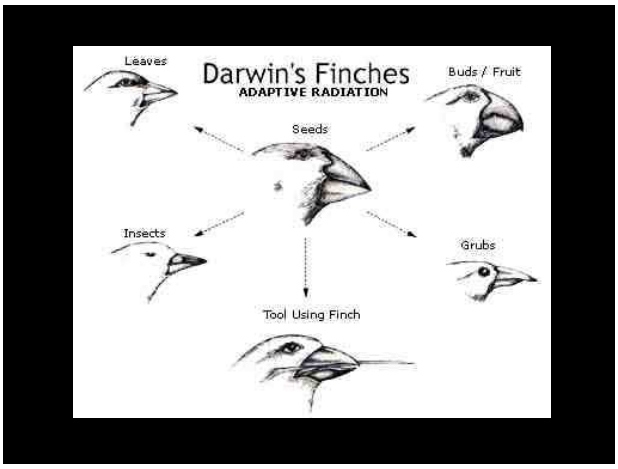
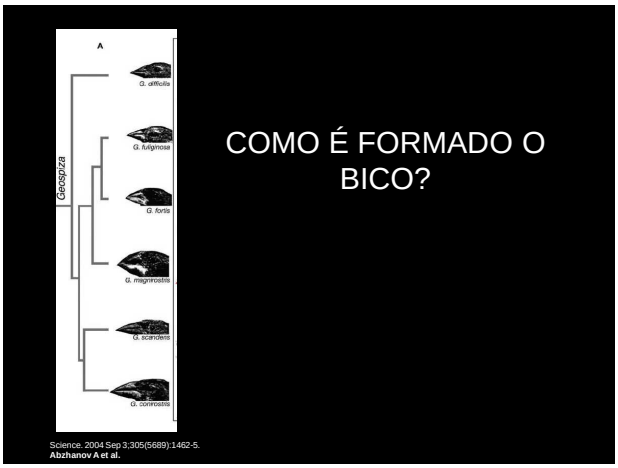
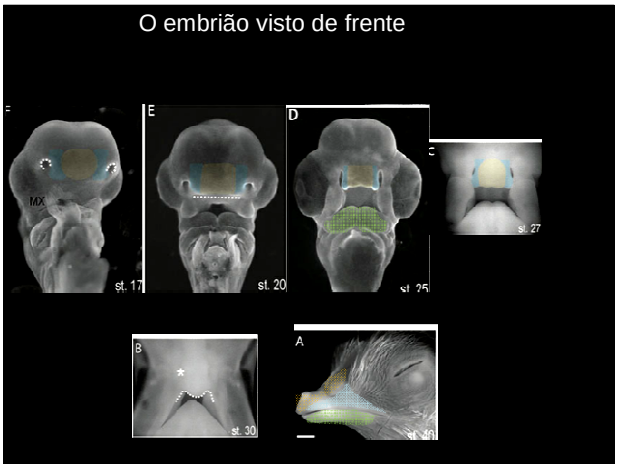
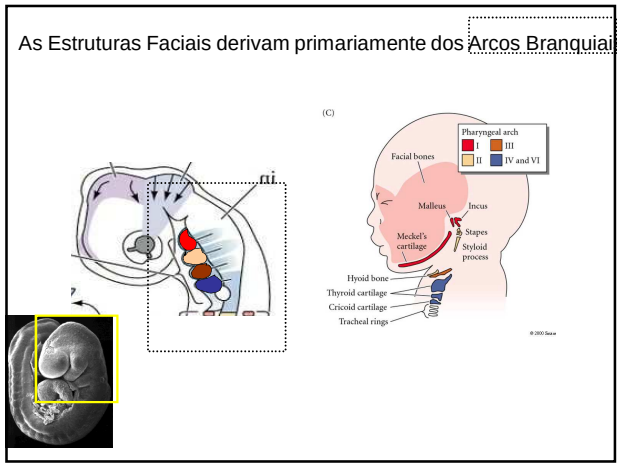
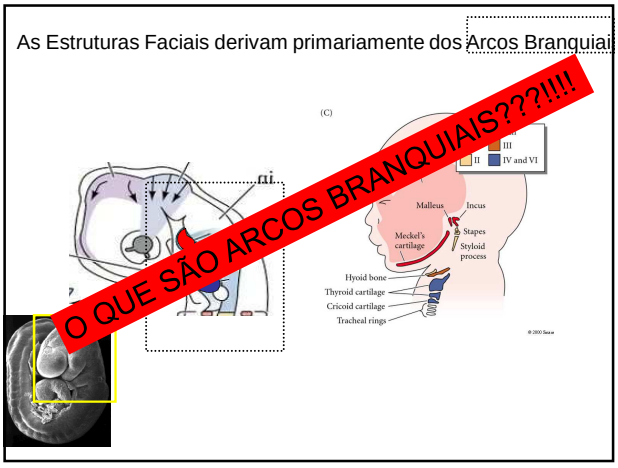
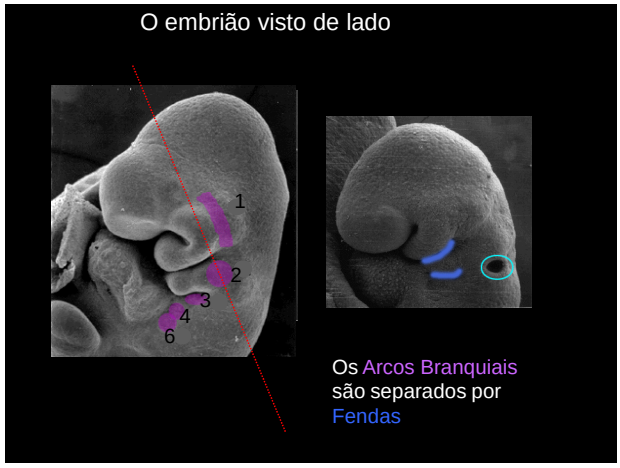

Darwin's Finches
ADAPTIVE RADIATION
Leaves
Buds / Fruit
Seeds
Insects
Grubs
Tool Using Finch


A
Geospiza
G. difficilis
G. fuliginosa
G. fortis
G. magnirostris
G. scandens
G. conirostris
COMO É FORMADO O BICO?
Science. 2004 Sep 3;305(5689):1462-5.
Abzhanov A et al.

