

# A smart bilayer scaffold of elastin-like recombinamer and collagen for soft tissue engineering

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**Abstract** Elastin-like recombinamers (ELRs) are smart, protein-based polymers designed with desired peptide sequences using recombinant DNA technology. The aim of the present study was to produce improved tissue engineering scaffolds from collagen and an elastin-like protein tailored to contain the cell adhesion peptide RGD, and to investigate the structural and mechanical capacities of the resulting scaffolds (foams, fibers and foam-fiber bilayer scaffolds). The results of the scanning electron microscopy, mercury porosimetry and mechanical testing indicated that incorporation of ELR into the scaffolds improved the uniformity and continuity of the pore network, decreased the pore size (from 200 to 20  $\mu\text{m}$ ) and the fiber diameter (from 1.179  $\mu\text{m}$  to 306 nm), broadened the pore size distribution (from 70–200 to 4–200  $\mu\text{m}$ ) and increased their flexibility (from 0.007 to 0.011  $\text{kPa}^{-1}$ ). Culture of human fibroblasts and epithelial cells in ELR-collagen scaffolds

showed the positive contribution of ELR on proliferation of both types of cells.

## 1 Introduction

Materials science has begun to take advantage of the power of new techniques in molecular biology and genetic engineering such as recombinant DNA technology, which allows the introduction of a gene in the genetic content of a microorganism, plant or other eukaryotic organisms and induce the production of its encoded protein-based polymer as a recombinant protein [1]. These kinds of macromolecules are being generically named as “recombinamers” [2]. This technology is superior to any other polymer synthesis technology in terms of the control, complexity and fine-tuning possibility that it offers. Using this technology, it is possible to bioengineer protein-based polymers (PBPs) of more complex and well-defined structure. Elastin-like recombinamers (ELRs) form a subclass of these biocompatible PBPs. They are composed of the pentapeptide repeat Val-Pro-Gly-Xaa-Gly (VPGXG), which is derived from the hydrophobic domain of tropoelastin and where X represents any natural or modified amino acid, except proline [3].

ELRs have been used as coatings [4] and films [5] for improved cell attachment, as hydrogels to promote chondrogenesis [6–8] or as polymer injections [9, 10]. They could also be shaped into fibers in pure form [11]. The first ELR candidates for tissue engineering applications were simple polymers, to which the cells did not attach. Soon after, they were enriched with short peptides having specific bioactivity [1]. Recently, a scaffold containing an ELR with substrate amino acids for mTGase, recognition sequences for endothelial cell adhesion (REDV), elastic mechanical behavior (VPGIG), and for targeting of specific

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