National University of Ireland, Galway
Ollscoil na hÉireann, Gaillimh

SPRING EXAMINATIONS 2000

M.Sc. Biomedical Science

**EP513** Materials Science and Biomaterials

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Time allowed: 3 hours

Answer both sections. Use separate answer books for Section A and Section B.

Section A: Answer **THREE** questions

Q.1 Describe the different forms of atomic bonding encountered in solid materials, indicating their relative strengths. Write a brief note on the importance of the hydrogen bond in the composition and shape of some fundamental biological molecules.

Q.2 Describe the phenomenon of polymerisation of unsaturated hydrocarbon-based molecules and the resulting large family of useful "plastic" materials. In your answer, discuss such terms as cross-linking, elastomer, vulcanisation, thermoplasts and thermosets.

Q.3 Draw a typical stress-strain diagram for a metal, and explain such terms as elastic region, plastic flow, and tensile strength.

For most materials, the tensile strength is orders of magnitude smaller than the theoretical strength of the material, as estimated from the known force between atoms. Explain why this is the case.

Q.4 Discuss the iron-carbon alloy system, sketching the phase diagram for the region of technically-useful steels. Explain how the mechanical properties of the alloy depend on the amount of carbon and on the heat treatment of the alloy.

Explain how the addition of other elements can change the mechanical properties as well as affect the ability of the surface to resist corrosion – forming "stainless steel".

Q.5 Write short notes on *three* of the following topics:

(a) Composite materials
(b) Surface corrosion of metals

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(c) Covalent bonding and the shape of the $CH_4$ molecule
(d) glass and other solid amorphous materials
(e) The bonding of amino acids to form large protein molecules

## Section B: Answer **THREE** questions.

Q.1 Outline the primary concerns when developing a new biomaterial for implant.

Q.2 Write an essay on bone and biomaterials

Q.3 Write notes on:

a) the structure of connective tissue
b) wound healing

Q.4 Discuss some strategies and outcomes in skin replacement

Q.5 Write notes on:

a) methods of *in vitro* assessment of biocompatibility/biotoxicity
b) intimal hyperplasia