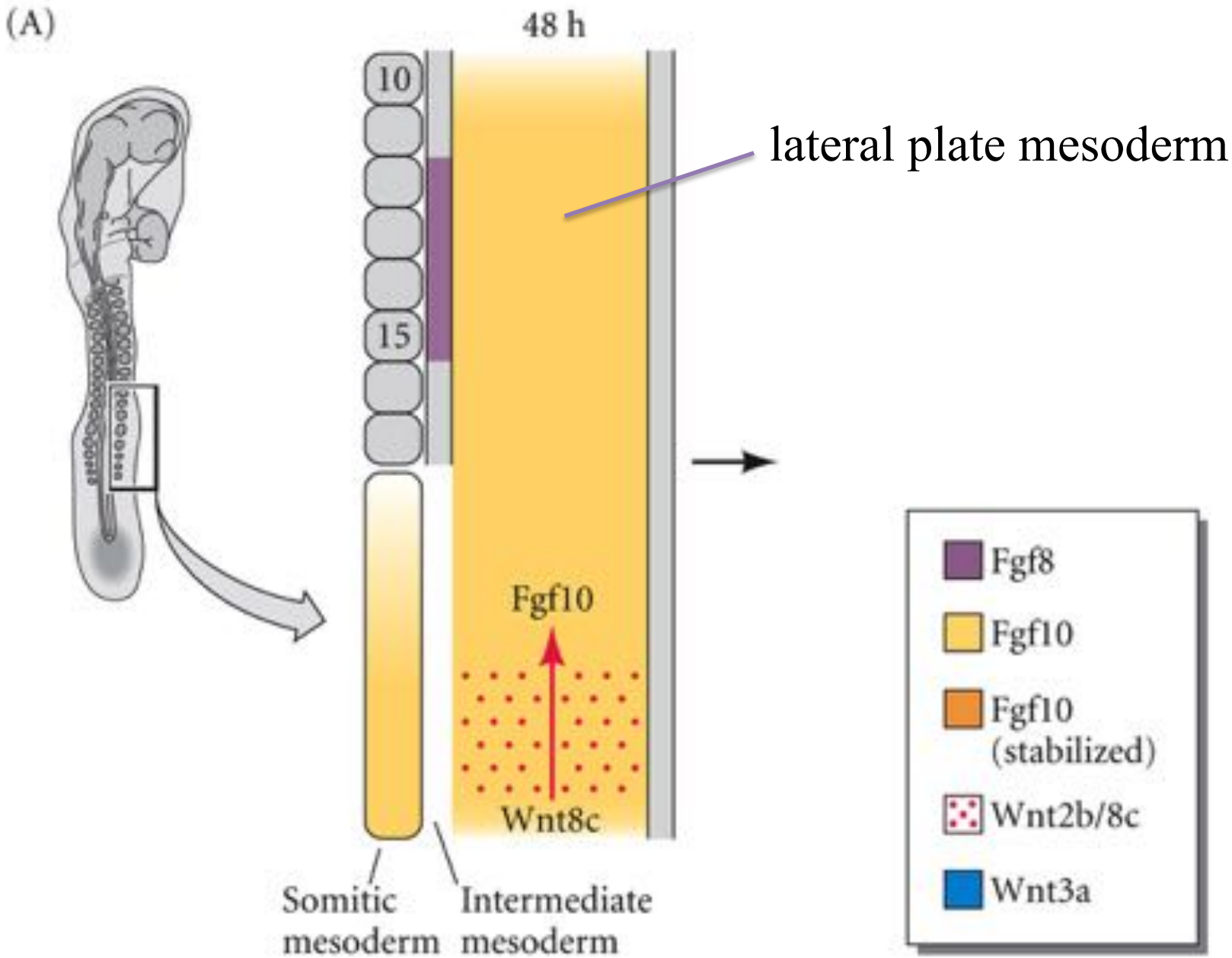
Dr. Saunders' Physiology Lab at Marquette in the early 1950's. Dr. Saunders is in the middle with the pipe.

Dr. John saunders at Marquette University in the 1960's.

Expressão de Fgf10 e ação sobre os membros em desenvolvimento da galinha



Modelo molecular da iniciação do desenvolvimento do broto de membro na galinha de **48 horas** de incubação (Parte 1)



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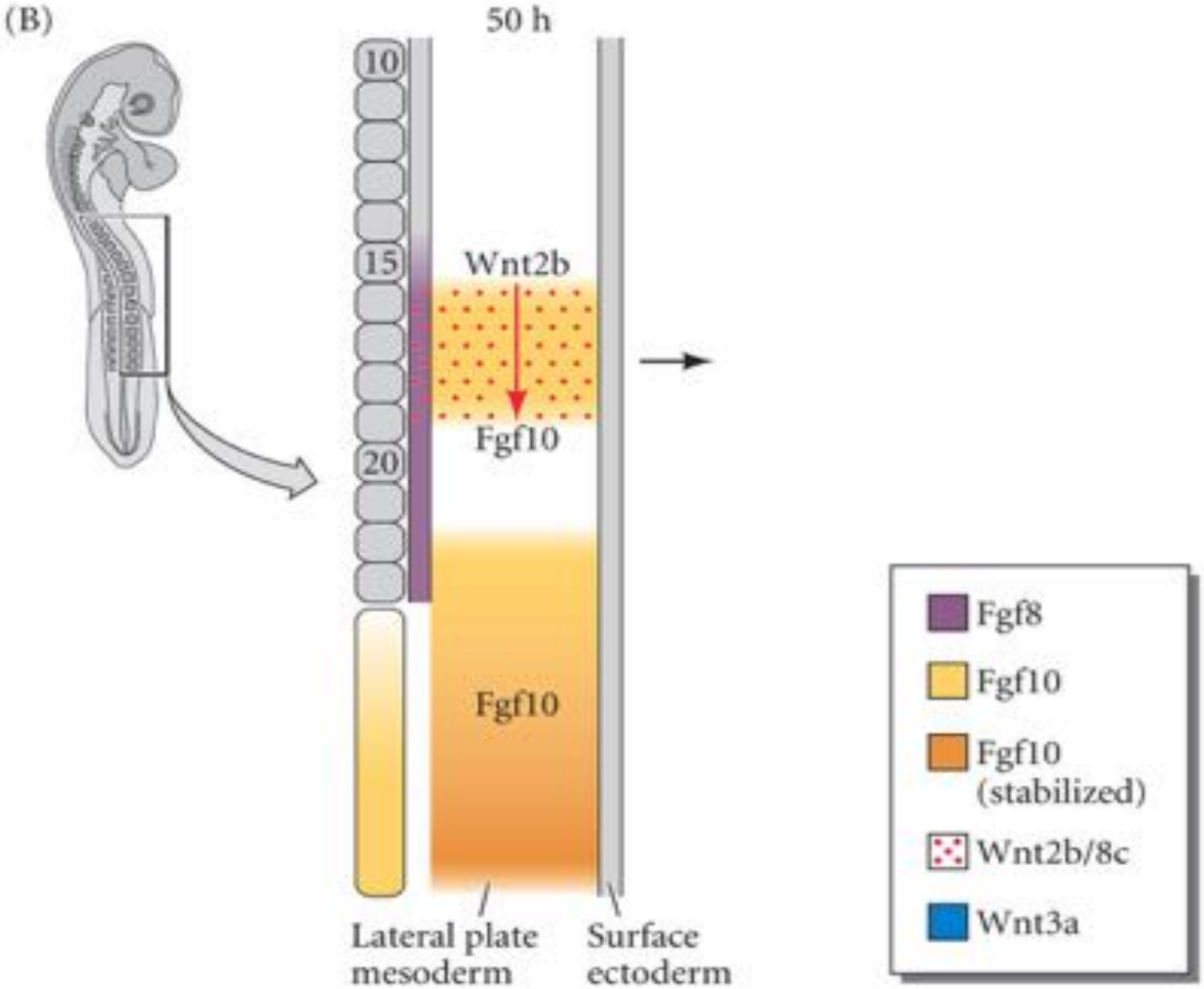
Modelo molecular da iniciação do desenvolvimento do broto de membro na galinha de **50 horas** de incubação (Parte 2)



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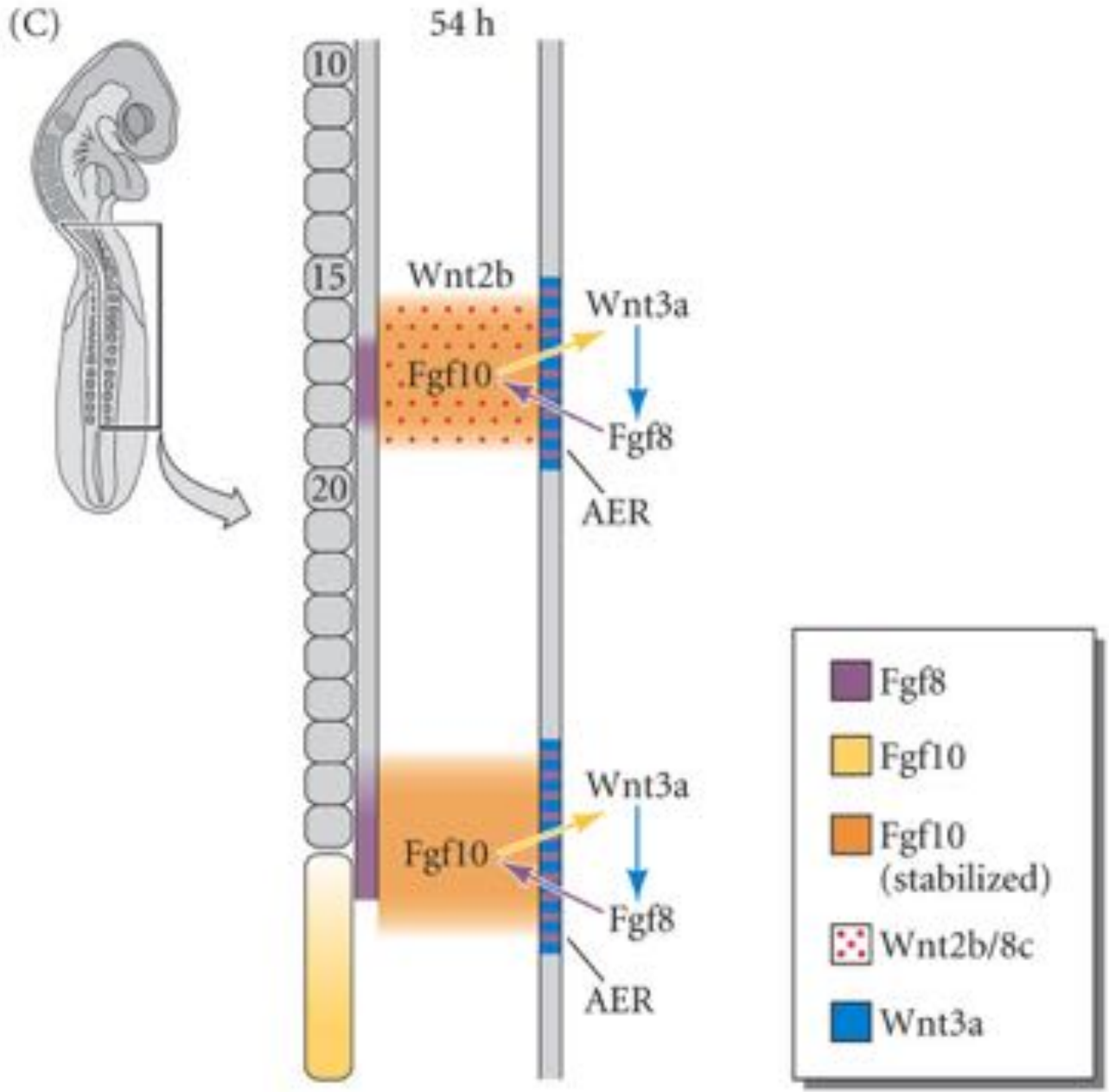
Modelo molecular da iniciação do desenvolvimento do broto de membro na galinha de **54 horas** de incubação (Parte 3)



