**Remarkable Cells**

STEM CELLS (such as the ones from a mouse pictured right) are some of the most remarkable cells in the world, because they have the potential to develop into practically every cell in the Human body. The reason for this is that unlike normal body cells Stem cells which are specialised to forming and creating daughter cells which have the same job as the parent cells, stem cells are undifferentiated. This means that they have the potential to divide and create most of the 216 different cell types.

The cells that they divide into can then either remain a stem cell or become a more specialised cell in the body, such as a muscle cell or a brain cell. However the extent to which they are able to do this is governed by the class of stem cell that they belong to.

Unlike normal body cells which can only divide a limited number of times (30 or so) a key aspect of stem cells is that; they theoretically have the potential to divide and infinite number of times, as long as the animal is still alive. Unlike normal body cells which will die after a certain length of time and be replaced, stem cells will never die unless the body that they are in die and they are starved of food and oxygen.

There are also two major types of stem cells; **Embryonic Stem Cells**, these are cells that make up the inner cell mass of the blastocyst. They are pluripotent. **Adult or Somatic Stem Cells**, these are stem cells that reside dormant in many tissues in the body. They are multipotent.

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**Key Terms**: 
- **Totipotent** - These are stem cells which have the ability to specialise into any of the cells in the human body. There potential is total.
- **Pluripotent** - These are stem cells have the ability to become every type of cell in the body apart from those needed to make an embryo.
- **Multipotent** - These are stem cells that only have the potential to become only a few different varieties of cell.
- **Blastocyst** - A hollow sphere of cells formed four days after a sperm fertilises an egg
- **Autologous** - Stem cells are from the patient and used in the patient
- **Allogeneic** - Stem cells come from a donor, and go to the recipient.
What’s All the Hype?

STEM Cells have been called the "miracle cure" to many diseases and conditions that hitherto seemed incurable. But what is it that makes them so exciting?

In reality there are two main properties of stem cells that make them so different to other cells;

Stem Cell: The Undifferentiated Cell

The significance of this aspect of Stem cells is that one stem cell can give rise to most of the types of cells in the body. This means that cells which hitherto could only be repaired through transplanted tissue or organ transplant could then be cultured from just one basic stem cell. This should in theory reduce the number of transplanted organs needed, and save lives that would otherwise be lost.6

Indivisible

The implication that stem Cells are able to divide an infinite number of times, offers a great possibility in using stem cells to treat medical conditions. The main reason for this is that by using stem cells only a small number of stem cells need to be taken from either the adult or the blastocyst. These can then divide and continue dividing until there are enough cells to form a tissue that can be transplanted. This is beneficial because it causes far less trauma than there would be taking for example a skin graft.6

A colony of human embryonic stem cells grown over 10 months. The cell nuclei are stained green, the cell surface appears red2
The Miracle Cure?

To be at all useful stem cells need to be able to save lives. Scientists and Doctors have high hopes of what might come from researching stem cells. However, many treatments into stem cells still seem a long way off.

However, the fact that stem cells have only recently been discovered hasn’t stopped them already finding a place in today’s medical world.

For 40 years now somatic stem cells have been used in bone marrow transplants. In the bone marrow, there are called hematopoietic stem cells, or HSCs. Treatments of this nature have increased year on year as can be seen from the data (left). The graph clearly shows that since the 1990s there has been a rapid increase in bone marrow transplants. These adult stem cells will divide and become practically every type of human blood cell (see diagram above). This has been used to cure many people with bone, and blood diseases, and many others with cancers.

As well as this, although only in its infancy there have been some recent stem cell treatments for diabetes and kidney cancer. However only a few people have had this treatment.

Most of the other current treatments that are being used currently are those associated with blood disorders.

Even these are seldom used. The main reason for this is that all of the current treatments are not very cost effective. These include most noticeably the use of stem cells in “skin grafting, corneal transplantation……treatment of diabetes by transplantation of pancreatic cells” (Report and Recommendations of the UK Stem Cell Initiative).
As well as the current treatments that are incorporating the use of stem cells, the largest medical area is that of research.

Currently (06/03/2006) there are 513 clinical trials happening in America all using possible stem cell treatments. There is no doubt that stem cell treatments are one of the fastest growing research areas in Medicine.

STEM CELLS could open up doors to a whole new area of treatment of medical conditions. The future possibilities are enormous with the possibility of curing disabilitating diseases such as Parkinson’s disease, to stopping the current organ shortage.

However these are all still a long way off, Professor Waldmann, an immunologist currently researching stem cells at the Sir William Dunn School of Pathology Oxford, says ‘if any of these things are to become routine, it may well take 20 years to happen.’ Currently there are many hurdles that need to be overcome. Professor Alastair Campbell of Bristol University agrees suggesting that there has been too much hype about the possibilities of stem cells. This validates the comment since they are both professors at large UK universities.

Most noticeably is the problem of rejection of the tissues or organs that have been created. Stem cell biologist Dr Paul Fairchild, who is working with Professor Waldmann, suggests that there are four possible ways to get around rejection;

1. Using therapeutic cloning like that used with Dolly the Sheep, to make tailor-made stem cells - The main problem here is that if the degeneration being treated is genetic this will out work you will be replacing bad material with more bad material. There are also ethical problems that come into play here.
2. Using the closest possible immunological match - This too has a draw back, because as Professor Waldmann says the experience from bone marrow donation schemes shows that one would require millions of cell cultures to cover immunological diversity in the UK alone.
3. Using Embryonic Stem Cells and inactivating the gene that allows the immune system to recognize whether the cell is from the body or not. Although this is being investigated in many laboratories it is possible that these cells could act as a safe haven for viruses.
4. Using only a small number of Stem cells and coaxing the immune system to accept the cells. However using drugs to suppress the immune system into doing this does leave the patient susceptible to disease.

