Limb Regeneration: A Human Endeavor

Cullan Davitt
Oregon Institute of Technology
Writing 345: Science Writing
Michael Lucas
October 28, 2022

The human body has evolved over centuries, and has acquired many physical features along the way. Unfortunately, the ability to regenerate a lost limb due to injury or genetic defect has never been something the human body is capable of. However, the natural regrowth of limbs is commonplace among small reptiles and amphibians. For generations, human beings have noticed this power in these smaller creatures, and sought to possess this natural ability but have been stumped by its complexity. Fortunately, within the last few decades leaps in scientific knowledge of limb regeneration have been uncovered, and now the possibility for humans to regenerate their own limbs has been thrust into the spotlight. New information has surfaced around the chemical and biological process of how organisms can activate the regrowth of their limbs. The following literature explains some of these groundbreaking discoveries towards limb regeneration for the human species, and that it is not only possible, but could be within reach sooner than we think.

An article by “Texas A&M Today” introduces us to Dr. Ken Muneoka who is one of the leading scientists in studying the biological processes of limb regeneration. Dr. Muneoka is a professor at the Texas A&M University College of Veterinary Medicine & Biomedical Sciences (CVMBS) and he is known for “disrupting the field of regeneration.” He and his team have been “challenging beliefs held for centuries around the theories of regeneration,” (Bloom, Aubrey July 2022) and in his 2019 publication *Nature* proved that regeneration in mammalian species was possible.

The article continues about Dr. Muneoka’s stress on the “mechanical load” during any given process an organism does. It was previously thought that the basis for natural limb regeneration was due to the presence of specific nerves, and by stimulating these nerves an organism could control limb regrowth. Although nerves play a role in limb regeneration, Dr. Muneoka finds something far deeper and more important. Mechanical load represents the tissue and muscular stresses that growth has on an organism's body, and he has found the biological importance of the phenomenon.

Muneoka conducted certain experiments along the lines of one endeavor taken by NASA, in which animals known for natural regeneration had a limb removed, were sent into space at zero gravity, and observed. It was found that while in space, none of the organisms were able to regrow their missing limbs, despite having an abundance of nerves in the severed areas. Once the cast of creatures returned to earth however, they began to regenerate their limbs after a few weeks. This was to prove that the “mechanical load” aspect in limb regrowth is not only important, but vital.

In a different article by the *Wyss Institute* titled “Achieving a Milestone, Scientist Regrow Frog’s Lost Leg” an experiment about the regrowth for organisms without natural regeneration capabilities is explained. In this experiment, Scientists from Harvard and Tufts University studied adult frogs who are incapable of naturally regenerating their limbs. They amputated the frog's leg, created a special “five-drug cocktail” then applied this mixture in a sealed, bioreactor dome over the frog’s stump. Each of the five drugs served a specific purpose including tamping down inflation, inhibiting collagen production (to stop the stump from covering itself in scar tissue and halting the regenerative process altogether) and reinstating the growth of tissues, nerve fibers, blood vessels, and muscles.

Although the end product wasn’t a 100% recreation of the missing limb, what grew back was nearly fully functional. The limb had a bone structure and other limb features that were similar to the original leg, as well as toes and normal tissues that should accompany the leg. The limb was also able to respond to external stimuli such as being touched with a stiff fiber, and the frog was even able to make use of it while swimming in the same way most frogs do. What is exceptional about this experiment was the concoction of drugs used on the stumps of each of the frogs was only applied over a 24 hour period, yet started a few month long regeneration process. Researchers working on the drugs stated that they must have been able to reactivate the same growth process found in embryos of organisms while they are still developing, but normally go dormant once they are developed. Activating these processes is

what ultimately led to the regeneration of the limb.

A third article by “Wiley Online Library” titled *Mechanisms of urodele limb regeneration* explains that other researchers have attempted limb regeneration at a smaller scale, in an attempt to be as accurate as possible when it comes to regeneration of lost organic material. While many scientists have attempted to regrow entire limbs, the resulting limbs have been somewhat defective. However, this article explains why some scientists like Elizabeth Zilens, aim to just regrow the toes of smaller amphibians, but to do so perfectly. This way, they can work from small scale to big picture, with what they hope is a better base for moving forward.

Although the topic of limb regeneration has been around for some time, it is only within the last 70 years (roughly) that science has made outstanding accomplishments and discoveries. These findings are leading us into a new age where the possibility of natural limb regeneration for the human species is possible. This would quite literally change lives, especially for those who have lost their limbs due to disease, injury, or some type of genetic anomaly. Once this ability becomes possible and accessible to all humans, life for all individuals would be forever changed.

Sources:

Achieving a milestone, scientists regrow frog's lost leg. Wyss Institute. (2022, January 26). Retrieved October 28, 2022, from https://wyss.harvard.edu/news/achieving-a-milestone-scientists-regrow-frogs-lost-leg/

American Association for Anatomy - Wiley Online Library. (n.d.). Retrieved October 29, 2022, from https://anatomypubs.onlinelibrary.wiley.com/

Clark, C. (2022, July 5). ***New research challenges long-held beliefs about limb regeneration.*** Texas A&M Today. Retrieved October 28, 2022, from https://today.tamu.edu/2022/07/05/new-research-challenges-long-held-beliefs-about-limb-regeneration/

Zielins ER;Ransom RC;Leavitt TE;Longaker MT;Wan DC; (n.d.). ***The role of stem cells in limb regeneration.*** Organogenesis. Retrieved October 28, 2022, from https://pubmed.ncbi.nlm.nih.gov/27008101/