TISSUE ENGINEERING
(BIOT 4242)

Time Allotted : 2½ hrs **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) Hydrogel forming natural polymers includes both proteins and _____
(a) Polysaccharides (b) DNA (c) Lipids (d) Nucleic acids.

(ii) _____ family of ceramics is widely used for bone defects.
(a) Calcium phosphate (b) Calcium oxide
(c) Calcium carbonate (d) Calcium bicarbonate

(iii) _____ are the most widely used stem cell source for articular cartilage regeneration technique.
(a) Mesenchymal Stem Cells (b) Induced Pluripotent cells
(c) Adult stem cells (d) Inner cell mass

(iv) Protein kinases and phosphatases act by altering _____ of the signaling proteins.
(a) basicity (b) conformation (c) acidity (d) size

(v) _____ are the favourite cell type in tissue engineering as they don't evoke an immune response.
(a) Autologous cells (b) Heterogeneous cells
(c) Differentiated stem cells (d) Fibroblasts

(vi) Which of the following role is played by agitation in bioreactor?
(a) Increase oxygen rate transfer by diminishing size of air bubbles
(b) Prevention of sedimentation
(c) Proper distribution of nutrients to cell
(d) All of these.

(vii) One scaffold fabrication technique is solid free forming and it is used for
(a) 3D scaffold (b) 2D scaffold
(c) nano-patterned scaffold (d) microscaffold.

(viii) The possible contribution of computational fluid dynamic modelling to the development of a bioreactor system.
(a) Prediction of patterns of shear stress
(b) Prediction of local profiles of oxygen consumption
(c) Prediction of efficiency of glucose utilization
(d) Both (a) and (c).

(ix) Static culture systems may be unsuitable for thick TE constructs because
(a) cells will not attach
(b) preferential flow paths might develop
(c) diffusion limitations result in nutrient and oxygen deprivation in central regions
(d) none of the above.

(x) Albumenised surface is used to improve
(a) tissue compatibility (b) mechanical properties
(c) blood compatibility (d) contour.

Fill in the blanks with the correct word

(xi) The Inner Cell Mass of the embryo is rich in _____ stem cells.

(xii) _____ is a protein that helps in maintaining the structural integrity of most of the connective tissues in animals.

(xiii) _____ is a Poly (lactic acid-co-glycolic acid) based skin product available commercially.

(xiv) *In vivo* complete degradation of an ECM scaffold occurs within _____ days.

(xv) Name of the mouse created with human ear developed in its back _____.

Group - B

2. (a) Discuss the various steps in the embryonic development of peripheral nerve tissue. *[(CO1)(Remember/LOCQ)]*
(b) Give an overview of the different phases of skin wound healing. *[(CO2)(Remember/LOCQ)]*
(c) Analyse with reasons why decellularization is a very important step in preparation of ECM scaffolds. *[(CO1)(Analyse/IOCQ)]*

4 + 4 + 4 = 12

3. (a) Discuss the role of integrins in cell signalling pathways. *[(CO2)(Analyse/IOCQ)]*
(b) Highlight the major molecular events involved in a hypothetical signal transduction. *[(CO2)(Analyse/HOCQ)]*
(c) Give an overview of cell signalling pathways involved in bone tissue engineering. *[(CO2)(Remember/LOCQ)]*

4 + 4 + 4 = 12

Group - C

4. (a) How collagens interact with cells? *[(CO3)(Analyse/IOCQ)]*
   (b) What are the advantages of Rapid Prototyping technique over the other scaffold fabrication techniques? *[(CO3)(Analyse/HOCQ)]*
   (c) What is ECM? Why do all multicellular animals have ECM? What are the different components of ECM, describe with diagram? *[(CO2)(Analyze/IOCQ)]*

3 + 3 + (1 + 1 + 4) = 12

5. (a) Explain in detail the role of alginate in tissue engineering. *[(CO3)(Explain/IOCQ)]*
   (b) Give five examples in human system, where cell migration occurs. Mentioned five different *in vivo* techniques name by which you will detect cell migration. *[(CO3)(Understand/IOCQ)]*
   (c) Describe the properties of two synthetic biodegradable polymers. *[(CO3)(Remember/IOCQ)]*

4 + (2 + 2) + (2 + 2) = 12

Group - D

6. (a) (i) Write the names of three different techniques for preservation of cells or tissue. (ii) Describe any one of the cell preservation techniques that you mentioned. *[(CO4)(Remember/LOCQ)]*
   (b) What type of bioreactors are used for Tissue Engineering (TE)? Differentiate between fixed bed and fluidized bed bioreactors. *[(CO4)(Analyze/IOCQ)]*
   (c) What is stem cell niche? *[(CO4)(Remember/IOCQ)]*

(2 + 4) + (1 + 4) + 1 = 12

7. (a) What are the different types of stem cells present according to their source? Describe properties of any one type of stem cells. *[(CO4)(Remember/IOCQ)]*
   (b) Which type of stem cells are used in TE and why? *[(CO4)(Understand/IOCQ)]*
   (c) What is 3-D culture? How 3-D culture helps in TE? *[(CO4)(Understand/IOCQ)]*

(2 + 3) + (1 + 2) + (1 + 3) = 12

Group - E

8. (a) Mention some of the examples of dermal grafts used successfully in commercial applications. *[(CO6)(Remember/LOCQ)]*
   (b) Illustrate the use of BMP in tissue remodelling used in surgical matrices. *[(CO6)(Analyse/IOCQ)]*
   (c) Justify with reasons the ethical issues involved in tissue engineering. *[(CO6)(Justify/OCQ)]*

4 + 4 + 4 = 12

9. (a) Discuss the role of various growth factors involved in bone repair. *[(CO6)(Remember/LOCQ)]*
   (b) Compare among the 3 modes of controlled release of drugs from a matrix. *[(CO2)(Analyze/IOCQ)]*

(c) Give a critical appreciation of various type of scaffolds used in cartilage tissue engineering. *[(CO6)(Criticize/IOCQ)]*

4 + 4 + 4 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	27.08	65.63	7.29

Course Outcome (CO):

At the end of this course students will be able to:

1. Explain the significance, current status and future potential of tissue engineering, identify requirements of tissue engineering, comprehend the structural organization of cells and tissues, the role of cell interaction, cell migration, wound healing and cellular processes.
2. Identify key challenges in tissue engineering of different human tissues; understand the importance of cell signaling, angiogenesis in tissue engineering.
3. Understand the design, fabrication and biomaterials selection criteria for tissue engineering scaffolds.
4. Understand the sources, selection, potential manipulations, storage and challenges of using stem cells for tissue engineering.
5. Use simple models to quantify aspects of bioreactor design in the context of tissue engineering, understand the basics of 3D cell culture.
6. Discuss the challenges of in vivo implantation of biomaterials and scale-up issues relating to human clinical applications and explain the ethical and regulatory issues of significance in tissue engineering.

**LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.*