Practice Quiz #2 Questions: Answers

Following are brief notes that could be expanded for the answers. Other answers could be acceptable based on the explanations. There was no need to provide a detailed description of the chemical composition of the scaffold for the specific applications, but this were acceptable.

1. Cardiovascular Applications.
   As a result of her own coronary bypass, the CEO has been motivated to develop a construct that could be adapted to a variety of cardiovascular applications. Her idea is to seed a single sheet of a scaffold with cells and then to: (1) roll up the sheet to form a tube for use as a coronary artery; (2) cut out pieces of the sheet to apply to a heart valve frame; and (3) cut pieces of the sheet to use as patches for the treatment of myocardial infarcts.
   a. Which cell type(s) would you propose if the initial application is the coronary artery?
      The 3 layers of the normal vessel are: endothelium, smooth muscle, and connective tissue. One could propose seeding one side of a porous, absorbable sheet with endothelial cells and the other side with smooth muscle cells, expecting that because fibroblasts/fibrous tissue is so ubiquitous it would eventually encapsulate the vessel. If proposing that all 3 cell types are to be seeded at the same time (mixed), one needs to make some mention of the likelihood that the cells will self-aggregate and segregate into the 3 tissue layers.

   b. Would there be any benefit to implanting the tube, which is to be used for engineering a coronary artery, first in another tissue site?
      Yes, if the tube is seeded with endothelial and smooth muscle cells, implantation in another site would provide the opportunity for the vessel to become surrounded by connective tissue. If noting that this allows for “maturation” of the vessel, some description is needed of what maturation refers to.

   c. Would it be likely that this construct would be effective for use for the heart valve and as a patch for the myocardial infarct?
      If the sheet is made up of layers of endothelium and smooth muscle, one might propose that it could fill a defect in the valve or serve as patch for the inner surface of the heart, but the latter is unlikely because the smooth muscle will not substitute for the function of cardiac muscle.

   d. If you could produce a construct (single sheet) specifically to be used to treat the myocardial infarct, how would you proceed? Include mention of any methods that you would use to treat/condition the cell-seeded construct in vitro, before its implantation.
Seed neonatal cardiomyocytes into the porous, absorbable sheet, and expose the construct to cyclic tension or electrical stimulation.

e. In considering the use of cells alone for treatment of myocardial infarcts, it has been proposed that marrow-derived mesenchymal stem cells be used because they can be shown to differentiate to cardiac cells in vitro. If there is a benefit to their use in vivo, would you expect that it is due only to their differentiation into cardiomyocytes in the patient? A benefit of the MSCs might be to release regulatory molecules that affect the host cardiac cells.

2. Marrow-Derived Mesenchymal Stem Cells (MSCs) for treating Defects in Meniscus and Articular Cartilage.
   a. A recent press release from a company which processes MSCs indicates that injection of the cells into a joint in which there is a torn meniscus may be of benefit. What traits of MSCs would explain their benefit in this application?
      The principal trait of the MSCs for this application is their homing (migration) to the defect (site of injury). Once they get there they may differentiate into meniscal cells or release regulatory molecules.

   b. Many patients who present with a defect in articular cartilage of the knee joint also have a defect in the underlying bone. Which technologies would you use together to produce an implant for the treatment of such defects?
      A porous, absorbable scaffold could be implanted into the osteochondral defect. Marrow-derived cells infiltrating the pores may undergo osteogenic differentiation in the bone region of the implant, and the conditions in the superficial zone may induce cartilage differentiation of the cells. Additionally, selected cells or growth factors, to facilitate bone and cartilage formation, could be added to the scaffold.