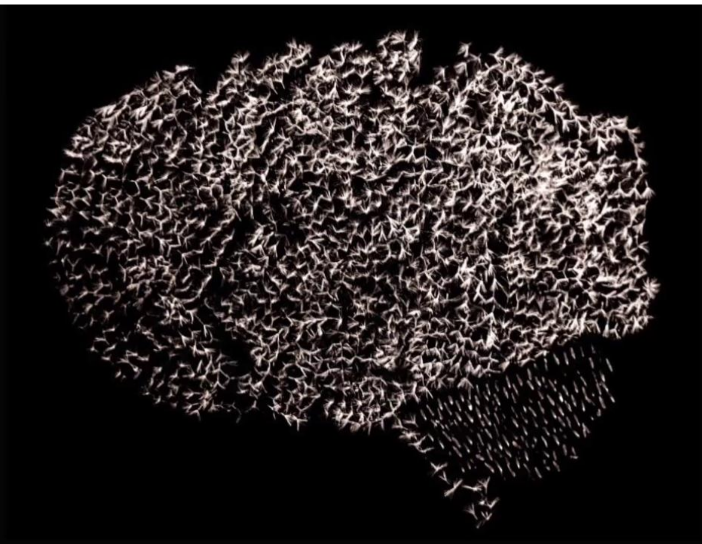
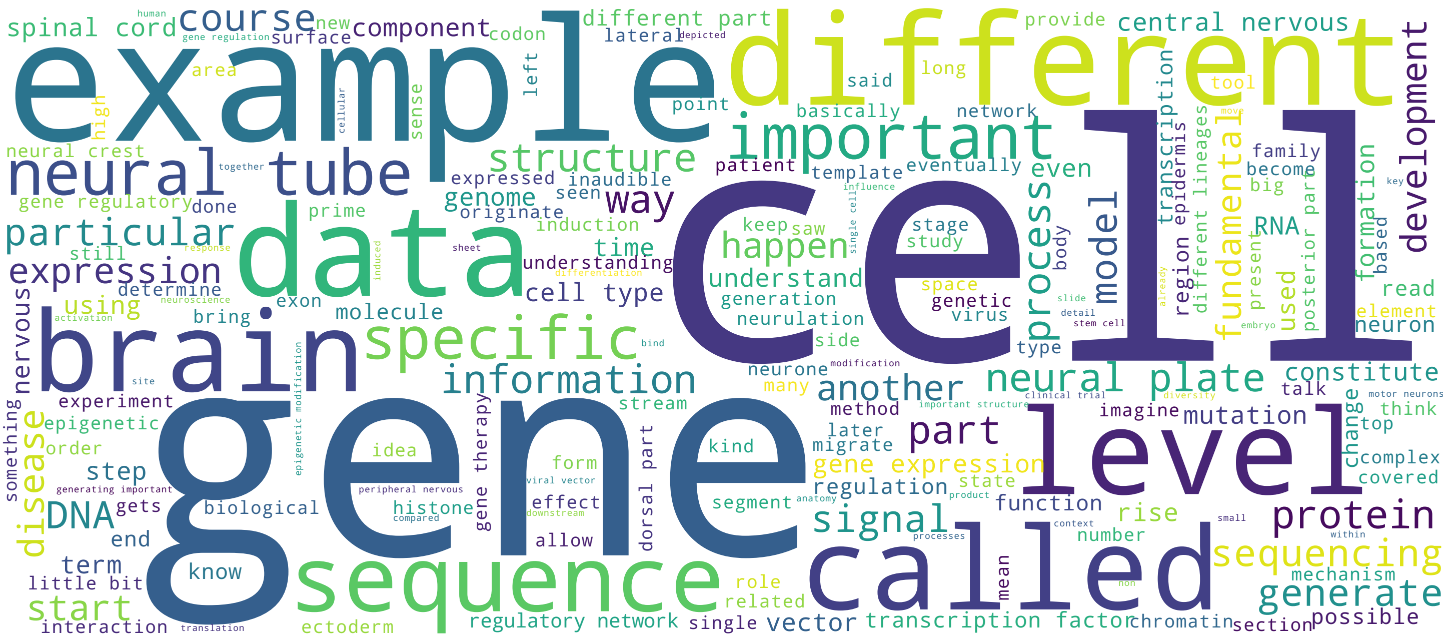


