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Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)



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VII SEMESTER B.TECH (BIOMEDICAL ENGINEERING) END SEMESTER EXAMINATIONS, NOV/DEC 2015

SUBJECT: TISUUE ENGINEERING [BME431]

REVISED CREDIT SYSTEM Tuesday, December 1st, 2015: 2pm-5pm

Time: 3 Hours

MAX. MARKS: 100

Instructions to Candidates:

✤ Answer ANY FIVE FULL questions

- **1A.** Discuss the different classes of epithelial tissues and their functions.
- 1B. State clearly the principles associated with the following sterilization methods:
 (i) Gamma ray sterilization, (ii) ethylene oxide sterilization, (iii) moist heat sterilization.
- **1C.** A bioengineer is asked to extract collagen for the fabrication of a composite **g** matrix (for designing a femoral prosthesis).

(i) Compare the steps involved in the isolation of soluble and insoluble collagens.

(ii) After isolation, which one would be suitable for the fabrication of the composite matrix?

(iii) How can you sterilize both the isolated collagens and matrices?

Explain with proper reasons.

2A. Explain the impact of sterilization on the following polymers:

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(i) polymethyl-metha acrylate (melting point 130°C) (by dry heat),

- (ii) polyamide (melting point 200°C) (by dry heat),
- (iii) polyamide (by moist heat)
- (iv) polyolefin (exposure 10⁶) (by gamma rays)
- 2B. Explain the developmental fate map associated with the cardiovascular 7 system.

2C. Discuss briefly, the role of the following in cellular signaling:

(i) Ligand, (ii) secondary messenger, (iii) transcription factor, (iv) transcription, and (v) translation.

- 3A. Following are the cells involved in cellular signaling in bones:
 (i) Osteocyte, (ii) lining cell, (iii) osteoblast, and (iv) osteoclast.
 Establish the interdependence among these cells with the factors regulating the signaling paradigm. Map the BMP regulated cell signaling pathways for bone formation (state clearly the role of each component).
- **3B.** What is 'integrin'? How does integrin regulate 'outside-in' and 'inside-out' **4** signaling (Be specific with the answer).
- 3C. Discuss the steps involved in the isolation of human embryonic stem cells (IVF Process). How would you evaluate the regenerative potentials of both the isolated human embryonic stem cells and human hematopoietic stem cells (isolated from placenta) by *in vivo* process?
- 4A. Chitosan is a biopolymer extracted from waste materials (exoskeleton of prawn). How would you use chitosan to fabricate interconnected porous scaffolds? Write down your strategies in brief and logical manner.
- **4B.** Discuss the major components of cartilage, and explain why cartilage has **6** limited capacity to get repaired.



The graph indicates the swelling indices for the un-crosslinked and crosslinked gelatin matrices. Analyze, based on the graph, the matrix you would prefer for designing (i) temporary scaffold, and (ii) carriers for sustained drug delivery.

5A. State the roles of polycomb group protein and G1 phase regulators for **6** regulating the self renewal of mesenchymal stem cells.

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5B. You have harvested chondrocyte, hepatocyte and osteocytes from a human **9** subject (primary culture). How would you:

(i) Select specifically chondrocyte from the heterogenous population (ii) convert them to cell line,

(iii) Comment on whether FACS study could be appropriate for selecting the above cells. After selection, how would you maintain and preserve these cells? In this context, analyze the roles of dimethyl sulfoxide and polyethylene glycol for cell preservation.

5C. You are asked to fabricate freeze-dried hydrogels to manage the articular cartilage defect for an osteoarthritis patient, using the following polymers: polyvinyl alcohol, hyaluronic acid, collage, chitosan.

Assess the pros and cons of using each of these polymers. Is any polymer more suitable than the rest? Indicate the significance of using the above polymers for managing cartilage defect. Assess your strategy for the fabrication to make cost effective and compatible matrices.

- **6A.** Highlight the significance of using growth factors in scaffolds for tissue engineering application. Mention the ligands and receptors involved in the PDGF signaling network.
- **6B.** (i) Overexpression of VEGF can cause vascular damages in diabetic **16** retinopathy and cancer. Justify the statement and suggest remedial measures.
 - (ii) In the superficial and transzonal region of an articular cartilage, collagen fibers are horizontally oriented. Indicate the significance of such orientation.
 - (iii) Justify how ALP facilitates mineralization of bone cells.
 - (iv) Do bone allografts subjected to lyophillization followed by sterilization, have any impact on osteoinductivity of the graft? Justify your answer.