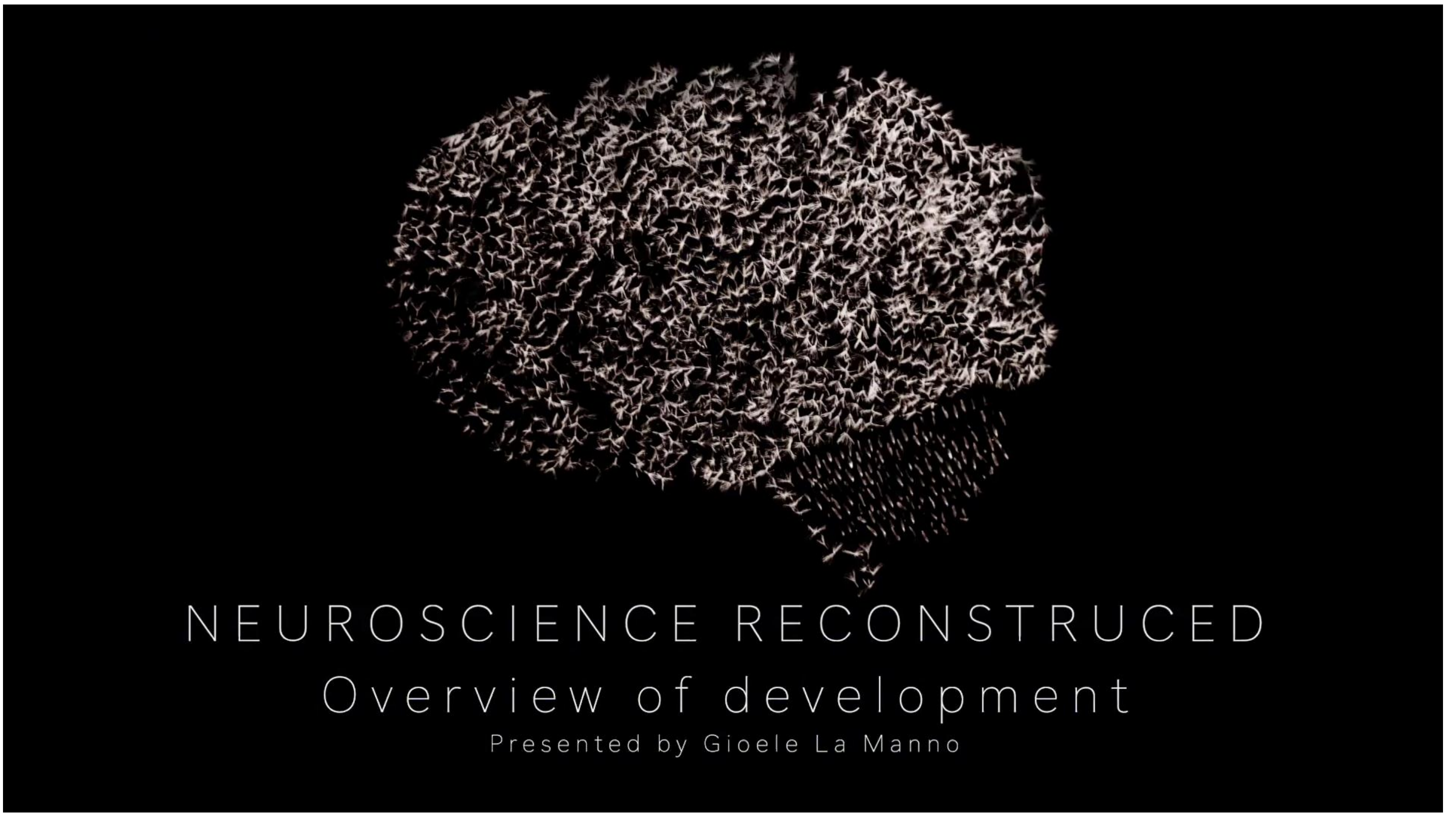

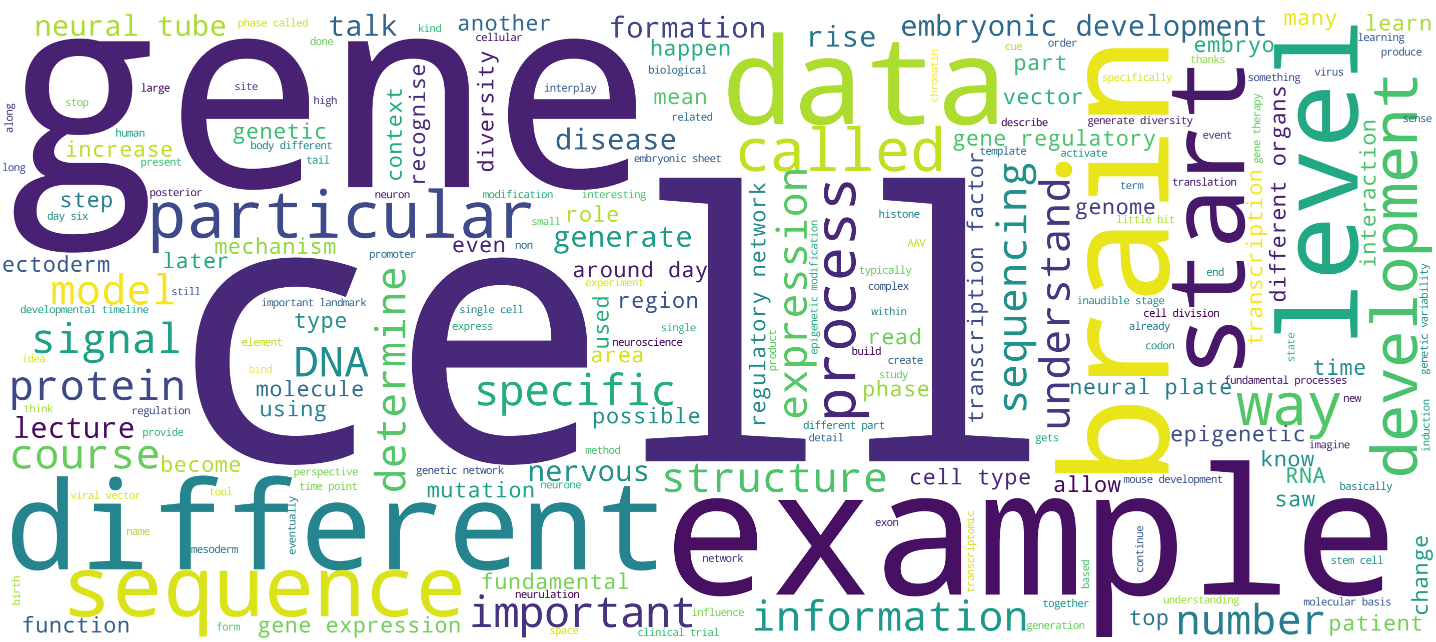

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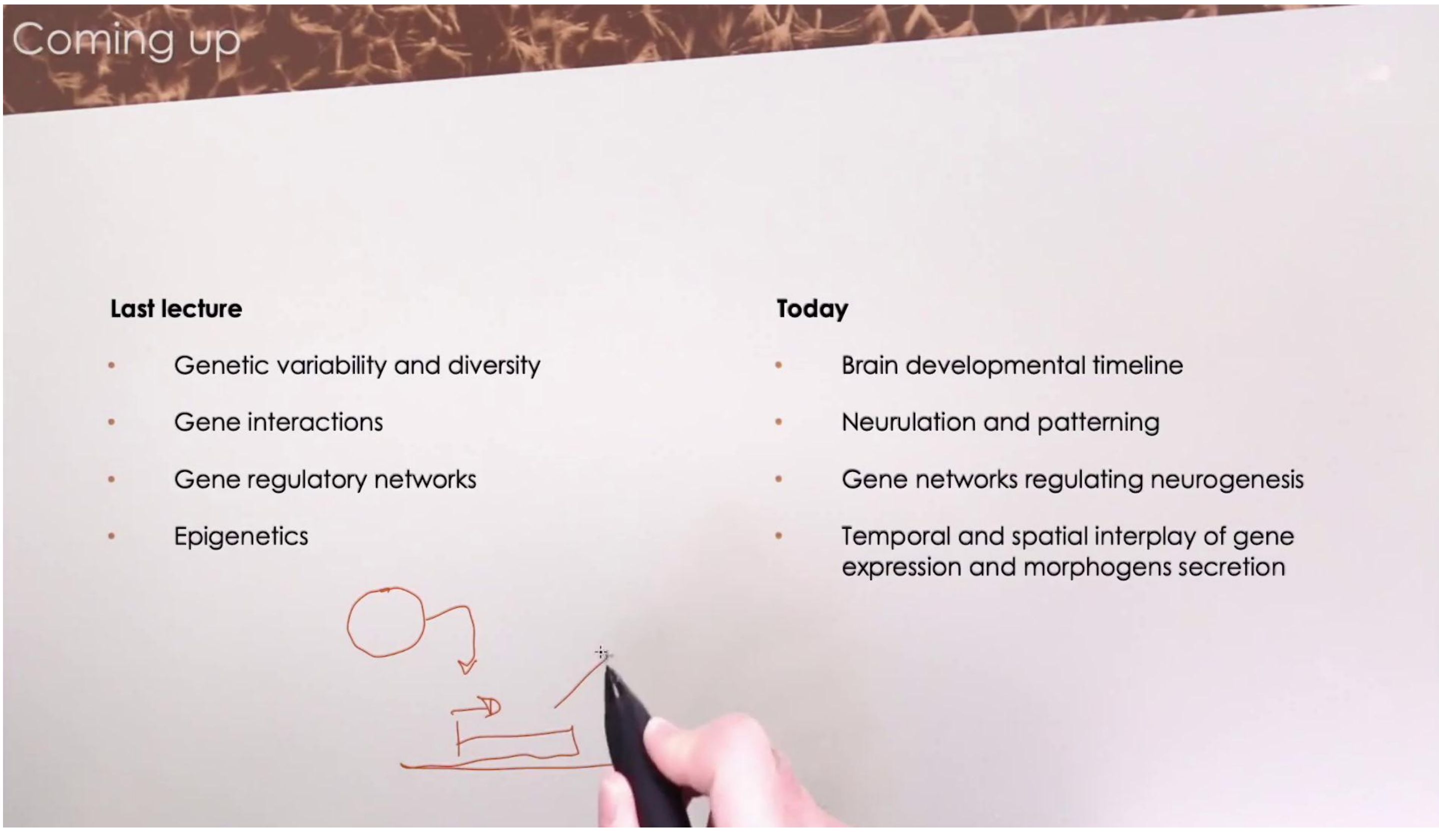
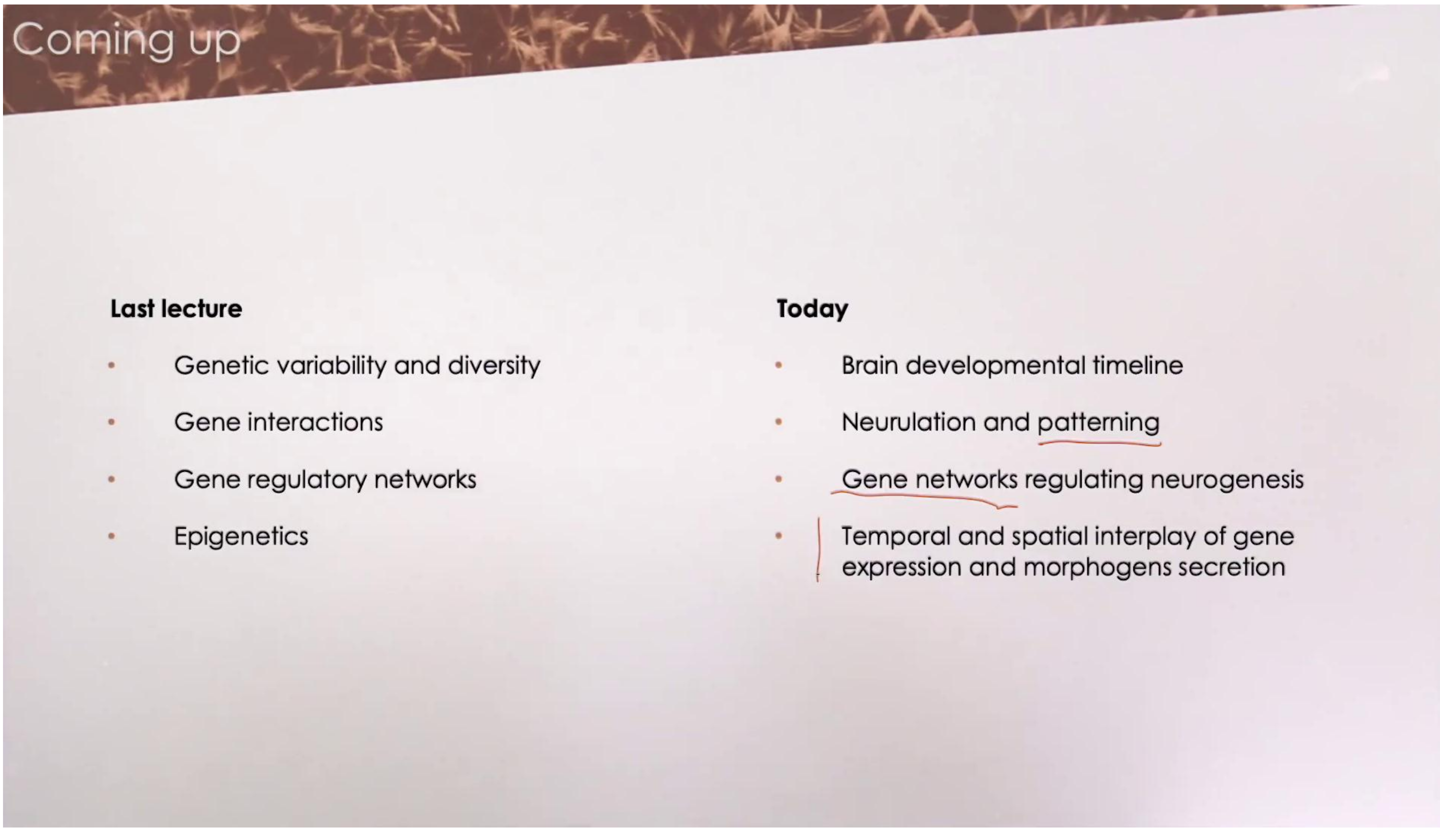


Welcome to this lecture of neuroscience reconstructed. Today, we're going to talk about genetics and brain development. In this lecture, we're going to focus on the development of the nervous system, and in particular, the brain and the molecular basis. We're going to see how genetic networks are important to give rise to fundamental processes and their important different moments of development in a normal developmental timeline. You will be able to describe after this lecture, the main governing process of development, a process like neural induction, neurulation, and the formation of neural vesicles by pattern process. You'd understand how genetic networks play a role to determine the differentiation of specific subtypes of cells like particular kinds of neurons, astrocytes, and glial. During last lecture, you have been learning about genetic variability and diversity, the importance of gene-gene interaction to give rise to biological processes, and in particular situations like to see the transactivation of other genes. For example, a gene can encode for transcription factor that can transactivate, bind the promoter of another gene, and therefore determine its expression.