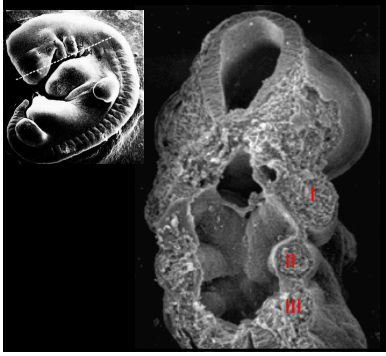

O embrião visto de frente
MX
E
D
C
st. 17
st. 20
st. 25
st. 27
B
A
st. 30


As Estruturas Faciais derivam primariamente dos Arcos Branquiai
mi
(C)
Pharyngeal arch
I
III
II
IV and VI
Facial bones
Malleus
Incus
Meckel's cartilage
Stapes
Styloid process
Hyoid bone
Thyroid cartilage
Cricoid cartilage
Tracheal rings

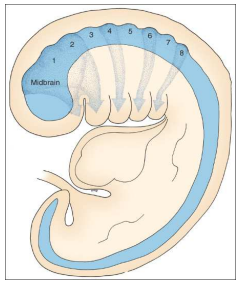

As Estruturas Faciais derivam primariamente dos Arcos Branquiai
O QUE SÃO ARCOS BRANQUIAIS???!!!
mi
(C)
III
II
IV and VI
Malleus
Incus
Meckel's cartilage
Stapes
Styloid process
Hyoid bone
Thyroid cartilage
Cricoid cartilage
Tracheal rings

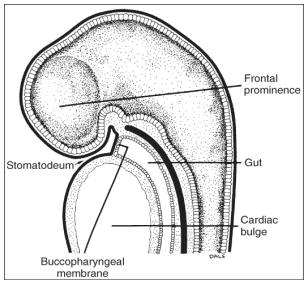

O embrião visto de lado
1
2
3
4
6
Os Arcos Branquiais
são separados por
Fendas

Visão dorsal dos arcos branquiais

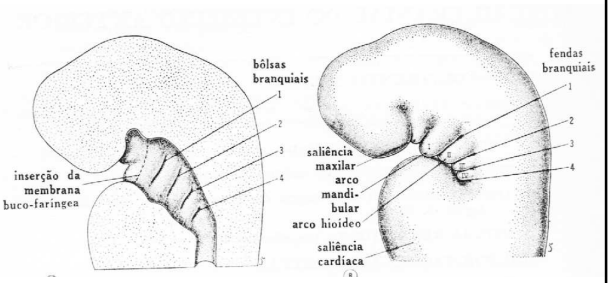


Arcos branquiais são entumescências cefálicas, separadas por sulcos/fendas

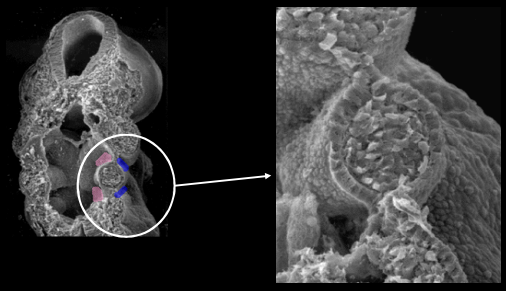


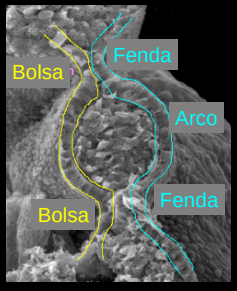


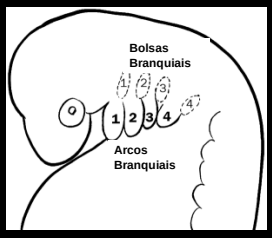
Visão lateral dos arcos branquiais



Visão dorsal dos arcos branquiais



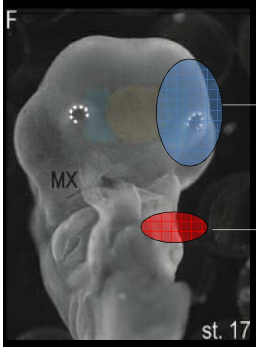




Para cada Arco Branquial, há uma Bolsa Branquial Endodérmica intercalada interiormente

Como que os arcos branquiais formam a face?

O embrião visto de frente



Prominência FRONTO-NASAL

Primeiro Arco Branquial

Como os arcos branquiais podem formar as estruturas faciais (visão frontal)

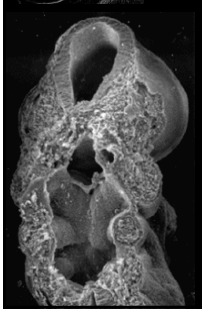
A Proeminência fronto-nasal esquerda e direita se fundem, formando o Nariz e definindo o Lábio Superior

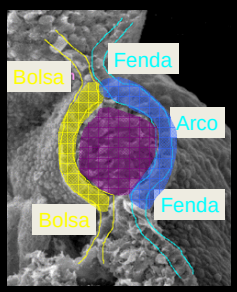
Saliência Nasal Medial
Saliência Nasal Lateral
Processo Maxilar

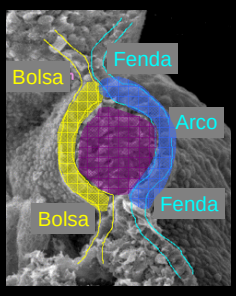
http://www.biomed2.man.ac.uk/ugrad/biomedical/calpage/sproject/rob/week4.html

O que dirige o crescimento dos arcos branquiais?

Visão dorsal dos arcos branquiais



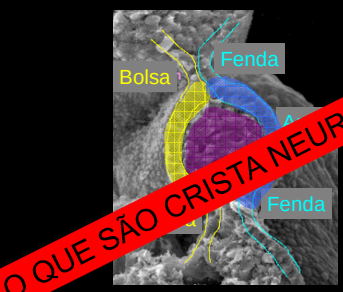




Cada Arco Branquial é forrado por Ectoderma na superfície externa, e Endoderma na superfície interna. O "recheio" é de origem mesodérmica e de cristas neurais.

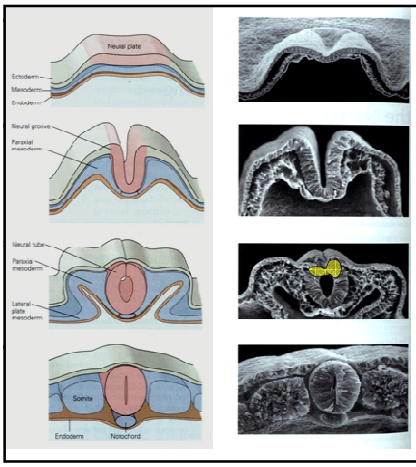
(

o que são cristas neurais?



