Dream of regenerating human body parts gets a little closer

June 24 2013, by Dr James Godwin

Credit: AI-generated image (disclaimer)

Damage to vital organs, the spinal cord, or limbs can have an enormous impact on our ability to move, function – and even live. But imagine if you could restore these tissues back to their original condition and go on with life as normal.

Well, this is the dream for regenerative medicine. And while humans missed out on these abilities in the evolutionary lottery, a recent study in mice shows we're making small progress to achieving this dream.

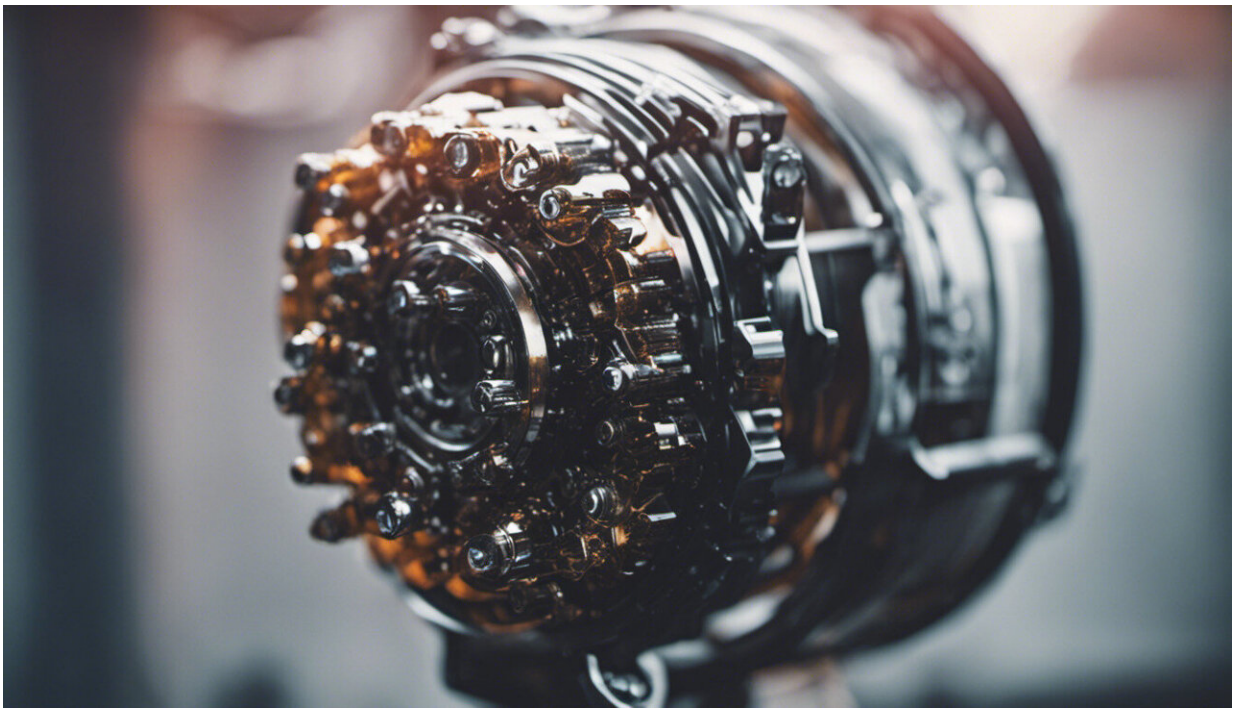
Learning from animals

Nature has provided the animal kingdom with many different ways to achieve perfect regeneration. Some amphibians – such as salamanders – are famous for their superhero-like ability to regenerate heart, brain, spinal cord, tail and can even whole limb tissue throughout their life.

Although organ and spinal cord regeneration are clinically important and worthy of intense research investment, regrowing whole limbs provides a flagship example of perfect regeneration in the salamander.

It has been known for more than a hundred years that if a salamander loses a limb, it grows right back. This process is extremely precise and removal of the limb at the shoulder regrows a full limb, but removal at the wrist only regrows the missing hand portion.

Interestingly, there does not seem to be a limit on how many times they can perform this clever trick and each time the limb comes back perfect.



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But mammals (including humans and mice) seem to have missed out on this important skill. The question of how to enhance the regenerative capabilities in humans, either by adding the missing ingredients, or activating these latent abilities currently lies wide open.

Extending regeneration to mammals

Mammals currently only have the capacity to regenerate the very tip of their finger. But the result is far from perfect. A range of studies in mice have shown the digit-tip regrowth is severely restricted. Removal of the very tip of the mouse digit will be replaced, but removal of the tissue a small distance further up the digit and closer to nail bed (the equivalent to a human cuticle), will fail to regrow.

Last week, a group of researchers from the United States and Japan published work extending our understanding of the mechanism by which a resident stem cell population within the mouse digit tip nail bed can be activated to induce digit tip regeneration. In other words, we can now grow more of the digit back in mice and possibly more of the human finger.

Resident stem cells are specialised cells found at various locations within the body. When activated, these cells multiply and then transform into other cell types required to replace worn out cells under conditions of normal tissue maintenance.

This work builds on previous studies identifying the stem cell population in the nail bed by unveiling a signalling mechanism that could be exploited to enhance the amount of tissue that could be regrown. The potential for repair after injury appears very limited in many tissues and organs. Understanding how to enhance stem cell activation in these tissues may stimulate repair not previously thought possible.

The ability to switch on and mobilise resident stem cells in regeneration will be important in a wide range of new therapies, particularity for organs affected by injury or disease. On a world stage, momentum is currently growing for these types of strategies. It is clear that once refined, these approaches are sure to have a profound influence on many different aspects of clinical medicine, opening up the possibility of replacing diseased or injured tissues.

We may be some way off from the dream of replacing whole limbs in humans but recent progress confirms that by deepening our understanding of stem cell activation, we can directly unlock more regeneration in mammals than normally possible.

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