Article

# TO HEAL A WOUND, TURN UP THE VOLTAGE

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ELECTRO ENERGETIC

It may sound like something out of Frankenstein, but electric currents applied to the skin could potentially speed up wound healing. Ironically, though the phenomenon was reported 150 years ago by the German physiologist Emil Du Bois-Reymond, it has been ignored ever since.

Now Josef Penninger of the Austrian Institute of Molecular Biotechnology in Vienna and Min Zhao of the University of Aberdeen, UK, have demonstrated that natural electric fields and currents in tissue play a vital role in orchestrating the wound-healing process by attracting repair cells to damaged areas.

The researchers have also identified the genes that control the process. “We were originally sceptical, but then we realised it was a real effect and looked for the genes responsible,” Penninger says. “It’s not homeopathy, it’s biophysics.”
Cells and tissues essentially function as chemical batteries, with positively charged potassium ions and negatively charged chloride ions flowing across membranes. This creates electric field patterns all over the body. When tissue is wounded this disrupts the battery, effectively short-circuiting it. Penninger and his colleagues realised that it is the resulting altered fields that attract and guide repair cells to the damaged area.

The researchers grew layers of mouse cells and larger tissues, such as corneas, in the lab. After “wounding” these tissues, they applied varying electric fields to them, and found they could accelerate or completely halt the healing process depending on the orientation and strength of the field (Nature, vol 442, p 457).

Next, they set about finding which genes were involved. They looked at those already known to make repair cells migrate under the influence of chemical growth factors and attractants, and found that their level of expression could be influenced by electric fields. “We have not reinvented the cells’ genetic migration machinery,” says Penninger. “We have simply shown that electric fields switch them on too.” The gene expression of several types of repair cells was affected, including neutrophils and fibroblasts.

They then focused on one particular gene known to prepare cells for migration, and another that halts the process. When the team knocked out the migration “promoter” gene, wounds exposed to electric fields healed more slowly. They healed faster when the migration “blocker” was knocked out.

The next stage is to investigate ways of manipulating the phenomenon to accelerate healing, says Mark Ferguson, a wound-healing specialist at the University of Manchester, UK. “For many years there have been anecdotal reports of the effects of electrical currents on wound healing,” he says. “This paper not only demonstrates the effects of electrical currents on cellular migration to wound defects, it also provides a mechanistic understanding of how such signals alter cell behaviour.”