STEM CELLS – TODAY, YESTERDAY AND TOMORROW.

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ABSTRACT
During this paper we shall be investigating current affairs concerning the development of stem cell research with senses; including the study of Katie Piper, the girl who was blinded by acid burns and has recently a retinal stem cell implant and is in the process of regaining some sight in the damaged eye, the possible future developments of stem cell research concerning the rejuvenation of eye sight and hearing and the ethical issues surrounding the use of embryonic stem cells to regress the damage.

INTRODUCTION
So, what are stem cells? They are undifferentiated cells; they have no specific structure but have the ability to differentiate into specialised cells. There are three broad types; adult stem cells, embryonic stem cells and foetal stem cells.

In 1981, Martin Evans and Matthew Kaufman first derived independent embryonic stem cells from mouse embryos. Gail R. Martin published her paper in December of 1981 and created the term “Embryonic Stem Cell”. It was her that illustrated that embryos could be cultured in vitro and following this, embryonic stem cells could be derived from the embryos. As first discovered by James Thomson in 1998, he first isolated human embryonic stem cells and unlocked their potential. However this also began the remarkably controversial ethical debate about human embryonic stem cell research.

Embryonic stem cells are derived from a developing fertilised egg from a clinic. A developing 8 cell embryo has the potential to differentiate into almost any cell in the body. These cells are pluripotent cells. After the development of the embryo is over, the stem cells lose the ability to differentiate into any cell type. Their pluripotency is thus lost.

Foetal stem cells can be found in blood from the umbilical cord or the placenta. Experimental evidence by Naoko Koike-Kiriyama (2007) elucidates the possibility of human cord blood cells to differentiate into retinal nerve cells. Currently cord blood is in use treating numerous malignant diseases including many types of cancer. Cord blood is also being used to treat more common diseases, such as anaemia. Adult stem cell’s main purpose is to replenish cells that are dying and regenerate damaged tissues. They are vastly scarcer in the body and harder to harvest than embryonic stem cells. The body is in constant need of adult stem cells thus making their viability questionable. Their use is limited to the cell types of their original tissue.

Researchers continue to explore the factors that control stem cell behaviour. In November 2007 Yamanaka and Thomson independently derived iPS cells. The cells were created from four genes with viruses inserted into skin cells. The skin cells then acquired similar properties to those of stem cells. Scientists were then able to develop these iPS into becoming functioning heart and nerve cells.

Stem cell treatments are a form of intervention strategy that inserts new cells into damaged tissue in order to treat disease or injury. In general stem cells hold an enormous potential in helping scientists learn about diseases and develop successful treatments. Many scientists believe stem cell treatments hold the potential alleviate suffering and all together change the face of human disease. Diseases caused by uncontrolled cell division, such as cancer, link to how and why stem cells divide many times. A greater understanding of stem cells may unlock the mystery of many common diseases. The regenerative properties that stem cells posses may prove constructive in discovering treatments for conditions including strokes, Alzheimer’s, diabetes and spinal cord injury. It is clear to see that the further progression of stem cell research is essential for the future well being of the world’s population.
DISCUSSION.

Regenerative medicine is a new field that aims to use stem cells to repair damaged tissue that can’t heal itself. Some existing drugs may already be activating the production of stem cells. Some anti depressants stimulate the growth of new neurones in the brain; which would have once originated from stem cells. The hope for the future is to develop drugs which would trigger different types of stem cells to heal damaged tissue.

Even another approach may be possible, this would be to grow embryonic stem cells in a lab, differentiate them into specialised cells and transplant them into patients. Experiments have been carried out on rats which have positive effects. In rats with damaged spinal cords they were injected neural stem cells. These stem cells proceeded to wrap around the injury and improve the rat’s ability to walk. Thus showing promise for treatment of patients with a spinal cord injury.

Stem cell treatment for blindness is the topic under discussion in a new UK documentary featuring Katie Piper. She was subject to a vicious acid attack in 2008 and lost all sight in her left eye, due to a condition called Aniridia, where there is no iris in the eye. Following experimental stem cell treatment for blindness however, Katie appears to have regained some sight prompting hope in others with optical injuries.

Surgeon Mr Sheraz Daya said “a layer of tissue that acts to protect the cornea grows abnormally on its surface, this results in pain, poor vision and the blood vessels grow into the eye, making it red. Limbal tissue – where the white coat of the eye meets the clear cornea – is removed from a donor eye. These cells are then multiplied in a laboratory. First I had to remove all the abnormal cells in Katie's eyes – the scarring and blood vessels which had grown on the surface of her eye. The stem cells were then transferred. We have to cover the new cells with a piece of tissue membrane which is taken from the lining of a woman's womb. Since her procedure, Katie's cornea is cleared considerably and she has had an improvement in her sight.”

