

# Neurogenesis

## by Brandon Di Michele - 2005

The human mind has long been thought by the world's leading scientists to be born with a fixed amount of brain cells that can never regenerate throughout a lifespan. However, recent scientific studies and a theory-turned fact called Neurogenesis have proven otherwise. Neurogenesis is the study of regenerative cells in the brain. Neurogenesis was first studied by an Argentinean biologist named Fernando Nottebohm who, since childhood, was fascinated with the songs of birds. Nottebohm "demonstrated two decades ago that the brain of a male songbird grows fresh nerve cells in the fall to replace those that die off in summer" (Kiestler 36). This is an amazing finding in the respect that traditionally scientists have always believed "a brain gets its quota of nerve cells shortly after birth and stands by helplessly as one by one they die" (Kiestler 36). In fact, this finding turns every previous scholastic "fact" taught in schools about brain development throughout life upside down. The notion of killing brain cells that will never return is made inadequate and untrue, and many scientists have been skeptics and against this theory since its inception. Previously, states Nottebohm, "I was in the 5 or 10 percent of scientists who believed in Neurogenesis" (Kiestler 36), but because of recent findings by other scientists in other animals including humans, "now 95 percent accept that position" (Kiestler 36). Personally, I find this man truly amazing not only for his incredible studies, but also because of his never-say-die mentality towards his beliefs.

The chairman of the neurobiology department at Yale University, Pasko Rakic, doubted that the findings of neurogenesis in songbirds have any correlation to neurogenesis occurring in humans that could be beneficial to neuron development. All evidence of Neurogenesis in mammals up to a point had been limited to the hippocampus region of the brain, and no scientist is yet quite sure of what function is performed by neurons other than the obvious animation and processing of the body and mind. Without neurons, the electrical synapses of the brain cannot occur since there would be no neurons for them to transmit between. There is still much to be studied and determined. Even though presently some scientists have found that cells do in fact appear in the cerebral cortex, Rakic states that "with neurogenesis in the cerebral cortex, you would have neurons that never went to elementary school. New cells would erode all your memories. You would give up all you have labored to acquire" (Kiestler 38). This is an interesting point made by Rakic who means to say if new cells were created they would essentially be void and not infused with your past memories. Making the new cells useless to you because they wouldn't be filled with the information you have learned in life before they were created by your brain. Despite constant new evidence of neural growth found by scientists after Rakic had disputed it, many scientists agree with Rakic's theory, stating the disbelief of any function of these new cells. "This 'he-said, she-said' battle began in 1985, when Rakic published a study of rhesus monkeys and stated unambiguously that neurons were not born in any animal's brain after infancy" (Cohen 1). Rakic seems to dismiss the notion of new brain cells having function almost like he doesn't want to believe in their possibility, stating "read my lips: no new neurons" (Kiestler 36). After that, his studies were contradicted in 1998. Princeton neuroscientist Elizabeth Gould used a different technique to show that adult marmoset monkeys did indeed generate new neurons. This caused Rakic to conduct another study. This time, "Rakic looked for new neurons in adult macaque monkeys by labeling neuronal and glial cells with bromodeoxyuridine or (BrdU). Rakic found newly generated neurons, which were limited to the hippocampus and olfactory bulb; some BrdU cells were also found in the neocortex but Rakic identified them to be non-neuronal. Another leading scientist, David Kornack, assistant professor of neurobiology and anatomy at the center for the aging and developmental biology at Rochester University, "says that he and Rakic used the same methodology as Gould and could not replicate their findings" (Cohen 2). Science is of course a subject built entirely on the premise of the ability to recreate results, and Kornack states "we are the first group to attempt to replicate Gould's results, and we couldn't.... We thought this was important to publish" (Cohen 2). What I find particularly interesting in reading the articles and their progress through the years is the fact that the opposing viewpoints change because they must, after conducted experiments, prove them to be inadequate. However, the viewpoint still remains opposed. Those opposing always create a different angle of opposition or reason why Neurogenesis won't work because of one reason, and then when that is disproved, they move to another reason. To me, it just seems like an inability to accept something they don't want to believe. Logically, though, if Rakic and his fellow scientist's theories held up, along with the scientific factual evidence produced by scientists such as Gould and Nottebohm, it would seem if the cells in fact were developing and maturing from scratch, then that which holds information, learns from experience, acquires new skills, and simply is the culmination of all of your past experiences, is not something material or that can be measured in a laboratory. It could be something not present in a cellular form but possibly an electrical one, such as some sort of spiritual energy. Or it could be any number of different things.

