Use of stem cells on ageing prevention

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Abstract

This scientific report will look at stem cells and their abilities to prevent ageing. My[DS1]research was mostly qualitative, secondary research which didn’t cost any money to conduct. I have discovered through writing this report that in the future it may be possible to achieve biological immortality with the aid of stem cells, either by altering the genes of human stem cells or by using other biologically immortal organisms stem cell information. However stem cell research is controversial and it will be many years before stem cell research will have developed to the point that biological immortality will be feasible.

Introduction

Ageing can be described in many ways. It is often used to refer to a passage in time in which someone gets older. Ageing in humans can be judged on the number of years lived and on appearance both external and internal such as grey hair and organs no longer working the way they are supposed to. This is because ageing leads to a decline in the regenerative abilities of all the tissues and organs in the body. [Kirkwood T. B, 2005]. This is connected to a decline in stem cell function.

Why would we want to prevent or reverse ageing?

Whilst a person cannot simply die of old age, as a person gets older there are more chances of genetic mutations and damage from the environment which can lead to a person being more likely to get a disease or condition.

When a person ages, their cells can no longer defend themselves against diseases as well as they could when the person was younger. This means that as a person ages, they become more vulnerable to injuries and diseases [Radford B, 2012]. If it was made possible to prevent ageing, this would mean that the average life span would increase dramatically and it may be possible for humans to become biologically immortal.

What is biological immortality?

Biological immortality is the idea that whilst you are able to die (by disease or other means), you do not age. This would mean that a person with biological immortality would no longer experience loss of physiological function. This would allow people to stay relatively healthy whilst also not looking as though they were ageing [Despain D, 2010]. There are many ways in which people believe biological immortality can be achieved, either through lifestyle changes or genetic changes. One particular way focuses on stem cells.

What are stem cells?

Stem cells are undifferentiated cells which are able to become other cells. Stem cells are also able to self-renew. There are two main types of stem cells, embryonic stem cells and adult stem cells. Embryonic stem cells are found in human blastocyts which are newly fertilised eggs (three-five days old) which are created by IVF. These stem cells are used in various therapies and tests and can be grown into any organ in thebody[DS2].

The other main types of stem cells are Adult stem cells, also known as Tissue-specific stem cells. These stem cells generate the same type of cell of the organ or tissue that it lives on. However, adult stem cells don’t self-renew as easily as embryonic stem cells. Adult stem cells can be studied to show a lot about the process of ageing. [closerlookatstemcells. org , 2015]

Adult stem cells are essential for the maintenance of organs and tissues of mammals during their lives. With age, this maintenance is decreased due to the deterioration of co-ordination from molecular signalling. This leads to organs and tissues not being rejuvenated as quickly or as well in an older mammal than that of a younger one [Silva H. and Conboy I. M, 2008]. This means that overtime organs and tissues would become weaker and more susceptible to failure. If an animals’ stem cells were to remain fully functioning for a longer period of time, this would increase the time before organs and tissues begin to lose functionality and if the stem cells were able to be fully functional forever, then an animal would achieve biological immortality.

How can stem cells be used to achieve biological immortality?

Organisms such as the Hydra (Hydra oligactis), an animal related to the jellyfish, have achieved biological immortality. Whilst it’s unknown exactly how long the Hydra lives, a Hydra which was kept in captivity for 4 years remained unchanged which is remarkable for a creature of its size (15mm). The Hydras biological immortality can be attributed to its’ stem cells which are able to renew and regrow parts of the Hydras’ body. Using 3 different types of stem cell populations, the Hydra is able to fully create clones of

itself. Scientists found that the 3 types of stem cells all contained the same gene, the FoxO (a protein thought to be anti-ageing) and when this gene is removed the Hydra ages [Barras C, 2015]. If scientists were able to isolate this gene and place it into the DNA of another organism, theoretically another non-ageing organism would have been created. However, trying this with humans is likely to be a long way off as many people believe it would be unethical to conduct this sort of experiment on ahuman[DS3].

