Module 10: Biomaterials and Host Integration

Assignment

Total Point Value = 30

Due by midnight on Day 7 of Module 10

This should be submitted to Blackboard as a pdf.

1. The company Baxter received approval for its Fibrin Sealant (Tisseel®) in July, 2000 for application in surgical procedures. Features of this produce can be found at the website (http://tisseel.com/us/index.html). This material is being evaluated for a number of tissue engineering applications. Consider its use as a possible material in which to deliver tendon cells to a defect between bone and avulsed tendon. With regard to this prospective biomaterial application, please answer the following questions. Remember to give references when appropriate.
    a. What type of biomaterial is Tisseel® and what are its components?

    Sealer Protein Solution:

Total protein:	96-125 mg/mL
Fibrinogen:	67-106 mg/mL
Aprotinin:	2250-3750 KIU/mL

    Thrombin Solution:

Thrombin (Human):	400-625 units/mL
$CaCl_2$:	36-44 umol/mL

    http://www.baxterpi.com/pi-pdf/Tisseel_PI.pdf

    b. What reaction does Tisseel® undergo to form a sealant?

    Tisseel undergoes a polymerization reaction. Fibrinogen is converted into fibrin monomers, which aggregate to form a gel. Thrombin transforms Factor XIII to Factor XIIIa in the presence of calcium ions. Factor XIIIa crosslinks the aggregated fibrin monomers to a high molecular weight polymer.

    c. How quickly does Tisseel® degrade?

    Tisseel degrades when plasmin cleaves the polymerized fibrin into fibrin monomers. This takes 10-14 days in the body. Aprotinin is a protease inhibitor but instead of inhibiting this it is cleared by the kidney in ~30min-60min. The shelf-life of the product is 2years at 8degC.

    d. What surface properties would be desirable for such an application? Does the product have such properties?

    Rapid protein adsorption and adhesion, geometrically consistent with natural tendon structure, stimulates cell migration and proliferation, bacterial resistance

    e. What bulk properties would be desirable for such an application? Does the product have such properties?

    Elastic, high tensile strength, modulus similar to normal tissue, homogeneous, large pores for cell migration.

2. In lecture 1 we discuss the use of lithographic methods for tailoring biomaterials at the cellular level. Please briefly describe one technique each for tailoring biomaterials at the subcellular and supracellular length scales. 2-3 sentences each MAX.

    There are many answers to the question. Some possibilities include:

    Subcellular

    Peptide protein grafting, Molecular imprinting

    Supracellular

    Solvent casting, extrusion, insoluble gradients, Rapid prototyping

3. Name the immunomodulatory strategy based on the description:
    a. Encapsulation of cells with semipermeable material

    Physical Immunoisolation

    b. Blocking co-stimulators of T-cell activation

Tolerance induction

c. Use of corticosteroids
Pharmacological treatment

d. Forced expression of human proteins in xenograft cells
Genetic modification

References:
Question 1 adapted from *Tissue Engineering, Palsson and Bhatia*

Assignment Rubric

Question	Component	Total Point Value
1	a	2
	b	2
	C	2
	D	2
	E	2
2	Subcellular	6
	supracellular	6
3	A	2
	B	2
	C	2
	D	2

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