NEUROSCIENCE RECONSTRUCTED

Neurulation

Presented by Gioele La Manno



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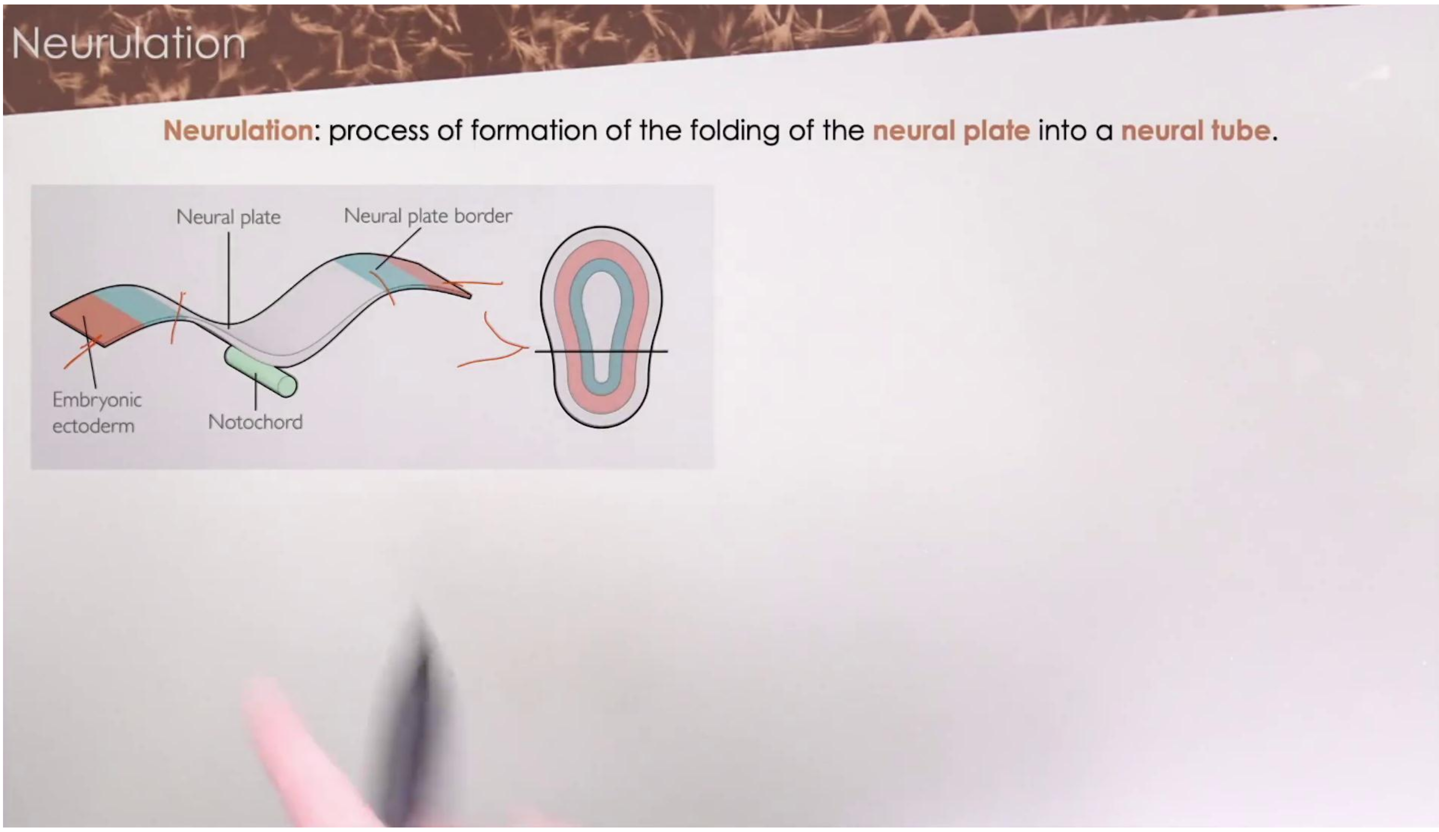
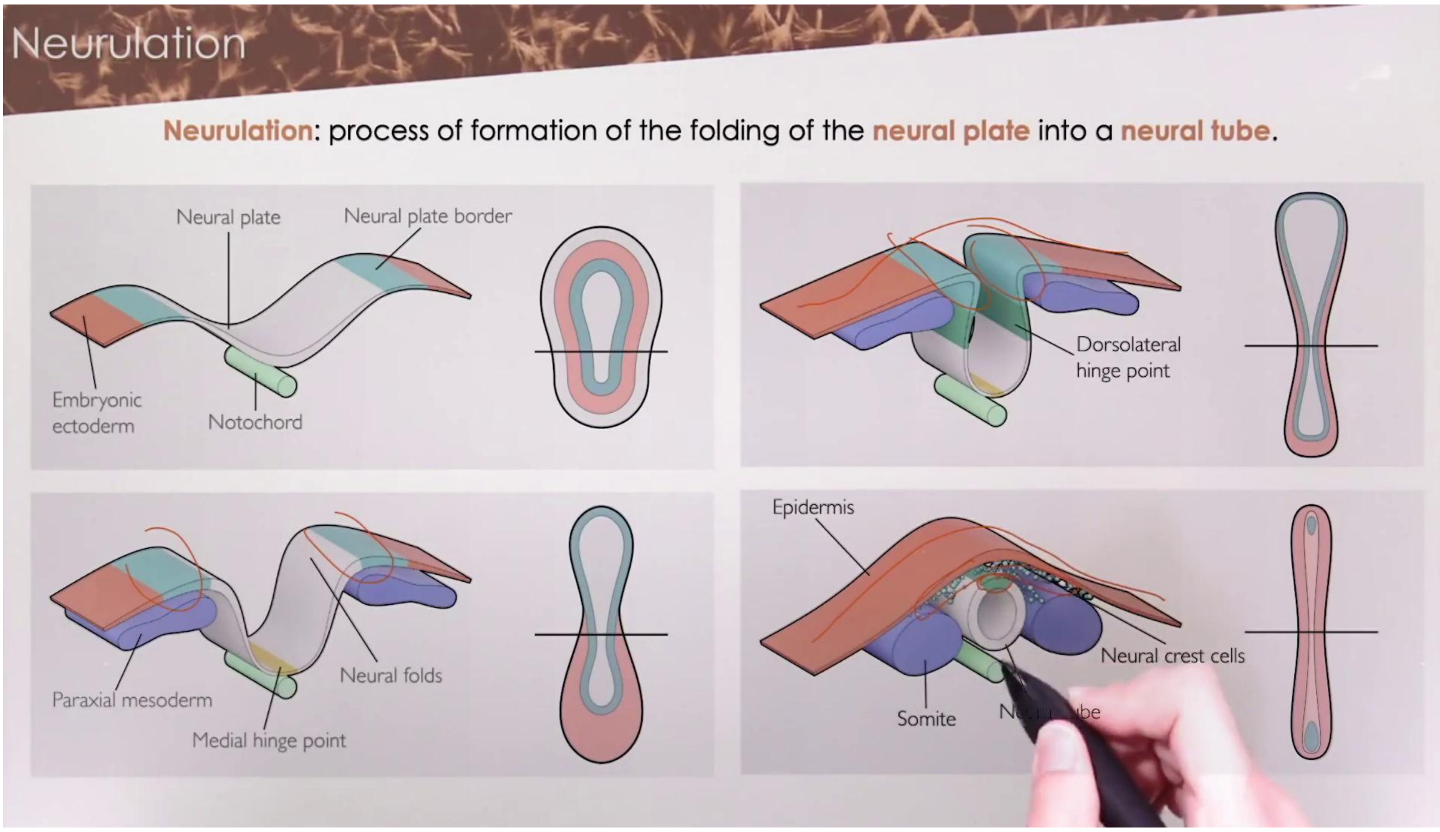