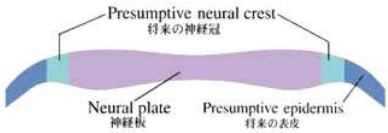
O QUE SÃO CRISTA NEURAIS???!!!!

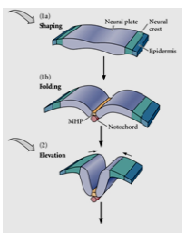
Cada Arco Branquial é forrado por Ectoderma na superfície externa, e Endoderma na superfície interna. O "recheio" é mesênquimal, de origem mesodérmica e de cristas neurais.



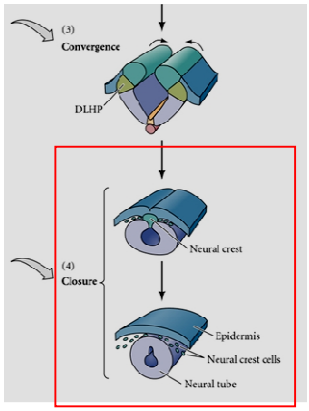
A **CRISTA NEURAL** é uma população que migra da região mais dorsal do Tubo Neural

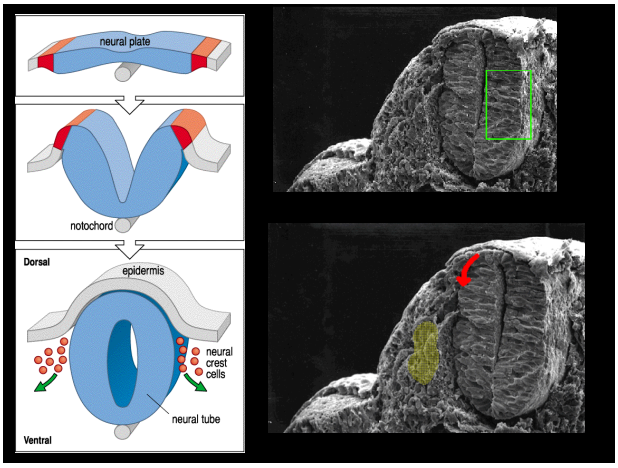
A formação do tubo neural se dá pela elevação das DOBRAS NEURAIS e a perda da conexão do tubo com o ectoderma de revestimento



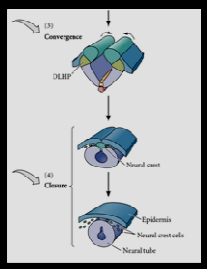


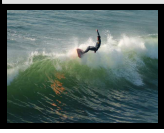
A migração das células da Crista Neural ocorre durante o fechamento do Tubo Neural

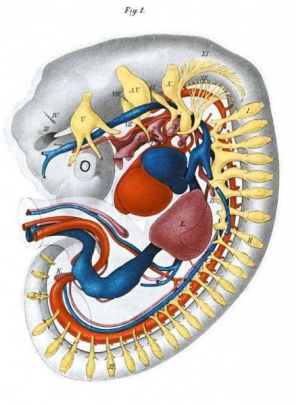




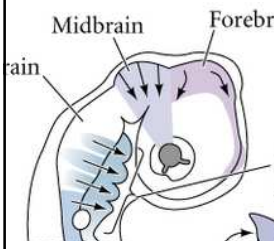
Recapitulando: As crista neurais migram pelo corpo todo a partir da região dorsal do tubo neural







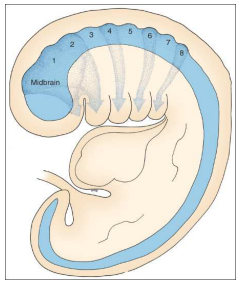
As células da crista neural podem ser divididas em cefálicas e truncais

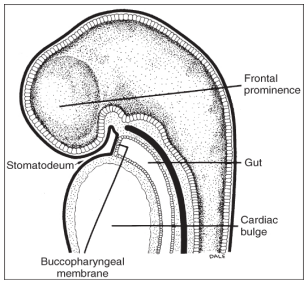


A Crista Neural CEFÁLICA dá origem a:

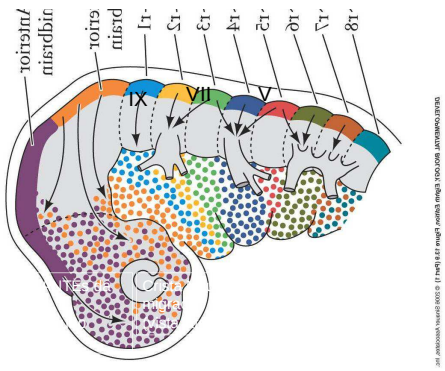
Melanócitos (células pigmentadas)
Neurônios
Glia
Cartilagens faciais
Ossos faciais
Nervos cranianos

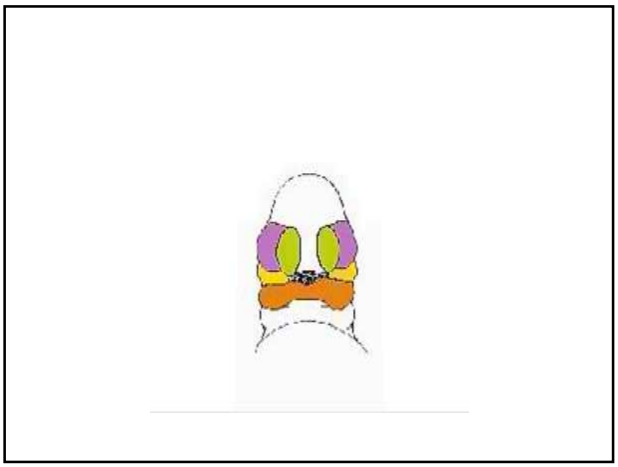
As células das cristas neurais da região cefálica migram para cada um dos arcos branquiais



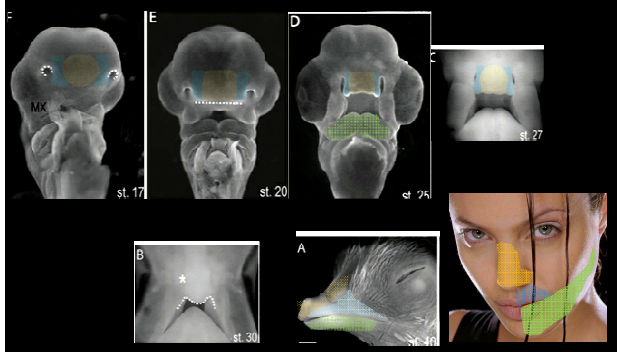


As células das cristas neurais da região cefálica migram para cada um dos arcos branquiais