Notes

Summary

0m 09s

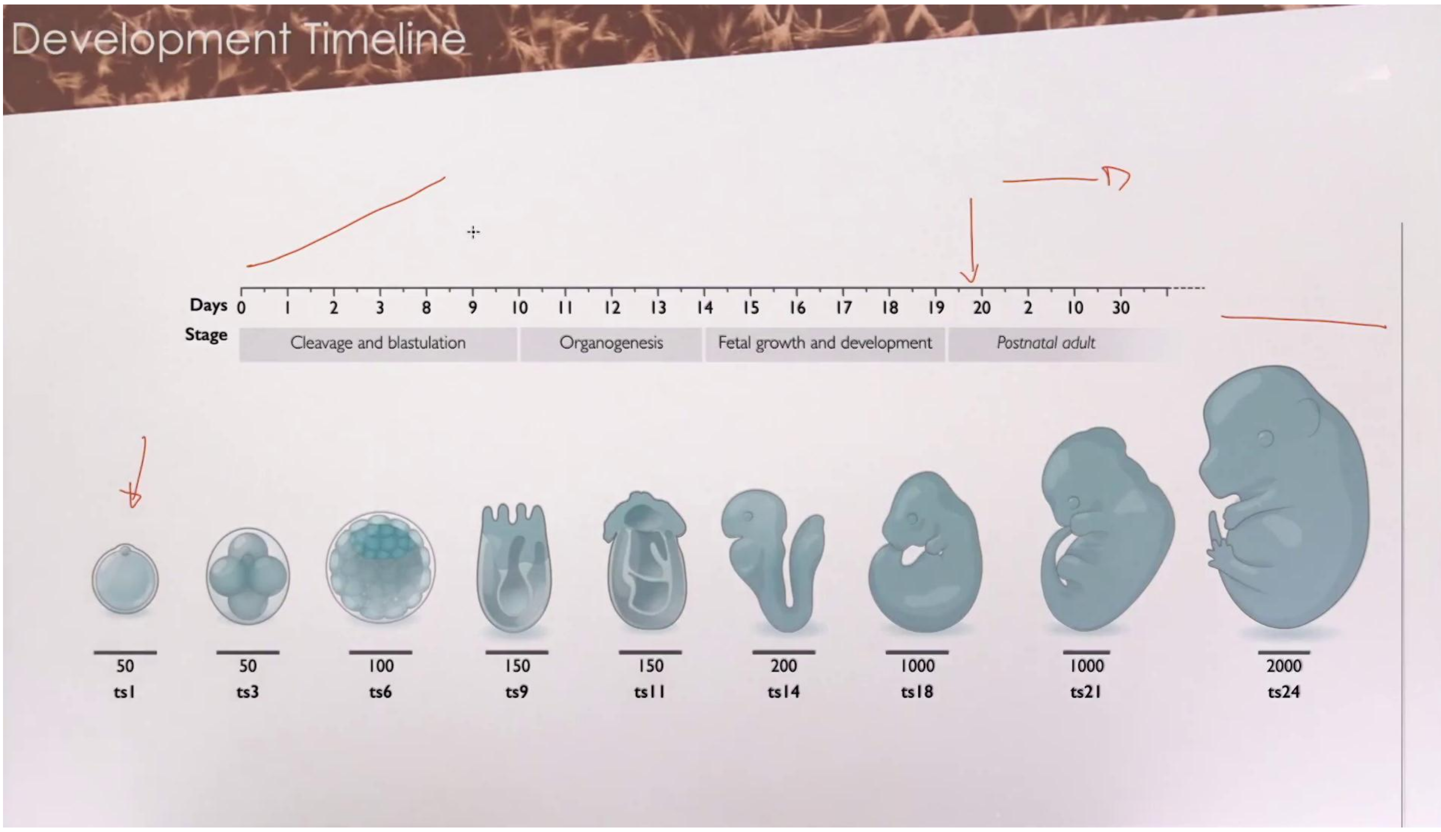


In turn, this gene can activate or inhibit further genes downstream. In this way, genes interact with each other, forming complex gene regulatory networks that we're going to talk about again, in this lecture, in the context of how they determine sequence of events during development and driving the transformation of the embryo. You also saw the structure of epigenetics as a role in modulating the gene regulatory networks and can help crystallise them in a later point in development. If we now look at what we're going to talk about in this lecture, we're going to start describing a developmental timeline of the nervous system and on the brain. We're going to learn about fundamental processes that create and generate diversity from an initial symmetry processes like patterning and neurulation, and we understand their molecular basis. Gene networks are, of course, fundamentally important. We're going to see some particular one and we're going to see their interplay. Finally, we're going to learn how different population of cells through interaction, both in space and along the time course of development, give rise to specific interaction that then generate further diversity and specification of different cell types.