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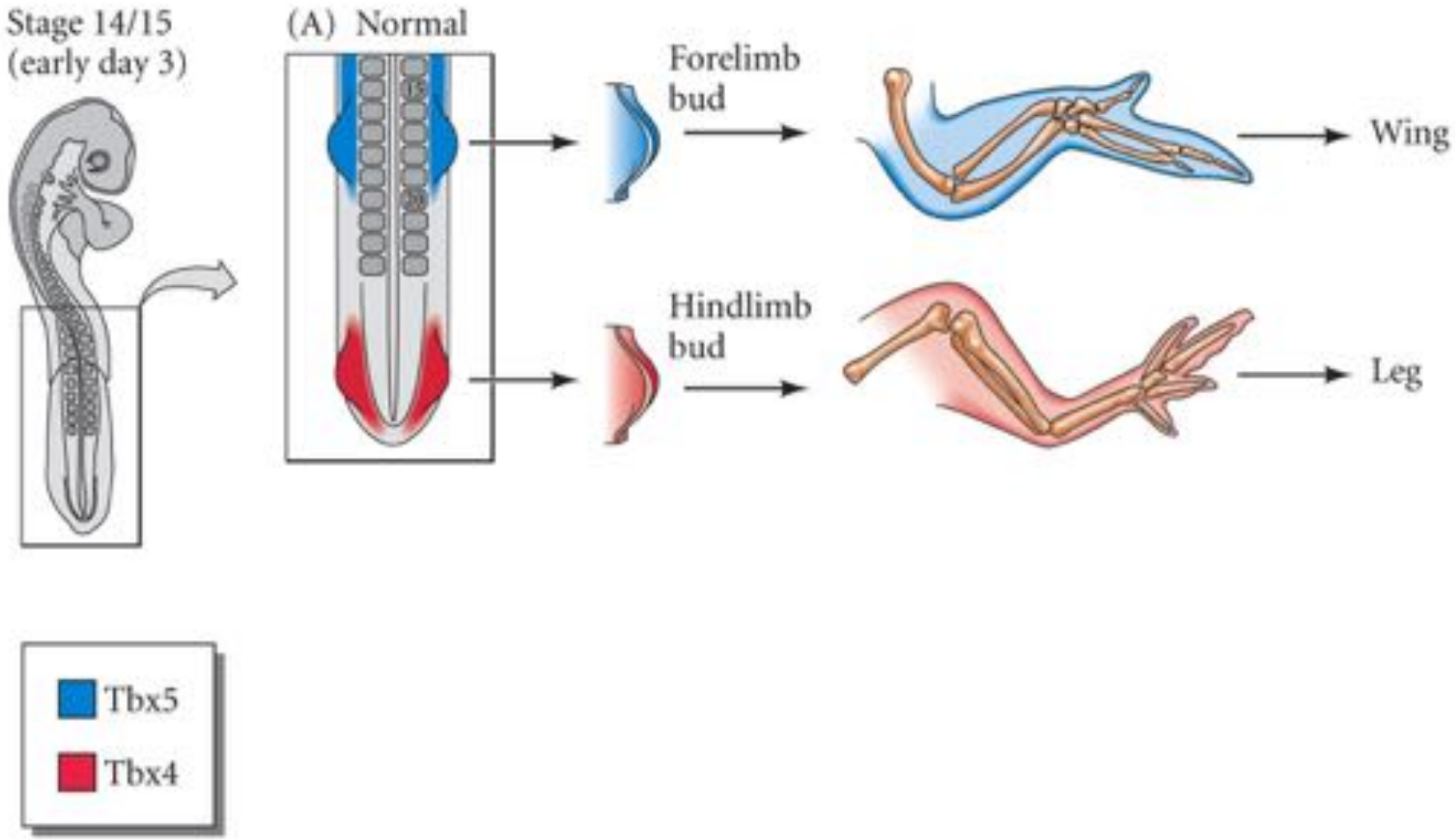
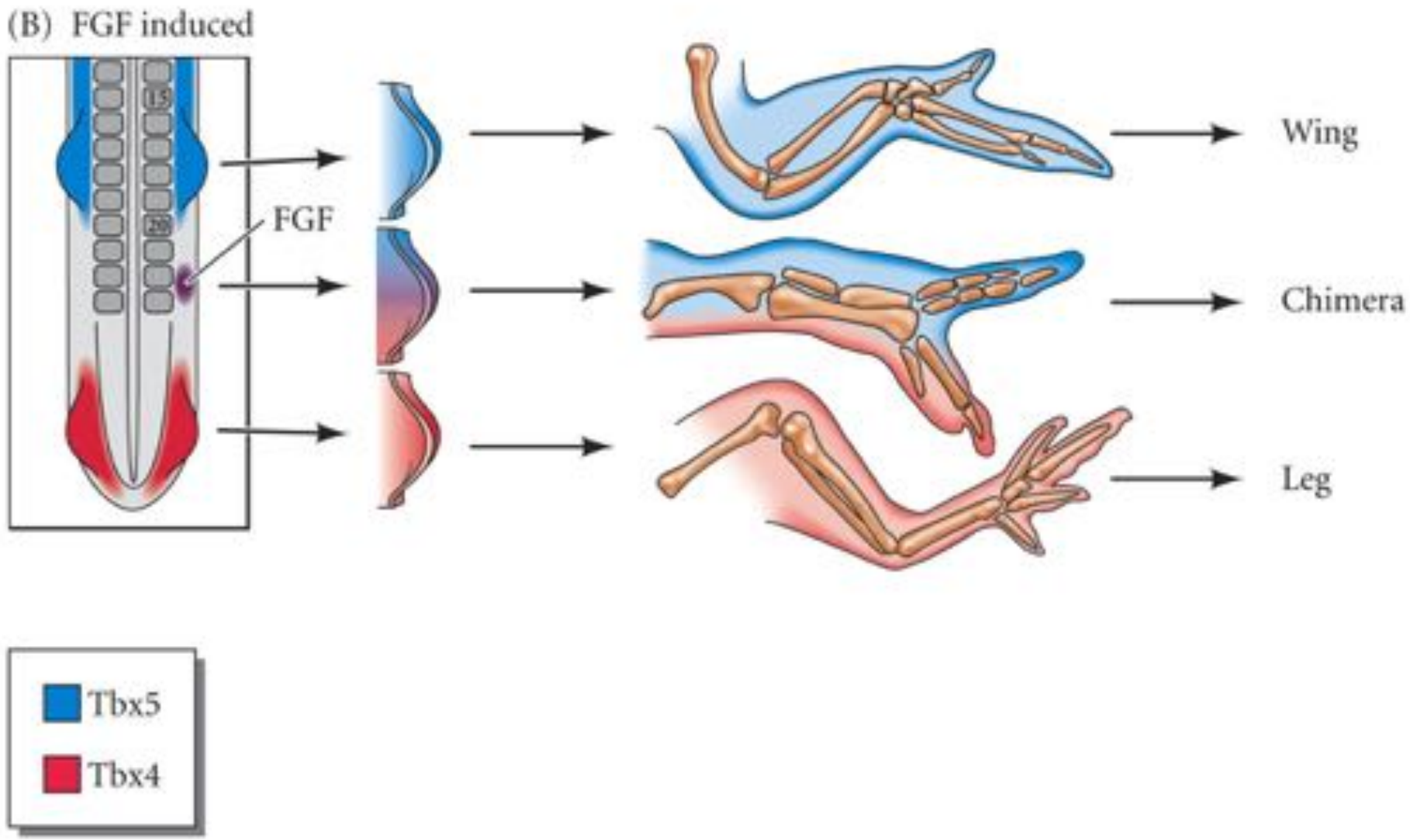
Identidade do membro anterior e posterior: Especificação por Tbx4 and Tbx5 (Parte 1)



DEVELOPMENTAL BIOLOGY, Eighth Edition, Figure 16.7 (Part 1) © 2006 Sinauer Associates, Inc.

Identidade do membro anterior e posterior: Especificação por Tbx4 and Tbx5 (Parte 2)



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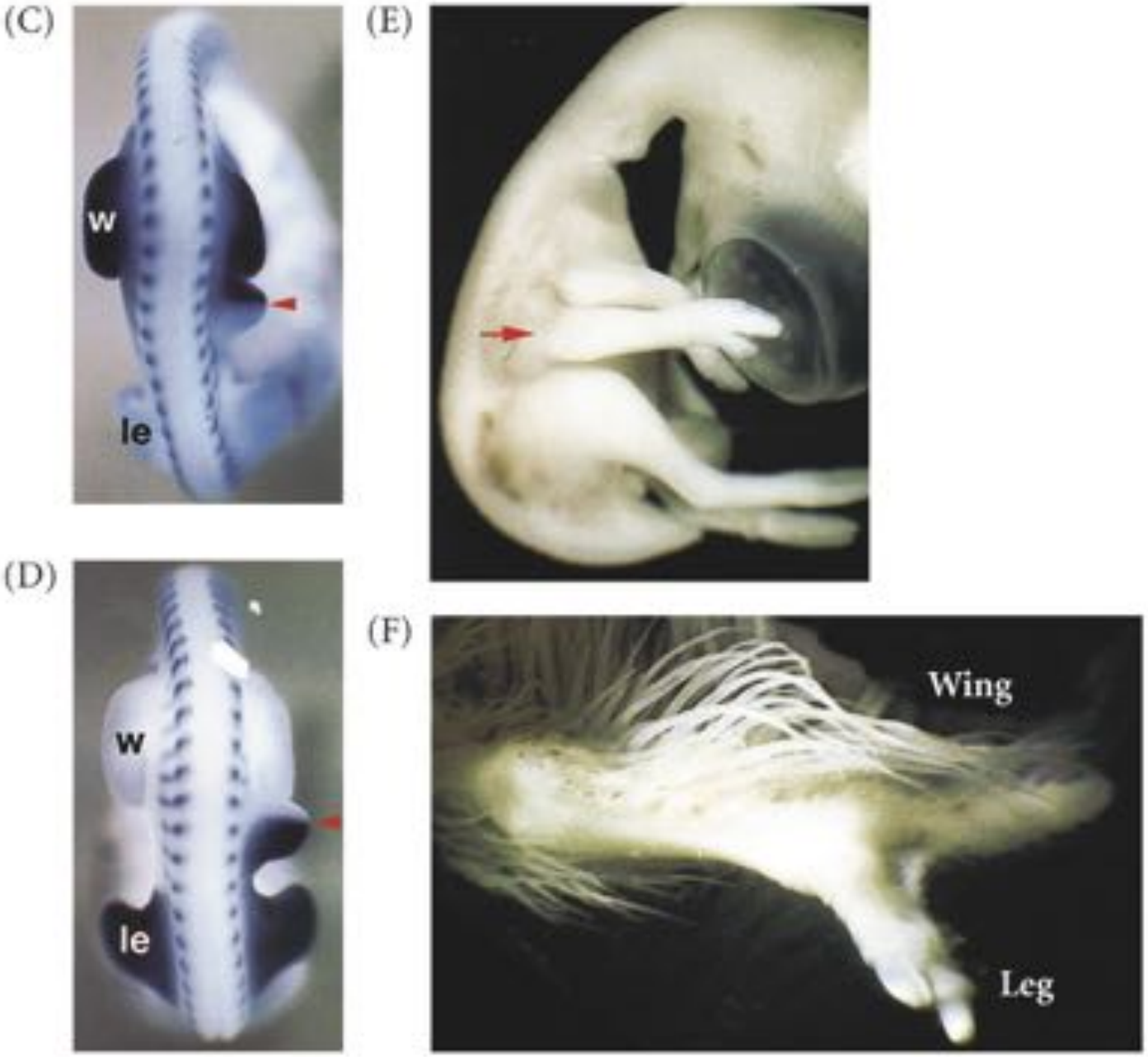
Identidade do membro anterior e posterior: Especificação por Tbx4 and Tbx5 (Parte 3)



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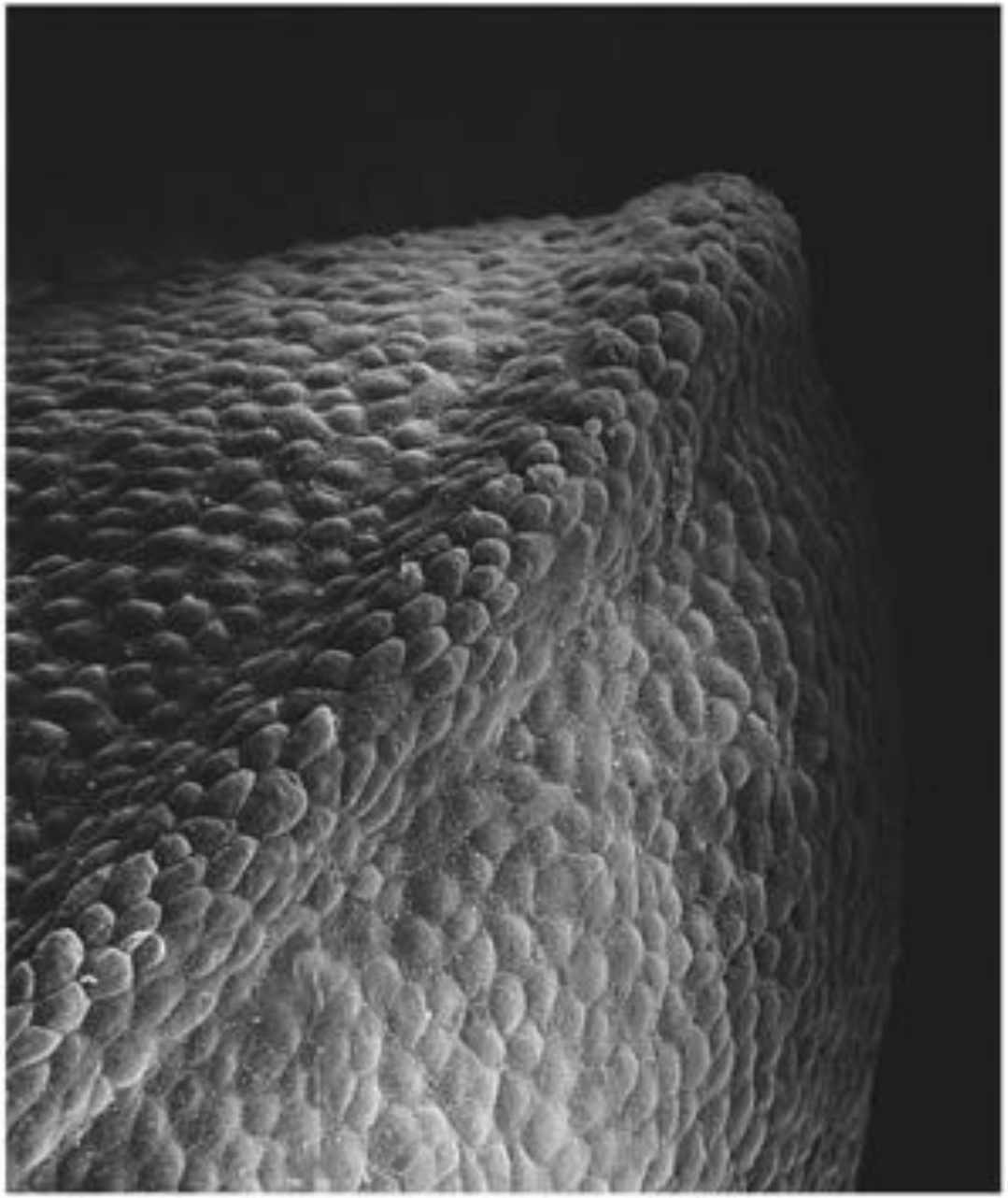
Broto cedo do membro anterior da galinha com o “apical ectodermal ridge (AER)”



