DEPARTMENT OF NANOSCIENCE AND NANOTECHNOLOGY

UNIVERSITY OF KERALA

M.PHIL PROGRAMME IN NANOBIOLOGY

SYLLABUS

Under Credit and Semester System w.e.f 2016 admissions

DEPARTMENT OF NANOSCIENCE AND NANOTECHNOLOGY

UNIVERSITY OF KERALA

M.PHIL PROGRAMME IN NANOBIOLOGY

Programme Objectives

- To introduce students to areas of creative thinking and critical reasoning which are relevant to his/her research and to introduce the students to the current research issues and processes.
- The programme will consist of lectures and related activities that will help in developing good understanding of methods of research process and management
- To provide students knowledge in the field of Nanoscience and nanotechnology and Nanobiology
- The programme will consist of lectures and related activities that will help the students to understand the characterization techniques to analyze the nanomaterials.
- To provide students knowledge in the field of Nanobiology and current trends in the field of nanotechnology.
- The programme will consist of lectures and related activities that will help the students to understand emerging technologies in the field of Nanobiology

Structure of the Programme

Semester No.	Course code	Name of the Course	No.of Credits
I	NBY-711	Research Methodology	4
	NBY-712	Introduction to Nanoscience	4
	NBY-713	Recent advances in Nanobiology and Nanotechnology	4
II	NBY-721	Dissertation	20
		Total Credits	32

Semester : I

Course Code : NBY-711

Course title : RESEARCH METHODOLOGY

Credits : 4

Aim : To introduce students to areas of creative thinking and critical reasoning which are relevant to his/her research and to introduce the students to the current research issues and processes.

Objectives : The course will consist of lectures and related activities that will help in developing good understanding of methods of research process and management.

Module I : OBJECTIVES AND TYPES OF RESEARCH

Meaning of research – Motivation and objectives – Research methods vs. Methodology. Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical.

Research formulation

Defining and formulating the research problem - Selecting the problem - Necessity of defining the problem - Formulation of a working hypothesis - Importance of literature review in defining a problem – Literature review – Primary and secondary sources – Reviews, treatise, monographs-patents – web as a source – Searching the web and information mining - Critical literature review – Identifying gap areas from literature review.

Module II : RESEARCH DESIGN, METHODS

Research design – Basic Principles- Need of research design – Features of good design – Important concepts relating to research design – Observation and facts, laws and theories. Prediction and explanation, induction, deduction - Development of models - Developing a research plan - Exploration, Description, Diagnosis - Experimentation - Determining experimental and sample design.

Data collection and analysis

Execution of the research - Observation and Collection of experimental data. Methods of data collection - Sampling Methods - Sampling techniques, steps in sampling, sampling size, advantages and limitations of sampling - Data Processing and Analysis strategies - Data Analysis with Statistical Packages - Hypothesis-testing - Generalization and Interpretation.

Module III : REPORTING AND THESIS WRITING

Structure and components of scientific reports - Types of report – Technical reports and thesis – Significance – Different steps in the preparation – Layout, structure and Language of typical reports – Data presentation – Illustrations, graphics, tables, histograms and pi diagrams - Bibliography, referencing and footnotes – Oral and poster presentation – Planning – Preparation – Practice – Making presentation – Use of visual aids.

Module IV : RESEARCH ETHICS

Environmental impacts - Ethical issues - Ethical Committees - Commercialisation – Copy right - royalty - Intellectual property rights and patent law – Trade Related aspects of Intellectual Property Rights - Reproduction of published material-Plagiarism - Citation and acknowledgement - Reproducibility and accountability.

Module V : ERRORS AND UNCERTAINTIES IN MEASUREMENTS

Introduction to Errors and uncertainties in the measurement - Performance parameters of instrument - Propagation of uncertainties in compound quantities - curve fitting, regression and correlation.

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ADDITIONAL REFERENCES

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Semester : I

Course Code : NBY- 712

Course title : INTRODUCTION TO NANOSCIENCE

Credits : 4

Aim : To provide students knowledge in the field of Nanoscience and nanotechnology and Nanobiology

Objectives: The course will consist of lectures and related activities that will help the students to understand the characterization techniques to analyze the nanomaterials.

Module I : INTRODUCTION TO NANOMATERIALS

Zero-dimensional, one-dimensional and two-dimensional nanostructures - size dependent properties – quantum confinement – optical properties - specific heat and melting point- mechanical properties – super plasticity - plastic deformation of ceramics - nanoceramics - catalytic properties.

Crystal structure – bonding and antibonding orbitals – hybridization – types of bonding – types of crystal structure.

Synthesis of nanomaterials - bottom-up and top-down approaches - nanoparticles - colloidal technique - homogeneous and heterogeneous nucleation - synthesis of metallic and semiconductor nanoparticles - stabilization of nanoparticles - sonochemical method - synthesis and properties of core-shell nanoparticles.

Nanowires and nanorods - spontaneous growth - vapour-liquid-solid growth – template-based synthesis - nanostructured films - self-assembly - molecular self-assembly in solutions – self assembly of nanoparticles - Langmuir-Blodgett films - electrochemical deposition.