Notes

Summary

1m 31s

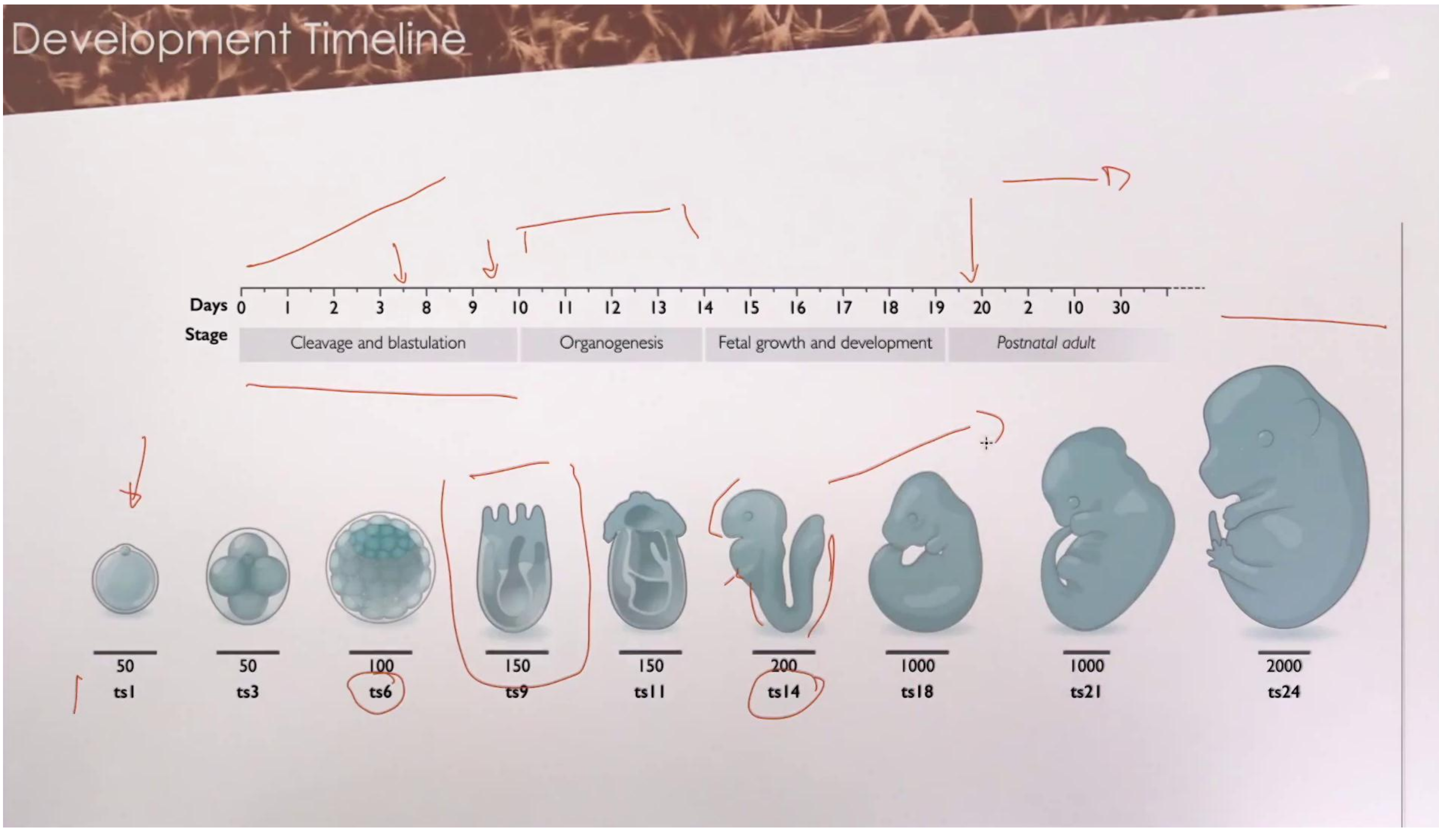


What you see here is the developmental timeline of a mouse embryo, We're going to talk about mouse development today because thanks to the tools available to modify and perturb mouse development, thanks to genetic tools and genetically-modifying organism, nowadays, we know a lot about the molecular underpinning of the mouse nervous system development. Let's have a look at the old timeline. First, embryonic development, then we're going to put in context of nervous system specifically. We start from the fertilised egg, the zygote here, symmetric cell, big cell, that will have to give rise to a complex organ at the end of this embryonic developmental process. Of course, embryonic development doesn't stop at birth, but it continues with a phase called postnatal development, where there are going to be further changes and cell differentiation. But the fundamental timeline for the mouse lasts 19 days. It starts at the very early stage where we're going to have a fast increase in number of cells. We have segmentation of cell division that are actively happening. This determines an increase of cell size, cell number, and also the embryo size. Everyday, the number of cells is increasing, but there are some important landmarks.