Other animals are also able to rejuvenate themselves using stem cells. Limbs and complex organs such as eyes and kidneys are able to be re-grown once lost or damaged. These animals such as frogs and fish either use pluripotent cells (stem cells able to differentiate into different cell types eg. Embryonic stem cells) to regenerate the whole limb or different types of stem cells to regenerate the different types of tissue like humans. So whilst humans use different types of stem cells for the maintenance of different tissues, humans aren’t able to rejuvenate their tissues to this level. This could be because humans are mammals and therefore lack the ability to direct stem cells to different parts of the body like certain amphibians. Future research will show why humans are lack this capability [Tanaka E, 2015].

Another possible method of using stem cells to achieve biological immortality would be to alter genes in order for more microRNAs to be produced. MicroRNAs are snippets of genetic material which can be linked to growth regulation in cells. MicroMRNAs keep cells dividing as they prevent ‘ stop signals’ that stop cells from dividing. Using microMRNAs, ageing stem cells could be made to keep dividing for a longer period of time therefore meaning that the stem cells would be able to maintain organs and tissues for

longer. However, microRNAs have also been linked to the development of cancer when produced in abundance. Therefore, finding the right amount of microRNAs to boost ageing stem cells whilst also making sure that cancer growth and tumours aren't created at the same time is essential. Scientists also have to identify which, out of the 200+ human microMRNAs, is responsible for keeping stem cells dividing [Boyle A, 2005].

There has been further research into embryonic stem cells and adult stem cells. A gene has been discovered called ' Nanog' in the embryonic stem cells which allowed it to remain youthful. This would allow for later research to be done in order to give adult stem cells the pluripotent properties of ESCs which would eliminate the need to harvest embryonic stem cells from blastocyts for medical treatments [Bhattacharya S, 2003]. Adult stem cells would become induced pluripotent stem (iPS) cells. This would now be able to rejuvenate other somatic cells (any cell making up an organism other than gametes and undifferentiated cells). The iPS cells would be able to create new somatic cells for an indefinite period of time. This would mean that cells lifespan would be able to be increased [West M. D, 2013].

Currently, stem cells are used in various rejuvenation therapies from degenerative and debilitating conditions to cosmetic and dermatological therapies. Stem cell transplants are also used to treat some forms of cancer such a leukaemia and lymphoma. The stem cells are adult stem cells which are either collected from the patient themselves or are donor stem cells. These stem cells are collected and transplanted in order to replace the stem cells killed in other cancer treatments [stem cell transplants, cancerresearchuk. org]. Some other stem cell therapies use donor placentas

from healthy young mothers. Stem cell therapies are still not risk free, even when using the patient’s own stem cells, complications can arise.

Whilst stem cells aren’t yet used to create organs for organ transplants, progress is being made in creating organs from scratch purely using stem cells. Working organs have been created, however it will be at least another 10 years of research and millions of pounds invested before the process is deemed fit to use on human patients [The Guardian, 2014].

What ethical concerns surround stem cell research?

Stem cell research is opposed by a lot of people. The majority of those people are religious who believe that life starts at conception. This would mean that using blastocyts created through IVF for medical research would be equivalent to testing on living humans. Those who agree with stem cell research do not believe that life starts at conception and/or believe that the benefits of stem cell research and its future of curing various conditions outweigh the risks andharm[DS4].

Conclusion

Stem cell research leads to an exciting future where current debilitating conditions will be able to be cured, ageing will be prevented and more will be discovered about how stem cells work and the many ways they can be harnessed to improve humans’ quality of life. In the future this could lead to life spans dramatically increasing, but is that necessarily a good thing? This could lead to various issues such as overpopulation and other social changes, such as a change in the age of retirement [Emanuel P, 2005].

Will stem cell research continue after we have found the key to biological immortality?

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