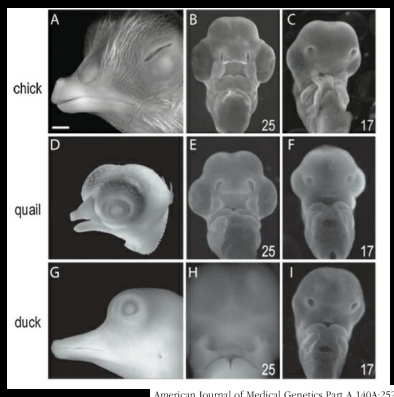




O Bico superior de aves equivale ao lábio superior

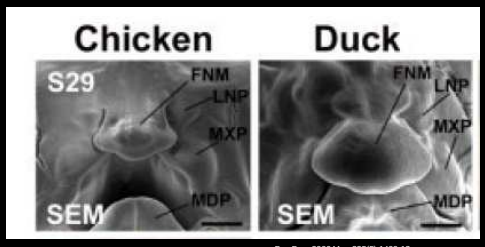


Em estágios precoces a forma da Prominência Fronto-nasal é similar em aves diferentes



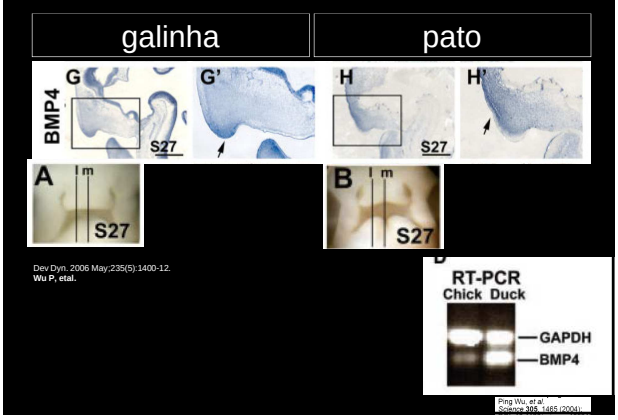
American Journal of Medical Genetics Part A 140A:2521–2529 (2006)

Mas no estágio 29, existe uma boa diferença entre o pato e a galinha. O que acontece?



Dev Dyn. 2006 May;235(5):1400-12.
Wu P, etal.

A ponta do precursor do bico superior expressa BMP

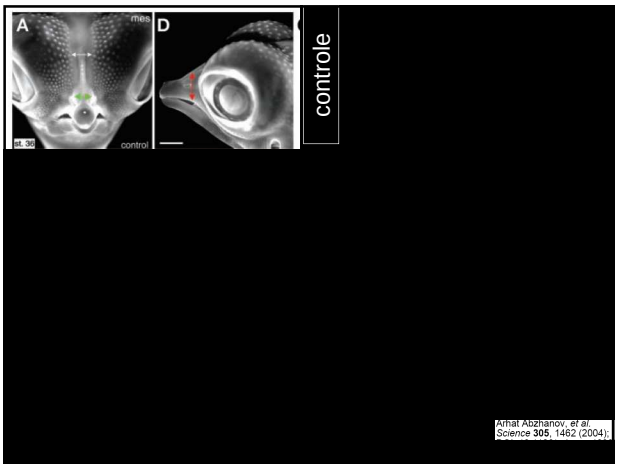


Dev Dyn. 2006 May;235(5):1400-12.
Wu P, etal.

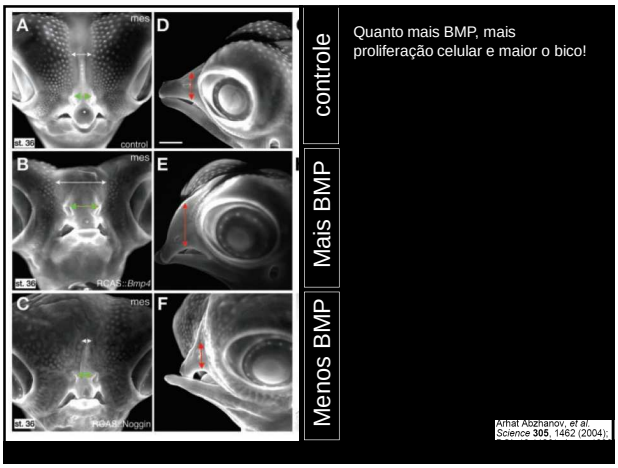
Ping Wu, et al.
Science 305, 1465 (2004)

HIPÓTESE:

QUANTO MAIS BMP MAIOR O BICO.

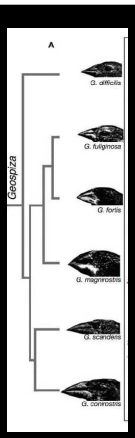


Arhat Abzhanov, *et al.* *Science* **305**, 1462 (2004);



Quanto mais BMP, mais proliferação celular e maior o bico!

Arhat Abzhanov, *et al.* *Science* **305**, 1462 (2004);



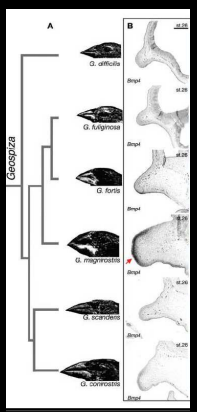
HIPÓTESE:

QUANTO MAIS BMP MAIOR O BICO.

O QUE OCORRE COM OS PÁSSAROS DE DARWIN?

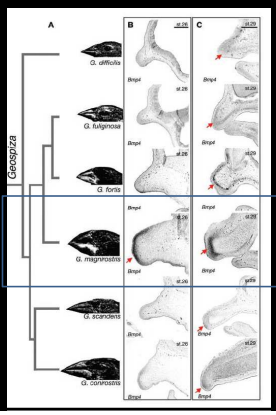
Science. 2004 Sep 3;305(5689):1462-5.
Abzhanov A et al.

Comparação do expressão de BMP nos diferentes embriões de tentilhões



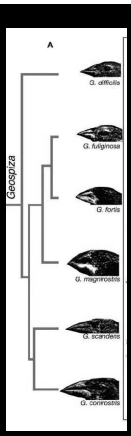
Science. 2004 Sep 3;305(5689):1462-5.
Abzhanov A et al.

O bico maior tem BMP por mais tempo e numa área maior



Surge ANTES
MAIOR superfície de expressão

Science. 2004 Sep 3;305(5689):1462-5.
Abzhanov A et al.