We've seen the previous slide, the neural plate, this time.28,.25. Now is the key moment where neurulation is going to take place. Now we're going to see this a little bit more into this cartoonish diagram form. I need to imagine, of course, happening in this 3D space. You're seeing this diagram on the left, the neural plate, and here more a dorsal view, for which this part is supposed to be the section of. What is neurulation? Neurulation is the process of formation of the folding of the neural plate and its closure to form the neural tube. This is not only more for genetic movement, it's not only about anatomy, but it's fundamental for the generation of very different lineages that give rise to very different parts of the nervous system and also other structures. It's important to understand it both, in terms of morphological movement, but also in terms of the molecular underpinning and the effects on generating completely different structures. At the beginning, neurulation is initiated by the induction of the notochord of ventralising signals. This prime and induces different region of the ectoderm to specify, we said, the neural plate. Regions that are more lateral, they get induced to become embryonic ectoderm.

Notes

Summary

0m 05s

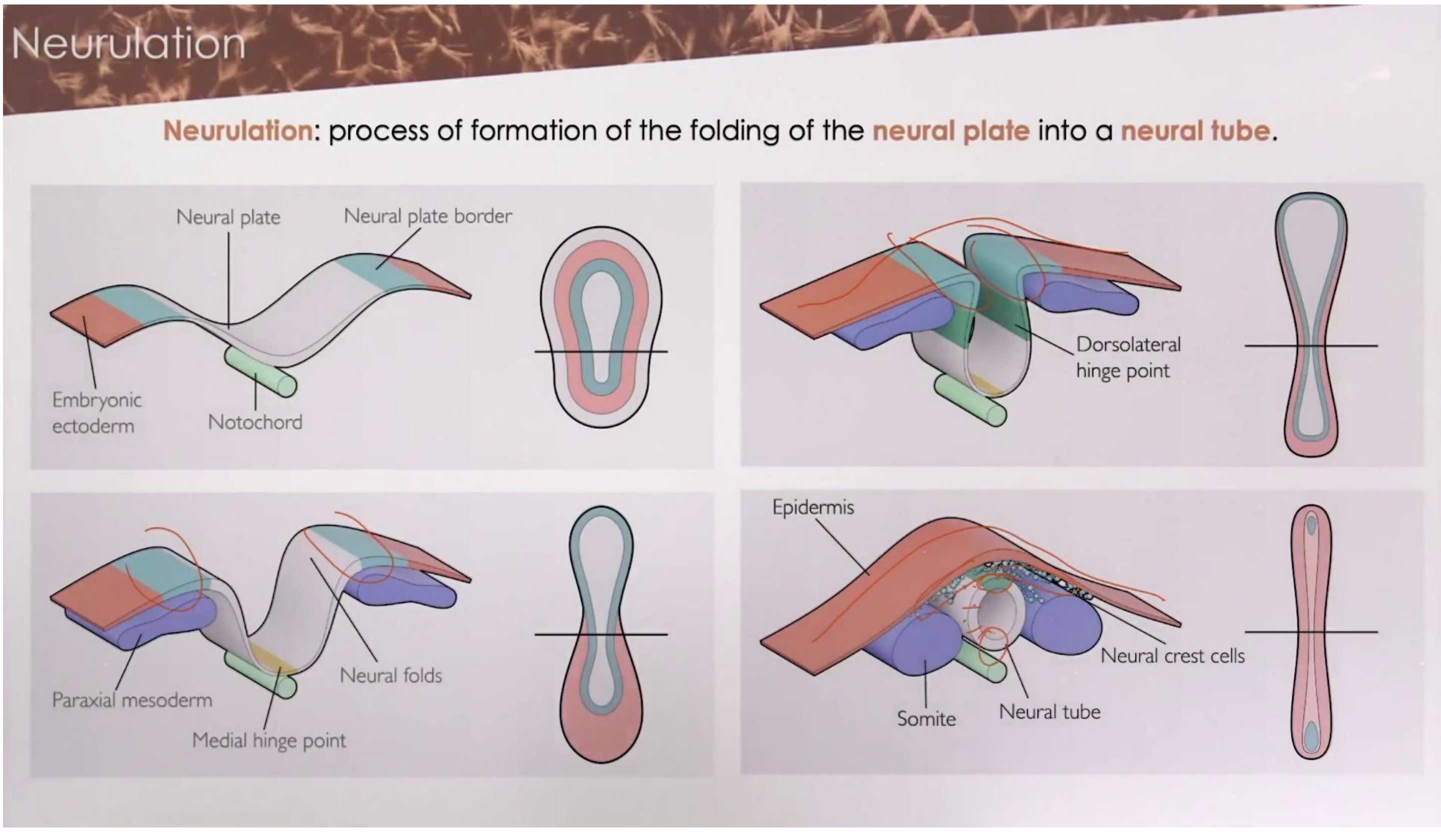


The parts in the middle we see are a specific fate. It is called neuro fold or neural plate border. We're going to see from the protein of these cells will originate the so-called neural crest cells. How does this happen? We first have movement contraction of the cells that bring the lateral part of the neural plate to fold. It rises first, and by some conservative movement, then the part that will constitute a hinge for the neural tube starts to come together and eventually merge into generating the formation of a continuous layer sheet of epidermis of surface ectoderm, we should say. The cells that we saw at the level of the neural fold here and here, they are going to undergo an epithelial-mesenchymal transition. They will become migratory, lose their epithelial phenotype and they're going to migrate. We're going to see going to migrate, generate a stream of cells, will move mainly towards the anterior part of the embryo generating important structure, including the part of the face. Some of them will migrate more laterally, generating important structure of the peripheral nervous system. We're going to see it in a second. Now the neural tube that are closed will present a more dorsal part that is the so-called roof plate.