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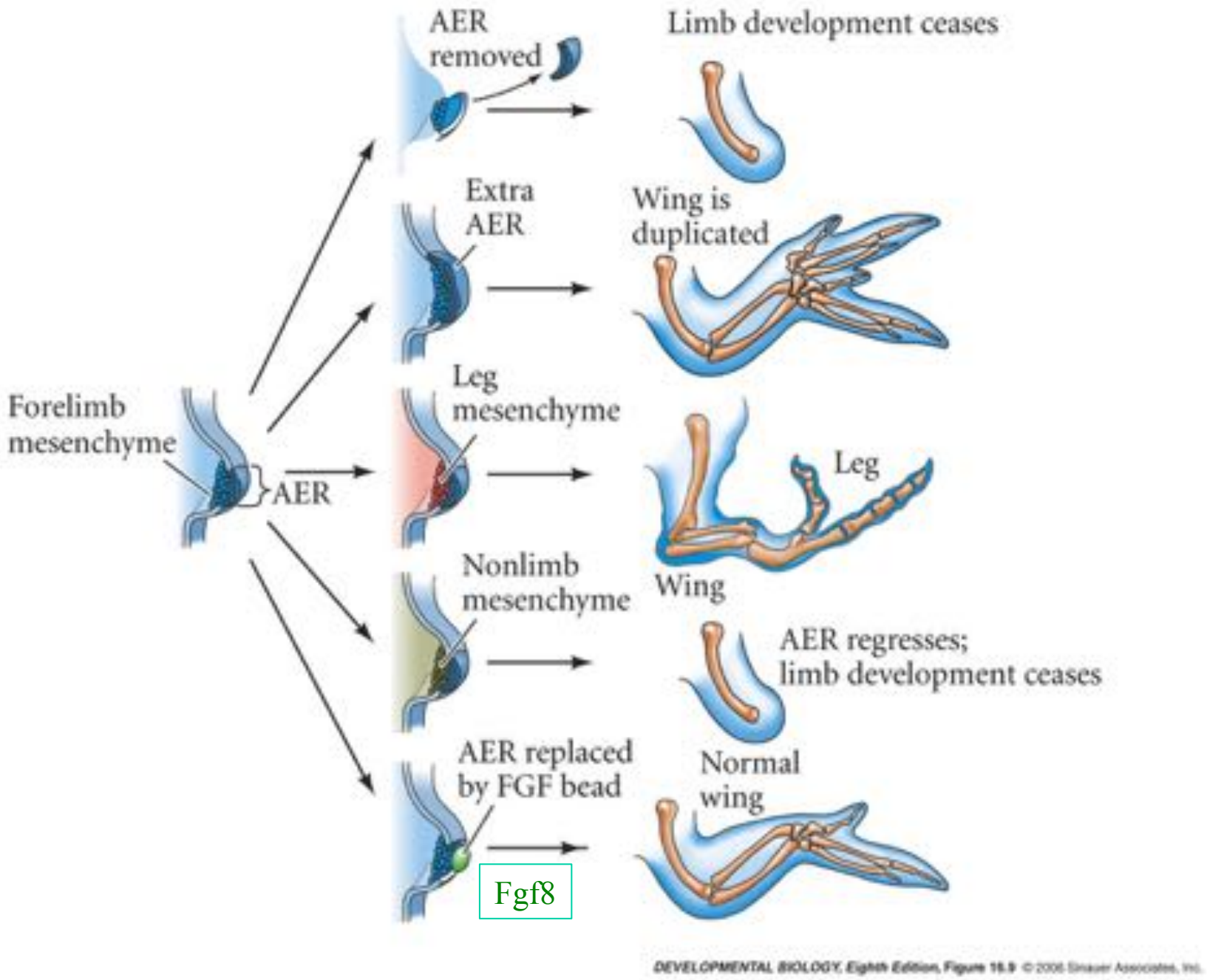
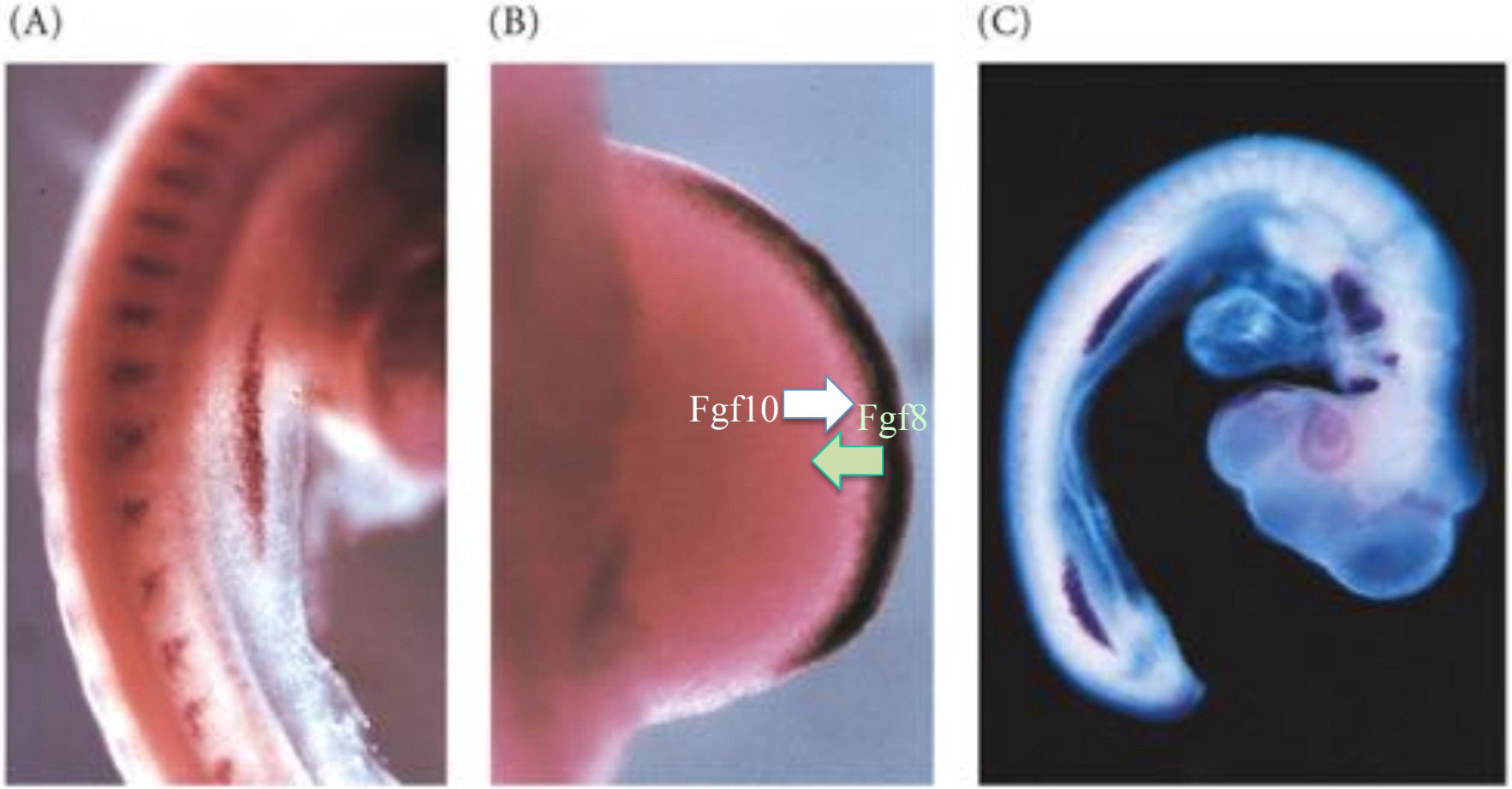
Summary of experiments demonstrating the effect of the apical ectodermal ridge on the underlying mesenchyme



Fgf8 in the apical ectodermal ridge



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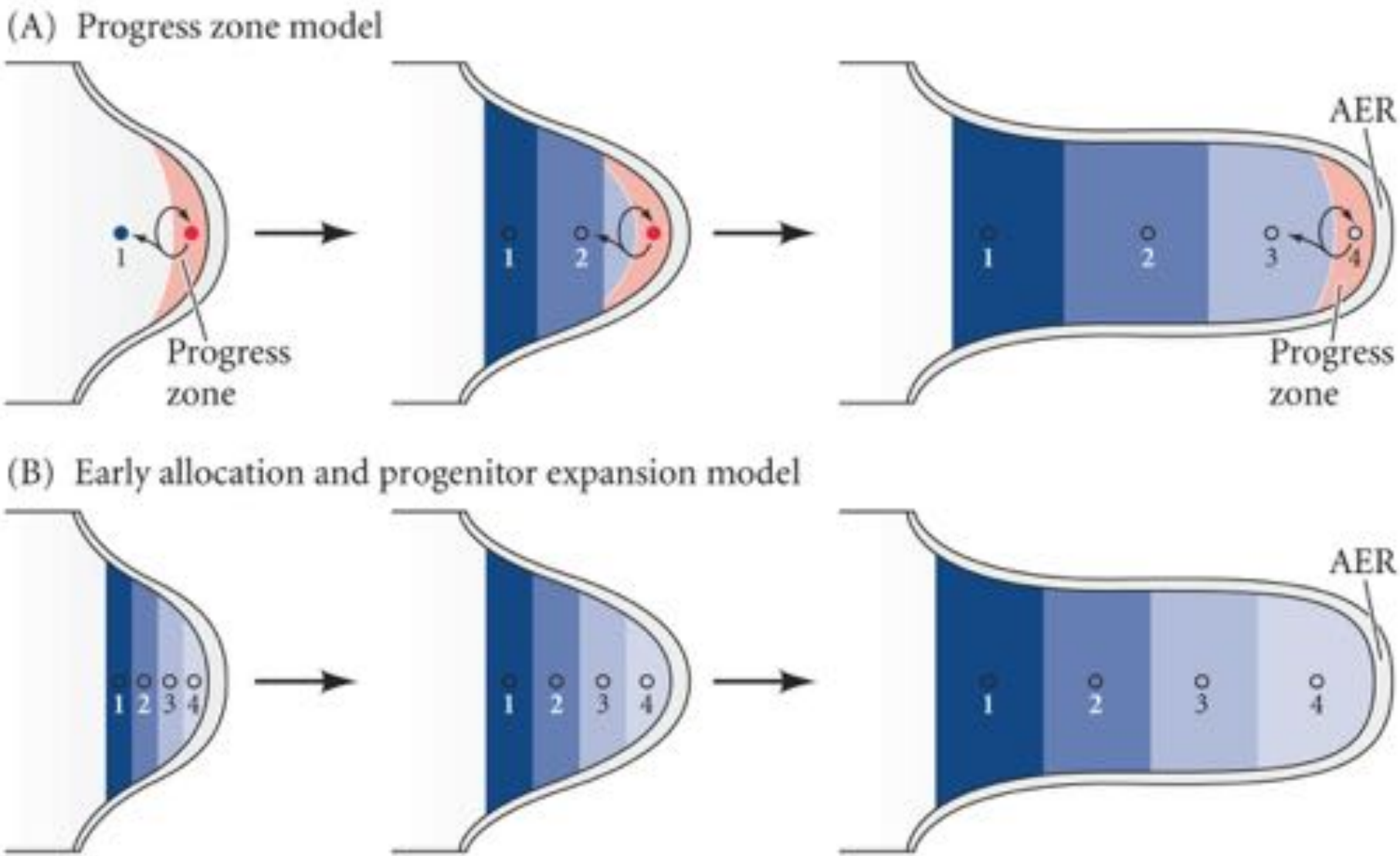
Two models for the mesodermal specification of the proximal-distal axis of the limb



What experiments would you do to test these two models?

