Robotic Scaffolds for Tissue Engineering and Organ Growth
Biocompatible and biodegradable smart scaffolds could reconfigure their shape and size to accommodate organ development.

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The aim of tissue engineering (TE) is to restore tissue and organ functions with minimal host rejection. TE is seen as a future solution to solve the crisis of donor organs for transplant, which faces a shortage expected only to increase in the future. In this innovation, a flexible and configurable scaffold has been conceived that mechanically stresses cells that are seeded on it, stimulating them to increased growth.

The influence of mechanical stress/loading on cell growth has been observed on all forms of cells. For example, for cartilages, studies in animals, tissue explants, and engineered tissue scaffolds have all shown that cartilage cells (chondrocytes) modify their extracellular matrix in response to loading. The chondrocyte EMC production response to dynamics of the physical environment (in vivo cartilage development) illustrates a clear benefit (better growth) when stressed. It has been shown that static and dynamic compression regulates PRG4 biosynthesis by cartilage explants.

Mechanical tissue stimulation is beneficial and (flexible) scaffolds with movable components, which are able to induce mechanical stimulation, offer advantages over the fixed, rigid scaffold design. In addition to improved cell growth from physical/mechanical stimulation, additional benefits include the ability to increase in size while preserving shape, or changing shape.

By making scaffolds flexible, allowing relative movement between their components, adding sensing (e.g., for detecting response of cells to drug release and to mechanical actions), building controls for drug release and movement, and building even simple algorithms for mapping sensing to action, these structures can actually be made into biocompatible and biodegradable robots. Treating them as robots is a perspective shift that may offer advantages in the design and exploitation of these structures of the future.

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Stress-Driven Selection of Novel Phenotypes
A methodology allows the experimental design of novel peptides and RNAs that have desired properties.

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A process has been developed that can confer novel properties, such as metal resistance, to a host bacterium. This same process can also be used to produce RNAs and peptides that have novel properties, such as the ability to bind particular compounds. It is inherent in the method that the peptide or RNA will behave as expected in the target organism. Plasmid-born mini-gene libraries coding for either a population of combinatorial peptides or stable, artificial RNAs carrying random inserts are produced. These libraries, which have no bias towards any biological function, are used to transform the organism of interest and to serve as an initial source of genetic variation for stress-driven evolution.

The transformed bacteria are propagated under selective pressure in order to obtain variants with the desired properties. The process is highly distinct from in vitro methods because the variants are selected in the context of the cell while it is experiencing stress. Hence, the selected peptide or RNA will, by definition, work as expected in the target cell as the cell adapts to its presence during the selection process. Once the novel gene, which produces the sought phenotype, is obtained, it can be transferred to the main genome to increase the genetic stability in the organism. Alternatively, the cell line can be used to produce novel RNAs or peptides with selectable properties in large quantity for separate purposes. The system allows for easy, large-scale purification of the RNAs or peptide products.