Biomaterials – Tissue Interactions

Homework #8

You have been hired by a start-up company to assist in identifying applications for their new biomaterial (Vitafilm) that is a thin sheet (approximately 1 mm thick) of a polymer to which laminin/type IV collagen or fibronectin can be bonded. The polymer film can be made to be porous or nonporous and nonabsorbable or absorbable, and it can be applied as a coating to metal.

Vitafilm can be wrapped on a mandrel to form a tube. It can also be rolled to form a cylinder or stacked in layers and bonded to form a thicker sheet up to 1 cm in thickness.

Production of the nonporous, nonabsorbable film is the least costly process. There is added expense in modifying the polymer to be absorbable, introducing porosity, and applying the type IV/laminin and fibronectin surfaces. You should consider the cost of manufacturing the various forms of Vitafilm in deciding which type would be best for a particular application. In determining which form of Vitafilm would be best for an indication, state whether you would use the (1) nonabsorbable or absorbable,
(2) nonporous or porous, and (3) coated or noncoated (and which protein formulation). If you choose the porous form give some indication of pore size, and for the absorbable form note how long the time period for degradation should be. Explain your rationale for your selection in each case.

a) One of the other engineers in your group has told your boss that Vitafilm would be of no value in the fabrication of total joint replacement prostheses. Can you propose a configuration in which it could be used as a bone attachment vehicle for the femoral stem of a total hip replacement prosthesis?

b) As a second application for a joint replacement prosthesis, in what form would you propose that it be used to replace the polyethylene components? What would be the principal issues to be addressed for this application?

c) How would you propose to use Vitafilm for the regeneration of articular cartilage?

d) One application suggested for Vitafilm is treatment of shallow, partial thickness skin wounds. Which variation of the product would you use?

e) For deep full thickness skin wounds would there be value in employing a second form of Vitafilm in addition to the product you proposed in (d)?

f) What type of tubular device would you suggest be investigated for treatment of a segmental defect in a large diameter blood vessel blood vessel (*e.g.*, about 15 mm in diameter)?

g) If the device that you proposed for (f) is now to be considered also for replacement of a small diameter vessel (4 mm in diameter), would it be necessary to add cells or regulators to the Vitafilm prior to implantation? If so, which?