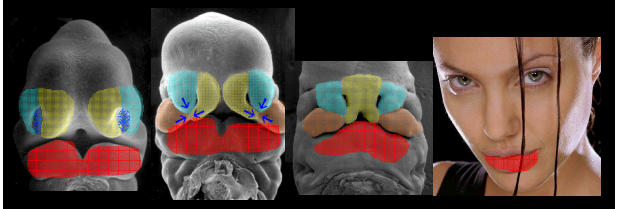
O QUE OCORRE COM OS PÁSSAROS DE DARWIN?

A EXPRESSÃO DE BMP VARIA

temporalmente
espacialmente

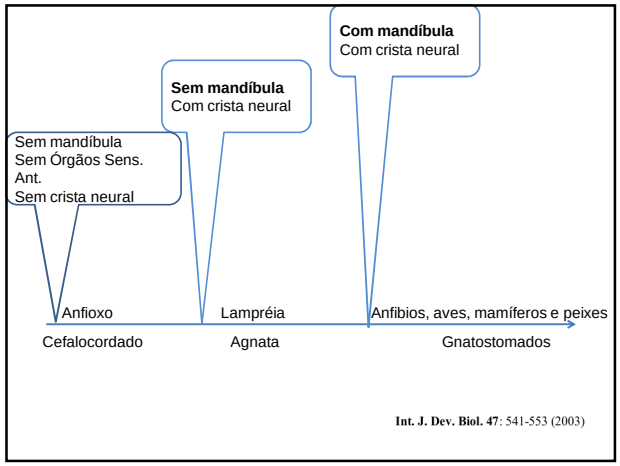
Science. 2004 Sep 3;305(5689):1462-5.
Abzhanov A et al.

O primeiro arco branquial forma a mandíbula ou bico inferior



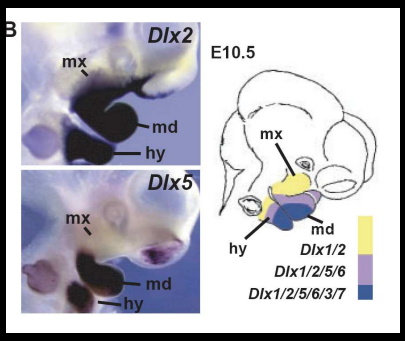
Saliência Nasal Medial
Saliência Nasal Lateral
Processo Maxilar

http://www.biomed2.man.ac.uk/ugrad/biomedical/calpage/sproject/rob/week4.html



O que determina a formação de mandíbula/lábio inferior?

O primeiro arco branquial expressa Dlx5 e Dlx 6
O prom. Fronto-nasal não expessa Dlx

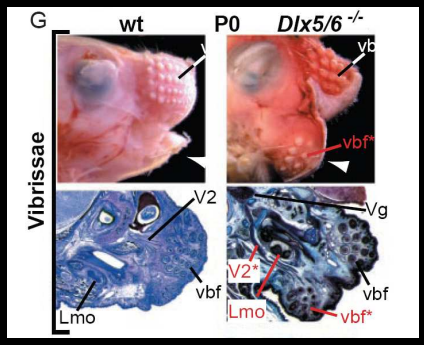


Specification of Jaw Subdivisions by Dlx Genes
Michael J. Depew, et al.
Science 298, 381 (2002).

HIPÓTESE:

OS GENES Dlx DETERMINAM O DOMÍNIO DA MANDÍBULA OU BICO INFERIOR

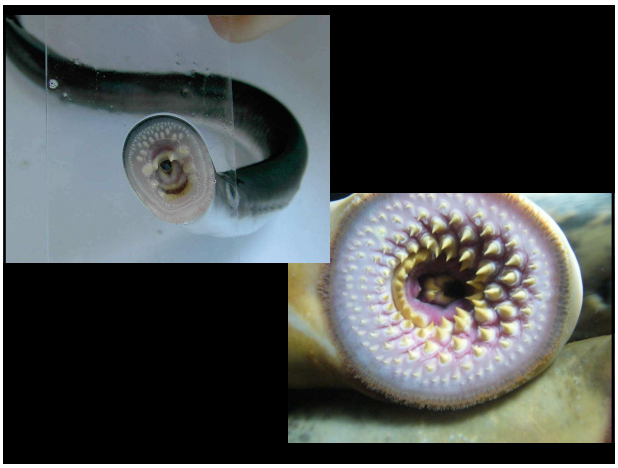
A remoção dos genes Dlx5 e Dlx6 convertem mandíbula em maxila



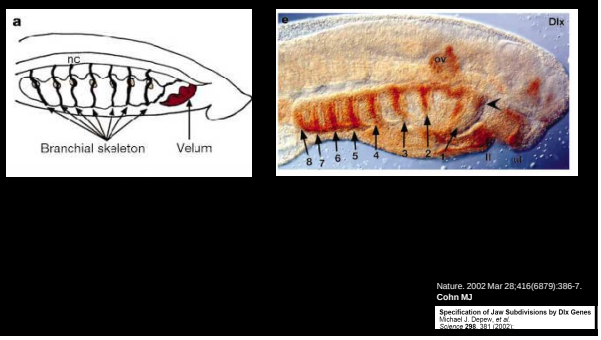
Specification of Jaw Subdivisions by Dlx Genes
Michael J. Depew, et al.
Science 298, 381 (2002).

O QUE DETERMINA AS ESTRUTURAS CEFÁLICAS?
Os genes Dlx determinam maxila Vs. mandíbula

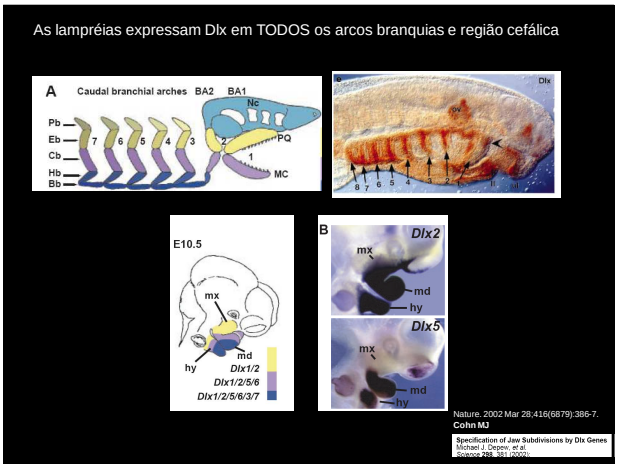
E OS AGNATAS?