The AER is necessary for wing development

AER Vade mecum

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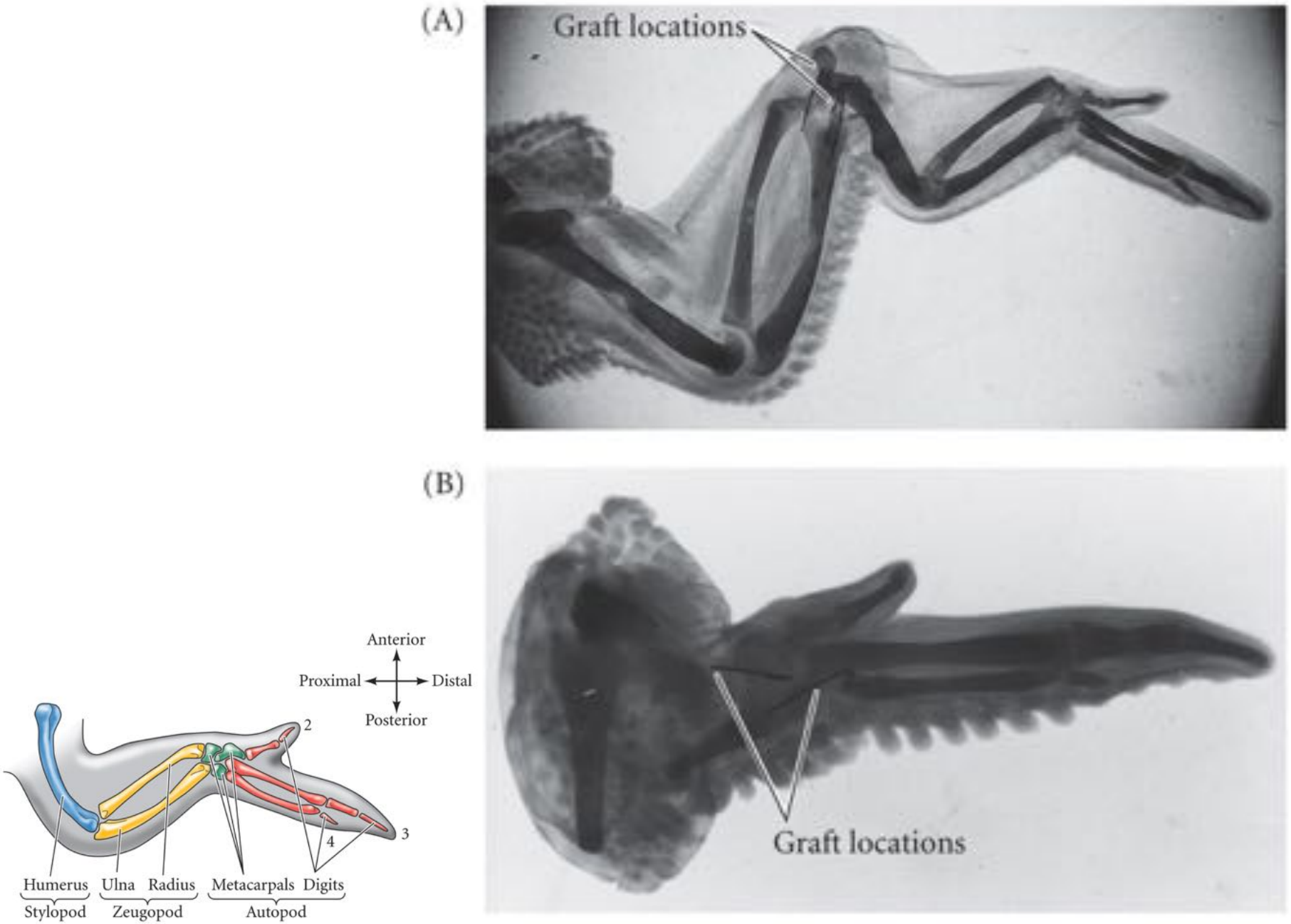
Control of proximal-distal specification by the progress zone mesenchyme



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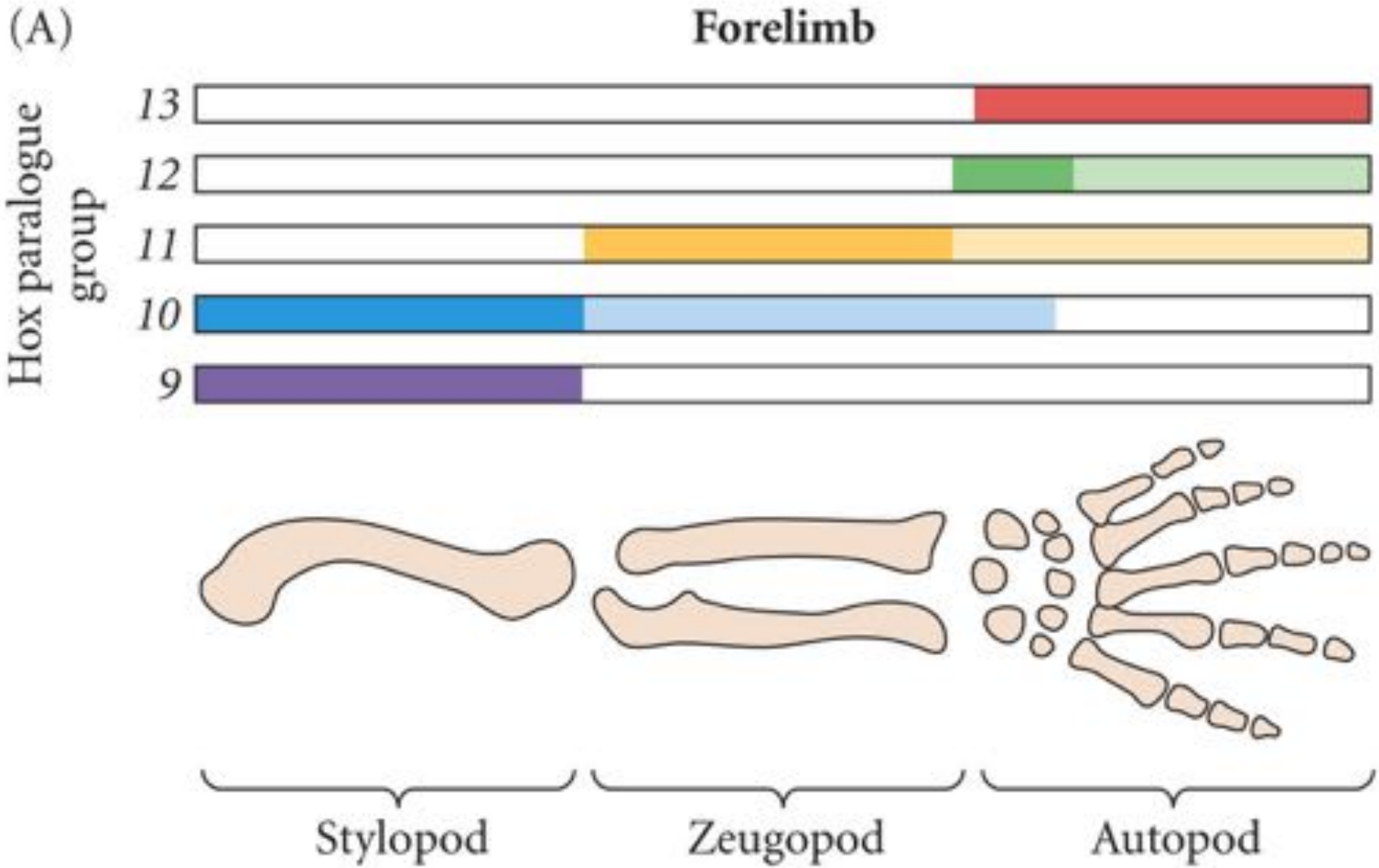
Continuar sólo com integral!!!! (turma noturno acabou)....

PD patterning: Deletion of limb bone elements by the deletion of paralogous Hox genes (Part 1)



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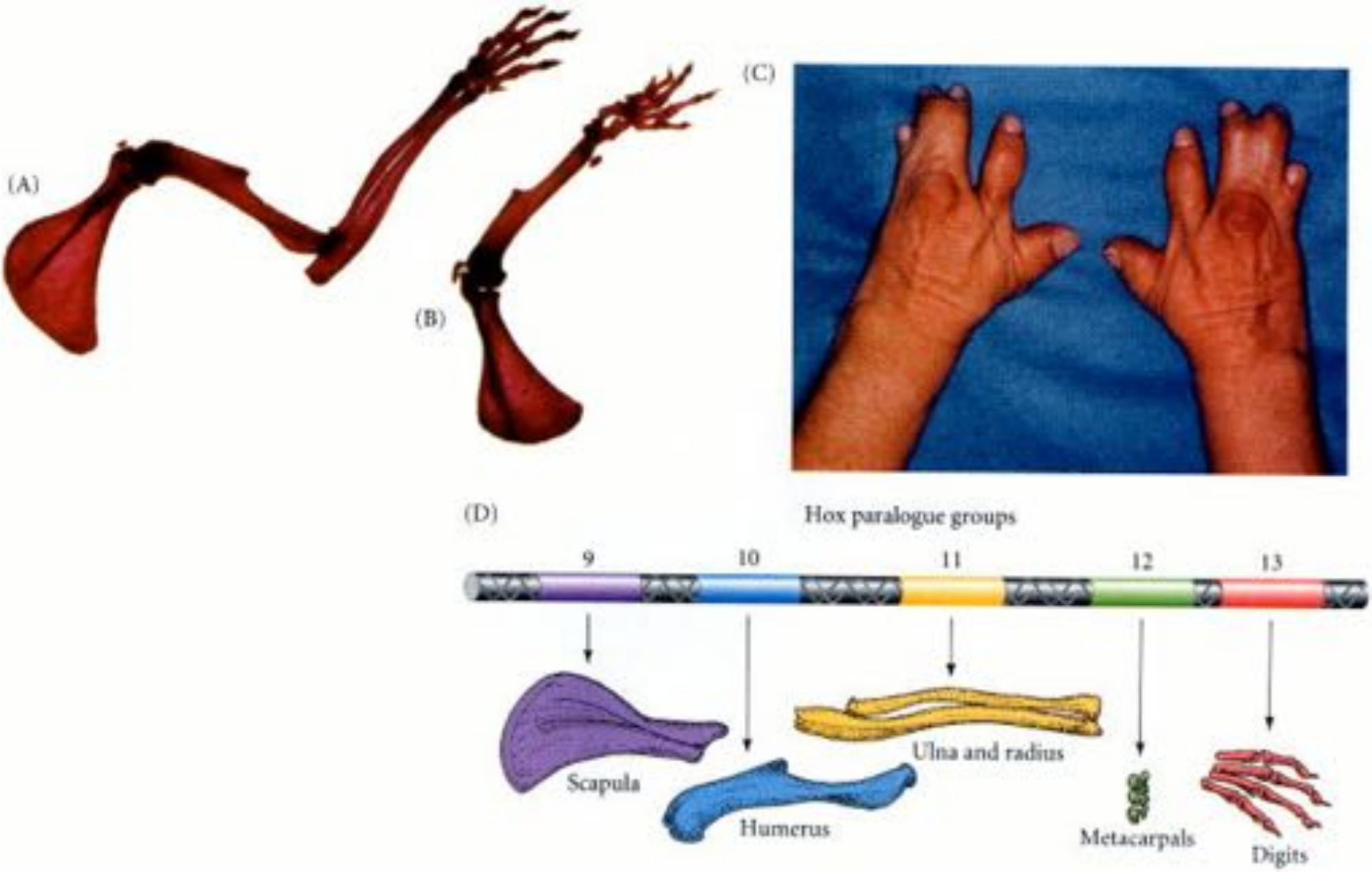
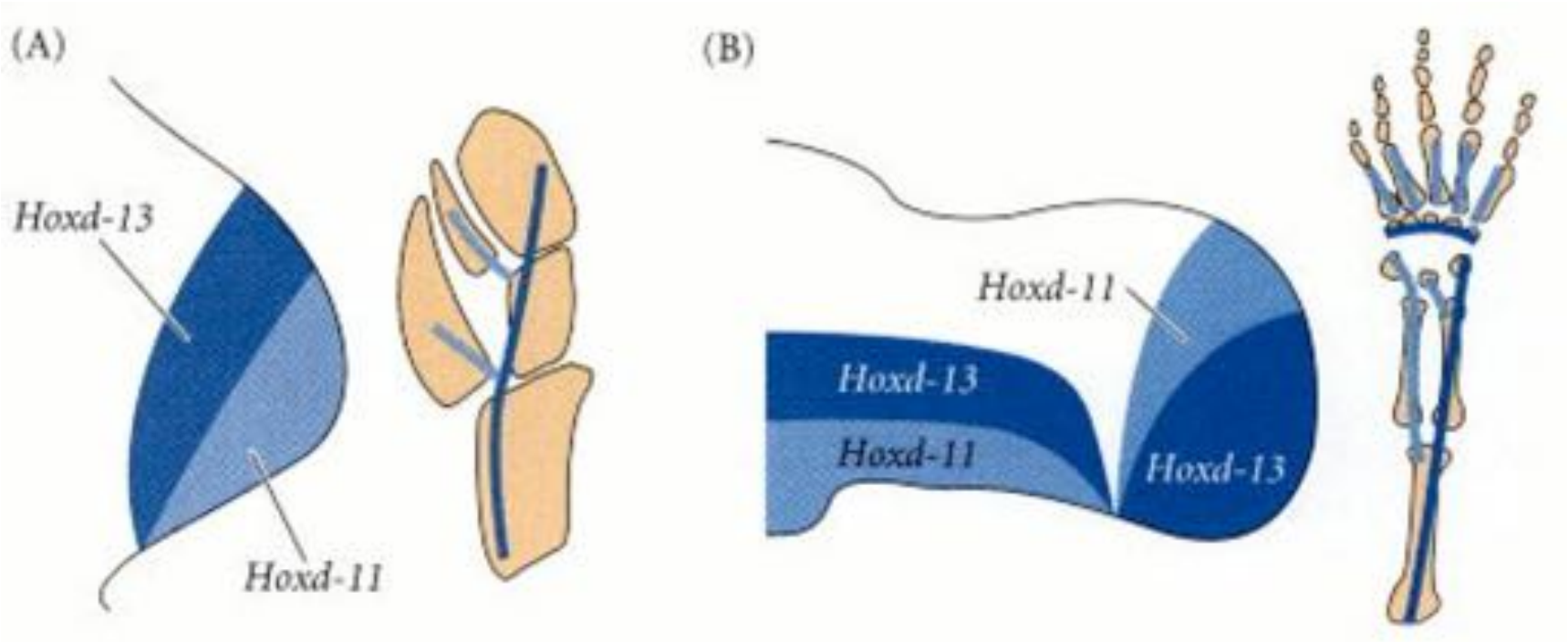
PD patterning: Deletion of limb bone elements by the deletion of paralogous Hox genes (Part 1)

