# Editor Notes: Neurogenesis and Neurodegeneration: Basic Research and Clinical applications

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The induction of endogenous neurogenesis and engraftment of stem cells for neural repair are demanding tasks in view of the increasing incidence of neurodegenerative diseases. Modern medicine continuously increases life expectancy and subsequently the frequency of neurological diseases, occurring in the ageing population. Efforts have been made to understand molecular mechanisms of neurodegeneration and neuroregeneration. In this regard, embryonic and induced pluripotent fetal and adult stem cells as well as fetal and adult tissue-specific stem cells are employed in in vitro assays to study pathways of neurogenesis as well as for the development of protocols for differentiation into defined neural phenotypes and optimization of the yields of neural differentiated cells. Besides obtaining pre-differentiated or fully differentiated cells for transplantation purposes, such stem cell differentiation models can be used to elucidate molecular mechanisms of neurodegenerative disorders and their developmental origin as well as to discover targets for therapy and to probe therapeutic strategies. Furthermore, stem cells are used for engraftment in conditions of brain damage, such as caused by traumatic events and stroke, and as consequences of neurological diseases. Neural stem cells (NSC) have been used for replacement of lost neurons. Functional integration of transplanted cells into neural networks in vivo has been shown by tracing technologies, using fluorescent probes and viral vectors as tracers, as well as by functional analysis based on electrophysiology and optogenetics [1]. While in vivo animal studies have documented the feasibility of stem cell engraftment as possible treatment, functional engraftment of induced pluripotent stem cells (iPSC) into the putamen of a Parkinson's disease patients was demonstrated following 18-24 months of transplantation [2]. Likewise,

the treatment of neuronal loss following stroke has also been shown to be promising for cell replacement therapy. Neurons differentiated from human iPSC integrated into neural networks of organotypic neurons of adult human cortex [3]. These data are in line with animal studies, in which human pluripotent stem cells were employed for the treatment of stroke in animal models, such as by transplantation of human embryonic stem cells or IPSC into the sensorimotor cortex, lateral ventricle, hippocampus or striatum [4]. The endogenous environment is determining for neuroregeneration fate and regeneration processes. As an alternative for inserting stem cells for neural network repair, chemotrophic and neurotrophic factors may guide endogenous stem cells to the local of injury for the replacement of lost neurons [5]. Preclinical and clinical studies are underway for the use of stem cells of various origins for the replacement therapy and stimulation of endogenous neurogenesis in ischemic stroke [6, 7]. This special issue focuses on the modeling of neurogenesis and neurodegeneration by using iPSC, neurospheres and brain organoids and studying effects of extrinsic and intrinsic epigenetic factors as well as exploiting mechanisms of microglial activation. Topics include the characterization of neural crest cells and iPSC-derived neurons as well as neural stemness as the basis of differentiation and its tumorgenic potential. Further optimization of in vitro neural differentiation protocols and the effects of external magnetic fields as determents of differentiation fate are discussed. Mesenchymal stem cell (MSC) activated through electropuncture or stem cell neurogenesis regulation by micro and other non-coding RNAs are discussed for their potential in neuroregeneration. Genetical engineering of MSC as well as inducing them to transdifferentiate into neural stem cells are attractive for the development of therapies to combat neurodegeneration. Oxidative stress reduction following ischemic stroke is an important effect exerted by MSC. Overall, this Special Issue combines in vitro differentiation studies with results obtained in animal models of neurodegeneration.

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