**What does development tell us about evolution in the vertebrates?**

Different Ontogenies!!

http://www.mun.ca/biology/desmid/brian/Biol3530/DEVO_15/devo_15.html


**What is Heterochrony? Why is it an important concept?**

Kardong, Fig. 5.37

**Explain & compare the models for paedomorphosis.**

<table>
<thead>
<tr>
<th>Normal</th>
<th>Slower Rate Somatic Growth</th>
</tr>
</thead>
<tbody>
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<td>Earlier Sexual Maturation</td>
<td>Delayed Onset (start) of Somatic Growth</td>
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**Explain & compare the models for peramorphosis.**

<table>
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How did the complex vertebrate nervous system evolve from the simpler chordate one?

Brains

(A) larval amphioxus
(B) larval tunicate
(C) lamprey (Tripartite, complex sensory systems)

Feinberg & Mallatt, 2013

What germ layer forms the nervous system?

Somatic = Non-neural ectoderm

Embryonic ectoderm

Saint-Jeannet & Moody, 2014

Early Amniote embryo

Neural plate → CNS

Neural Crest

Cranial/Neurogenic Placodes

Somatic (non-neural) Ectoderm

Neural Crest Cells:

spinal ganglia

Neural Crest in a lamprey larva.

Blue = cartilage, dark blue = cranial ganglia, purple = dorsal root ganglia, orange = dorsal fin mesenchyme, & melanocytes.

Muñoz & Trainor, 2015

What else can neural crest cells become?

Ectomesenchymal fates

Non-ectomesenchymal fates

Chondroblasts

Sensory neurons

Osteoblasts

Sympathetic neurons

Mesenchymal cells

Enteric neurons

Fibroblasts

Parasympathetic neurons

Adipocytes

Peripheral glial cell

Odontoblasts

Chromaffin cells

Muscle cells

Melanocytes

Medeiros, 2013

Ivashkin & Adameyko, 2013

Explain neural tube formation. Where do neural crest cells go?

Neural Crest Placode

Neural Crest Ectoderm

Neural Crest in a lamprey larva.

Muñoz & Trainor, 2015

Feinberg & Mallatt, 2013

Neural crest in a lamprey larva.

Blue = cartilage, dark blue = cranial ganglia, purple = dorsal root ganglia, orange = dorsal fin mesenchyme, & melanocytes.

Neural crest in a lamprey larva.

Blue = cartilage, dark blue = cranial ganglia, purple = dorsal root ganglia, orange = dorsal fin mesenchyme, & melanocytes.

Medeiros, 2013

Ivashkin & Adameyko, 2013

Explain neural tube formation. Where do neural crest cells go?
Describe the formation & locations of neurogenic placodes.

Blastopore
Radial cleavage
Maunoury, 2014

Green, Simoes-Costa, & Bronner, 2015

Neural crest specifiers
Larger ocellus
Small ocelli
Specialized neural border
inversion & new mouth
Pigmented cells from
placodes & neural crest cells in the eye & nose.

Sensory cells

Some Major Cell Types:
Neurogenic placodes
Brain, Spinal Cord

Kardong Fig. 5.28

Selected References
Review Questions for Embryology Lecture

1. Define ontogeny. How is it relevant to the concept of heterochrony? Discuss the significance of the concept of heterochrony to macroevolution.

2. Describe the differences between paedomorphosis & paramorphosis. Describe & graph how changes in the timing or rate of development of sexual maturity or changes (speed up/slow down, early onset/delayed onset) in somatic growth rates can alter features of adults.

3. On your own & from lab: Compare gastrulation in non-amniotes (frogs) with amniotes. What evidence supports this statement: the blastopore & Hensen’s node are homologous.

4. Describe & diagram neurulation. What role does a notochord play in this event?

5. Where are these tissues (neural crest cells & neurogenic placodes) located relative to the neural plate prior to differentiation?

6. Describe the embryonic development & migration of neural crest cells. List 4 structures derived from neural crest cells (at least in part).

7. Describe the embryonic formation, migration & ultimate location of neurogenic placodes & list 4 structures derived from them. Kardong’s “ectodermal placodes”. How do the placodes & neural crest help create a more complex nervous system?

8. Summarize the shared, derived traits within the Deuterostomes, Chordates & Vertebrates. Why are tunicates placed as a closer relative to Vertebrates?