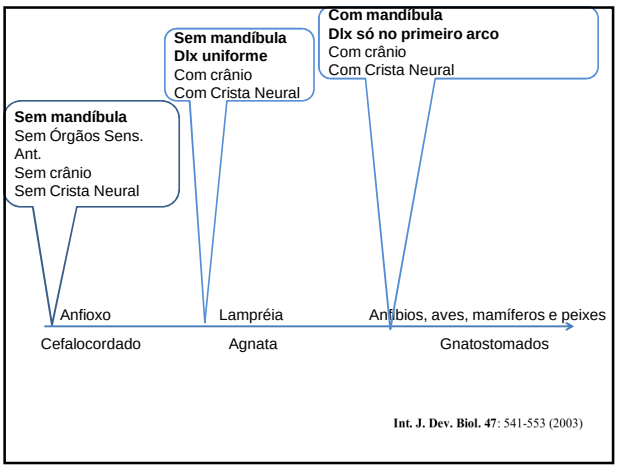


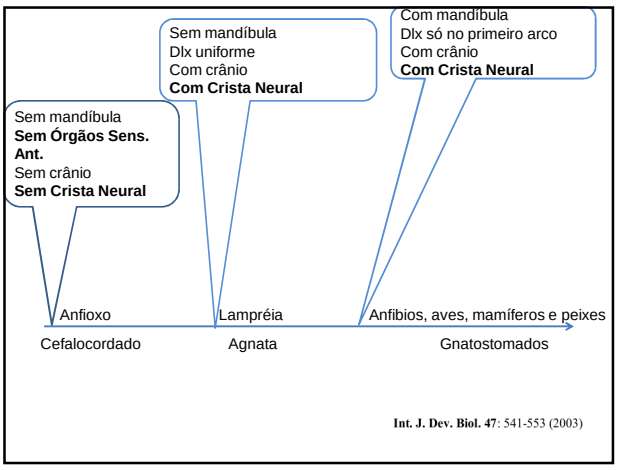
As lampréias expressam Dlx em TODOS os arcos branquias e região cefálica



As lampréias expressam Dlx em TODOS os arcos branquias e região cefálica

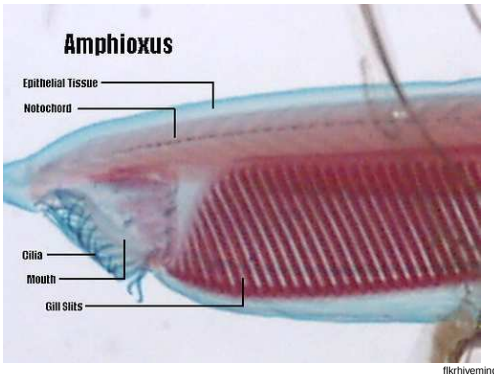






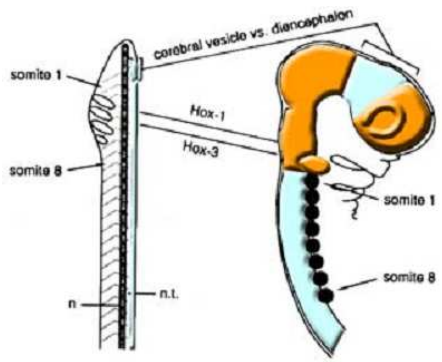
COMO que surgiu o crânio?

Anfioxo não tem órgãos sensoriais anteriores



flkrhivemind.net

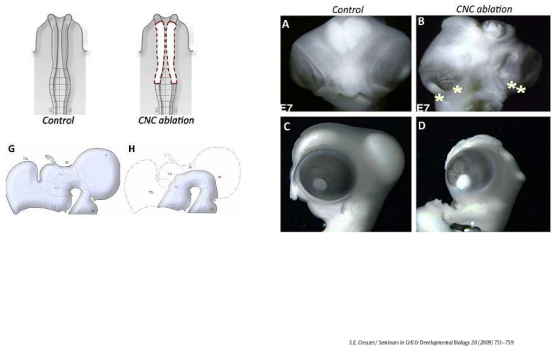
O sistema nervoso mais anterior do anfioxo equivale ao diencéfalo de vertebrados



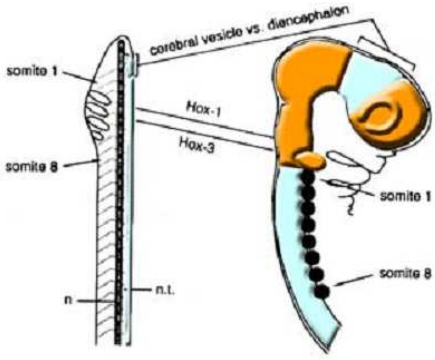
Modified from P. Holland and J. Garcia-Fernandez, 1996

O SURGIMENTO DO TELENCÈFALO ESTÀ RELACIONADO COM A CRISTA NEURAL CRANIANA?

A remoção da crista neural craniana interfere com o desenvolvimento do telencéfalo



O sistema nervoso mais anterior do anfioxo equivale ao diencéfalo de vertebrados



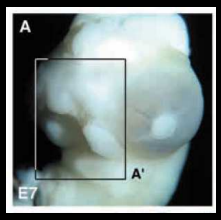
Modified from P. Holland and J. Garcia-Fernandez, 1996

O QUE GERA O DOMÍNIOS CRÂNIO E TRONCO?

HIPÓTESE: Ausência de genes Hox permite a formação da face/Crânio

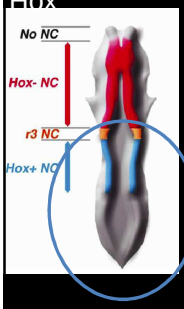
CONTROLE

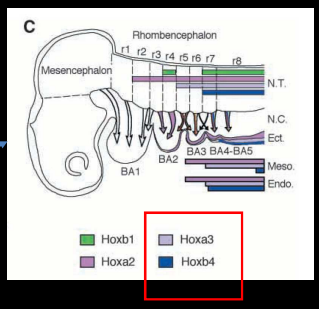
Hoxa3+ Hoxb4 na crista



Development 129, 4301-4313 (2002)