Notes

Summary

1m 47s

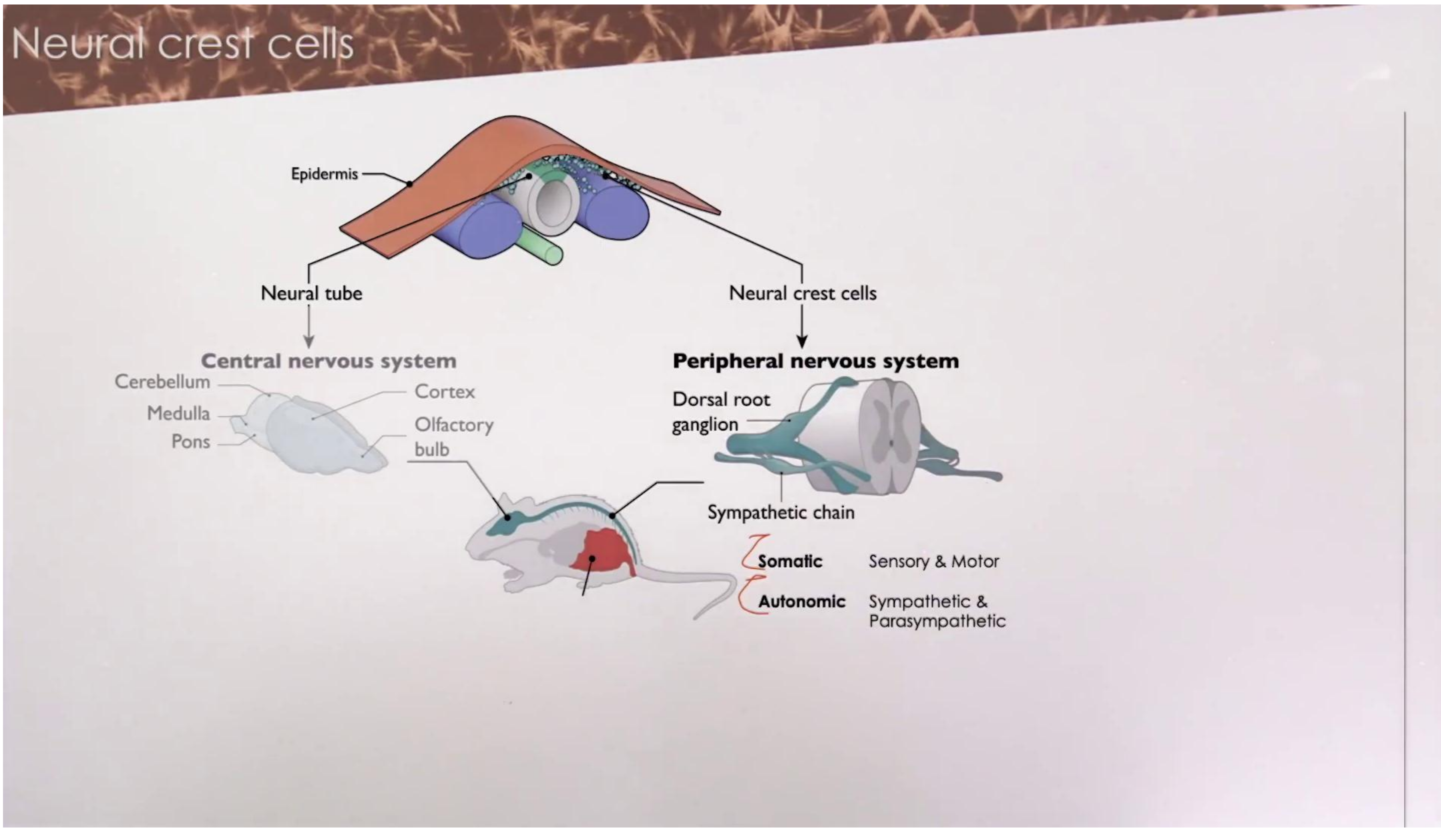


They will follow the outer plate, the basal plate, and the floor plate more ventrally. Those four fundamental areas are conceptual region from which different lineages will originate. At the end, we get a tube that is polarised. It's not just a symmetric neural tube, but it has a specific ventral or lateral and dorsal parts.