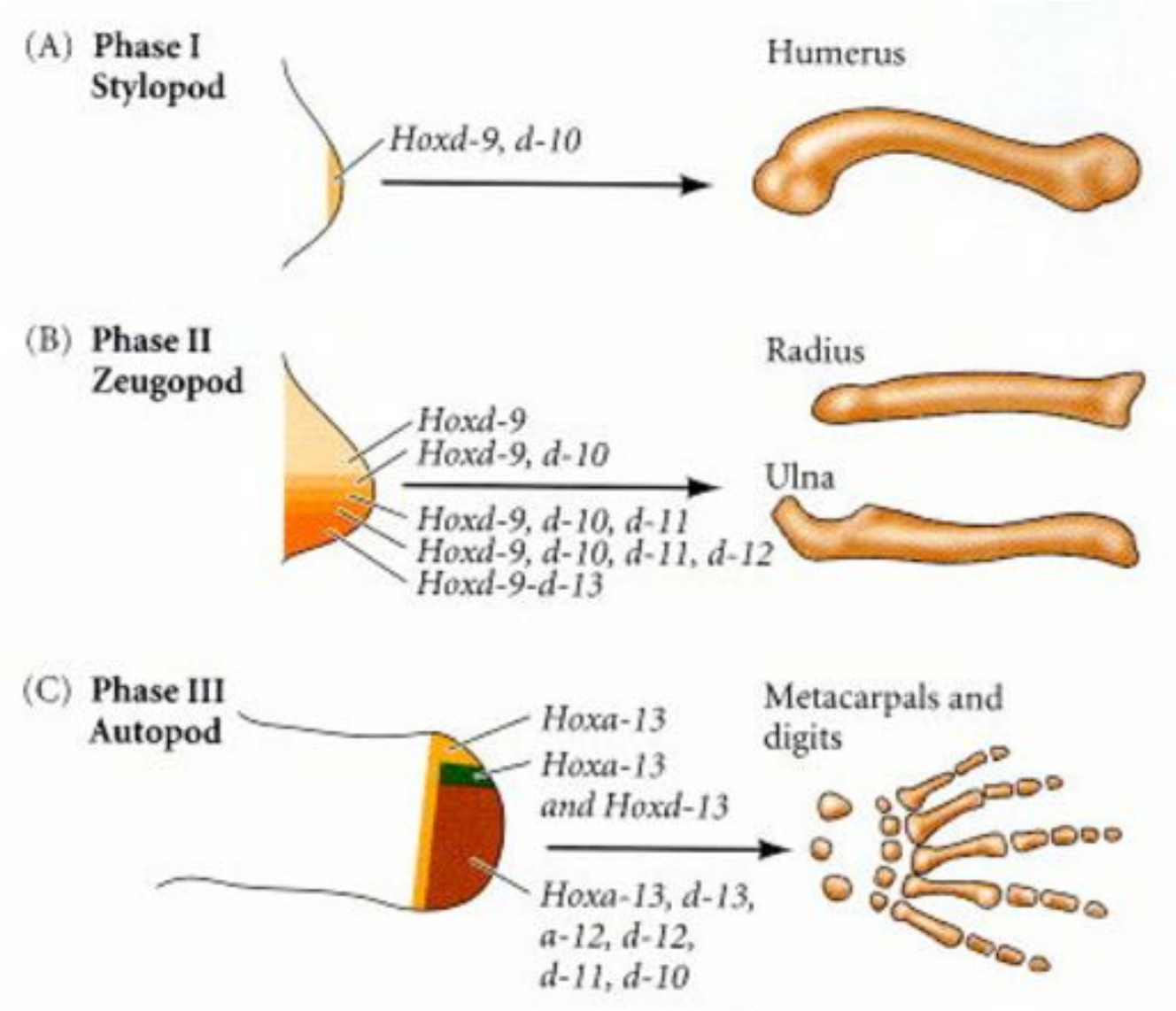


Peixe:

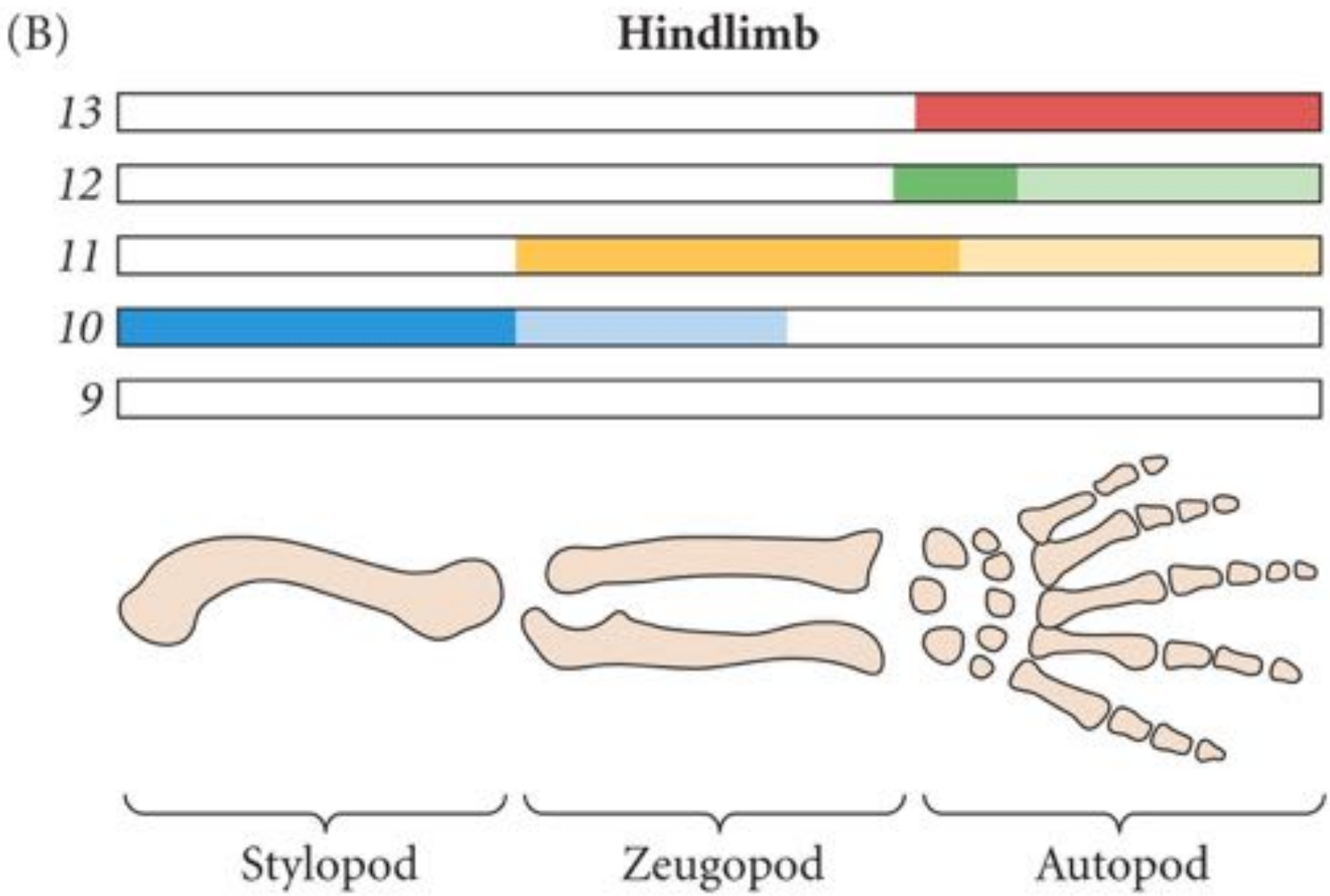
Tetrapodo:



AP patterning: Hox e desenvolvimento dos membros



PD patterning: Deletion of limb bone elements by the deletion of paralogous Hox genes (Part 2)



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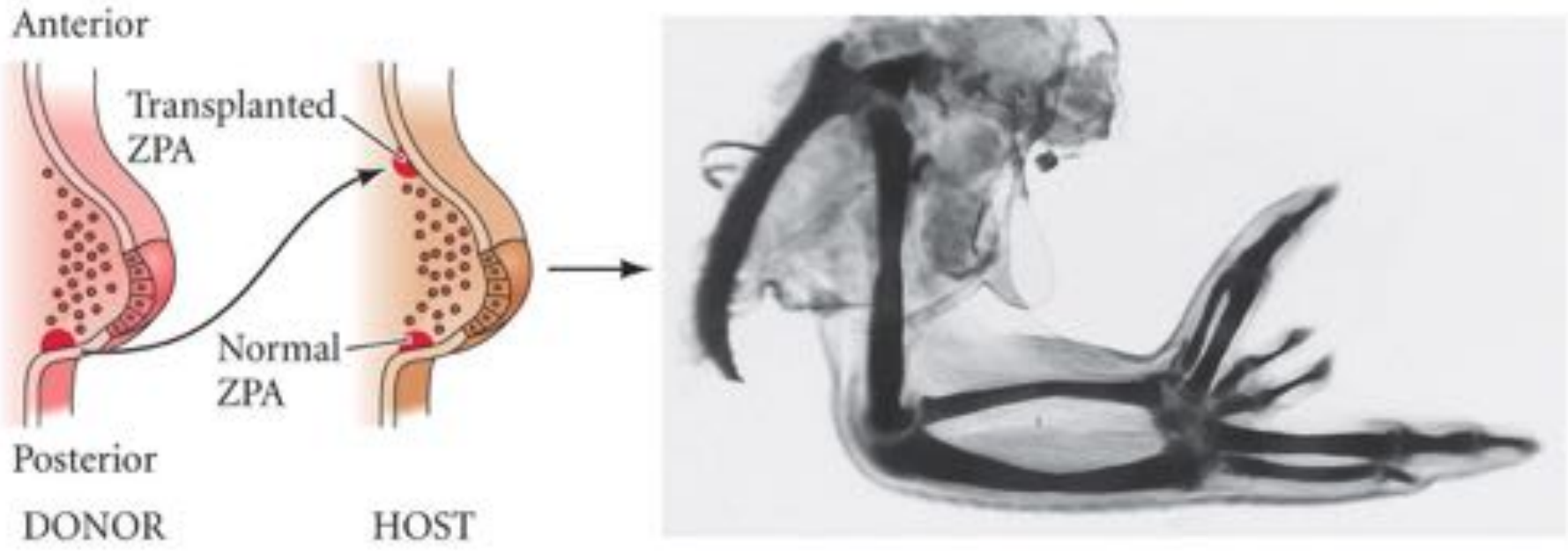
AP patterning: When a ZPA is grafted to anterior limb bud mesoderm, duplicated digits emerge as a mirror image of the normal digits

Discovering the ZPA: Vade mecum



ZPA= zone of polarizing activity

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AP patterning: Sonic hedgehog protein is expressed in the ZPA (Part 1)

(A)

Is it sufficient?

