

**Olivia Erlanger** What is regeneration?

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**Regeneration is the innate capacity of certain organisms and some body parts in some organisms to restore themselves after injury.**

OE What is human?

**AS** There are many answers to this question... **Biologically, we are the only surviving member of the hominin clade, an evolutionary branch of great apes.** But, we are also the only species we know of capable of formulating hypotheses and taking measurements at multiple scalar levels, from the subatomic (think Hadron supercollider), to the atomic and molecular levels (think genetics and molecular biology), all the way to the nearly infinitely large (think Hubble telescope). Personally, I think that if we are indeed endowed with these capacities that in the final analysis, **we humans are a way for life to know itself.**

OE What materials do you need to get the base scaffolding of an organ?

**AS** Mostly polymers. Natural scaffolds made out of biologically encoded molecules normally found in organs are collagen, actin, tubulin, fibronectin, glycosaminoglycans, proteoglycans, and a few others. These molecules share the property that they more often than not make chains of repeating units, i.e., polymers, against which cells in an organ rest upon

OE How do you design new body parts? What are the steps involved?

**AS** In nature, for those organisms that can regenerate limbs, even heads after loss or amputation, the process involves either the recruitment of endogenous stem cells or their generation from pre-existing differentiated cells to produce the building blocks required to reconstruct the missing part.

OE What do you believe is the future of transplants?

**AS** Because human organs for transplantation are in obvious limited supply, the future of transplants will involve the generation of organs from cells derived from the patient in vitro, i.e., artificially. **In other words, instead of having to have a donor and a host, i.e., two individuals, in order to perform transplantations, the aim is to have a single individual serve simultaneously as the donor and host.**

OE Are there ethical issues that regeneration brings up?

**AS** All human activities are eventually weighed against their repercussions with our existence. As a species, we seek order and therefore systematize not only the world and universe around us, but also human activities. We call this ethics, and therefore I see no reason why regeneration will not be eventually considered a topic for ethical deliberations. Whatever those issues will be will ultimately depend on what communities and societies will consider good or bad. Because full regeneration of missing human body parts such as a limb, for example, has yet to be experienced by individuals, regeneration has not extensively occupied the time of ethicists. **Moreover, because the instances in which regeneration has been experienced thus far by our species (liver regeneration, bone marrow transplants) have been compatible with the extension of life and the reduction of pain and suffering (things generally considered good by ethics), issues with regeneration proper have yet to be uncovered.** However, if experience and history are any indication, we humans are an

inventive bunch and it is possible to predict that, in due course, we will find an use for regeneration that may raise ethical concerns.

**OE** Is immortality possible?

**AS Yes, but not very probable.** Immortality of a biological system implies that the effects of time on the living physical entity have been mitigated to the point where either the components (proteins, DNA, RNA and the many other biomolecules) that make up living entities have been reduced to negligible levels or completely eliminated. Because all living organisms are exposed to chance and random events every second of their existence, the likelihood that such events may have consequences on the viability of the organism is rather high. As such, a hypothetically immortal organism would have to find a way to repair both the normal wear and tear of just living and the vicissitudes inflicted on the organism by external factors. **If this mitigation process involves the constant replacement of damaged body parts, a time will come when none of the original molecules composing the organism at its inception will be present, that is, when ALL of the original molecules would have been replaced. Which begs the question: Is such an organism the same or an entirely different one?** This is an intriguing thought experiment dating back to ancient Greece. Here is a quote from Plutarch I used in one of my articles:

“The ship wherein Theseus and the youth of Athens returned had thirty oars, and was preserved by the Athenians down even to the time of Demetrius Phalereus, for they took away the old planks as they decayed, putting in new and stronger timber in their place, insomuch that this ship became a standing example among the philosophers, for the logical question of things that grow; one side holding that the ship remained the same, and the other contending that it was not the same.”

Plutarch (c. 46 – 120 C.E.), 75 C.E.

**In other words, and at least for biological systems, immortality, does not equal immutability.**

**OE** What is your biggest hope for the future of organ regeneration and transplants and what is your biggest fear?

**AS My biggest hope is that both organ regeneration and transplants can reduce pain and suffering. My biggest fear is that if all physical pain and suffering is removed from the human experience that it may ultimately diminish the value and uniqueness of human life.**