A crista neural truncal de vertebrados expresssa Hox

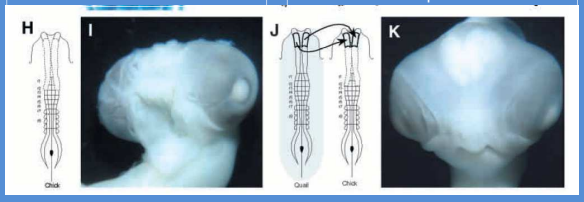




Mech Dev. 2004 Sep;121(9):1089-102.
Le Douarin NM

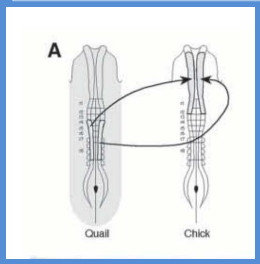
Crista cefálica removida

Crista cefálica removida e retransplantada



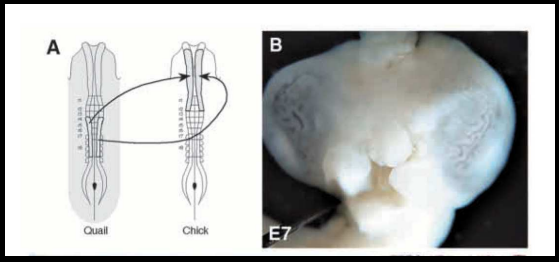
Development 2002 Sep;129(18):4301-13.
Creuzet S, Couly G, Vincent C, Le Douarin NM

Crista cefálica removida e retransplantada com crista truncal



Development 2002 Sep;129(18):4301-13.
Creuzet S, Couly G, Vincent C, Le Douarin NM

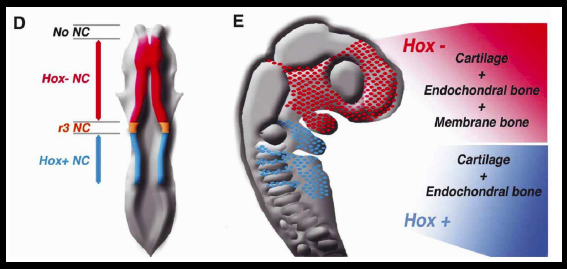
Crista cefálica removida e retransplantada com crista truncal



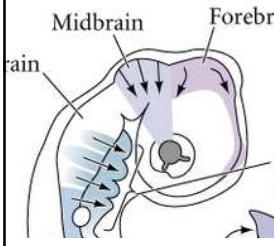
Development 2002 Sep;129(18):4301-13.
Creuzet S, Couly G, Vincent C, Le Douarin NM

CRISTA CEFÁLICA E DO TRONCO SÃO DIFERENTES JÁ ANTES DA MIGRAÇÃO.

A crista neural truncal expressa genes Hox
A crista neural cefálica NÂO expressa genes Hox

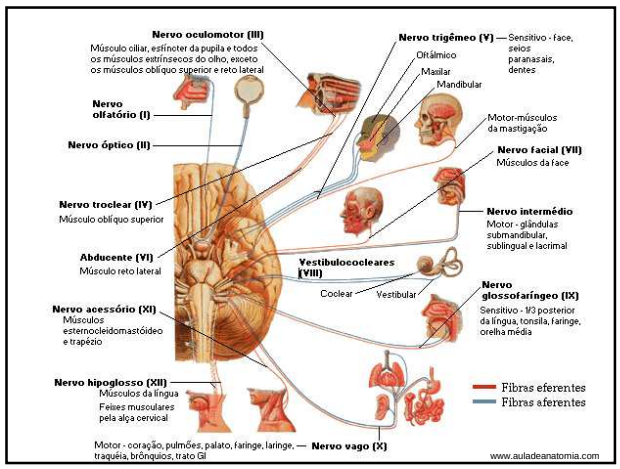


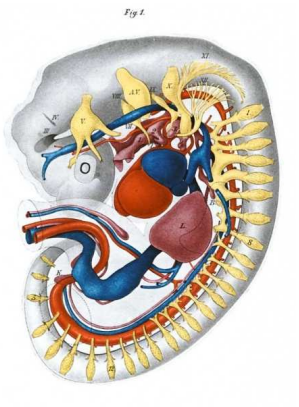
Mech Dev. 2004 Sep;121(9):1089-102.
Le Douarin NM



A Crista Neural CEFÁLICA dá origem a:

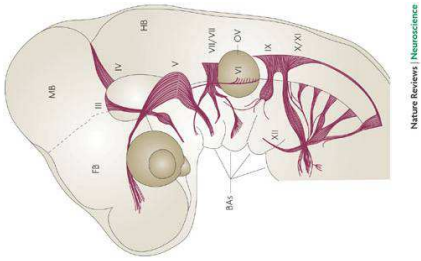
Melanócitos (células pigmentadas)
Neurônios
Glia
Cartilagens faciais
Ossos faciais
Nervos cranianos

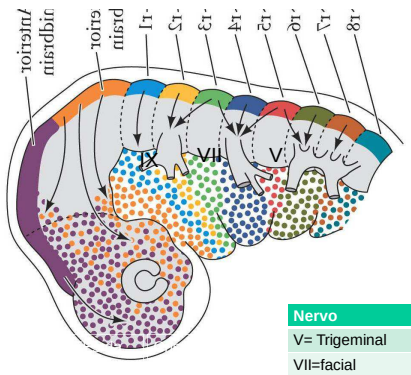




As células da crista neural podem ser divididas em cefálicas e truncais

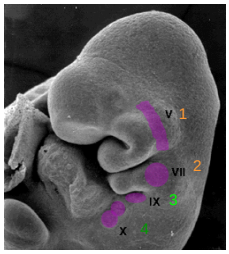
Os Nervos Cranianos e seus gânglios são enumerados cefalo-caudalmente por algarismos romanos

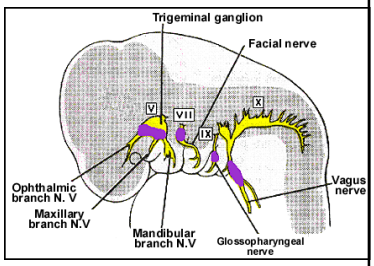




Nervo
V= Trigeminal
VII=facial
IX=Glossofaríngeo
X=Vago

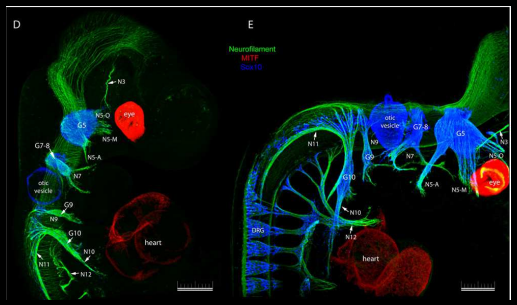
A correspondência de cada Arco Branquial a um nervo craniano