Notes

Summary

2m 56s

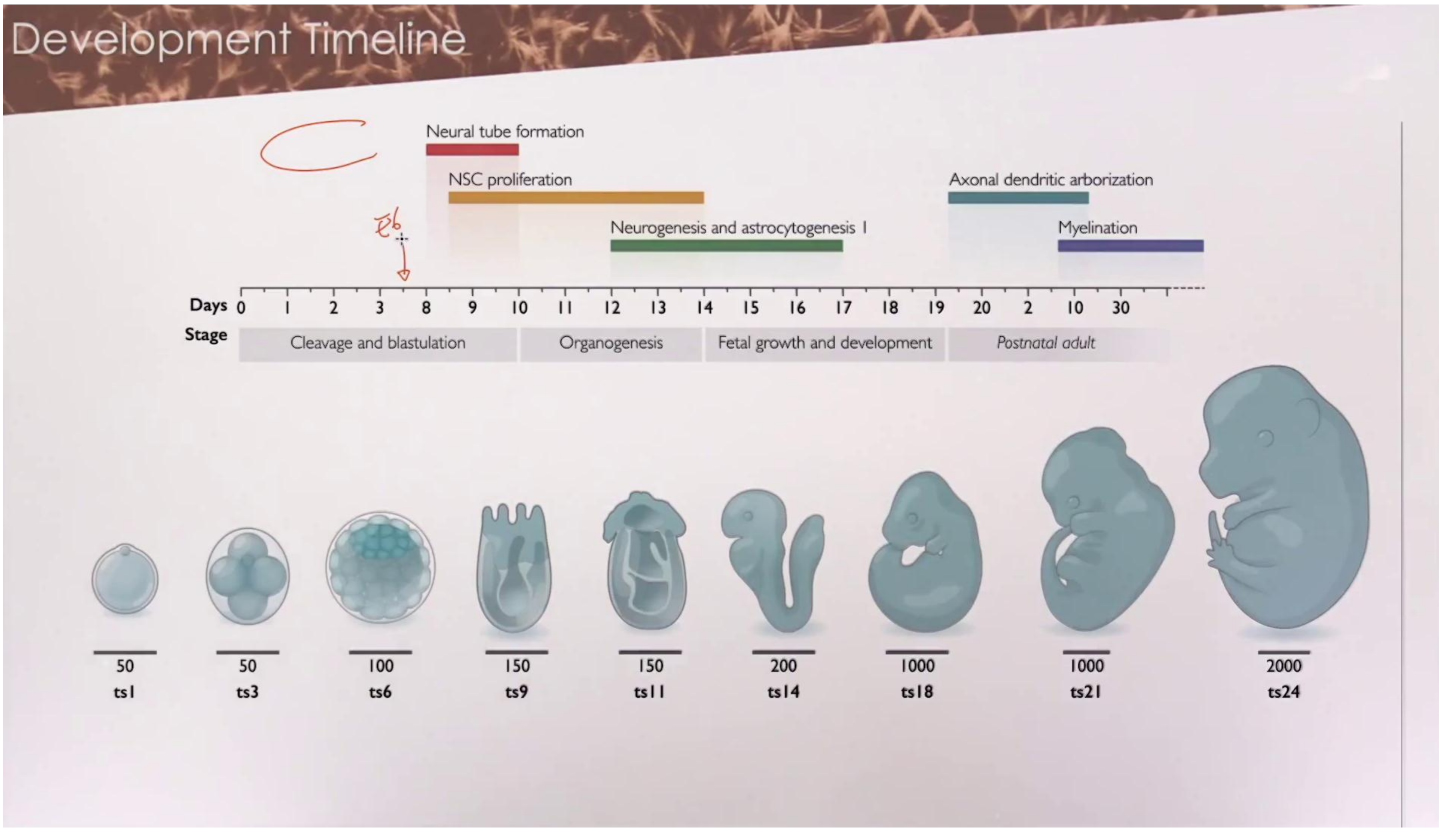


Usually, developmental biologists use a system called [inaudible 00:04:38] staging to identify key landmarks in this process that correspond, of course, to specific days of development. For example, [inaudible 00:04:48] stage 6, the level where the embryo's at the level of what is called a morula, is happening around day 4 of embryonic development. The first phase of embryonic development consists of a lot of cell division and proliferation. It has an important landmark point around day six, where the process of gastulation takes place, three embryonic sheets start to get formed and the embryo shape starts to really break the symmetry we're going to recognise an anterior part in different layers of cell that then, only through a second phase called organogenesis, will determine the generation of the primordia of the different organs. For example, at [inaudible 00:05:39] stage 14, happening between day nine and day 10 of the embryonic development, we start to recognise the shape, a familiar body plan. We start to recognise a head, a vesticle where we're going to find the heart, a trunk, and a tail. Since then, the body structure is going to become more and more complex.