Notes

Summary

3m 26s

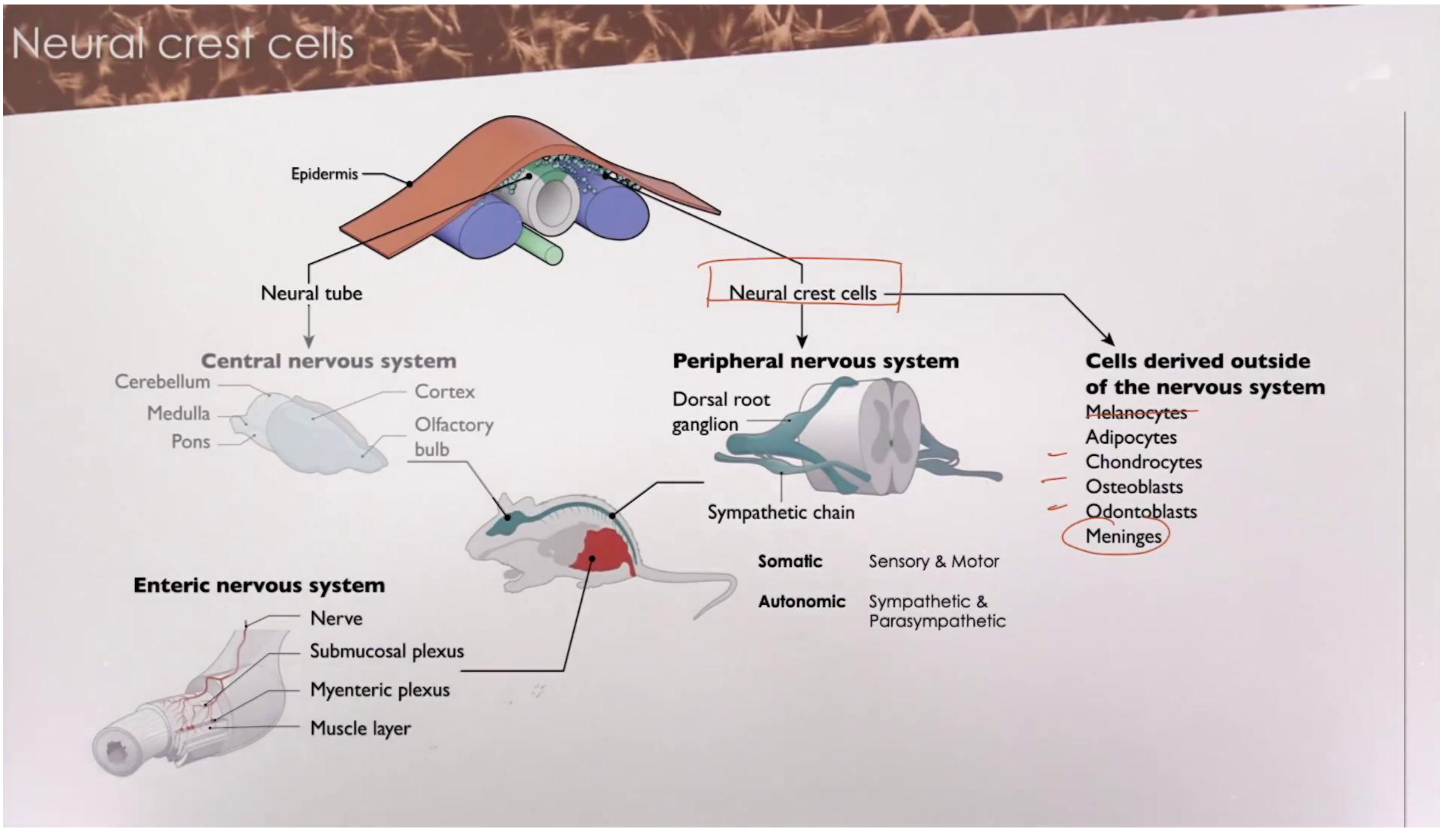


As I was saying before, what is important about neurulation is not only understanding those movements, and now we move from a neural plate to a neural tube of all the structure, and it is now covered by epidermis, which is the first ectoderm, that was first just on the side of the neural plate, where it is now covered by it. But it's important to understand now, from this original sheet of cells, different parts of it specialise to very different destinies. The parts of the proper neural tube will generate all the components or most of the component, or some other component of the central nervous system, the different area, including cerebellum, medulla, pons, cortex, olfactory bulb, and so on and so forth. They will also generate the spinal cord, in the more posterior part of the neural tube. It's really all the fundamental parts of the central nervous system. Neural cress cells instead generate the peripheral part of the nervous system, both the somatic and the autonomic components. For example, sensory and motor neurons, you see here depicted, for example, the dorsal root ganglion, where nuclei of the somatic part of the peripheral nervous system reside.