The findings in the study of Neurogenesis have been undeniable and continue to yield positive results. The first studies conducted on canaries have given way to studies conducted on rabbits, rats, mice, monkeys, and humans as well but only in very small amounts due to what the governing bodies call ethical reasons. "On August 9, 2001, President Bush announced a new federal policy permitting limited use of embryonic stem cells for research" (Stem Cells and the Future of Regenerative Medicine 5). Canaries were the first subjects found to actually perform neurogenesis in their brains because of the need to learn new mating songs. Scientists have found this same type of neurogenesis in virtually all mammals and have attributed it to the ability of the body to convert stem cells into virtually any organ, or function needed within the body. A stem cell is a neutral cell that does not yet have any function. Fred Gage of the Salk Institute for Biological Studies says "replacing blood, for example, is straightforward—an adult can even replenish the supply with stem cells from an umbilical cord" (Lewis 2). Another example could be that "menstruating women replace the cellular lining of their uterus each month" (The Human Embryonic Stem Cell Debate, Okarma 4). In this being said and understood, "does the human Central Nervous System self-repair? Of course it does! We live 90 years. It is unreasonable to think that there is no turnover like in every other organ," says Gage (Lewis 1). Gage's lab is trying to pinpoint the conditions necessary that allow for regeneration of the nervous system or, Neurogenesis. They believe that there are also environmental factors that play a role in Neurogenesis. A particularly interesting one is that of exercise, and its correlation with the stimulation of neurogenesis. "One of the most clinically effective moderators of stress or depression and robust stimulators of neurogenesis is simple voluntary exercise such as running" (VEGF is a prerequisite for exercise-induced hippocampal neurogenesis 1) states K. Fabel. Fabel and his colleagues from the Stanford University Department of Neurosurgery also stated that "curiously, running also elevates circulating stress hormone levels, yet neurogenesis is doubled in running animals" (VEGF is a prerequisite for exercise-induced hippocampal neurogenesis 1). It seems as if an entire new field has been opened to explore in the world of neuroscience since the scientific discovery that "adult human brains generate new cells after all. Since then, scientists have been furiously studying the implications, and research in this area has accelerated" (Wilson 1).

Fred Gage says that the forms and functions taken on by new stem cells depend on where they are in the human body "when

exposed to a permissive environment, they become neurons as well" (Lewis 2) this means that "there must be something different about the regions where neurogenesis occurs" (Lewis 2). Depending on what part of the body stem cells currently exist in, they will usually take on the regenerative form of the types of organs or main functions that are closest to them. Logically, then "if we learn enough about endogenous brain neurogenesis, we may be able to induce endogenous repair" (Wilson 3). In Lemons terms Gage means to say that the more we learn about how neurogenesis functions in the brain the more we can begin to use it to induce repairing specific diseases of the mind or even to repair those who have unfortunately suffered from specific spinal and cranial injuries. "Experiments with rodents are promising" (Lewis 4). "At Johns Hopkins University, assistant professor of neurology Douglas Kerr and coworkers are using human embryonic germ-cell derivatives to heal rats whose spinal cords are damaged with Sindbis virus" (Lewis 5). Apparently it's working, as "some of the treated rats walked" (Wilson 5). Researchers have given crippled rodents the ability to use their hind legs on numerous occasions using the stem cell research. Also there are direct links to neurogenesis and its relation to depression, in another recent rodent study with many variable factors involved, the "results support the idea that neurogenesis is a factor in the treatment of depression" (New Neurons may Mediate Effect of Antidepressants; Antidepressants and Neurogenesis 2). Scientists have observed after studying rodents that when they prevent formation of new neurons in the hippocampus region of the brain, antidepressant drugs do not take effect and "that a key marker of hippocampal neurogenesis increased after four weeks of treatment, but not after only five days of treatment" (Neurogenesis may play a role in antidepressant action 1). These results suggest that the new neurons which form need time to become established and mature. All these findings definitely point to the fact that "the creation of new neurons in the hippocampus of the brain may play an important role in alleviating depression" (Neurogenesis may play a role in antidepressant action 1).

To me this sounds like it is possible to repair the brain or any part of the body, if we have the possibility to command what it is inside you that controls every cell of your body. If we can understand how our natural immunity and adaptive evolution works which would be the same principal as what we do with our skin when we repair a scab, our bones when they are broken, or our muscles when they are torn, even our organs when they are infected, are we not learning what it would mean to completely control and master the physical realm. It would kind of be the same thing as unlocking the key to immortality in natural evolution through the countless adaptations of human beings to master our environments. We are a very young species, us Homo sapiens, and a very adaptive one, as is evident in all our different evolved skin tones, features, and pigmentation which have enabled the humans in the fitting regions to live more efficiently with their environment. We cannot currently fully know in this country anything more about how Neurogenesis could repair the physical mind flawlessly because of our Presidents' limitation on its study. Our government really has nothing to gain after all from a scientific breakthrough that could heal any disease, deformation before childbirth, or sickness. It would virtually mean the elimination of need for prescription drugs by our society. The most important note we must take into account about the Presidents limitation of further scientific advance in regenerative medicine not coming from drugs, is that according to the Center for Responsive politics pharmaceutical companies have given \$708,289 dollars to President George W. Bush's campaign in 2004 alone. Not to mention \$108,396,686 dollars to other political campaigns again only in 2004. Essentially if Stem Cell research and Neurogenesis therapies were achieved fully, there would be no need for pharmaceuticals anymore, and this would also mean, no multimillion dollar companies to fund the politicians' campaigns who are keeping them alive for just that reason. A travesty indeed and I'm sure once politicians in other governments realize that stem cell regeneration in medical fields means the loss of millions of dollars to their pockets or campaigns due to their respective governments' legalized drugs or pharmaceuticals being made in-efficient, they will place the same sort of ban on the continuation of the stem cell research on humans. It seems as if money has triumphed over scientific achievement and the ability to heal our bodies flawlessly and in every respect. What a world we live in.