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Traditional methods for controlling biological signals in cells are a sledgehammer: global, slow, and often non-specific. But, in a 2009 paper in *Nature,* Levskaya et al. describe a new technique to generate local, fast, and targeted cell signaling in live cells. They reported the first control of cell movement in real time using light-sensitive proteins!

The researchers genetically altered cells to contain plant proteins named Phytochromes, which detect red and near-infrared light. When exposed to red light Phytochromes bind to phytochrome interacting factor (PIF), when exposed to to infrared light they release PIF. Levskaya et al. added a membrane-localization domain to the Phytochrome, and attached a signaling protein to the PIF . The system works for any signalling proteins that are activated by interactions with the membran. When the scientist points a red laser, at the cell membrane, membrane-bound phytochromes bind to PIF, thus bringing the signaling proteins close to the membrane, and increasing their activity. Turning off the red laser frees the proteins and turns off the cellular signal.

To demonstrate the feasibility of this new technique, they performed three main experiments focussing on the signaling proteins Tiam and intersectin, which help organize actin cytoskeleton during cell movement. The first experiment showed that membrane recruitment of a small part of intersectin (ITSN-DH-PH) transiently increased local protein activity. and that this effect disappeared a few seconds after turning off the red laser. The second experiment showed that membrane recruitment of a part of Tiam (Tiam DH-PH domain) was sufficient to induce changes in the shape of NIH3T3 cells: When they illuminated the whole cell with red light for 20 minutes, almost 80% of cells made new lamellipodia (actin skeletal projections on the mobile edge of the cell) , compared with 10% of control cells. Even more interesting, in a third experiment they pointed a red laser dot on the edge of one cell and gradually moved it outward, slowly extending this red-targeted region from the cell body. They show in movies that they effectively guided the direction followed by the new lamellopodium-- thus controlling the movement of the cell!

ADD SHORT CONCLUSION WHAT ARE OTHER POTENTIAL APPLICATION OF THIS RESEARCH.