

DEPARTMENT OF BIOELECTRONICS AND BIOSENSORS

Ph.D. ENTRANCE – SYLLABUS (June 2023 Onwards)

Discipline: Bioelectronics and Biosensors

PAPER II - BIOELECTRONICS AND BIOSENSORS

Unit I: Nanomaterials

Introduction to Nanotechnology; Nanomaterial Synthesis-Top-down and bottom-up approaches; Soft chemical routes-Vapour growth-Thin film methods: Chemical vapour depositions, Physical vapour deposition (sputtering, laser ablation), Mechanical methods- Ball milling, mechanical attrition; Carbon nanostructures: fullerenes, carbon nanotubes, nanowires. Porous silicon; Bio-inspired synthesis.

Unit II: Biomaterials

Types of biomaterials- Metals- Ceramics- Polymeric-Composite biomaterials-Natural biomaterials- Bioresorbable and Bioerodible materials-Biodegradable polymeric materials-Biodegradable hydrogels -Tailoring properties and function through chemistry and structure modification-Material bonding-ionic and covalent-Tissue derived biomaterials-Soft tissue and Hard tissue replacements-Cardiovascular applications; Calcium phosphates-Dental implants-Ophthalmologic applications- Orthopedic applications; Drug delivery systems.

Unit II: Chemical reactions

Catalysts, theory of reaction rates: Arrhenius equation-collision and transition state theory, consecutive and parallel reaction-steady state approximation. Chemical equilibria and thermodynamics: First, second and third law of thermodynamics; entropy, free energy, partial molar quantities.

Unit III: Cell biology

Cell membrane-Membrane lipids, Membrane proteins-Biomembranes-overview; types of membranes- diffusion, osmosis-transport- cell junctions. Biological Molecules- carbohydrates, Proteins, amino acids, Nucleic acids-Biosynthesis, Phospholipids Organization- Metabolic energy-Enzyme catalysis.

Unit V: Biosensors

Biosensor - definition-Historical perspective; Sensor characteristics -calibration, dynamic range, signal to noise ratio, sensitivity, selectivity, interference; Transducer – definition types - optical, electrochemical (amperometric, potentiometric, conductimetric) - thermal, mass – piezoelectric-acoustic wave types with examples; Immobilization on transducers; adsorption, encapsulation - (hydro-gel, sol-gel glass, etc.), covalent attachment; Biomedical applications-Glucometer-Pregnancy kit-Covid-Kit.

References:

1. NANO: The Essentials: Understanding Nanoscience and Nanotechnology, T. Pradeep, McGraw Hill Education (India) (2007)
2. The Chemistry of Nanomaterials: Synthesis, Properties and Applications, C.N.R. Rao, A. Muller, A. K. Cheetham (Eds), Wiley-VCH Verlag (2004)
3. Molecular Cell Biology, Harvey Lodish, Anold Berk, W.H, Freeman and Co., 7th edition (2013)
4. Essential Cell Biology, Bruce Alberts, Dennis Bray, Taylor and Francis group, 3rd edition, (2010)
5. Introduction to Biomaterials: Basic Theory with Engineering Applications, C. Mauli Agrawal, T J international Ltd., (2014)
6. Physical Chemistry; Puri, Sharma, Pathania; Vishal Publishing Company, Jalandhar, (2021).
7. Advances in Biosensors, B.D. Malhotra, A.P.F. Turner, Elsevier JAI, (2003)
8. Electrochemical Sensors, Biosensors and their Biomedical applications, X.Zhang, H.Zu, J. Wang, Elsevier Science and Technology Books, (2008)