Notes

Summary

3m 51s

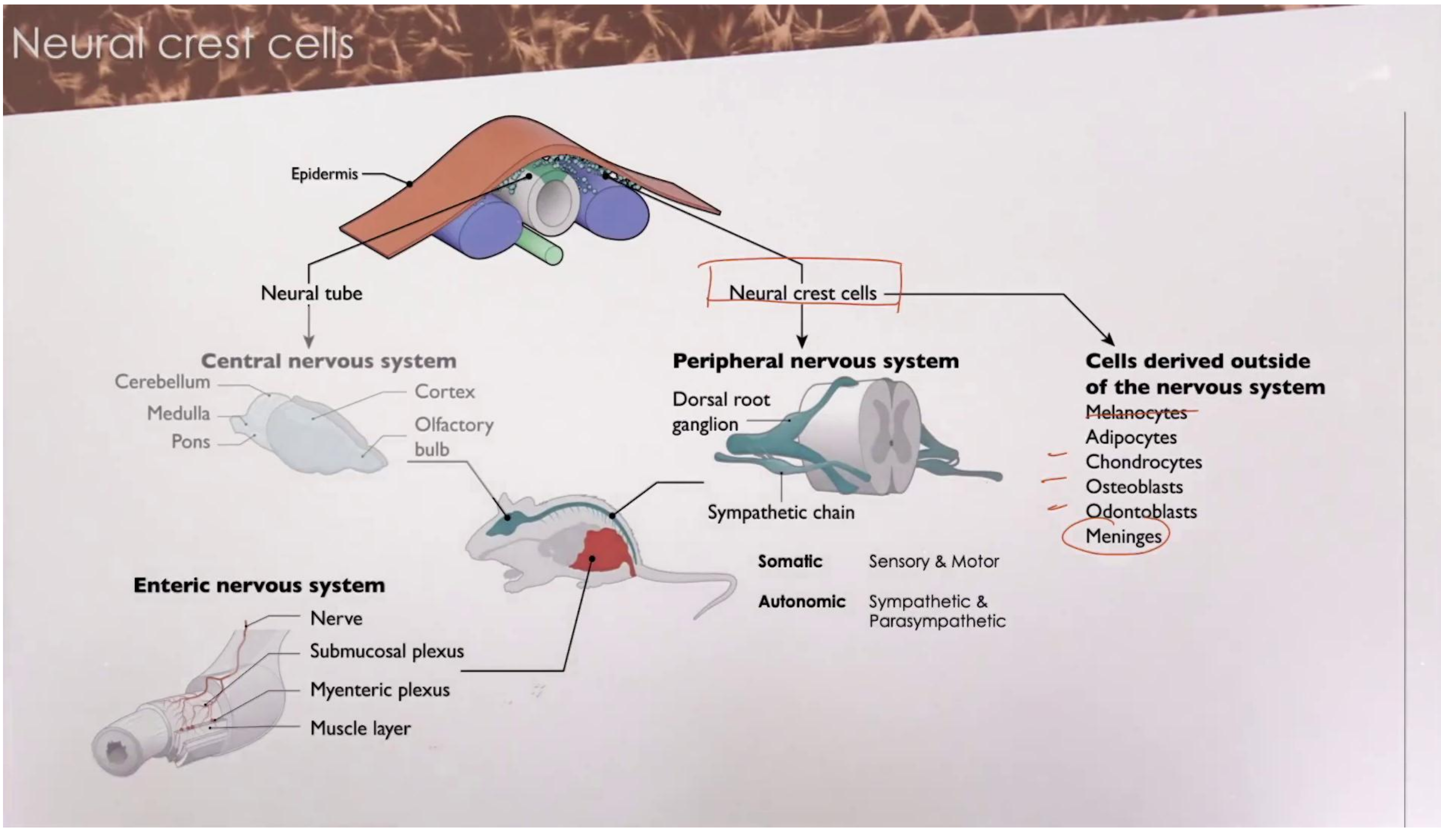


The autonomic part, as you can see here in the sympathetic chain, the neurons that constitute the sympathetic and parasympathetic nervous system, they are important for process like the regulation of the heartbeat, autonomous response like goosebumps, or even just the regulation of fight or flight response. Finally, there is, of course, a component, that could also give rise to components of the enteric nervous system, more disseminate the nervous system that constitutes nerves that regulate the digestion. Finally, it's important to keep in mind the neural crest are very versatile stem cells. They're one of the most exciting, probably, cells in embryology. They are actually a specific evolutionary invention that is specific to vertebrates. Cells of the neural crest