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**Tailor-made Stem Cells**

1. **Donor Egg**
2. **DNA from Skin**
3. **DNA and Egg Fused**
4. **Early Embryo**
5. **Stem Cells Removed**

“It may well take 20 years to happen”
There are other problems too in creating organs in-vitro. The main issue with this exciting area is that currently there is no biocompatible to make the organs grow. There is also a fundamental lack of knowledge of how the signalling in organs actually works and without this it would be very difficult to create an organ from scratch.

**Ethics**

MANY of the ethical considerations surrounding Stem cells are centred on the use of embryos to get pluripotent stem cells from embryos and even in some cases foetuses up to 8 weeks old. The main reason for this debate is that if stem cells are taken from an embryo, the embryo can no longer develop into a baby. Some people see this as essence killing a human being which is morally wrong. The crux of the debate is basically as to whether an embryo should have the same rights as a baby that has been born, and when life begins.

Some consider that life begins at conception and thus taking stem cells from an embryo is in effect killing it and likened to murder. Therefore they would suggest that embryonic stem cell research is wrong and so should not be carried out.

Others would argue that even if life starts at conception, using an embryo that would otherwise be destroyed, to possibly save so many lives is the right thing to do.

Yet others would argue that life does not begin until the baby is born and so to use the stem cells from a blastocyst is reasonable.

It is this ethical debate which must be resolved before stem cell research can really start to make head roads into finding applications for the research.

**Economic**

ONE of the major problems that Stem Cell treatments currently have and will have for at least the next few years is that of cost. Currently Stem Cell treatments are expensive and require a huge amount of technology.

This means that the NHS only rarely use it as a form of treatment, and would need a large cash injection to do so. This makes it possible that Stem Cell treatment will become funded by the patients that have it. This would then mean that only the wealthy could afford such a treatment, creating a possible social divide.

**Society**

IF Stem Cell treatment relied on tissue matching, even with the best will, the UK Stem Cell Bank would find it hard to build up a complete catalogue of all possible stem cell lines. This might well mean that any rare tissue types of minority and ethnic groups are unable to receive treatment.

This could cause an outcry, and it must be asked whether this sort of divide is healthy.

ALL of these issues must be safeguarded against before any meaningful treatments can be used across the country.
Currently there is a huge amount of controversy in the field of stem cell research. One of the biggest issues that divides scientists is whether embryos need to be used to produce stem cells. The use of embryonic stem is condemned by many religious leaders, but many others believe that it is the only way to treat certain conditions.

This is highlighted by the Catholic weekly supplement which says “Embryonic stem cell research has not helped a single patient”. However they obviously have a vested interest in saying this. The Catholic faith condemns all destruction of embryos, and so therefore will always argue in favour of not using embryos for stem cell research. On the other hand at the Embryonic Stem Cell Research Facility at the University of Wisconsin scientists say that using adult stem cells is not enough “only through exploration of all types of stem cell research will scientists find the most efficient and effective ways to treat diseases”. However they too have a vested interest, this is due to the fact that they are funded to research into stem cells, which they would not do if they believed in their use.

This debate has split the scientific and ethical community, and is the issue at the crux of stem cell research.

There is more controversy too in the case of scientist Hwang Woo-suk. He claimed to have made some of the tailor made stem cells discussed above; however a year later it was found that these results were fabricated, by the respected US journal ‘Science’ that printed them, this was further validated by two of the scientists working with Hwang Woo-suk. This can be validated by the Article that was actually written in the Journal in December 16th 2006. In a field this cutting edge, any discovery could lead to world wide fame, and for some scientist the pressure is simply too great.
1. http://news.bbc.co.uk/1/hi/health/4562235.stm - The comment was made in an article called 'Q&A: Stem cells' on the BBC News Website, last updated on the 15th May 2005.

2. http://www.news.wisc.edu/10720.html - The picture was published in an article entitled 'Scientists rid stem cell culture of key animal cells' first published 17th January 2005. It is written by the University of Wisconsin, this is a respected institute making it more valid.


4. Salters-Nuffield Advanced Biology page 114 paragraph 3. This is a textbook written for AS level students. This makes the information more valid, because all information must be re-checked.

5. http://en.wikipedia.org/wiki/Wikipedia - an online encyclopaedia, offering information several subjects. However the validity of the information is compromised by the fact that the general public have the ability to add to or edit the information.


7. “Report and Recommendations of the UK Stem Cell Initiative” - A report written by a government run and funded initiative to look at Stem Cell research in the UK.

8. http://www.clinicaltrials.gov/ - The governmental website for the whole of the United States that oversees all of the clinical trials. Since the website was set up by the government it becomes more valid.

9. http://www.oxfordtoday.ox.ac.uk/2004-05/v17n1/06.shtml - This is an article from the University of Oxford, making the source reliable, it is one of the largest bases for stem cell research.

10. Points taken from a Lecture by Professor Alistair Campbell Called “Stem Cells – Hype or Hope?” At Bristol University on the 22nd of March 2006. Professor Alistair Campbell was on the advisory committee for using therapeutic cloning. He is now the professor for Ethics of Medicine.

11. http://www.americamagazine.org/editorial.cfm?articleTypeID=3&textID=3905&issueID=511 - a weekly supplement by the American Catholic Weekly supplement.

12. http://www.news.wisc.edu/packages/stemcells/ - A University website which makes the information on it more valid, however due to the funding being given to the university there is a vested interest.