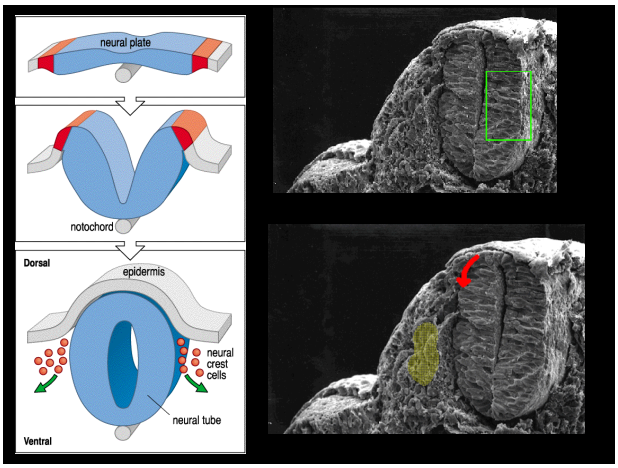


Arco	Nervo
1	V= Trigeminal
2	VII=facial
3	IX=Glossofaríngeo
4	X=Vago

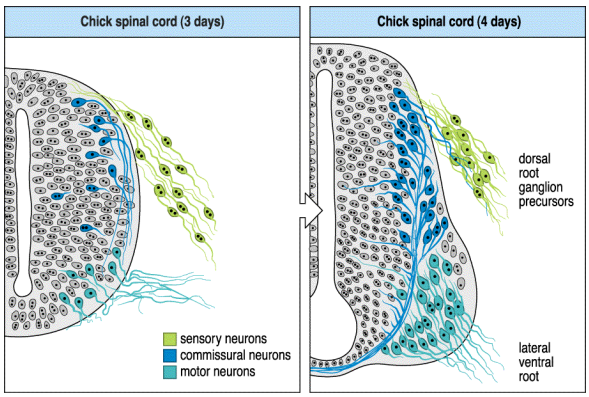
Os Gânglios formados extendem neuritos dorsal e ventralmente



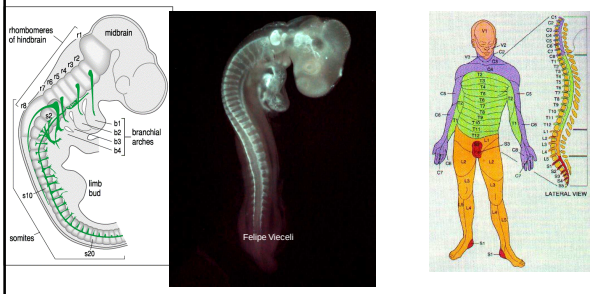
O QUE CRISTA NEURAL TRUNCAL FORMA?



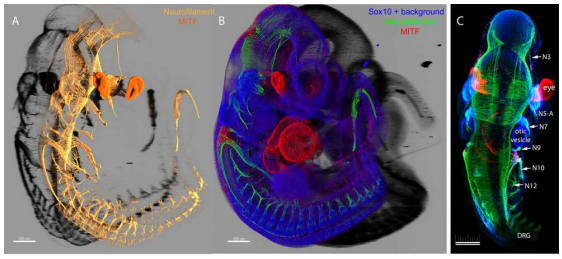
A crista neural truncal formará o sistema nervoso periférico



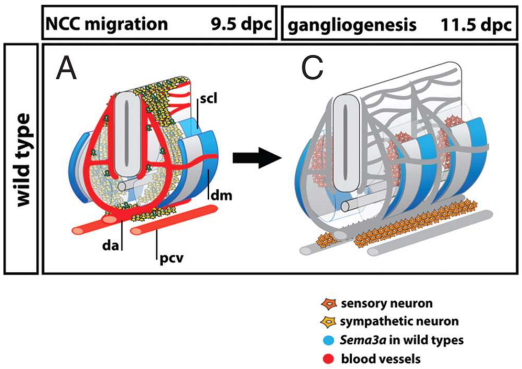
A migração das células da crista neural truncal ocorre em segmentos/faixas



A migração das células da crista neural truncal ocorre em segmentos/faixas



À medida que as células da crista migram ventralmente, vão formando estruturas neurais diferentes



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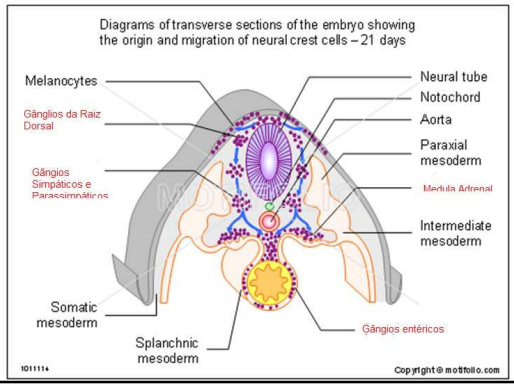
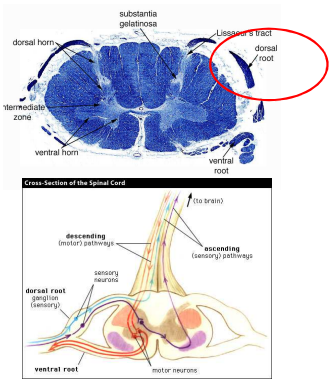
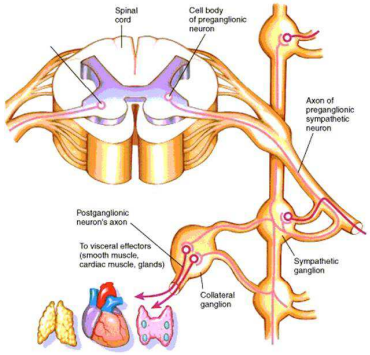


Os gânglios da raiz dorsal têm origem na crista neural



Os gânglios simpáticos e entéricos tem origem da crista neural



Sem mandíbula
Sem Órgãos Sens. Ant.
Sem crânio
Sem Crista Neural

Sem mandíbula
Sem G. simpático
Dlx uniforme
Com crânio
Com G. Raiz Dorsal
Com Crista Neural

Com mandíbula
Dlx só no primeiro arco
Com crânio, GRD e G. S
Com Crista Neural

Anfioxo — Lampréia — Anfibios, aves, mamíferos e peixes

Cefalocordado — Agnata — Gnatostomados

Int. J. Dev. Biol. 47: 541-553 (2003)

Expression of Sympathetic Nervous System Genes in Lamprey Suggests Their Recruitment for Specification of a New Vertebrate Feature

Daniela Häming[a], Marcos Simoes-Costa[a], Benjamin Uy, Jonathan Valencia, Tatjana Sauka-Spengler, Marianne Bronner-Fraser*

Division of Biology, California Institute of Technology, Pasadena, California, United States of America