Could certain causes of blindness be eradicated? There are many studies of blindness being essentially cured. Discovered in 1998, human embryonic stem cells had previously failed to deliver on their medical promise, however years later they have shown medical promise for this. The study of two people suffering from eye sight degeneration claim their vision improved in only a short period of four months. They received implants of retinal pigment epithelial cells made from hESCs. The treatments were a phenomenal successes with no sign of the cells triggering tumours, no inflammation and no sign of immune rejection.
One of the women in the trial had Stargardt disease, an inherited form of eye deterioration in which the pigment cells wither and die. Before her treatment she could merely make out hand movements. Replacement cells prepared from hESCs were injected into one of her eyes. Afterwards her sight in the treated eye had been improved substantially. She was now able to discern finger movements too. She could now, in addition, read five letters on a standard visual acuity chart – beforehand she could not make out any letters.

Many people suffer from eyesight problems; these can be due to diseases, or chemical accidents. One of the main causes of vision loss is due to Macular Degeneration which can cause blindness problems in the elderly and can also affect those who have lost vision due to diabetes. People who suffer from vision loss are affected in almost all of their day to day activities. The reason why Macular Degeneration is such a problem is because it directly affects the region of our eyes which help us to see the detail of an image.

Scientists have been testing stem cells to aid the recovery of vision loss. They found that matured stem cells developed to replace damaged photoreceptors into new ones whereas less matured stem cells did not successfully differentiate into the desired product. When this discovery was found, the scientists tested the stem cells on some blind mice. They injected the stem cells into the back of the mice’s eyes and found that the stem cells successfully differentiated into the photoreceptor cells. This shows that in the same way this procedure can be carried out to recover human vision loss and to treat blindness.

Some people may be unfortunate to be involved in a chemical accident where their cornea can become damaged. In this case stem cells can also be used to help repair this damage. The way in which the stem cells can be used to treat this kind of damage is by, taking limbal stem cells from the edge of the cornea which are unscathed - these stem cells can be taken from the patients themselves and then grafted into their eyes where the stem cells would differentiate into the required cells and start to recover the eyesight and cornea damage. These kinds of treatments have already shown positive results and are likely to increase in the future.

With embryonic stem cells being the master cells which can differentiate into any of the 200 varieties of human cells. The future may see scientists discovering the ability to control the differentiation and thus, being able to produce the stem cells required to treat blindness and for those to then be transplanted into patients.

The most obvious advantage for the use of these stem cells is to those who suffer from vision loss or blindness, the affect of losing sight can be devastating to people as they can simply not do basic tasks with ease anymore, stem cells help to recover this damage and allows the patient to regain their sight. Also, other advantages of using embryonic stem cells over eye or cornea transplants are that, the patient does not need to wait a long period of time to receive a donor and also the treatment is not likely to result in immunological rejection as the stem cells would be the patient’s own body cells therefore, the body would not reject them, but would recognize them as its own and accept them.

Recently, there was a clinical trial that tested the safety of using human embryonic stem cells. The trial treated two people with progressive eye conditions affecting the macula, the part of the eye responsible for central vision. In the study researchers developed stem cells into cell types found within the eye and carefully injected the cells into specific locations within the eye. After monitoring patients for four months the researchers found that neither patient had problems with abnormal cell growth, tumors, graft rejection or other safety issues. They also reported improvements in their vision, although
not complete reversal of their conditions. While certainly impressive, this small trial was designed to help establish the safety of the procedure, not whether it was effective.

Scientists have conducted this treatment on a lot of patients so far as a test and the end results have shown more positive outcomes rather than risks and dangers. Therefore this could mean that stem cells may be used more widely in the near future with further development in curing eyesight problems and treating more people.

Hearing can also become damaged. Many things can cause the tiny hairs within the ear to become damaged - this causes hearing loss. Before we can understand how stem cells can be used to repair damaged, we must first recognize how hearing works. There are two key features of hearing in our inner ears. These features consist of the auditory and vestibular system. The auditory region in the ear is used for the main hearing and the vestibular system is used for balancing the hearing. There are also hair cells within the inner ear which detect and then respond to sound from the surrounding environment; the response is then transmitted to the brain via nerve cells.

Hair cell damage is irreversible and causes hearing problems in around 10% of the world’s population. Embryonic stem cells could be used to create fully functional cells that could be used to treat total hearing loss because of their ability to become any kind of human cell. Not only could they be used to replace the permanently damaged hair cells but they could also replace spoilt nerve cells along which the messages generated by the hair cells are transmitted to the brain.