generate a set of structure and cells that are specific to, for example, vertebrates. For example, they generate cells like the chondrocytes, the osteoblasts component of cartilage and bones. Odontoblast at the level of teeth, but also the meninges at the level of the sheets that constitute a barrier for the nervous system. But also melanocytes and adipocytes, things that are very different, look very different as compared to the central nervous system.

Notes

Summary

5m 16s

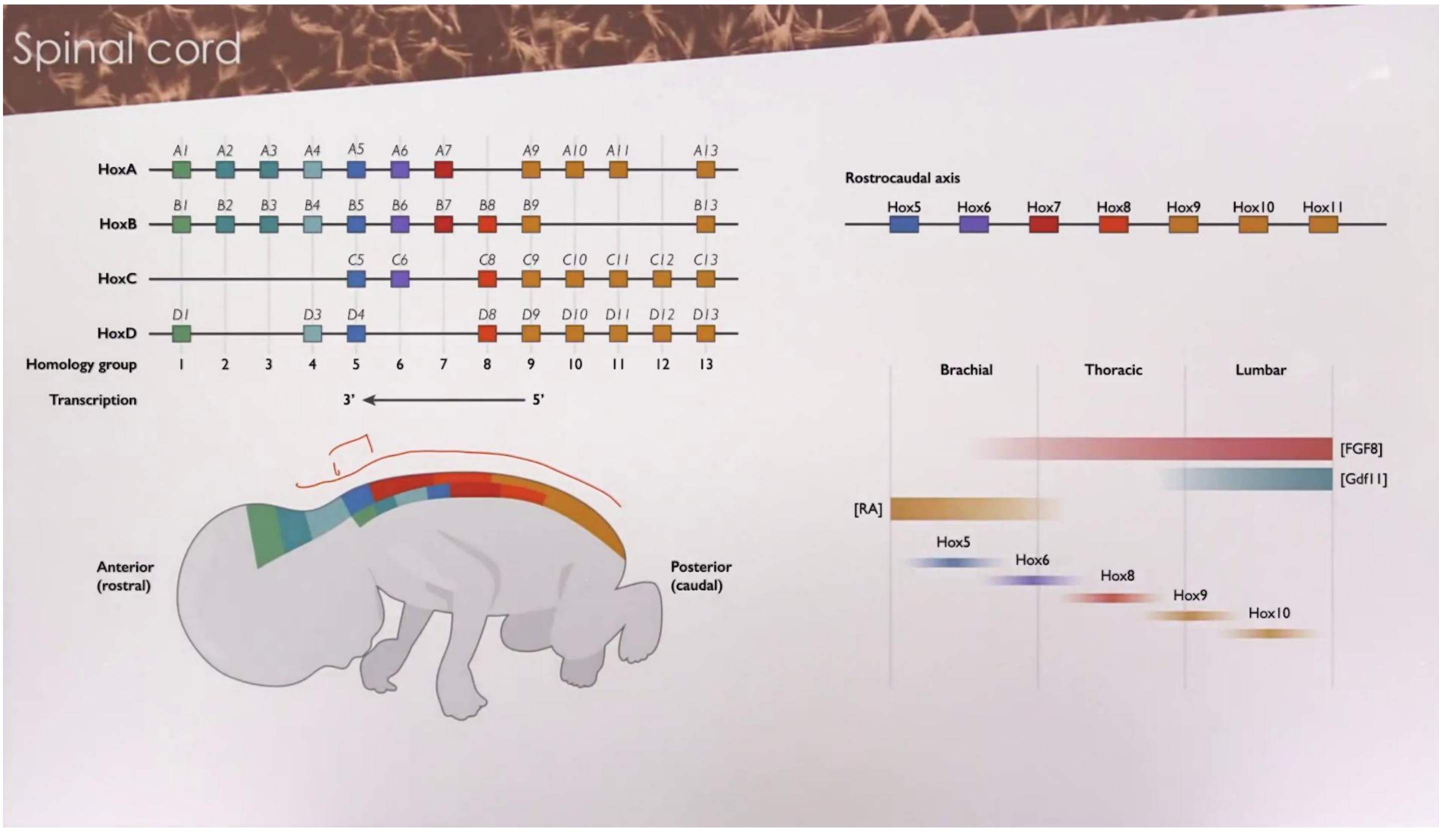


It's particularly interesting. This process of neural tube closure not only creates structure of the central nervous system, but fundamental cells that then take the constitutes, a separate lineage. May be even more like mesenchymal cells and that can acquire cell types that are more typically associated with mesoderm.