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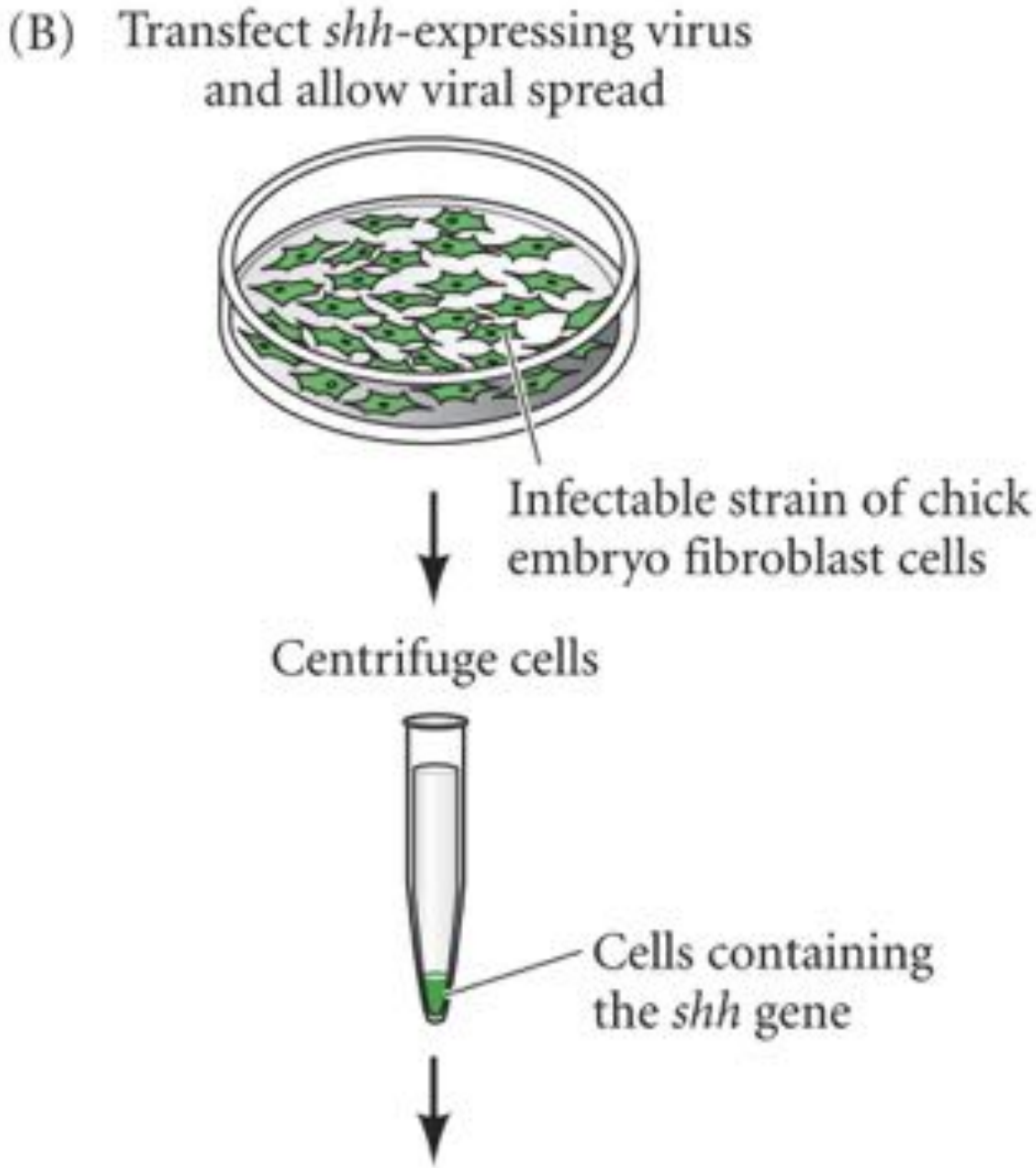
AP patterning: Sonic hedgehog protein is expressed in the ZPA (Part 2)



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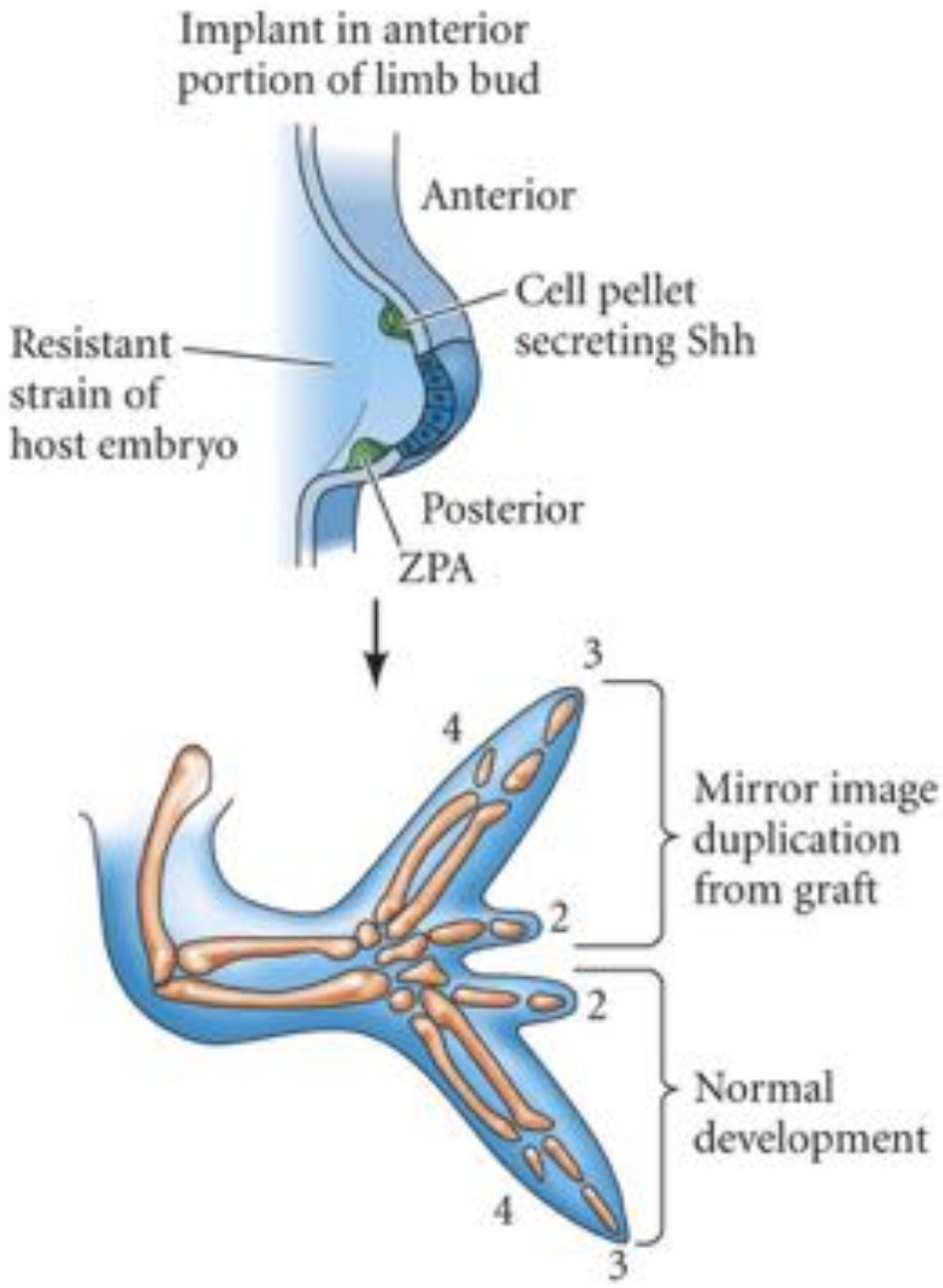
AP patterning: Sonic hedgehog protein is expressed in the ZPA (Part 3)



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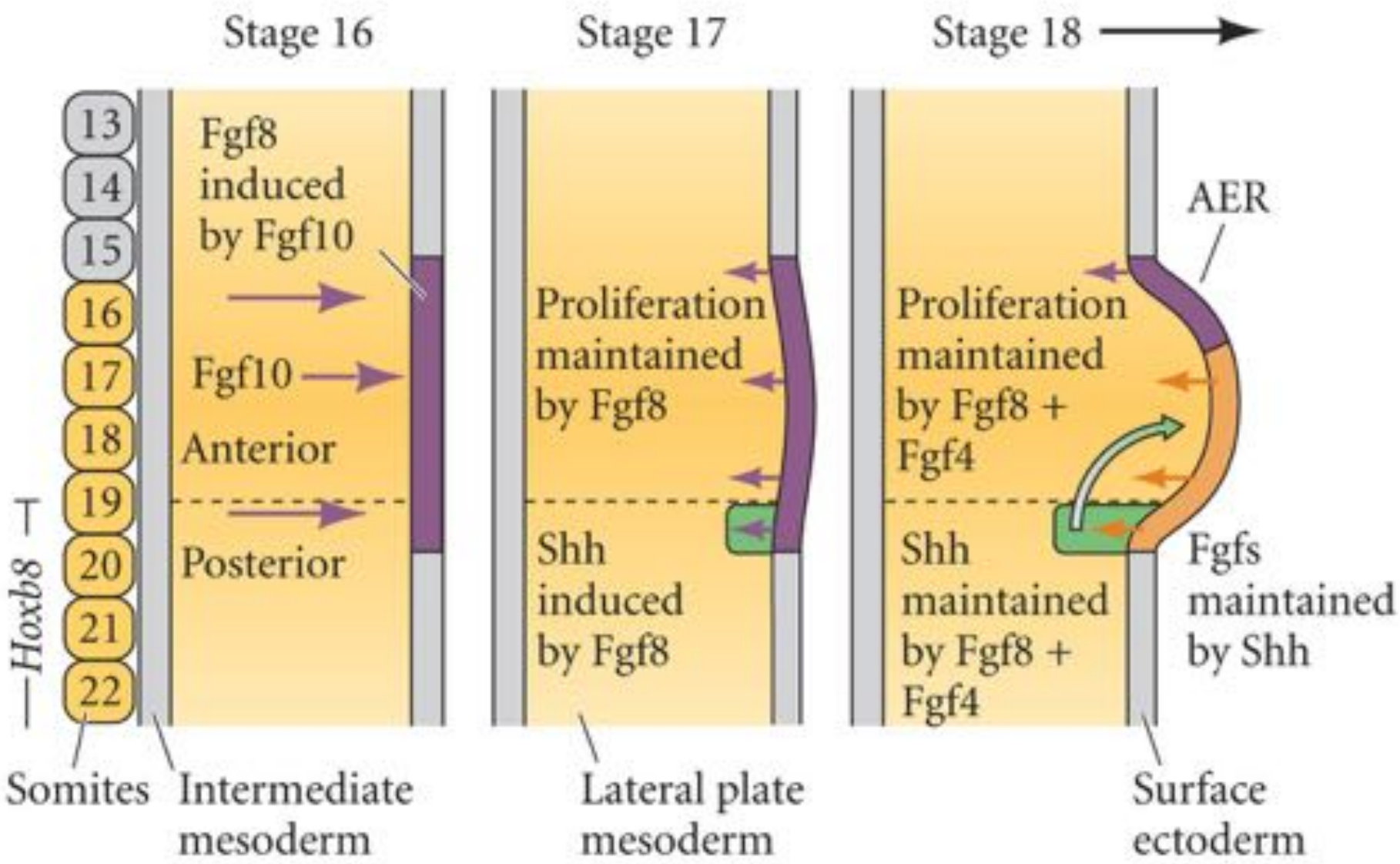
Patterning and growth of the bud: Feedback between the AER and the ZPA in the forelimb bud



