

National Exams May 2012

04-Bio-B5, Cell and Tissue Engineering

3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
2. This is a CLOSED BOOK EXAM.
A Casio or Sharp approved calculator is permitted. Candidates are allowed to bring ONE aid sheet 8.5" x 11" hand-written on both sides containing notes and formulae.
3. FIVE (5) questions constitute a complete exam paper.
The first five questions as they appear in the answer book will be marked.
4. Each question is of equal value.
5. Most questions require an answer in essay format. Clarity and organization of the answer are important.

Question 1:

You are employed by a company who has recently discovered a novel peptide system that seems to have cell adhesive properties. Your company is currently in the process of patenting this invention as they see significant potential for using it in tissue engineering applications. One of the scientists has suggested that the patent be targeted to a specific application and after lengthy discussions, it has been decided that the liver will be the target tissue. You have been placed on a team to research the issues surrounding the development of artificial liver substitutes. There are several issues that will need to be addressed. Your team will need to make a presentation to the company's board of directors to discuss your findings and make a recommendation for the purposes of patenting and future development. What are the issues that will need to be addressed in moving this system forward?

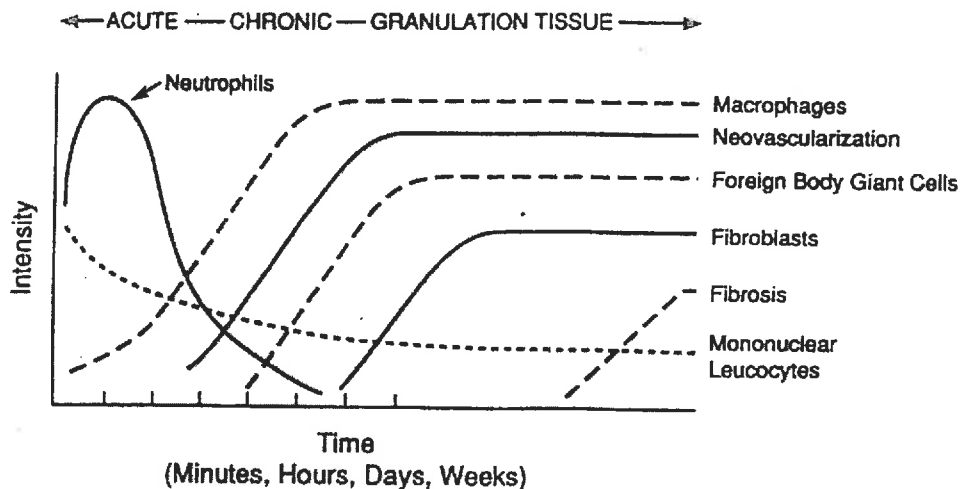
Question 2:

Tissue engineered constructs have been developed or are under development for a number of tissues (skin, cartilage, bone) and organs (heart, liver, kidney). It has been stated that the construct should contain appropriate components to mimic the functions of the native tissue.

- a) Related to tissue engineering of bone and the design components, discuss which models have been used and how these can lead to a construct which can mimic the function of native bone.
- b) Explain three mechanisms in which biomaterials might affect adaptive immune responses such as to tissue-engineered constructs.

Question 3:

What is the relevance of the following figure to the field of tissue engineering? Are there issues to which tissue engineers should pay particular attention?



Question 4:

You have created a tissue-engineered construct out using collagen. You wish to populate the scaffold with cells and are hoping that the cells will remodel the collagen scaffold to form their own extracellular matrix proteins.

- a) What would be the effect of:
 - i) Adding fibronectin to the construct.
 - ii) Adding hyaluronic acid to the construct
 - iii) Adding elastin to the construct.
- b) What other systems might you add to your tissue engineered construct to improve its performance? Be specific and state the expected effects. If appropriate, provide additional details about a possible system.

Question 5:

You have been hired by Health Canada as a consultant to assess tissue engineered constructs and to suggest regulations for this new class of devices.

- a) Define what products would fall under this designation.
- b) Identify the major safety issues that must be considered when Health Canada is deciding whether to approve these constructs.
- c) Propose a series of tests that could be used to ensure the risks to recipients are minimized. Discuss the effect of the application on these tests.

Question 6:

In the development of a tissue engineered device, various factors play a role. Choose a potential soft tissue that may benefit from treatment using a tissue engineered construct and state clearly what tissue you are considering.

- a) Building on what you have learned, you break the problem down. What information about the tissue will you want to learn prior to undertaking this project?
- b) Are there models for other tissues that would help as the basis of decisions.
- c) Discuss the importance of mechanical properties. Based on what you have learned about the cornea, propose a structure for your tissue engineered skin that is based on a collagen scaffold. Discuss which components that you might add to your system and justify your choices based on your previous knowledge. Consider such aspects as the mechanical properties of the system and how it might interact with the cellular components.
- d) Discuss the pros and cons of using stem cells as the cell source in your tissue engineered scaffold. Discuss the pros and cons of this plan.