Notes

Summary

6m 57s

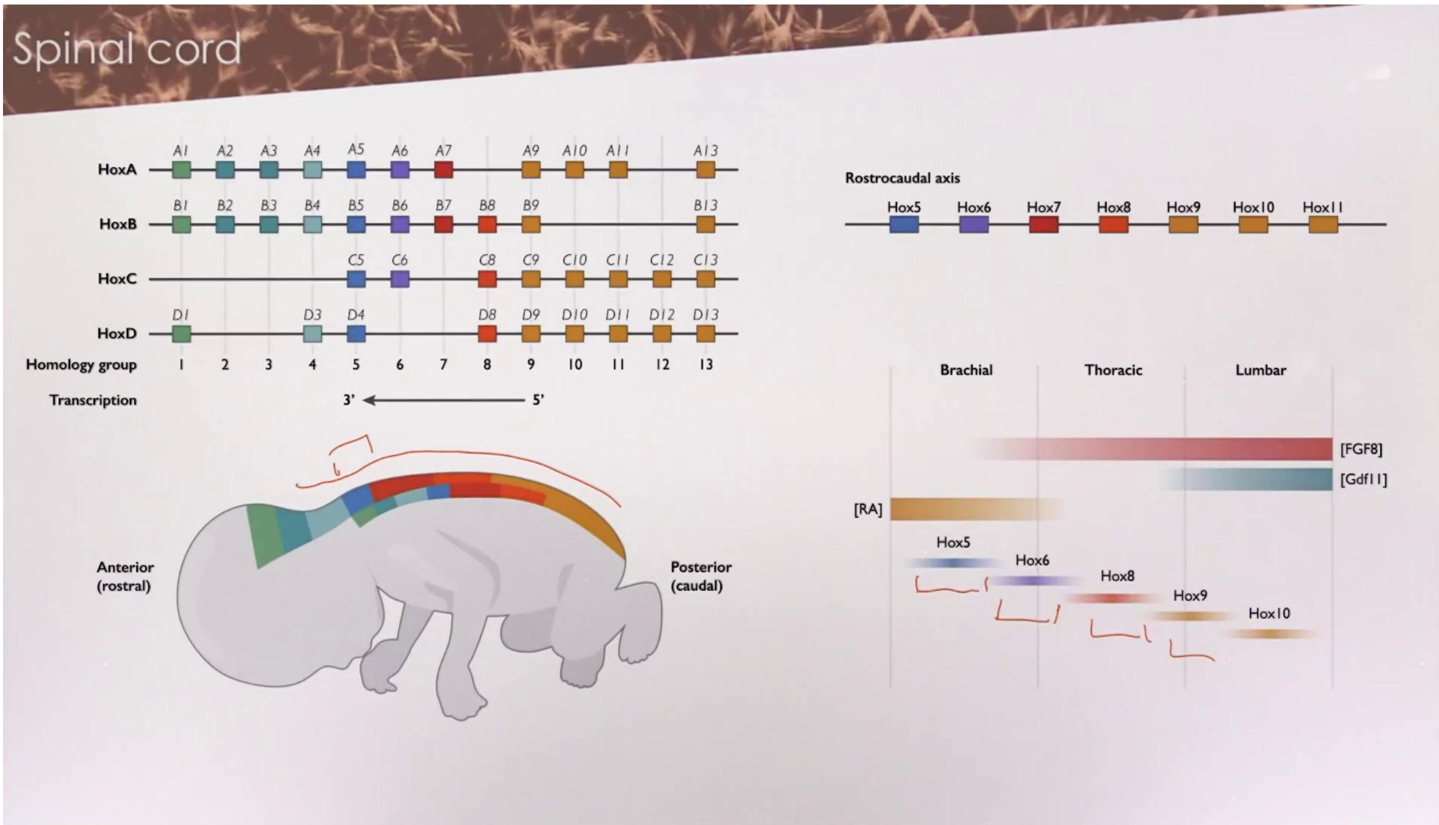


From the posterior part of the neural tube, it originates the spinal cord. The spinal cord is a structure that extends from the cephalic part, to thoracic lumber, and all the way posteriorly or cortically across the body. It's important for the streams of both motor and sensory signal. It's important that different segments of the spinal cord are specialised to... They know basically there is information that gets built up during development that tells the cells whether they need to bring some efferent fibres to specific upper limbs, particular location, or they need to be acceptor of signals from sensory neurons in the periphery, for example, in the surface of the skin. How to do that? This is encoding of a family of genes called the Homeobox genes. It's a particular interesting family. They're organised in different part of the different chromosomes, but in clusters. Usually, their order in the genome actually mirrors their expression and their distribution in space. That's what the colour code that you see in this slide. They will be their order along the rostro-caudal axis and they are activated as downstream of the other earlier signals, other earlier queues, and in particular, FGRF and retinoic acid signaling.

Notes

Summary

7m 23s



As a response of a gene regulation direct work in their activation and the particular mechanism of their temporal activation, they end up being expressed in segment that combinatorically by partial overlap, but also by exclusively in some areas that generate the information that gets a use at the level of the cell scene to trigger specific innovation activity or the differentiation of particular neurons that are specific to one segment or another.

Notes

Summary

8m 53s