Scientists achieve cellular transformation of bone marrow stem cells into nerve cells

Frank Gaglioti
22 August 2000

Scientists announced on 15 August that they have transformed adult bone marrow cells into nerve cells by altering the cells' environment. The implications are that scientists will be able to obtain a deeper insight into the process of cell specialisation.

On the basis of this development, medical science may be able to regenerate nervous tissue and ultimately develop a cure for diseases which involve degeneration or injury to the nervous system, such as Alzheimer's and Parkinson's disease. The research was carried out by scientists at the University of Medicine and Dentistry of New Jersey (UMDNJ) and published in the *Journal of Neuroscience Research*. Ira Black, the head of the research team, stated that "hopefully in the future, these stem cells will be useful for virtually any disorder that destroys neurons, from stroke to brain trauma to degenerative diseases such as Parkinson's and Alzheimer's disease to spinal cord injury."

The scientists isolated stem cells from the bone marrow of a rat. Stem cells are undifferentiated cells found in various parts of the body such as in bone marrow, the brain and in an embryo, which then develop into other cell types. The bone marrow stem cells used usually give rise to bone, muscle and fat cells. The scientists achieved the transformation by treating the isolated stem cells with a mixture of antioxidants and growth factors such as fibroblast growth factor. Each of the stem cells then divided into two cells—a stem cell and a nerve cell. The research team has been able to achieve an 80 percent conversion rate in the laboratory.

The resulting nerve cells were then placed into the brains of rats where they formed connections with other nerve cells and have survived within the rat brain for months without any ill effect. Scientists have detected the formation of various chemicals within the cells which are only found in normally functioning nerve cells. Preliminary studies found that the neurons were capable of migrating to target sites in the rat's brain. Such cells could be used to repair brain damage in specific areas of the brain. The results have been confirmed using similar human stem cells.

Further studies are planned to test the nerve cells in rats with spinal disorders and Alzheimer's and Parkinson's disease. Previous studies have indicated that damaged cells send out chemical signals to which stems cells respond by producing new cells which migrate to the damaged area and replacing the damaged cells. Black commented, "we know that neural stem cells migrate to areas in the brain that have been damaged. It appears that the cells can assume regional functions and actually improve function of the damaged systems."

The current research is part of the burgeoning field of stem cell research which has the potential to revolutionise medical science. Leroy Stevens at the Jackson Laboratory in Bar Harbor, Maine first proposed the existence of stem cells in 1970 after observing strange cells in mouse embryos which formed teratomas, a strange growth made up of various tissues such as bone, skin and teeth after birth. Stevens named the cells as "pluripotent embryonic stem cells". The term pluripotent is used to indicate embryonic cells with the ability to form other types of cells. In fact the embryonic stem cells go on to form the tissue and organs which make up the body.

In 1998, James Thompson of the University of Wisconsin and John Gearhart of Johns Hopkins University first isolated embryonic stem cells in independent experiments. Embryonic stem cells have been used to generate various types of tissue. Thompson has used such cells to form heart tissue.

Ronald McKay of the National Institute of Neurological Disorders and Strokes was able to use nerve tissue produced from embryonic stem cells to partially reverse the effects of Parkinson's disease in rats.

At first it was felt that each organ had its own stem cells in the mature organism; for example, skin stem cells replenishing skin cells and bone marrow stem cells replenishing blood. The implications of the UMDNJ work and similar recent experiments is that adult stem cells can be stimulated to transform into any type of cell given a suitable environment. In April, a research team from StemCells California Inc. announced they had produced liver cells from blood stem cells. In June, Rajendra Bhatnagar at the University of California at San Francisco reported transforming human skin and gum cells into bone and cartilage.

Potentially scientists will have the ability to produce organs and tissue from cell cultures which would be available for transplant. Such transplant material will have the advantage of being produced from cells taken from the patient, thus avoiding complications of tissue rejection.

On a more fundamental level, the research into the development of stem cells will provide an invaluable insight into human development. After fertilisation all the cells in the earliest stages of embryonic development are identical. Later, however, a differentiation occurs with the formation of various cell types which make up the human body. Scientists are not able to explain why such a differentiation occurs at all, given that all the cells contain identical genetic information. What determines whether a stem cell ends up being a muscle or a blood cell or the myriad of other cells which make up an individual? The stem cell research will enable scientists to follow the development of the cells from their very earliest stages to when the differentiation occurs. This will enable a greater insight into the formation of cancer and various birth defects, which are due to abnormal cell division and cell differentiation.

Although stem cell research has made enormous strides in the last few years it has been held back by the refusal of the Clinton administration to fund any research using embryonic stem cells. Most of the stem cell research is funded by private sources. Clinton has capitulated to pressure from religious groups who oppose the research on the basis that the embryonic stem cells have the potential to form a living organism, so claiming that the researchers are in effect performing an abortion. Such claims are based on religious bigotry and not scientific fact. The embryonic material is obtained clinically in tissue laboratory cultures and would not exist otherwise.

In December 1999 the National Institute of Health produced a draft guideline on stem cell research indicating that limited funds may be made available in the future.