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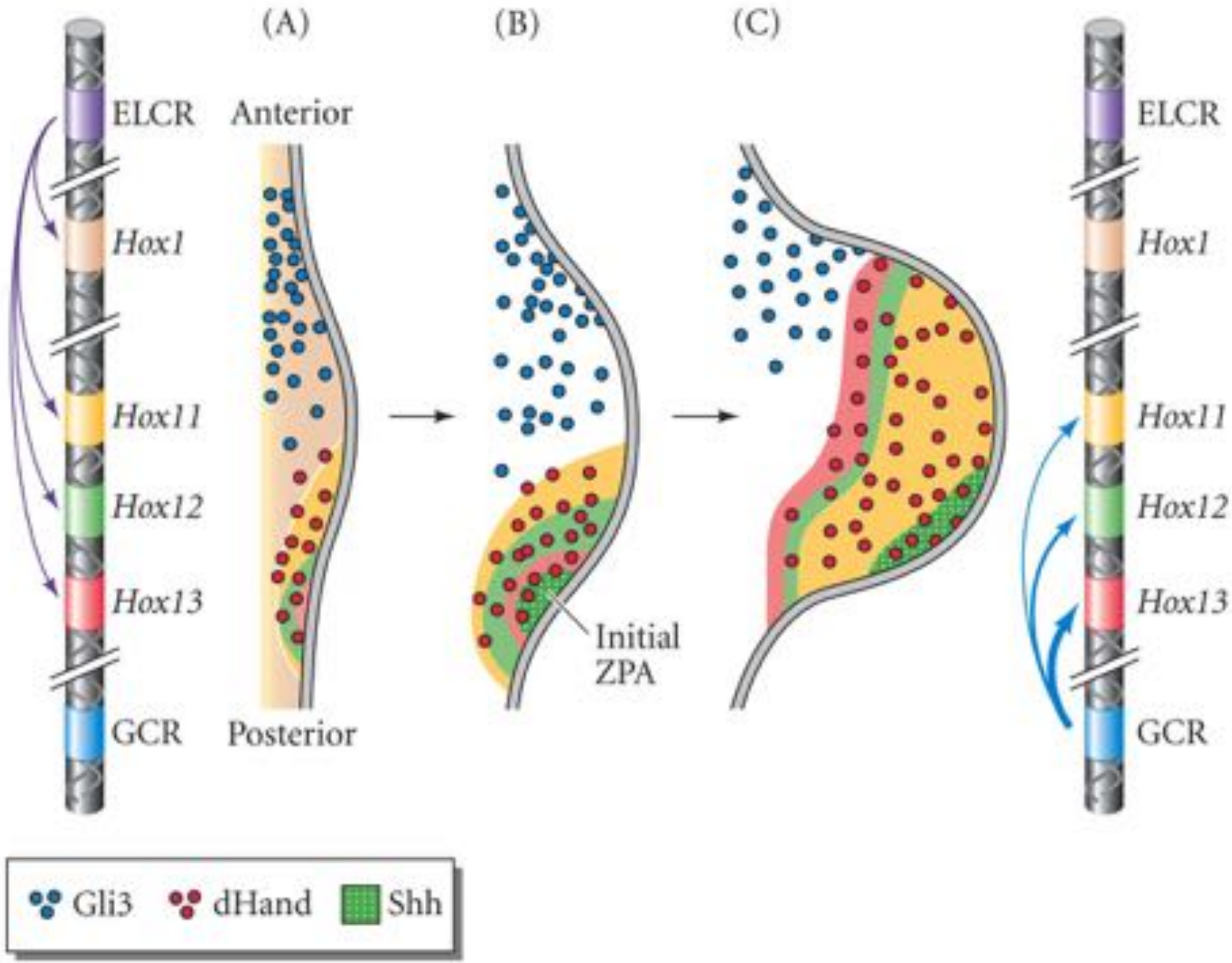
AP patterning: Hox gene expression changes during the formation of the tetrapod limb



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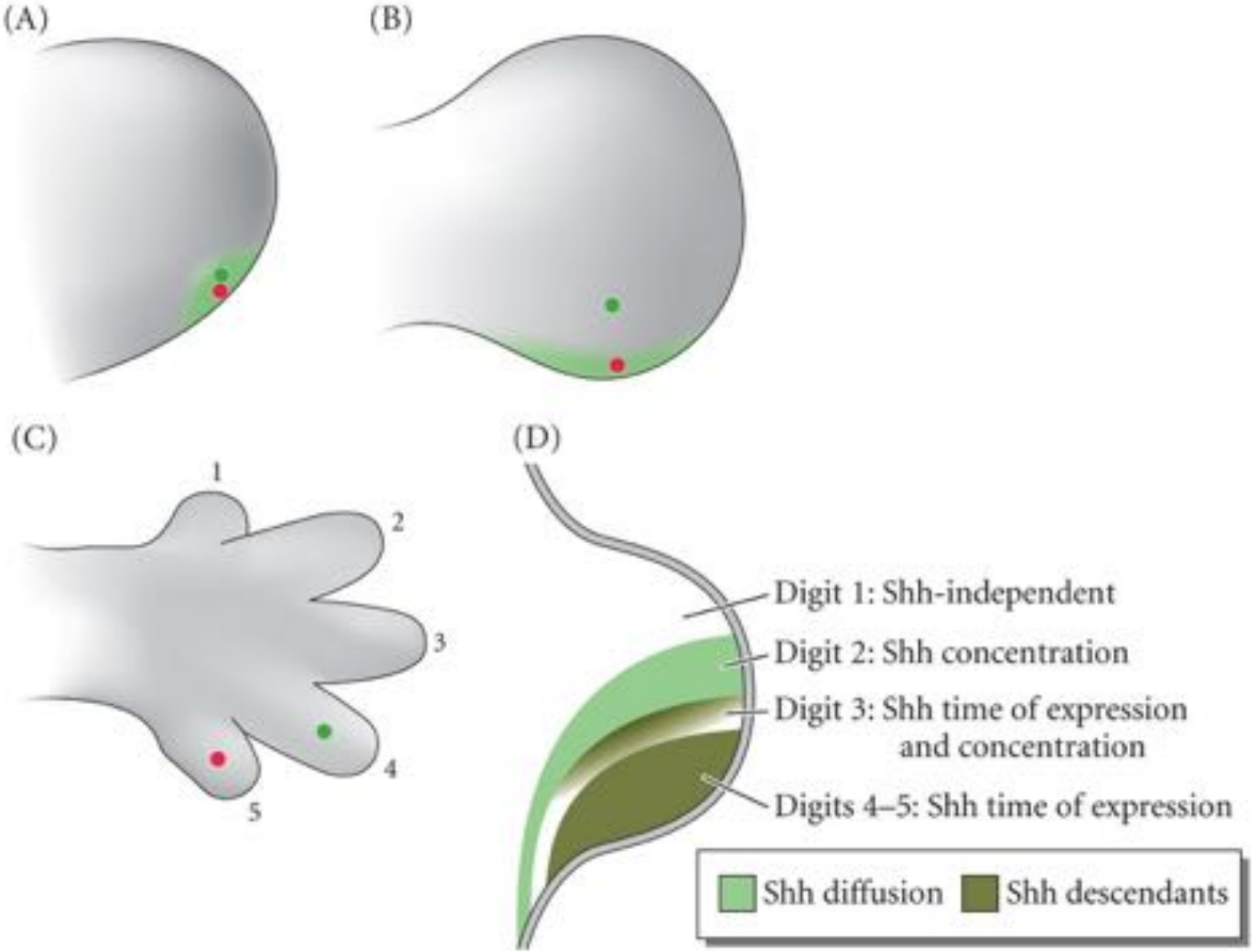
AP patterning and digit identity: The Shh-secreting cells form digits 4 and 5, and contribute to the specification of digits 2 and 3 in the mouse limb



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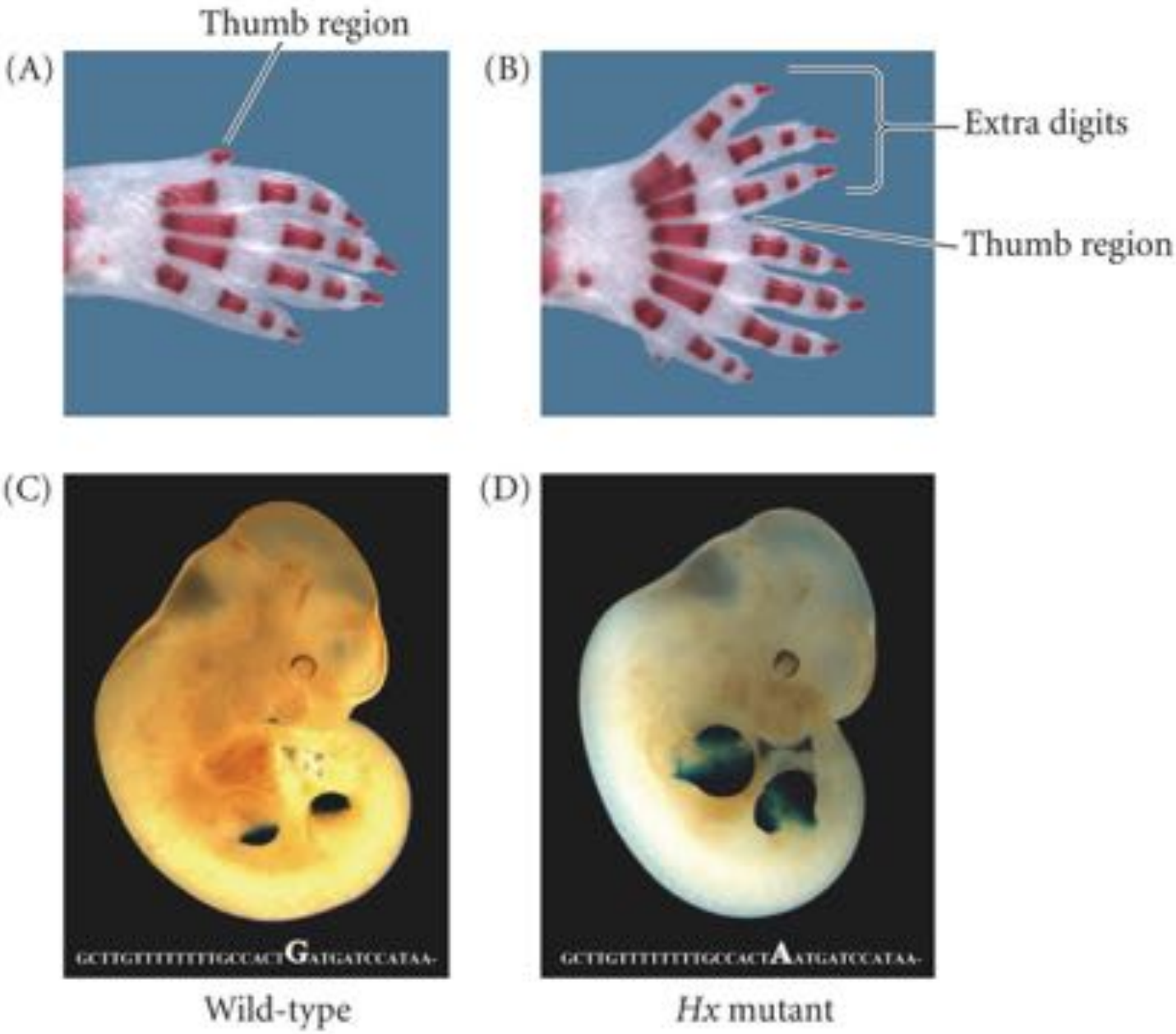
AP patterning: Ectopic expression of mouse *sonic hedgehog* by a mutation in *Hx* in the anterior limb causes extra digit formation



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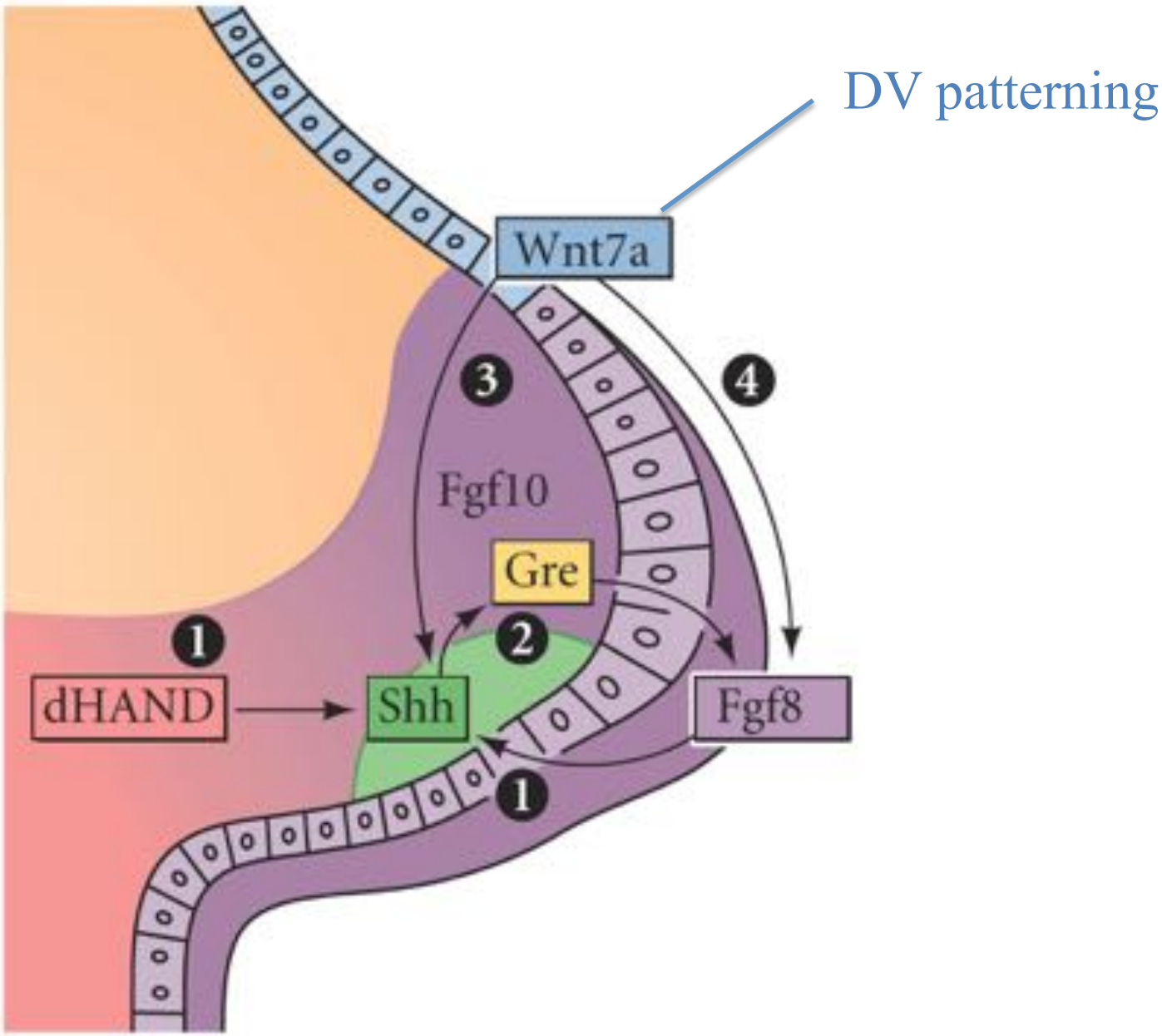
Patterning and growth of the bud: Some of the molecular interactions by which limb bud formation and growth are initiated and maintained



