Subject Code : P8GTE4

ELECTIVE COURSE III-1: NANOBIOTECHNOLOGY

UNIT - I

Quantum Physics: Forces between atoms and molecules, particles and grain boundaries, surfaces – strong intermolecular forces - Van der Waals and electrostatic forces between surfaces – similarities and differences between intermolecular and interparticle forces – covalent and coulomb interactions – interactions involving polar molecules and polarization – weak intermolecular forces and total intermolecular pair potentials – Forces between solvation, hydration.
Basis of Quantum Physics – De Broglie's concept – Operators – Bra and Ket notation- Physical imperfection of wave function – Normalised and orthogonal wave function - Heisenberg's Uncertainty Principle – Statement and illustrations – Ehrenfest Theorem.
Definition of a nano system -dimensionality and size dependent phenomena; Quantum dots, Nanowires and Nanotubes, 2D films; Nano & mesopores – size dependent variation in Magnetic, electronic transport, reactivity etc.

UNIT- II

Synthesis of Nano Materials: Synthesis and Characterizations of Nanoscale Materials; Strategies for Nano architecture (top down and bottom up approaches), Fabrication Technologies and Characterizations. Self-assembly Systems; Some aspects of Nanofluidics: surfactants, polymers, emulsions and colloids.
Various Nano Preparation Techniques – basic concepts of nanostructured materials – nucleation: surface nucleation growth – grain size distribution – nano particle transport in low density media – vapour nano phase thermodynamics – coagulation of nano particles, determination of grain size – aggregate formation – mass fractal morphologies.- Film deposition methods-Sol-gel processing.
New forms of carbon – types of nanotubes – formation, Characteristics and Applications of nanotubes- Quantum Dots and Wires.Gold Nanoparticles. Nanopores. Applications of NanoMolecules in Biosystems. -Nanoscale Elements for Delivery of Materials into Cells. Peptides Coupled Nanoparticles. DNA Based Artificial Nanostructure .Proteins as Components in Nanodevices-. Nanoparticle synthesis in plants, bacteria, and yeast.

UNIT- III

Characterization of Nano Materials: Electron microscopes & Spectroscopy: scanning electron microscopes – transmission electron microscopes - scanning probe microscopy – atomic force microscopy – scanning tunneling microscope – Scanning Non-linear Dielectric microscopy - Nuclear Magnetic Resonance Spectroscopy- Nuclear Quadrupole Resonance Spectroscopy Mossbauer & Microwave Spectroscopy and Electron Spin Resonance Spectroscopy-IR & Raman Spectroscopy.
Nanoanalytics - quantum dot biolabeling – nanoparticle molecular labels – analysis of biomolecular structure by AFM and molecular pulling-force spectroscopy– biofunctionalized nanoparticles for SERS and SPR-. nano manipulator nano tweezers – XPS – ICP.

UNIT- IV

Nanosensors: Chemical and Molecular Sensors – Displacement and Motion Sensors – Force
Nanosensors – Pressure Sensing – Thermal Nanosensors – Electric and Magnetic Sensing – Cellular Bioscanning – Non-invasive Neuroelectric Monitoring –

Macrosensing – Acoustic Macrosensing – Electric and Magnetic Macrosensing – Neural Macrosensing.

Nanocarriers for Drug Delivery: Nanoscale Devices for Drug Discovery -Application of Nano-biotechnology in drug Delivery- Needs and Requirements – Nanoparticle Flow: Implications for Drug Delivery – Polymeric Nanoparticles as Drug Carriers and Controlled Release Implant Devices – Micelles for Drug Delivery. Micro-array and Genome Chips. Genetic Vaccines: A Role for Liposomes – Polymer Micelles as Drug Carriers – Recent Advances in Microemulsions as Drug Delivery Vehicles – Lipoproteins as Pharmaceutical Carriers – Solid Lipid Nanoparticles as Drug Carriers.

Nanocapsules – A New Drug Delivery System

Nanocapsules preparation, Characterization and Therapeutic Applications – Dendrimers as Nanoparticulate Drug Carriers – Cells and Cell Ghost as Drug Carriers – Cochleates as Nanoparticular Drug Carriers – Aerosols as Drug Carriers – Magnetic Nanoparticles as Drug Carriers – Nanoparticulate Drug Delivery to the Reticuloendothelial System and to Associated Disorders – Delivery of Nanoparticles to the Cardiovascular System – Nanocarriers for the Vascular Delivery of Drugs to the Lungs – Nanoparticulate Carriers for Drug Delivery to the Brain – Nanoparticles for Targeting Lymphatics – Polymeric Nanoparticles for Delivery in the Gastro-Intestinal Tract – Nanoparticular Carriers for Ocular Drug Delivery – Nanoparticles and Microparticles as Vaccines Adjuvants – Pharmaceutical NanoCarriers in Treatment and Imaging of Infection.

UNIT -V

Nanotechnology and the Cell. Cell Motility: Nano Motors and Cellular Navigation Chemotaxis - Transmembrane Signalling and Related Protein. Nanoscale Artificial Platforms: Lipids in Self-assembly Structures.

Nano-Medicine: Bio-Pharmaceuticals – Implantable Materials – Implantable Devices – Surgical Aids – Diagnostic Tools – Genetic Testing – Imaging – Nanoparticles Probe – Case Analysis – 1) Resiprocytes – Mechanical Artificial Red Cells – 2) Using DNA as a construction medium.

Nanotechnology for Cancer Diagnostics and Treatment: Cancer Biology; Clinical Aspects, Current Approaches and Challenges. Nanotechnology for Cancer Research and Therapy. siRNA. Tumor-targeted Drug Delivery Systems. Nanotechnology for Imaging and
Detection.

REFERENCES:

1. Ratner, M. and Ratner, D. 2005.Nanotechnology: A Gentle Introduction to the Next Big idea. Pearson Education, Inc. NJ, USA.
2. Christef M. Niemeyer, C. A. Mirkin.2004. Nanobiotechnology: Concepts, Application and Properties. Wiley – VCH Publishers, New York.
3. Tuan Vo-Dinh. 2007. Nanotechnology in Biology and Medicine: Methods, Devices and Applications. Taylor and Francis Inc., London.
4. Pradeep, T. 2006 NANO.Tata McGraw Publishers, New Delhi, India
5. Jain, K.K. 2006. Nanobiotechnology in Molecular Diagnostics: Current Techniques and Applications. Horizon Biosciences, India.
6. Challa S.S.R. Kumar (Ed). 2006. Biological pharmaceutical Nanomaterial, Wiley- VCH Verlag Gmbh & Co, KgaA. Weinham, Germany.
7. Parag Diwan and Ashish Bharadwaj (Ed.). .2006. Nano Medicines Pentagon Press. SBN 81-8274-139-4.
8. Vladimir P.Torchilin (Ed.). 2006. Nanoparticulates as Drug Carriers. Imperial College Press, North Eastern University, USA. ISBN 1-86094.