Module 12/13: Tissue Engineered Products

Assignment

Total Point Value = 30

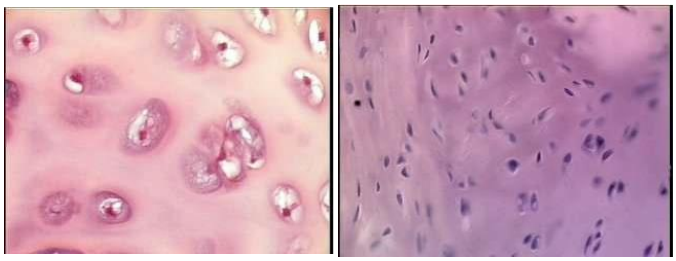
Due by midnight on Day 7 of Module 13

This should be submitted to Blackboard as a pdf.

1. Please answer the case study questions (a), (b) and (c) on page 436-437 in your textbook, *Tissue Engineering* by Saltzman.

   a. Describe the differences between hyaline cartilage and fibrocartilage. Histologically, what do these two types of tissue look like (that is, describe the cellular and extracellular features of each)?

   Hyaline cartilage is most commonly associated with articular hyaline cartilage – the cartilage that covers articulating bone surfaces and synovial joints. It is also located in tissues including the ear, nose and trachea. The function of this cartilage is to reduce friction and absorb shock. It is composed mainly large collagen fibers with an even distribution of chondrocytes and lacunae. Unlike hyaline cartilage, fibrocartilage contains a dense array of thin collagen fibers and appears non-uniform with spaces between lacunae. It is also a shock absorbing tissue and is located between intervertebral disks.



Hyaline Cartilage Fibrocartilage

   b. What features of the local site of repair would you expect to influence the outcome towards either of these endpoints? This study reports that half of the patients with femoral condyle defects showed only production of hyaline cartilage, which was the desired outcome. The other half had either a mixture of fibro and hyaline cartilage or only fibrocartilage. There are many factors of the repair site that could influence the outcome of hyaline vs fibrocartilage production after the Carticel procedure. These include the type and degree of the defect; the amount of tissue removed by the surgeons or the location of that tissue (together or in separated locations). One may hypothesize that a large, contiguous injury site may make it harder to get highly aligned collagen fibers as is seen in hyaline cartilage. Articular cartilage wraps around the femoral head, with some of it experiencing mechanical loading even when the joint is isolated. This makes location of the injury site can change the mechanical cues experienced by the Carticel treatment, again with a potential to influence the outcome.

   c. Are there any elements that you could add to the cell suspension that is injected into the defect site, or to the surgical procedure used to deploy the cells, to increase the probability of the most desirable outcome? With one of the main difference being the size and arrangement of collagen fibers it would

be desirable to alter the cell solution and/or procedure to foster the larger, aligned microenvironment of hyaline cartilage. Large collagen fibers could be injected with the chondrocytes as one option. Another option is to inject the cells into a collagen matrix that is already in place. Other elements that could be added were discussed by Dr. Khan – factors that specifically promote formation of cartilage matrix or uniquely regulate differentiation and/or recruitment of needed cells.

2. We explored cell and organ printing as strategies to support the fabrication of artificial tissues and organs. (A) Discuss the feasibility of using cell and organ printing to support the fabrication of an artificial liver. (B) Describe the advantages and disadvantages of using this technology in liver tissue engineering. (C) Develop a strategy to implement cell and organ printing to support artificial liver fabrication. (Reference: Ravi Birla. *Introduction of Tissue Engineering*. Wiley, 2014, p. 316)
    a. Cell and organ printing strategies have been investigated to fabricate 3D tissues and organs such as kidneys, liver tissue, etc. Although feasibility has been demonstrated through successful proof of concept studies, fabrication of multicellular functioning tissues have not been demonstrated. Additionally, capital equipment to conduct and to study organ printing is quite high in cost and limits widespread use of this technology.
    b. The advantage of using this technology for tissue fabrication is the creation of tissue/organs that are patient specific (size, shape, autologous cells). Cell and organ printing has the ability to place cells in relation to other cells or ECM proteins. Currently, the disadvantages to using this technology are ensuring the cells are not damaged during the transfer process, ensuring the cells adhere to the surface in which printing is taking place as well as ensuring that cells adhere to each other to form 3D structures and functional tissues.
    c. There are several ways to approach this question. The strategy should include harvesting of cells to use in cell and organ printing strategy. The delivery of hepatocytes to surface (scaffold or scaffold-free technology), the use bioreactors to support the metabolic demands of liver tissue and vascularization. The discussion can also include experimental tests that can be conducted to ensure the tissue/organ is functioning prior to implantation and/or ensure cell and organ printing strategy was successful. Finally, a statement on the construct that will be implanted should be provided.

Assignment Rubric

Question	Component	Total Point Value
1	A	5
	B	5
	C	5
2	A	5
	B	5
	C	5

Total Point Value = 30