TISSUE ENGINEERING
(BIOT 4242)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

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

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) _____ are multipotent stromal cells that can differentiate into a variety of cell types.
(a) Mesodermal cells (b) Ectodermal cells
(c) Endodermal cells (d) Mesenchymal stem cells

(ii) _____ is a very important component in tissue engineering, which incorporates the three important elements, cells, biomaterials, and growth factors.
(a) Scaffolding Technique (b) Seeding
(c) Cell culture technique (d) Cell isolation technique

(iii) The process by which extracellular messages translate into intracellular changes is termed _____.
(a) cell signaling (b) cell adhesion
(c) signal transduction (d) cell transformation

(iv) _____ is a network of polymer chains that are hydrophilic.
(a) Hydrogel (b) Alginate
(c) Starch (d) Amylose

(v) Which of the following is a cell surface receptor?
(a) Enzyme-linked receptors (b) G protein-linked receptors
(c) Ion-channel linked receptors (d) All of (a), (b) & (c).

(vi) In perfusion chamber of 6 mm diameter, fluid flows at a superficial velocity of 1 mm/sec. What is the flow rate in the system?
(a) Around 35µl/sec (b) Around 10µl/sec
(c) Around 28µl/sec (d) Cannot be determined.

(vii) Differentiation of stem cells
(a) occurs only when growth factors are added to the medium
(b) does not necessarily result in the desired cell type
(c) can easily be reversed
(d) does not occur in the human body, because of the cell's capacity to self-renew.

(viii) Alumina is a/an
(a) inert ceramics
(b) bioactive ceramics
(c) bioresorbable ceramics
(d) none of (a), (b) & (c).

(ix) Polyglycolic acid (PGA) scaffold is
(a) biotolerant
(b) bioactive
(c) bioinert
(d) biodegradable.

(x) Which is 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).

Group- B

2. (a) Elucidate the formation of different organs from ectoderm, endoderm and mesoderm. *[(CO1)(Understand/LOCQ)]*
(b) Analyze with a diagram the formation of a four-chambered beating heart from a single tube. *[(CO1)(Analyze/IOCQ)]*
(c) What do you mean by 'Lines of Blaschko'? Give a critical appreciation of the significance of this discovery. *[(CO1)(Criticize/HOCQ)]*

4 + 4 + 4 = 12

3. (a) Illustrate the molecular events involved in signal initiation process. *[(CO1)(Remember/LOCQ)]*
(b) Analyze the cell signalling mechanisms involved in vascular biology. *[(CO1)(Analyze/IOCQ)]*
(c) Comment on the function of GPCRs in cell signalling mechanisms. *[(CO1)(Understand/LOCQ)]*

4 + 4 + 4 = 12

Group - C

4. (a) What are the advantages of porogen leaching technique for scaffold fabrication? How self-assembly of molecule can be used for scaffold fabrication? *[(CO3)(Remember/LOCQ)]*
(b) What is the principle of electrospinning? How electrospinning is used in Tissue engineering? *[(CO3)(Understand/IOCQ)]*

(c) What is Rapid Prototyping? What are the advantages of Rapid Prototyping technique over the other scaffold fabrication techniques? *[(CO3)(Analyze/IOCQ)]*

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

5. (a) Explain in detail the role of alginate in tissue engineering. *[(CO3)(Explain/IOCQ)]*
   (b) How cellulose can be applied in vascular tissue engineering? What is the most important disadvantage of cellulose and how it can be controlled? *[(CO3)(Understand/IOCQ)]*

6 + (3 + 3) = 12

Group - D

6. (a) Explain kinetic model of mammalian cell proliferation. *[(CO5)(Explain/IOCQ)]*
   (b) Draw a diagram of typical bioreactor showing all of the parts of it. Describe the functions of the following parts of a bioreactor: (i) Vessel, (ii) Agitator and (iii) Baffles. *[(CO5)(Describe/IOCQ)]*
   (c) Explain key functions of bioreactors used for tissue engineering with diagram. *[(CO5)(Explain/IOCQ)]*

3 + (3 + 3) + 3 = 12

7. (a) Mention the names of three different techniques for the preservation of cell or tissue. Describe any one of the techniques. *[(CO4)(Understand/LOCQ)]*
   (b) Differentiate between fixed bed and fluidized bed bioreactors. *[(CO5)(Analyse/IOCQ)]*
   (c) With the help of a diagram explain the functioning and set-up of a flow chamber bioreactor system. *[(CO5)(Explain/IOCQ)]*

(1 + 3) + 3 + 5 = 12

Group - E

8. (a) Discuss the mechanism of controlled release of bioactive molecules of interest in tissue engineering. *[(CO5)(Understand/LOCQ)]*
   (b) Give a comparative analysis between homogenous degradation and surface degradation modes of controlled release. *[(CO6)(Compare/IOCQ)]*
   (c) Justify with reasons the ethical issues involved in tissue engineering. *[(CO6)(Justify/HOCQ)]*

4 + 4 + 4 = 12

9. (a) Illustrate the application of nerve guides for repair of peripheral nerve injury. *[(CO5)(Understand/IOCQ)]*
   (b) Give a brief outline of regenerative therapeutic approaches using cochlear implants. *[(CO5)(Analyze/IOCQ)]*
   (c) Give a critical appreciation of various type of scaffolds used in cartilage tissue engineering. *[(CO5)(Criticize/HOCQ)]*

4 + 4 + 4 = 12

Cognition Level	*LOCQ*	*IOCQ*	*HOCQ*
Percentage distribution	*25*	*62.5*	*12.5*

Course Outcome (CO):

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

CO1. 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.

CO2. Identify key challenges in tissue engineering of different human tissues; understand the importance of cell signaling, angiogenesis in tissue engineering.

CO3. Understand the design, fabrication and biomaterials selection criteria for tissue engineering scaffolds.

CO4. Understand the sources, selection, potential manipulations, storage and challenges of using stem cells for tissue engineering.

CO5. Use simple models to quantify aspects of bioreactor design in the context of tissue engineering, understand the basics of 3D cell culture.

CO6. 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.*