Notes

Summary

4m 34s

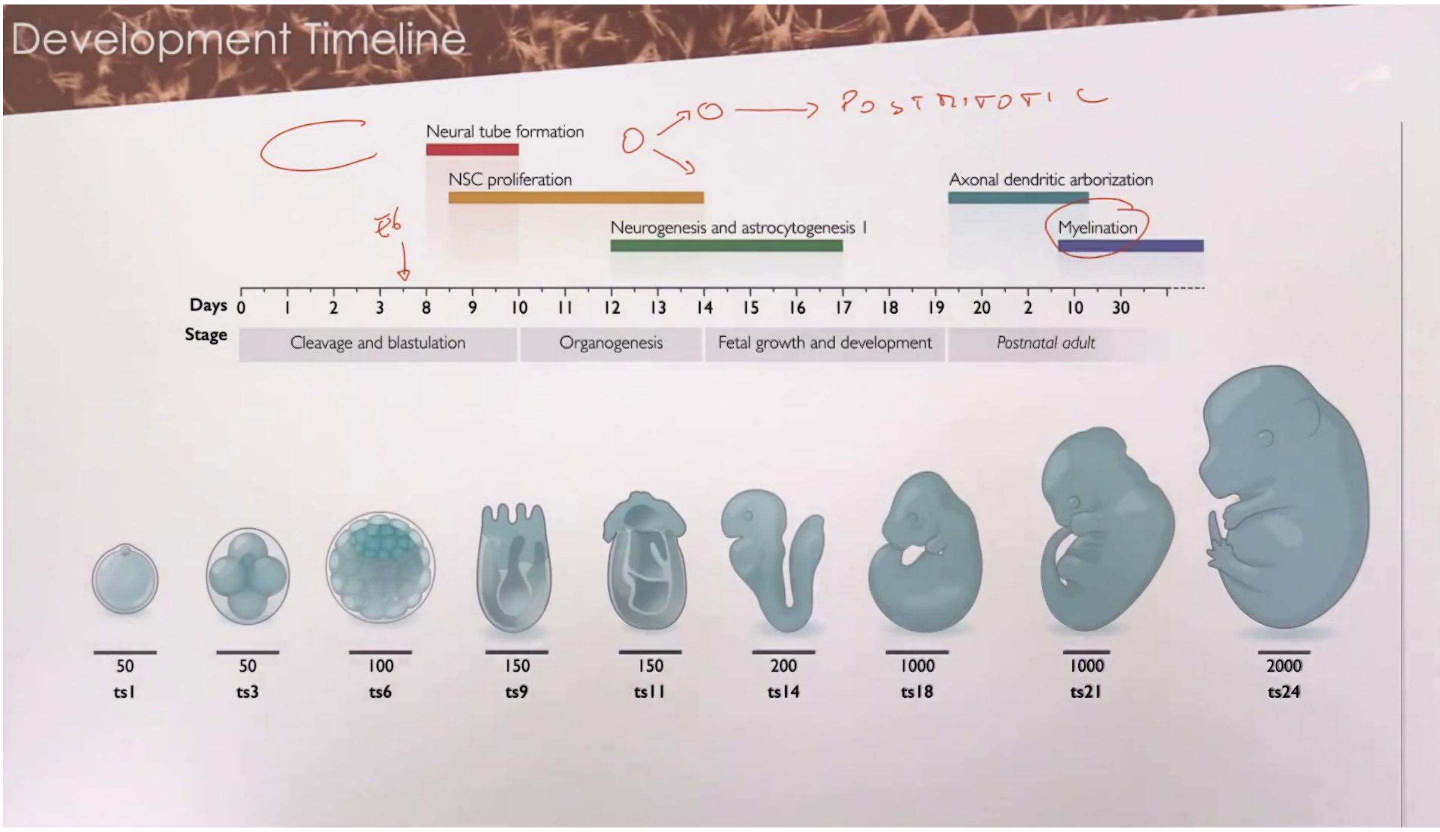


We have the formation of the different organs and the definition of fundamental cells types that then will go and play the fundamental physiological role in different organs. Later on, around day 14, 15, we can define a phase that is indicated usually with [inaudible 00:06:28] stages bigger than 20, where we see mostly growth and finer differentiation of cells that have already committed to a specific fate. They know they're going to be, for example, cells of the brain or some cells of the liver. Now, let's look at this timeline in the perspective of nervous system development. In particular, we want to look at events that generate diversity of cell types and they are fundamental to determine structure, to build from. We will see just a sheet, a one dimensional sheet of cells, what is called the neural plate. They will generate first a neural tube and then we'll see from these different regions of the brain. Everything starts at the level of gastrulation. Gastrulation happens around day five, day six of embryonic development. At that time point, the embryo has been segregated in three embryonic sheet, the ectoderm, the endoderm and the mesoderm.

