The science behind regenerative medicine

The fountain of youth may be just a legend, but doctors and scientists around the world are beginning an epic journey with a medical revolution that may ultimately lead to human immortality.

PRACTICAL SCIENCE WITH PHIL FREDA

Organ donation may be a thing of the past in the near future. Doctors, researchers and scientists the world over are discovering the science of regenerative medicine. Many people have received transplanted organs and tissues that were grown in a laboratory!

I recently had the pleasure of watching an episode of National Geographic's Explorer entitled "How to Build a Beating Heart" that extensively covered regenerative medicine.

The process of regenerating an organ

Regenerative medicine utilizes the patient's own cells. By using the patient's own cells, the risk of rejection is greatly reduced. The organ that has had the most success in this process is the bladder.

Anthony Atala, director of the Wake Forest Institute for Regenerative Medicine, appeared in "How to Build a Beating Heart," as well as a recent article in Smithsonian and a video on PBS' Wired Science YouTube channel where he illustrates the procedure.

First, a small piece of the patient's bladder is removed, and cells are separated based on cell type. Next, the cells are bathed in a fluid that prompts them to divide and multiply.

After the next six weeks, there will be enough cells for an entire bladder.

Muscle cells, which make up the exterior of the bladder, are poured over a collagen scaffold. Then, the inner cells of the bladder are injected.

This scaffold is an example of an extracellular matrix. These matrices are nonliving material that are akin to building scaffolding or a rebar (the metal used in concrete structures).

The bladder is then placed in a specialized incubator that mimics body conditions. The organ is now ready to be transplanted into the patient! The first person to receive this treatment was Luke Massella, who had been diagnosed with spina bifida at birth. (Read Luke's story to learn more.)

This procedure works not just for bladders, but also for skin, ears, blood vessels, muscles and even hearts and fingers!

The importance of the extracellular matrix

In the episode of Explorer, a man had lost part of his finger in an unfortunate accident. Instead of allowing the wound to scar over, the man's brother, a surgeon, knew of some new research in regenerative medicine. An extracellular matrix (ECM) from pig bladder was ground into a fine powder and given to the man.

Instead of allowing the wound to scar, the man sprinkled the pig bladder ECM over the wound. Over a few weeks, the finger, including the nail, was fully developed. Even the fingerprint regenerated, and when compared to fingerprints he had when he enlisted into the military years earlier, the prints were identical!

Because of successful applications like this, the researchers began to realize that ECM isn't just a scaffold, but a signaling molecule that attracts stem cells to form new tissue.

Currently, research shows that low levels of signaling from ECM encourages scarring. But when doused with ECM from pig bladder, the signaling for regeneration goes through the roof. This process promotes new growth.

ECM is extremely important to the process because it is nonliving. In other words, it does not carry genetic information, which means that cells from your body can interact with it, even if it wasn't originally from your body — it is almost like moving to a new home. This eliminates rejection because the ECM is occupied by your cells.

What about a heart?
The heart is a much more complicated organ with many cell types, electrical interaction and muscular precision.

Can a heart be regenerated?
The answer is yes — at least for rats.

Scientists have been able to successfully regenerate a rat heart, and even got it to beat. The process is essentially the same as the bladder and the finger. ECM must be removed of all living cells from the donor. When all that remains is the ECM, a cellular media from the person getting the transplant is injected into the matrix.

Within a few days, the heart is complete, and all that remains is to give it a jolt of electricity to start the beating!

If you're wondering — yes, researchers are working on the process to regenerate a functional human heart.

What are the implications?
The major implication of this research is saving lives of people that have been affected by war, accident and medical issues, but this isn't the only possible outcome.

This research may bring us closer to immortality.

Regeneration of organs and tissue may drastically reduce the effects of aging and degradation. There may come a day where humans actually outlive organs that they were born with. Think about it!

I personally think that the idea of living forever is enticing, but I also think that the human race is not ethically prepared for such a scenario. The moral and cultural evolution of our society needs to catch up to the idea of immortality and what it means for the human race.

As always, I would love to hear feedback and comments from the readers concerning the ideas and research described in this article.

I would also stress that anyone interested in this topic should check out the links provided in the article, especially to the Explorer episode's official site.