

MIRACLE GROW

Three years ago, Lee Spievack, now 69, was helping a customer fix a radio-controlled model airplane at the Hobby Town USA store where he works in Cincinnati. While he was pointing to the airplane's engine and its spinning wooden propeller, Spievack's hand came too close to the propeller, which chopped off the end of his middle finger. "It was a very clean cut," Spievack told *Current Science*.

With the fingertip nowhere to be found, Spievack wrapped the stump of his bleeding finger in paper towels and rushed to a local hospital. Doctors there bandaged the wound and told him that in a few days they would shave a piece of skin from his leg and stitch it to the wound. The "new" skin would help heal what was left of the finger.



Lee Spievack (left) and his regrown middle finger (right). He lost the tip of the finger when a model airplane propeller cut it off.

Spievack's brother had other ideas. Alan Spievack was a surgeon in Boston and had been researching a whitish powder used to regrow tissues. He sent some of the powder to Lee, who put it on every other day until it ran out "I could see growth after two days," says Lee.

Within four months, the tip of Lee's finger had grown back completely - fingernail, fingerprint, and all. Medical science made Lee one of the first humans to possess the kind of power that only fictional characters like *Heroes'* Claire Bennet have.

MAGIC POWDER Lee wasn't sure what would happen when he started using the powder. Every other day, he sprinkled some of the powder on the open wound, then re-covered it with a bandage. The powder ran out after 10 days, but by that time the new tissue was clearly developing. "It was stark white," he says.

What was in that powder? And how did it prompt Lee's finger to grow a brand-new fingertip? The answers to those questions lie in the body's normal repair process. When the propeller lopped off Lee's fingertip, his body automatically launched an inflammatory response. That complex reaction usually involves the formation of a blood clot to stop bleeding. White blood cells then rush to the injured area to prevent infection. Special cells called fibroblasts dig into the clot and produce a mesh over the entire wound. The mesh gradually pulls the edges of the wound together. Eventually a scar forms.

The inflammatory response kicks in every time the body is injured - every time, that is, except during the first six months or so before birth. Something very different happens then.

Before birth, the body heals itself the same way a salamander does. If a salamander loses a leg, it regenerates (regrows) a brand-new one. A salamander can regenerate not only entire limbs, but also its tail and parts of its eyes and heart

In a human fetus, injury sparks regeneration rather than inflammation. "The fetus can completely regrow a limb, just like a salamander," explains Stephen Badylak, director of tissue engineering at the McGowan Institute for Regenerative Medicine in Pittsburgh.

At some point during the later part of pregnancy, however, the primary response to injury becomes inflammatory. "Something in the body turns off the regenerative response and turns on the inflammatory response," Badylak told *Current Science*.

THE MATRIX That something seems to be one or more chemicals found in the extracellular matrix (ECM). ECM is nonliving tissue that provides support for all living tissues throughout the body, among other functions. One of those other functions involves signaling the body to regenerate its tissues.

Badylak and other researchers are using a complex technique to remove the ECM from tissue in pigs. "We first take all the cells out of the tissue," explains Badylak. "Then we rinse out the inflammatory molecules, and all that's left is the regenerative matrix."

That regenerative matrix contains chemicals that tell the body precisely what kind of tissues to regrow. The powder Alan Spievack sent to his brother, Lee, was made up of ECM from a pig. "After a couple of days," recalls Lee, "I noticed that I smelled like a pig."

The smell didn't last long, but the growth did. Lee jokes that he might have a 69-year-old body, "but I have a 2-year-old finger."