2.79J/3.96J/BEH.441/HST522J

Biomaterials - Tissue Interactions

Homework #8

New hypothetical mechanism for tissue regeneration by a collagen-GAG scaffold

It has recently been observed that TGFβ1 binds extensively on the large surface of a highly porous collagen-GAG scaffold. It will be assumed that bound TGFb1 is unavailable for regulation of cell function and that only unbound, or "free", TGFb1 is involved in cell regulation. You are a researcher exploring the consequences of this new finding with the objective of using this fact in the design of new biomaterials-based approaches to regeneration.

A. The researcher is familiar with data ("contraction-blocking data") showing that collagen-GAG scaffolds block wound contraction most effectively when the average pore size lies between approximately 20 and 140 μm. See Fig. 1. Having conducted preliminary studies you have found out that the mass of bound TGFβ1, **m**, is directly proportional to the specific surface, **σ**, of a series of scaffolds.

$$\mathbf{m = C\sigma}$$

where **C** is a constant of proportionality. The specific surface, **σ**, of scaffolds is known to depend on the pore size, **d**, by the following relation (Gibson and Ashby, 1997):

$$\mathbf{\sigma = K/d}$$

where **K** is a constant of proportionality. Write the relation between the mass of bound TGFβ1, **m,** and the average pore size, **d,** of a series of scaffolds.

B. Collagen-GAG scaffolds degrade during implantation. Set up and solve a linear differential equation with one or more constant coefficients which can be used as a model to describe the decay of the mass of bound TGFb1, **m**, with time of implantation. Assume that the mass of bound TGFb1, **m**, is directly proportional to **M,** the total scaffold mass**.**

C. Describe briefly the hypothetical role that extensive binding of TGFβ1 on the scaffold surface plays in scaffold- induced organ regeneration. Describe one or a small number of measurements, conducted in vivo, that could be used to test the validity of such a mechanism.

D. Study the "contraction-blocking data" in Fig. 1. Can the entire set of these data be explained by the relation you have derived above between **m** and **d**? Explain briefly.

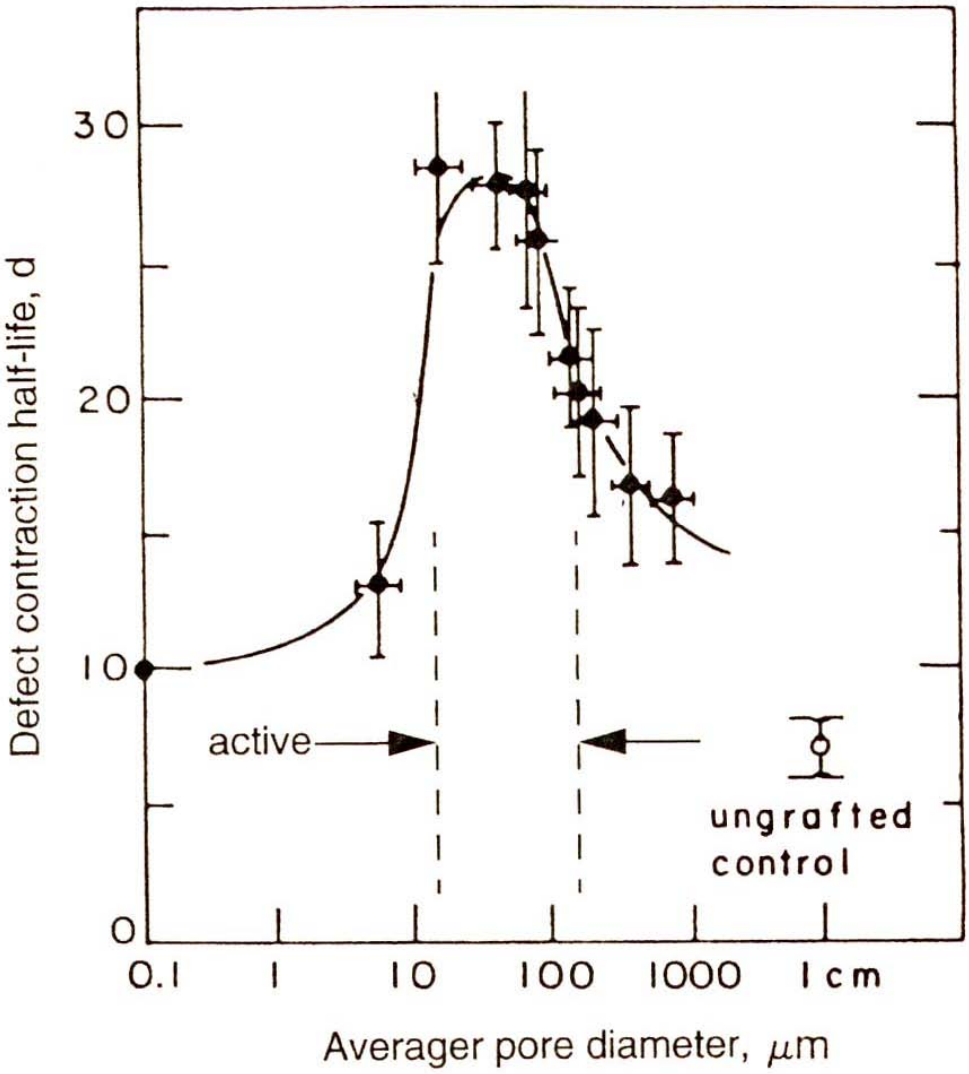

Figure 1: Yannas et al. 1989

Source: Yannas, I., et al. "Synthesis and Characterization of a Model Extracellular Matrix that Induces Partial Regeneration of Adult Mammalian Skin." *PNAS* 86 (1989): 933-937.

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