Neural crest

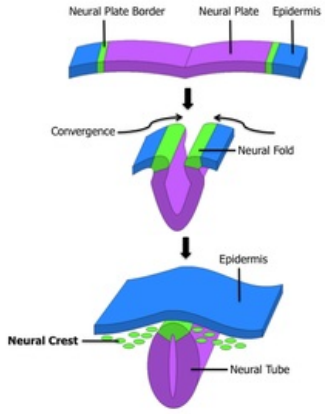
The neural crest is a structure formed during the third week of embryonic development during the process of neurulation, i.e. the formation of the neural tube. Neural crest cells migrate from their site of origin and underlie many diverse tissues and cell types throughout the embryo. For this reason, the neural crest is considered by some embryologists to be the fourth foetal membrane.

Formation of neural crest

During the third week, neural plate formation is first induced by increased fibroblast growth factor (FGF) signaling and inhibition of bone morphogenetic protein 4 (BMP4). By day 17, ectodermal cells start to proliferate (called ectodermal proliferation). It soon begins to increase in length and its lateral edges thicken into neural mounds, between which a sunken neural furrow remains. The center of the neural plate pulls down and the edges roll toward one another. Cells around the edges of the neural folds specialise and differentiate to become **neural crest cells.**

Further fate of neural crest cells

Cells located at the site of the neural crest undergo epithelo-mesenchymal transformation during neural tube closure, thereby escaping the neural tube and migrating to a number of locations throughout the body of the embryo where they will later differentiate into cells of various tissues , hold various functions. The escape time from the neural tube as well as the use of these cells varies slightly depending on the part of the body where they are located.



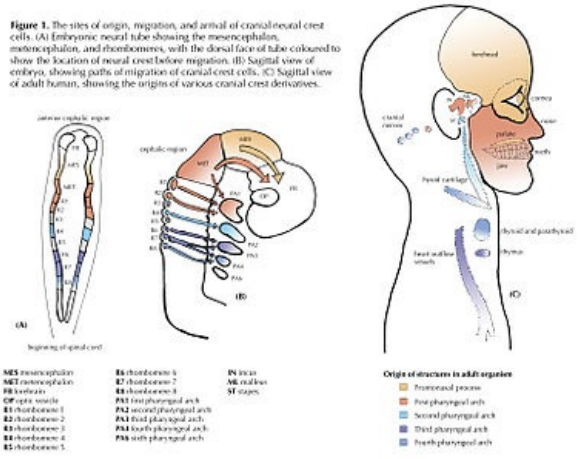
Development of the neural crest

Neural strip in trunk area

In the trunk region, the neural crests first fuse to close the neural tube, and only then do the neural crest cells leave them. Subsequently, a double fate awaits them. On the one hand, they migrate dorsally through the future dermis and penetrate openings in the basal lamina into the ectoderm, where they differentiate into melanocytes of the skin and hair follicles, on the other hand, ventrally to transform into neurons and glia of the spinal and autonomic ganglia and enteric nervous system, in Schwann cells and in adrenal medulla cells.

Neural strip in head and neck area

The neural crest cells in this region leave the neural crests before they join. Some of their future fates are similar to those of the trunk, namely transformation into melanocytes and transformation into the majority of neurons and glial cells of the cranial nerve ganglia (some of the cells also originate from the epibranchial placodes). Other formations are already typical for the head and neck area. Primarily, the cells of the neural crest give rise to connective tissues, as well as the dermis in this area. Furthermore, some of the cells grow into the ultimobranchial bodies and, after their migration caudally, transform into parafollicular cells (C-cells) of the thyroid gland. Another typical and important task of neural crest cells from the hindbrain is their migration to the truncus arteriosus and its septation, i.e. division into the aorta and truncus pulmonalis.


Migration of neural crest cells in the head and neck region

Summary of the main derivatives of the neural strip

1. Melanocytes
   - Found in the skin o Produce skin pigments
2. Enterochromaffin cells in the adrenal medulla
   - Secrete epinephrine (80%) and norepinephrine (20%)
   - Important for catecholamine surge for stress response.
   - Recall: Preganglionic axons synapse in the postganglionic motor neuron → release epinephrine and norepinephrine
3. Submucosal (Meissner's) plexus and myenteric (Auerbach's) plexus.
   - Important in the enteric nervous system
   - Found within the submucosa and muscularis externa of the GIT
   - Helps regulate the gastrointestinal tract
4. Dorsal root ganglion

    - Pseudounipolar cells located outside the spinal cord
5. Collateral and chain ganglia
    - Preganglionic sympathetic fiber in the lateral gray horn (T1-L2) project to the chain (paravertebral) or collateral (prevertebral) ganglia
6. Leptomeninges
    - Arachnoid + pia mater
    - Surround the brain and spinal cord
    - The dura mater is derived from the mesoderm
7. Cranial nerves V, VII, IX and X
    - Innervates the pharyngeal arches
    - Some sources/books also include CN III and VIII
8. Head and neck
    - Neural crest cells also differentiate to different structures of the head and neck
    - Muscles and bones (e.g. malleus, stapes and incus)
9. parafollicular thyroid cells
10. septum in truncus arteriosus
11. odontoblasts

Alar and Basal Plate

As cells differentiate and move away from the neural tube, they make the alar and basal plate

(1) Alar Plate

- “Bunny ears” extending dorsally and laterally
- Differentiates to become the posterior gray horn (PGH) o Where sensory neurons are found

(2) Basal Plate

- Anterior and lateral extension of the neural tube Differentiates to become the ventral gray horn (VGH)
- Where motor neurons are found

(3) Neural Tube Remnants

- Remnants of the neural tube becomes the spinal canal containing CSF

Links

Used literature

- SADLER, Thomas, W. *Langmanova lékařská embryologie.* 1. české edition. Grada, 2011. 414 pp. ISBN 978-80-247-2640-3.