KING'S College LONDON

INSTITUTE OF PSYCHIATRY,
PSYCHOLOGY & NEUROSCIENCE

Module:
Biological foundations of mental health

Week 2:
Building blocks of the brain

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Topic 2
From embryonic neural progenitor cells to adult hippocampal neurogenesis

Part 2 of 4

Topic overview

- Adult Neurogenesis
- Location/environment (niche) of Adult Neurogenesis
- Molecular control of Adult Hippocampal Neurogenesis
- Functionality of Adult Hippocampal Neurogenesis
- Modulation of Adult Hippocampal Neurogenesis

Adult neurogenesis?

"Once development was ended, the fonts of growth and regeneration of the axons and dendrites dried up irrevocably. In the adult centers, the nerve paths are something fixed, and immutable: everything may die, nothing may be regenerated."

Santiago Ramon y Cajal, 1928

Autoradiographic and histological evidence of postnatal hippocampal neurogenesis in rats.

Altman & Das, 1965

Neurogenesis in the adult brain is limited to specific neurogenic regions

Figure 1: Neurogenesis limited to specific regions

Dynamics of Hippocampal Neurogenesis in Adult Humans

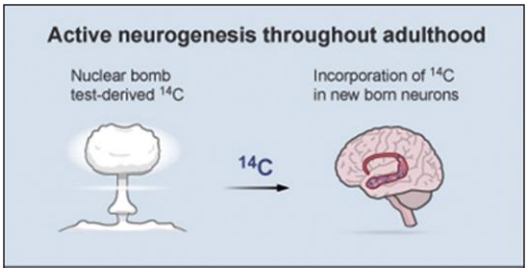


Figure 2: Active neurogenesis throughout adulthood

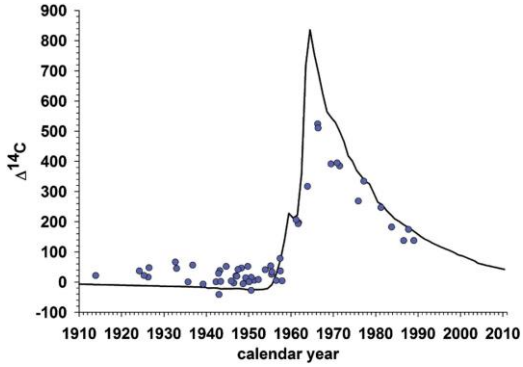


Figure 3 : Hippocampal Neurogenesis in Adult Humans
^{14}C concentrations in hippocampal neuron genomic DNA correspond to a time after the date of birth of the individual, demonstrating neurogenesis throughout life.

Source: Kirsty L. Spalding et al, "Dynamics of Hippocampal Neurogenesis in Adult Humans", *Cell*, Vol. 153, Issue 6, p1219–1227, 6 June 2013

Adult hippocampal neurogenesis

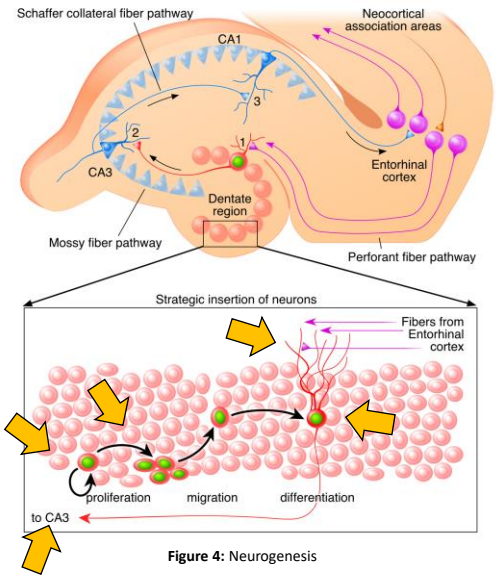


Figure 4: Neurogenesis

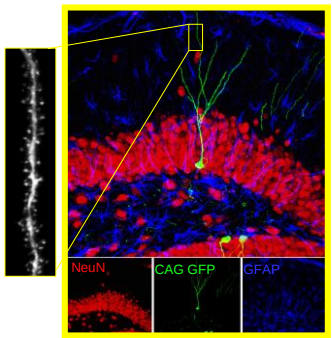


Figure 5: 4 to 6-week maturation period

Quantitative studies on adult neurogensis

≈700 new neurons in adult humans are added in each hippocampus per day

≈ 70% of the bulbar neurons are replaced during a 6-week period in an adult rodent

Environment of Adult Neurogenesis

Environment of Adult Neurogenesis

Adult neurogenic microenvironment (1)

Transplantation studies provide evidence for regulation of fate determination by extrinsic signals in the environment