Some researchers have newly discovered that stem cells from a mouse’s inner ear can be used to repair the hearing loss in humans. How this works is that under the correct conditions, the stem cells gathered from the inner ear of mouse can develop into hairs similar to those of the human inner ear which carry out the same function. Mouse embryonic stem cells have also been found to develop into precursor cells - these cells also differentiate into the inner ear like hairs. The advantage is that large numbers of hair cells can ultimately be generated from embryonic stem cells. The hair like cells may also be able to be used to screen drugs that may affect sensory hair cells.

With all discoveries, there are advantages and also disadvantages. The advantages of using stem cells in treating hearing loss are great for people who suffer from this problem. This is because hearing loss is a very bad experience for those who suffer from it, this problem can isolate people from communicating with others as humans communicate mostly through speaking and listening, hearing loss can cause distress and also many other problems. Therefore, using stem cells is very beneficial to those who are unlucky to have hearing problems as it allows them to regain communication with others, relieves them of stress and helps them to live a normal life.

However, the use of embryonic stem cells is a highly controversial subject that remains questioned because essentially is constitutes the destruction of a potential human formed from laboratory-fertilized human egg. This conflicts with moral and religious views that society holds. The central argument is what composes the beginning of new life. In one view, personhood begins with the fertilisation of the ovum; from that moment on, the admittedly primitive organism has an identity which will link it continuously to the infant, to the child, and later to the adult human being it will become. Ending the life of the embryo amounts to an ending of the future life of the infant and, indeed, of the child and the adult. Personhood in this view is an ethically significant quality, which human beings have at every stage of their lives, beginning with the embryo and surviving until death brings it to an end.
This view of personhood has been challenged by those moral philosophers who see personhood as being dependent on an ability to experience those features of life which lend to life its value and meaning. From the biological point of view, personal individuality can be attributed to the embryo only after the day in its early development when division into normal twins is not possible any more (up to 13 days after-fertilisation). Embryos are therefore entitled to respect but would not enjoy the personhood. The issue is one that has always been highly emotive and requires an open mind to all opinions. Balance between the harm that might be done against the potential good this research may provide for those suffering from debilitating diseases is vital.

CONCLUSION.

Evidently further research is essential; however, the true potentials are yet to be discovered and therefore, may become a huge scientific breakthrough. The essential bases of the research have been laid and time and funding play the main part in the development process. Embryos host live cells and they are kept in that permanent state of early development. Scientists can use this to test various forms of drugs and see how the drugs will affect the human cells. This will reduce the number of animals killed during medical tests. In the future, this might also lead to the discovery of the cures to many diseases.

The disadvantages of using stem cells are mostly related to surgical procedures. We do not know if using the stem cells may have a side effect in future years to those who have been treated with them. Researchers still need to find out how to successfully trigger the stem cells into differentiating into the inner ear hairs. If this is not done correctly the stem cells may not differentiate at all.

The major concern with transplantation of embryonic stem cells into a patient is their aptitude to form tumors; stem cells may not differentiate properly and therefore, may grow uncontrollably. A way to minimize this risk would be by discovering a way of differentiating mesenchymal stem cells into other cell lines by using a 3-D scaffold (because they can't communicate with each other properly when lying flat in single layers in the bottom of a Petri dish) that can be dissolved afterwards. The differentiated cells derived from the embryonic stem cells have a potential for rejection. It is possible to prevent such rejection by forming embryonic stem cells via therapeutic cloning. These cells would then be genetically identical to the patient.

Studies have demonstrated that mesenchymal stem cells which have expanded for less than two months pose no detectable risk of cell changes or tumour formation. Centeno et al have shown that they are safe in a prospective study. 227 patients found no evidence of the formation of cancer at the re-implantation site. This finding is also consistent with numerous other studies which failed to find any evidence of cancer formation from the use of mesenchymal stem cells.

Stem cell treatments greatly benefit the patient and thus we believe that the use of future stem cells development should continue. The public need to be educated on the benefits of using embryonic stem cells as a treatment method. Further research will be unnecessary and impossible if the people who are meant to be helped by the outcomes of the researches do not give their consent.
As this development of using stem cells to cure and heal patients progresses further, it is possible that stem cells may be used more widely with a high percentage of successful surgical procedures and results. Also as more stem cell based operations are carried out, more future discoveries will be, including the long term affects and side effects. This in turn will help surgeons to carry out these procedures more efficiently with little or no risk.

As the understanding of cell development using embryonic stem cells increases, scientists and doctors may be able to prevent many birth defects. Further research and studies on embryonic stem cells will help the doctors locate when and where the cells mutate to give a birth defect. They can then use appropriate medication, drugs or enzymes to stop the mutation and prevent the defect before the child is born.

It is well known that embryonic stem cells can regenerate. If these cells can regenerate, there is hope that the cells can be manipulated into generating into body parts.

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