...or just

Embryology, Part 2

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Outline

General overview of prenatal development

Embryonic period phase 1
  • Formation of bilaminar disk
  • Formation of trilaminar disk (gastrulation)

Embryonic period phase 2
  • Formation of neural tube
  • Differentiation of mesoderm
  • Folding of embryo
  • Formation of pharyngeal arches

Development of head, face and oral cavity
  • Face (bones and muscles)
  • Pituitary gland
  • Palate
  • Tongue
  • Thyroid
  • Jaw bones
Embryology Part 2 Lecture Objectives

• In what week do the arches form?
• Which germ cell layers contribute to the arches?
• Which neural crest cells (next to which part of the developing neural tube) supply each arch?
• What are the sensory and motor nerves associated with each arch?
• What muscles and cartilages arise from each arch?
• What happens to the grooves and pouches?
• What structures do the internal and external carotid arteries supply in week 5 vs. week 7?
Formation of Pharyngeal Arches ~ 4th week

- Frontal prominence
- Stomatodeum
- Pharyngeal arches and grooves or clefts
- Cardiac bulge
Pharyngeal arches, grooves/clefts and pouches
Arches are composed of:
- a core of mesoderm and neural crest cells
- an external surface lined by ectoderm
- an internal surface lined by endoderm *

* except the internal surface of the 1\textsuperscript{st} arch, which is lined by ectoderm!
Formation of Pharyngeal Arches

25-day-old embryo
No arches yet
Buccopharyngeal membrane intact

35-day-old embryo
Arches and pouches nicely formed
Mouth now open to esophagus
Remember where neural crest cells are?
There are neural crest cells adjacent to the developing hindbrain (which is divided into little segments called rhombomeres) and midbrain.

Some of these migrate to the arches.

Know which neural crest cells migrate to each arch. Seriously. No, really, it’s not a joke.
Here are the rhombomeres (labeled 1 – 8)

The gray arrows show the migration pattern. So for example, neural crest cells next to rhombomere 4 migrate to the 2nd arch.

Neural crest cells next to rhombomeres 3 and 5 don’t migrate to the arches.

Here are the arches, labeled I – IV. Arch 1 has a maxillary branch (labeled Ia) and a mandibular branch (labeled Ib).
The next diagram illustrates this concept really well! But the print is TINY...so you’ll need to zoom in to see stuff.

Just use it if it helps you.
If it makes you feel overwhelmed, forget it.
**Figure 1.** The sites of origin, migration, and arrival of cranial neural crest cells. (A) Embryonic neural tube showing the mesencephalon, metencephalon, and rhombomeres, with the dorsal face of tube coloured to show the location of neural crest before migration. (B) Sagittal view of embryo, showing paths of migration of cranial crest cells. (C) Sagittal view of adult human, showing the origins of various cranial crest derivatives.
26-day-old embryo showing stomatodeum and first two arches
Embryo, day 26-30

Frontal prominence

1

2

3

Somite
First four arches in a 32-day-old embryo

- Somites
- Optic placode
- Nasal placode
- Maxillary
- Stomatodeum
- Mandibular
- Heart
**Know this!**

<table>
<thead>
<tr>
<th>Arch</th>
<th>Nerve</th>
<th>Muscles</th>
<th>Skeleton</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>V (trigeminal)</td>
<td>Mastication*</td>
<td>Meckel’s cartilage</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mylohyoid, anterior digastic</td>
<td>(malleus, incus)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tensors tympani and veli palatini</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>VII (facial)</td>
<td>Facial expression**</td>
<td>Reichert’s cartilage:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Posterior digastic</td>
<td>stapes, styloid, lesser hyoid</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stylohyoid</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stapedius</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>IX (glossopharyngeal)</td>
<td>Stylopharyngeus</td>
<td>Greater hyoid</td>
</tr>
<tr>
<td>4-6</td>
<td>X (vagus)</td>
<td>Cricothyroid</td>
<td>Laryngeal cartilages</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Levator veli palatini</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Constrictors of pharynx</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Larynx muscles</td>
<td></td>
</tr>
</tbody>
</table>

* Temporal, masseter, and medial & lateral pterygoids
** Buccinators, auricularis, frontalis, platysma, orbicularis orri and oculi.

**Important!**
Meckel’s cartilage indicates where the mandible will develop – but it does not turn into the mandible!
## Know this too!

<table>
<thead>
<tr>
<th>Arch</th>
<th>Nerve</th>
<th>Branches</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>V (trigeminal)</td>
<td>Ophthalmic Maxillary and Mandibular</td>
</tr>
<tr>
<td>2</td>
<td>VII (facial)</td>
<td>Chorda tympani (taste)</td>
</tr>
<tr>
<td>3</td>
<td>IX (glossopharyngeal)</td>
<td>Sensation of pharynx, middle ear, root of tongue and taste</td>
</tr>
<tr>
<td>4-6</td>
<td>X (vagus)</td>
<td>Parasympathetic innervation</td>
</tr>
</tbody>
</table>
Arch 1
Meckel’s cartilage, malleus and incus

Arch 2
Reichert’s cartilage, stapes, styloid and lesser hyoid

Arch 3
Greater hyoid

Arch 4 and 6
Laryngeal cartilages
What happens to the pouches and grooves?

- 1\textsuperscript{st} cleft/pouch -> External auditory meatus/Tympanic cavity, Eustachian tube
- Rest of grooves disappear (see A)
- 2\textsuperscript{nd} pouch obliterated by tonsil
- 3\textsuperscript{rd} pouch -> inferior parathyroid, thymus
- 4\textsuperscript{th} and 5\textsuperscript{th} pouches -> superior parathyroid, ultimobranchial body (C cells thyroid)
Head and Neck Anomalies
From Improper Groove Closure

Pharyngeal cyst
(Second pharyngeal cleft)

Congenital auricular sinus
(Second arch or cleft)
Congenital Auricular Sinus

This little boy belongs to a student from a previous year!
At 4 weeks each arch has its own vascular supply. At 5 weeks the 3rd pharyngeal arch vessel becomes the common carotid, which supplies the face, neck and brain by means of the internal carotid and stapedial arteries.
Face and brain are initially supplied by the internal carotid artery.

By 7 weeks, facial vessels *detach from internal carotid* and attach to external carotid!

Internal carotid still supplies the brain.
Muscles of mastication = temporal, masseter, and medial & lateral pterygoids

In week 5, muscle cells show up in 1st arch. In weeks 6 and 7, they spread to each muscle’s site of origin.

These all relate to the developing mandible.
Muscles of facial expression: Buccinator, auricularis, frontalis, platysma, orbicularis ori and oculi.

By week 7, muscles of 2\textsuperscript{nd} arch grow upward. As they expand, they form sheets over the face, and become the muscles of facial expression.