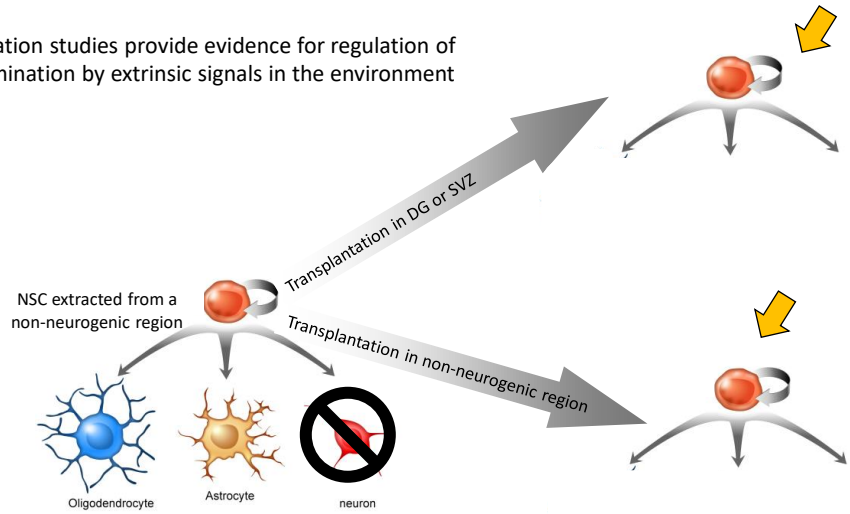


Figure 6: Adult neurogenic microenvironment

NSC derived from a non-neurogenic region produce neurons only when transplanted into a neurogenic region

Adult neurogenic microenvironment (2)

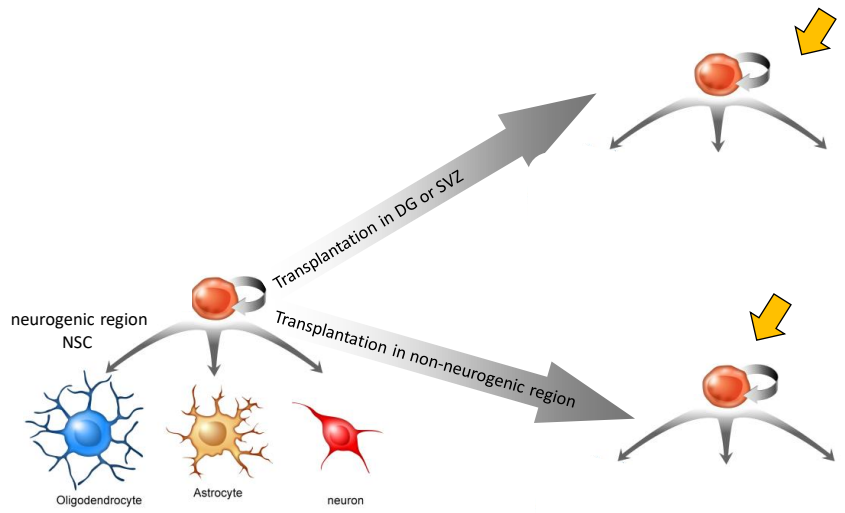


Figure 7: Adult neurogenic microenvironment

Adult NSC derived from a neurogenic region will differentiate into neurons only in the neurogenic environment

Adult neurogenic microenvironment (3)

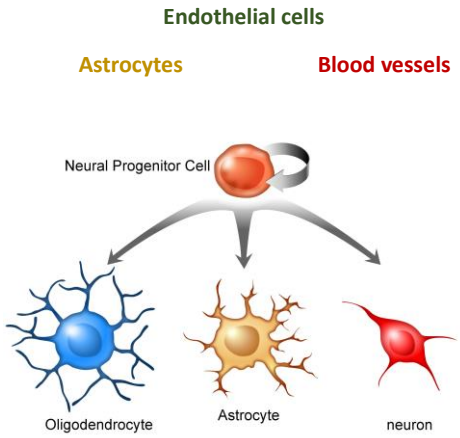
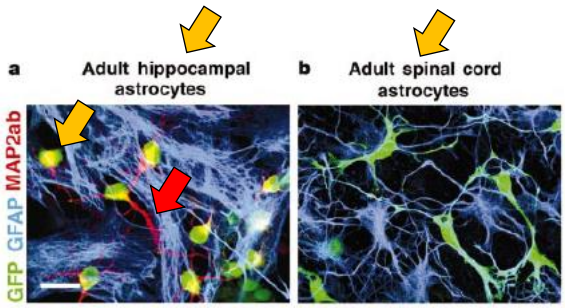


Figure 8: Adult neurogenic microenvironment

Astroglia induce neurogenesis from adult neural stem cells



Adult NSC derived from hippocampus co-cultured with adult hippocampal astrocytes can differentiate into neurons

Adult NSC co-cultured with astrocytes from a non-neurogenic region rarely differentiate into neurons

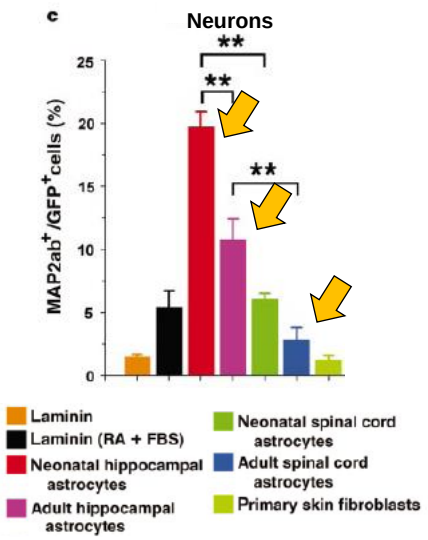


Figure 9: Astroglia induce neurogenesis from adult neural stem cells

Source: Song, Hongjun, Charles F. Stevens, and Fred H. Gage. "Astroglia Induce Neurogenesis from Adult Neural Stem Cells." *Nature* 417, no. 6884 (May 2, 2002): 39–44. doi:10.1038/417039a.