Neurogenesis

Neurogenesis, or the formation of new neurons, takes place not only in the prenatal period but also in the brain of an adult.

History

The first finding of neuroblasts was in 1960 by **Altman** in the brain of an **adult rat**.[1] However, without further doubt, neurogenesis was accepted when Fernando **Nottebohm** showed that in the hippocampus the canary neurogenesis takes place to a greater extent during the mating season, when new songs are learned.[2] In the following years, research was focused on the mechanisms of regeneration of the central nervous system (CNS). In 1998, Swede Peter S. **Eriksson** provided the first evidence of newly emerging neurons in the human brain.[3]

It was a **post-mortem analysis** of the brains of patients who were applied to the method of labelling proliferating cells, using **bromodeoxyuridine** (BrdU). See the illustrative image on the right. Since then, scientists have been searching for how neurogenesis takes place under both physiological and pathological conditions, where understanding the mechanisms could help in the treatment of certain diseases.

Neurogenesis in adults

- It takes place in neurogenic areas. It is conditioned by the presence of neuronal stem cells (NSCs = neural stem cells), a specific microenvironment and neurogenic potential, i.e. the ability to differentiate into neurons.
- There are a total of three main neurogenic areas in the mammalian brain. In *the reactively neurogenic region*, neurogenesis can only be induced experimentally, then a *potentially neurogenic region* where neuronal precursors are present, and finally three areas *of constitutive neurogenesis* where neurogenesis occurs continuously.[4] Some studies indicate the presence of a small number of progenitor cells in the spinal cord, midbrain, striatum and cerebral cortex.[5]

Areas of constitutive neurogenesis

Neurogenesis occurs continuously in only three areas of the adult brain – in *the subgranular zone* (SGZ = subgranular zone) in the dentate gyrus (DG = dentate gyrus) of the hippocampus, in *the posterior periventricular area* (PPv = posterior periventricular area), where NSCs are located under the ependymal cells that surround the hippocampus, and in *the subventricular zone* (SVZ = subventricular zone) on the lateral parts of the lateral ventricles of the forebrain.[6]

Subgranular and posterior periventricular zone

NSCs in the hippocampal dentate gyrus have only a limited ability for neurogenesis compared to the subventricular zone. These neuronal progenitors are located near the hilum DG, where they form a thin layer of cells between the hilum DG and the granular cell layer (GLC).[7] The subgranular zone is not in contact with the cerebrospinal fluid. There are *radial astrocytes* that have a pyramidal shape and long radial projections protruding through a layer of granular cells to the surface of DG. They constantly proliferate and the newly formed cells migrate to the GCL.

Similar to SVZ, DG precursors also express the glial fibrillar acidic protein (GFAP = glial fibrillary acidic protein) and these cells are considered primary progenitors of SGZ.[8] However, some studies are inclined to believe that there are two distinct types of progenitor cells present in SGZ, from which glia and neurons are formed separately.[9]

In DG, with the passage of age, cell proliferation decreases, which indicates that the self-renewal of cells is not eternal.[10] Multiple studies also confirm that A-cells, or neuroblasts, migrate to GCL to differentiate into granular cells.[11]

There are also *horizontal astrocytes* in SGZ that lack radial projections.[12] They behave like stem cells *in vivo* and may have the properties of hippocampus progenitor cells similar to radial astrocytes. In addition, they can divide asymmetrically and thus produce neurons. Their daughter cells can also acquire radial morphology.[13] Despite this new formation, most of the newly proliferating DG cells will soon die if they do not form the right synaptic connections.[14]

Subventricular zone

SVZ cell types

Regulation of neurogenesis

Functional significance of neurogenesis

Neurogenesis after cerebral ischemia

Links

Související články

- Neuroglia
- Brain

External links

- JANČÁLEK, Radim – DUBOVÝ, Petr. *Základy neurověd v zubním lékařství* [online]. MEFANET, ©2011. The last revision 27.10.2011, [cit. 26.11.2011]. <http://portal.med.muni.cz/clanek-560-zaklady-neuroved-v-zubnim-lekarstvi.html>.

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Reference

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Literature used

Recommended reading

- Fred Gage, Gerd Kempermann, Hongjun Song: Adult neurogenesis, Cold Spring Harbor Laboratory 2008.[4] (https://books.google.cz/books?id=5Kyahdob-NsC&printsec=frontcover&hl=cs)

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