Notes

Summary

6m 06s

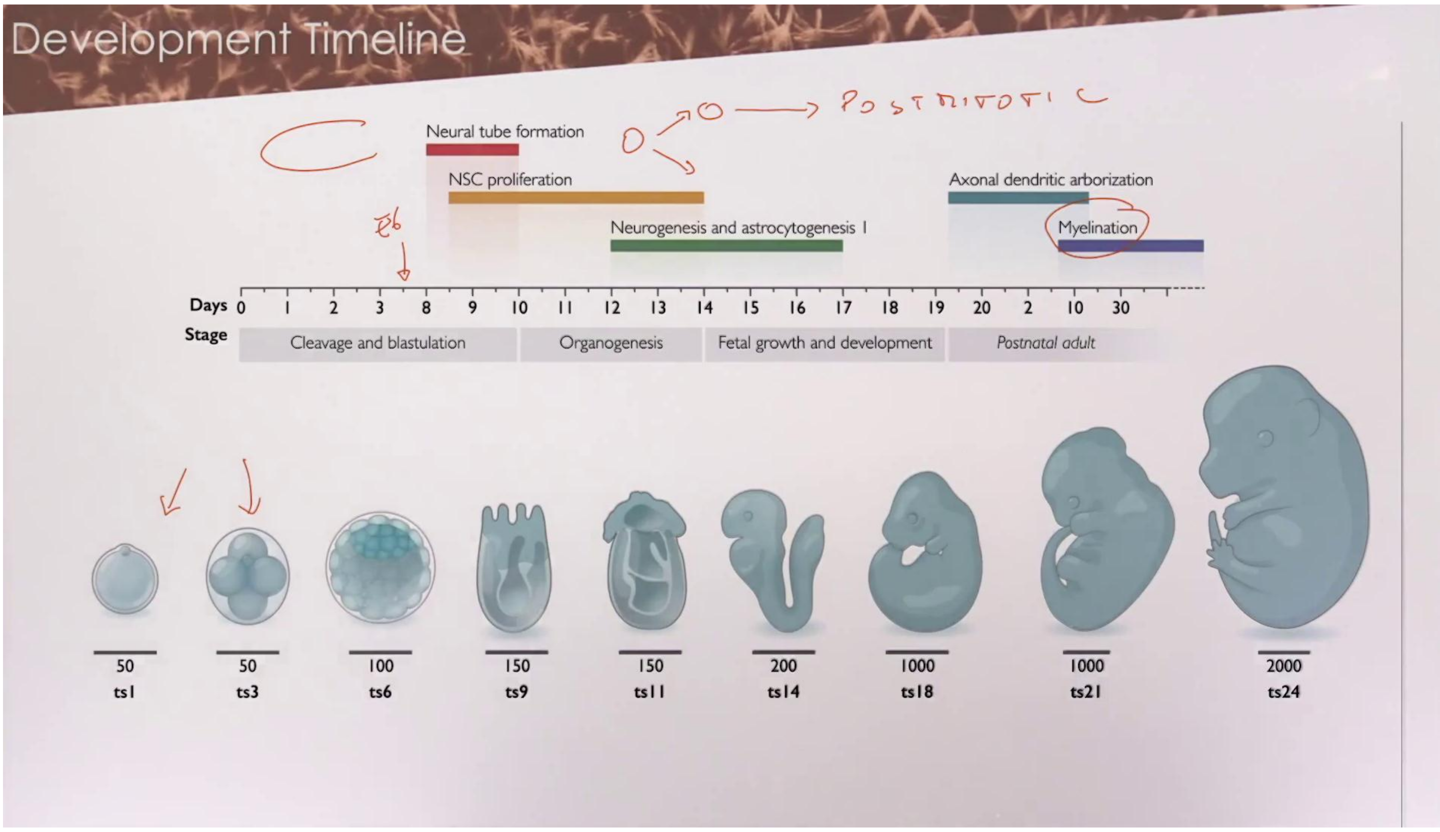


There will be the induction of the neural tube from the ectoderm, the first of the neural plate. Then it will become a neural tube. There will be a very proliferative phase where the neural stem cells are proliferating, increasing in number, and only later the cells will start to divide asymmetrically. From one cell, we're going to get two, and some of those cells are going to stop proliferating and become postmitotic. Postmitotic cells can then start their journey towards full maturation in process called neurogenesis and astrogenesis. Those will continue up to birth when other process of development are going to kick in, in particular finer axonal arborisation and dendritic arborisation. There will be formation of synapses that then will be refined during learning in later life. There is fundamental process of myelination that is a fundamental role of all the oligodendrocytes cells in the brain. They will ensheet with their cell body different neurons to allow for a faster neuronal transmission. Now that we have looked at these fundamental events, we want to learn also important principle that understand how those are regulated and get to happen.

Notes

Summary

7m 36s



What is the mechanism that allows the formation of the different part of the body, different part of the brain, and induction it from something that is very symmetrical, where all cells are basically similar, they express the same genes.

Notes

Summary

9m 10s