DV Patterning: Vade mecum

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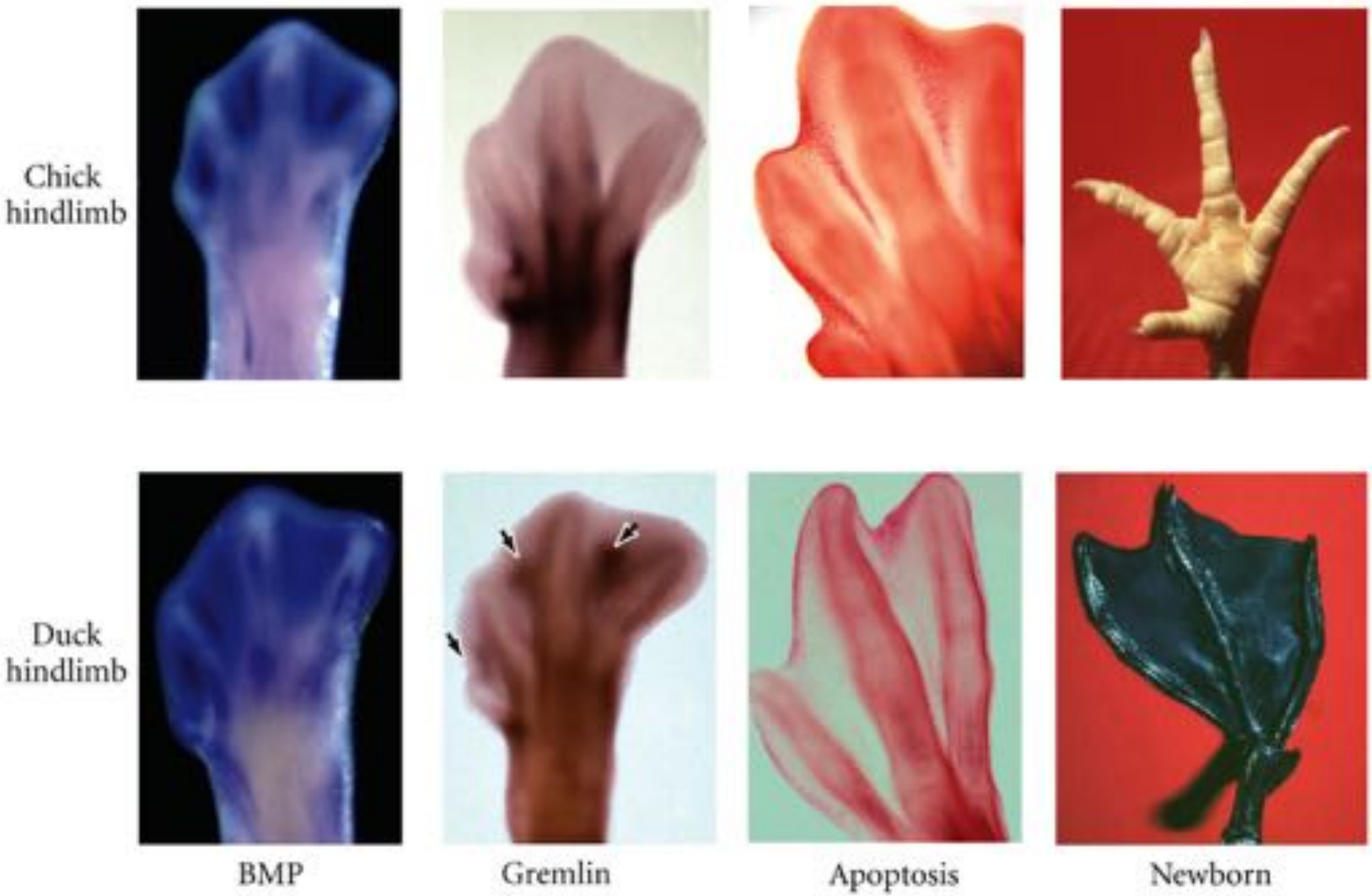
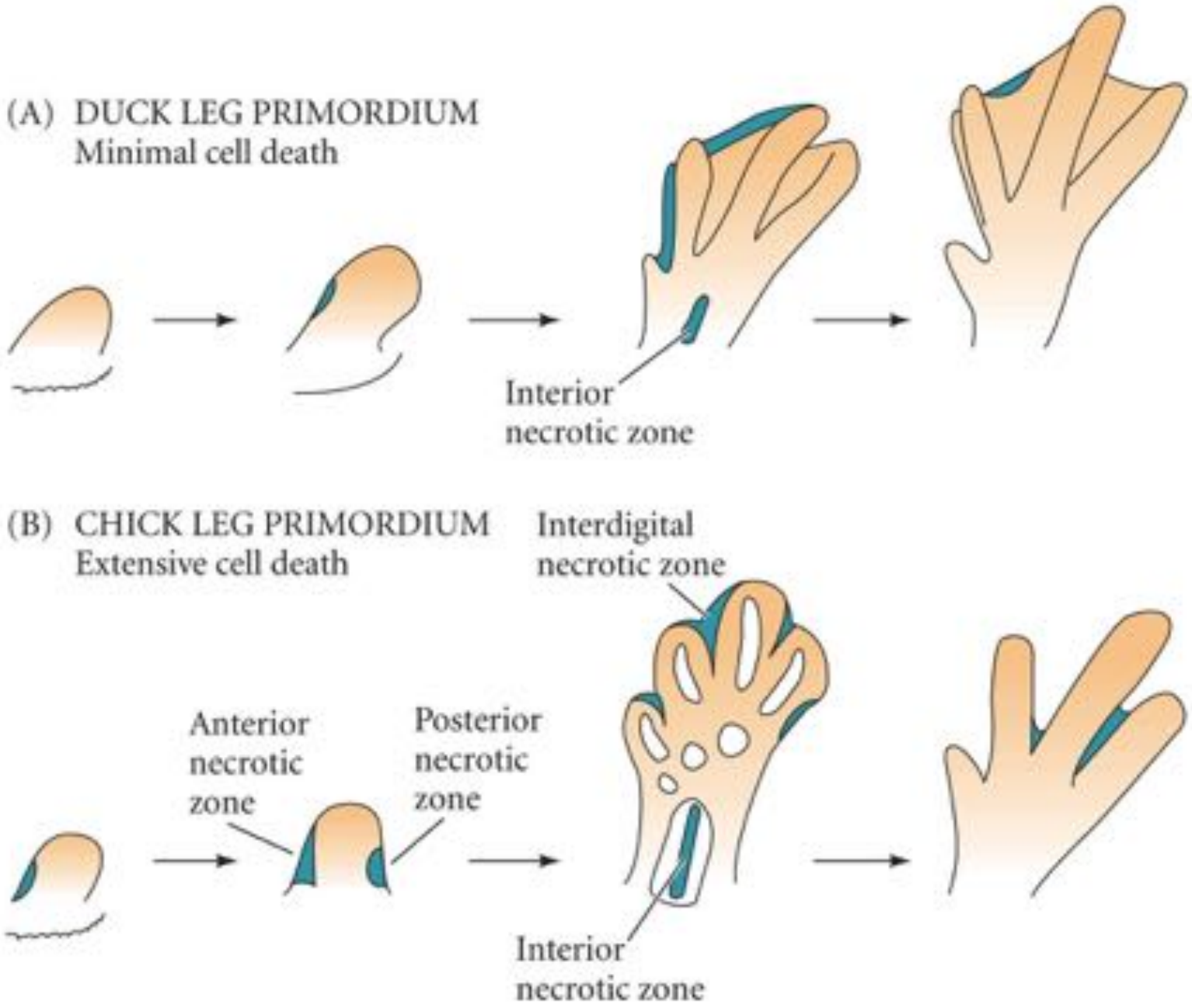
Apoptosis in late digit formation: Inhibition of cell death by inhibiting BMPs by Gremlin

Patterning through cell death: Vade mecum



Late digit formation: Patterns of cell death in leg primordia of (A) duck and (B) chick embryos



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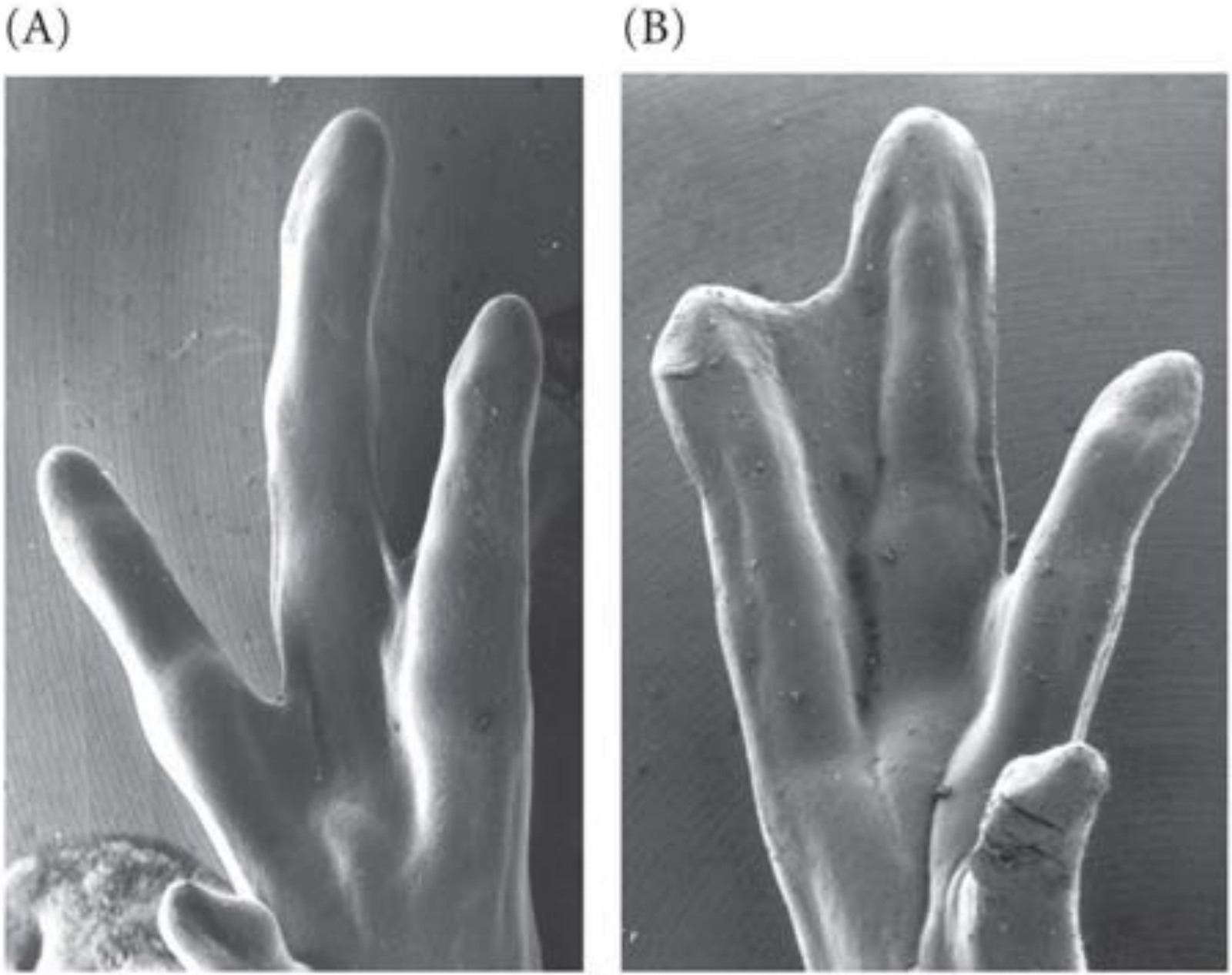
Apoptosis in late digit formation: Inhibition of cell death by inhibiting BMPs in chick leg



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