Stem Cells – What, Why, Whereabouts and When? – Part II

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Plasticity and therapeutic cloning

As explained in the first part of the article, embryonic stem cells have the possibility of development into all types of tissue into all different sources of tissue. Adult stem cells, up till recently believed to be tissue-specific stem cells, have generated a lot of interest (and a good amount of controversy too) in the past few years due to recent studies showing a good deal of plasticity.

Plasticity can be defined as the capability of a stem cell derived from one tissue to produce cells of a number of different tissues. The extent of plasticity is controversial and is thought to depend on the environment of these stem cells, including the extent of surrounding tissue damage.

A lot of what is known about stem cell plasticity comes from animal studies and also clinical studies of sex-mismatched organ transplants where different tissues in the recipient (usually of a bone marrow transplant) were assessed for cells containing sex-mismatched cells in other tissues.

Bone marrow stem cells, probably the most well studied stem cells, have been shown in various studies to give rise to numerous other different types of cells, including muscle cells, cardiac muscle cells, liver cells, lung cells, bone cells, cartilage cells, fat cells and even neuronal cells.[1,2] These are derived from either the haematopoietic stem cell or the mesenchymal stem cell found in bone marrow.

The therapeutic potential of this phenomenon causes a lot of interest to ethicists, scientists and clinicians alike. The option of efficiently re-programming cells derived directly from the patient (rather than depending on a few lines of embryonic stem cells, maintained in tissue culture) is one we all look forward to with hope. It would reduce most problems with transplant rejection, and the ensuing problems of immunosuppressive regimens and their associated complications.

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The mechanism of therapeutic cloning holds a lot of potential for the ultimate re-programming of adult cells into totipotent stem cells. This introduces a lot of ethical issues, due to the creation of a novel zygote-like cell (and therefore potentially a new human being). Theoretically, however, it would also create a source of every cell-type, potentially needed for transplantation procedures and regeneration therapies, from any one of the patient's skin or blood cells.

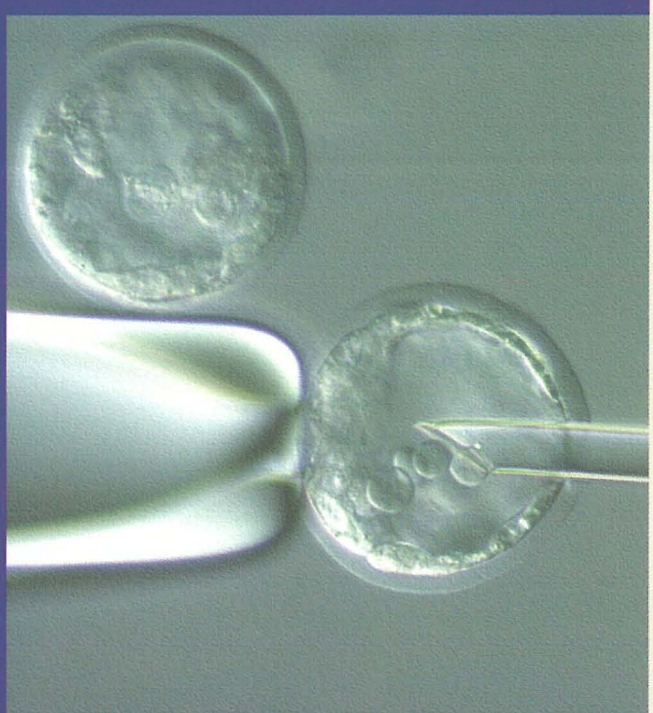
Making human embryonal cell lines from adult cells through the process of therapeutic cloning is presently an unachieved goal of stem cell research. It holds great potential but as it is seen as ethically problematic, human cloning has been outlawed in several national and international declaration.[3,4] The process of therapeutic cloning – creating a novel zygote-like cell to develop person-specific stem cells, unfortunately tends to be hijacked by the fact that this research could also result in the much more controversial reproductive cloning.

Most mammalian embryos created through cloning do not in fact develop into mature animals, in fact the great majority die at a very early stage of development as was the case with the experiments which eventually produced Dolly – she was one success story from 300 plus attempts.[5]

This is due to a number of characteristics of the embryonal development, including the process of imprinting, only a few of which are understood to any extent.[6]

Due to the very low likelihood that a zygote created through cloning would ever develop into a human being, even in the best circumstances in the womb, one may argue whether it may be possibly acceptable on moral grounds to accept the process of therapeutic cloning.

Normally, embryonic stem cells are derived from a clone once it has been allowed to develop into a blastocyst.[7]



This in itself engenders certain aspects of personhood to those of us (including myself) who believe that human life starts from the zygote formation, despite the fact that the chances of development into a person are presently non-existent. It may be possible in the future to directly derive the therapeutic clone from the initial nuclear-transferred cell. This may possibly reduce some of the ethical conundrums associated with therapeutic cloning by not allowing anything similar to an early embryo to ever develop.

Clinical and Therapeutic implications of stem cell biology

Lots of interesting clinical results have already been seen from stem cell transplantation and many others await us in the near future.

Bone marrow transplants are a form of stem cell transplantation which has been curing patients of aplastic anemia, leukaemia, and various other diseases for many decades.

This has more recently been supplemented with similar procedures of cord blood transplants and G-CSF-mobilised peripheral stem cell transplants.

Heart disease is one of the front runners in the field of stem cell clinical trials, where bone marrow injected into the heart of patients during or after myocardial infarction has resulted in an improvement of ejection fraction and other cardiac function parameters.[8]

The great interest is that unlike all other previous therapies available, this therapy results in a return of function to the post-infarct heart – a finding that holds much promise.

Other areas of ongoing clinical research into stem cells include retinal, pancreatic and skeletal diseases.[9-11]

With the perpetual lack of donor organs, the capability of developing new organs from one's own stem cells (or those of donors) provides a new frontier in medicine.

Tissue engineering is a whole new branch of medical research which is developing rapidly to make the most of advances in stem cell research as well as biomechanics and other technologies.

The option of introducing nerve cells to sites of neuronal injury following accidents or vascular events also opens up new frontiers into an as yet restricted field, resulting in rehabilitation of seriously disabled patients.

Preferences

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