

[Sylwester Gogolewski](#), [Polymer Research, AO Research Institute, Davos, CH](#)

INTRODUCTION: Infection, tumour resection, trauma and ageing often lead to the loss of tissues and internal organs. The number of patients who suffer from these problems is increasing while the availability of autogenous tissues for transplantation remains limited. Annual healthcare costs associated with these problems exceed 400 billion dollars in the USA alone.

Genetic engineering may offer a possible solution to this problem. This is, however, still at the exploratory stage and some time may pass before it gains common clinical acceptance.

Yet another solution might be the use of structural tissue scaffolds instead of autogenous tissues. Optimally, such scaffolds implanted in place of resected or defective tissues and organs should induce their healing and/or regeneration. This, however, would only be feasible if the scaffold's biological properties approximate those of autogenous tissues. This is not yet the case for state-of-the art biomaterials technology. Therefore, the scaffold's regenerative potential needs to be enhanced, for example, by loading it with autogenous and/or synthetic growth factors or by seeding it with cells, the latter being commonly called "tissue engineering".

Structural scaffolds can function in many ways. They can fill defects, substitute tissues and organs, support attachment and proliferation of cells, enhance tissue healing, initiate regeneration, release drugs or genes.

The form and structure of the scaffold may resemble the structure and form of the tissue or organ it is intended to substitute. Thus, scaffolds used as artificial skin, artificial pericardium or periosteum would take a form of a flat microporous membrane. Scaffolds for the substitution of blood vessels or nerve regeneration would be tubular in shape, while three-dimensional spongy structures are preferred for bone substitutes and repair of articular cartilage.

Structural tissue scaffold should be biocompatible, preferably bioresorbable and porous. The scaffold's material should resorb at the required time dependent on its function. The pore structure should be interconnected allowing for a flux of nutrients, ingrowth of cells, blood

vessels and tissues. The size of pores having a significant impact on the scaffold biological functionality will depend on the intended application, i.e. there is no one "universal" pore size which suits all types of tissues to be substituted.

Materials which have found an established place in the design of tissue repair and replacement implants are primarily homopolymers of lactides and glycolide, copolymers of these monomers and copolymers based on lactides or glycolide with ϵ -caprolactone, trimethylene carbonate or tyrosine carbonate.

Poly(hydroxybutyrate), poly(hydroxybutyrate-co-valerate), polyorthoesters, polyesteramides, and poly(propylene fumarate)-based materials can also find applications in implantable devices for tissue repair and regeneration.

Various tissues and internal organs have successfully been repaired using structural microporous scaffolds from bioresorbable polymers.

An "artificial skin" from microporous biodegradable polyurethanes promotes healing of full-thickness skin wounds. Tubular implants that form primary scaffolding for oriented migration of fibroblasts, Schwann cells and regenerating axons, facilitate healing of large defects in the sciatic nerve. Microporous 3-D scaffolds enhance the regeneration of critical size segmental long bone defects and mono-, bi- and tricortical defects in the ilium. The biodegradable elastomeric microporous vascular prostheses used to replace resected long segments of arteries in growing animals induce regeneration of a neo-artery. The cellular structure, mechanical and biological properties of the neo-artery resemble those of the native artery. Critically selected bioresorbable polymers are materials of choice for tissue repair and regeneration implants.