Einblicke in die Forschungsarbeit

Research project

„A simulation of early development“

CLEMENS STEINEK

Elite Graduate Program „Human Biology“

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Creating embryo-like structures in Petri dishes

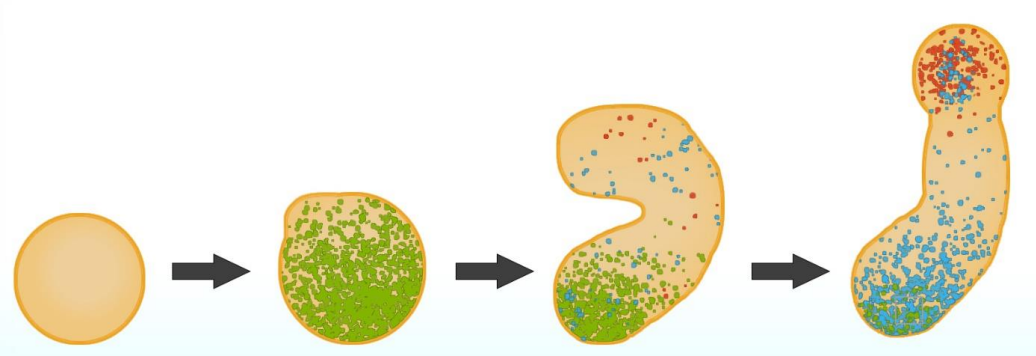
The appearance of embryos changes dramatically during early development. In order to study this spectacular period of life in an ethically responsible manner, Clemens Steinek, a former student of the of the Elite Graduate Program “Human Biology - Principles of Health and Disease”, aims to re-create embryonic structures in the laboratory.

The fascinating world of early development

Early development is accompanied by remarkable changes in the size and shape of embryos. Shortly after conception, the fertilised egg undergoes rapid cell division, thereby forming a symmetrical ball of cells. In a process called gastrulation, stem cells within the ball of cells move extensively and are transformed into three different types of cells (ectoderm, mesoderm, endoderm). These three cell types will give rise to most parts of the adult animal. While ectodermal cells will form the central nervous system, mesodermal and endodermal cells will establish muscles and the outer lining of the gut, respectively. Although the underlying processes of early development are of great biological importance, it is often difficult to study mammalian gastrulation due to ethical concerns. To overcome this challenge, scientists have developed different techniques through which developmental processes can be mimicked in the laboratory. Recently, a new milestone in the simulation of early development has been achieved with the generation of gastruloids. Gastruloids are organised stem cell aggregates which seem to undergo gastrulation. Since gastruloids are novel systems to study early development scientists have yet to determine all possible applications.

What can we do with gastruloids?

Clemens Steinek aimed to observe when and where ectodermal, mesodermal and endodermal cells arise in gastruloids. In his first experiments, he modified murine embryonic stem cells using CRISPR/Cas9 technology to allow the visualisation of all three cell types. Over the past years, CRISPR/Cas9 has emerged as a reliable and powerful tool to edit the genetic information of organisms. In principle, the Cas9 protein is transported to specific locations in the genome where it provokes breaks of the double-stranded DNA. While the cell attempts to repair the damaged DNA, additional DNA can be provided which is then integrated into the genome. In this manner, different genes can be fused which lead to the production of proteins with new characteristics. If an ectodermal-specific gene is combined with a fluorescent reporter gene, then ectodermal cells will exhibit bright colours under the microscope. Based on this mechanism, Clemens Steinek genetically modified stem cells and observed the formation of ectodermal, mesodermal and endodermal cells in gastruloids. Remarkably, the spatial distribution of all three cell types was highly organised. This work provides a foundation for further studies and sheds light on early developmental processes.



Within a couple of days after the onset of the experiment, gastruloids elongate extensively and exhibit patterns of cell types which are prominently found in the developing embryo (green: Mesoderm, red: Endonderm, blue: Ectoderm). © Clemens Steinek

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