Module II : EXPERIMENTAL TECHNIQUES

Principle, working and interpretation of results of – XRD – XPS - AES – EDS - SEM - STM – AFM – TEM - HRTEM - BET surface area and porosimetry. UV-Vis – Photoluminescence - FTIR and Raman spectroscopy. Thermal analysis – TGA, DTA and DSC.

Module III :QUANTUM DOTS (QDs)

Surface chemistry and bioconjugation - luminescent quantum dots - quantum dot FRET-based protease probes - quantum dot-composite construction - applications of QD composites - QD applications in biomolecule assays - QD antibody - QD encoded human DNA - QD based immunostaining - QD for in vivo imaging.

Core-shell nanoparticles – core-shell nanoparticles with a lipid core – core-shell nanoparticles with a polymeric core - hyaluronic acid (HA) - core-shell nanoparticles with a metallic core - drug delivery and molecular imaging using core-shell nanoparticles.

Dendrimers and hyperbranched nanospheres - introduction - synthetic protocols - dendrimers as artificial proteins - nanoscale containers - carrier properties - imaging agents - mutifunctional nanoscaffolds - dendrimers as nanodrugs - biocompatibility studies.

Module IV : NANOBIOLOGY

Overview of cell structure and biomacromolecules - Nanobiotechnology – Introduction - learning from nature - DNA nanotechnology - self-assembled DNA nanotubes and their applications - nanoparticles for biological assays - nanoparticles for drug delivery vehicles - surface modification of nanoparticulate drug carriers - need of surface modification - attaching various ligands to surface of nanocarriers - polymers for longevity – ligands for targeting combination with protecting polymers - ligands for intracellular delivery of nanocarriers.

Module V: ENGINEERED NANOPARTICLES

Engineered nanoparticles and biomedical applications - Physical and chemical characterization of Engineered nanoparticles - genetic and chemical alteration of Engineered NPs – Effect of Engineered nanoparticles in biological systems - genetic alterations -“click chemistry” for bioconjugation of Engineered NPs – Engineered NPs in therapeutics – cell targeting – gene delivery – bioimaging – drug encapsulation and release – immune response.

REFERENCES

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Semester : I

Course Code : NBY- 713

Course title : RECENT ADVANCES IN NANOBIOLOGY AND NANOTECHNOLOGY

Credits : 4

Aim : To provide students knowledge in the field of Nanobiology and current trends in the field of nanotechnology.

Objectives : The course will consist of lectures and related activities that will help the students to understand emerging technologies in the field of Nanobiology

Module I : NANOTECHNOLOGY FOR DIAGNOSIS

Nanotechnology and patient diagnostics – optical diagnostic techniques – electrical diagnostic techniques – imaging diagnostics - nanotechnology enhanced tools - Raman spectroscopy - mass spectrometry – immunoassays - nanoscale cantilevers, for sensitive detection of cancer-related molecules - nanodiagnostic systems for HIV – nanotechnology and future of patient diagnostics.

Biosensors- Classes of biosensors - application of CNTs-based electrochemical sensors and biosensors- photonic crystals – basic concepts – plasmonic biosensors - photonic crystals sensors – nanoclinic gene delivery – nanoclinics for photodynamic therapy.

Module II : NANOTECHNOLOGY FOR TREATMENT OF DISEASES

nanotechnology for drug delivery- strategies for targeted delivery observed in nature – bacteria - viruses - viral vectors for therapeutic applications - strategies for targeted delivery designed by man - nanoparticles for targeted drug delivery - drug eluting stents - activation and targeting - polymeric nanoparticles - nanofibres- nanotubes and fullerenes – nanogels - nanocrystals - protein nanoparticles.

Cancer therapy using nanomedicine - development of cancer - fundamentals of targeting strategies - use of nanotubes and quantum dots - polymeric conjugates used for tumor targeted imaging and delivery - dendritic nanostructures used for cancer imaging and therapy - nanoshell based cancer therapy- use of multifunctional nanoparticles in chemotherapy

Module III : NANOMAGNETISM AND BIOMEDICAL APPLICATIONS

Nanoscale magnetism – superparamagnetic nanoparticles of iron oxide for magnetic resonance imaging applications - physicochemical characteristics - pharmacology and metabolism - current clinical uses and future developments - gastrointestinal tract imaging - liver and spleen diseases - blood pool characteristics - characterization of the atheromatous plaque - other potential uses.

Ferrritin and related proteins – ferritin as a superparamagnetic model system – magnetoferritin – magnetotactic bacterium – magnetosomes.

Module IV : **NANOTECHNOLOGY FOR TISSUE ENGINEERING**

Introduction - scaffolds for tissue engineering - nanofibrous scaffolds - relevance and role of nano structured scaffolds in vascular, neural and cardiac tissue engineering- nanocomposites and applications in tissue engineering - nanotechnologies for development of artificial skin substitutes – nanolithography - nanolithographic techniques in tissue engineering.

Module V : **TOXICOLOGICAL EFFECTS OF NANOMATERIALS**

Physiological and biochemical effects – modes of exposure - effects of environmental exposure-effects on human health - dermal local effects - inhalation effects on the respiratory tract - blood-brain barrier effects - differences or similarities in nanoparticle toxicity - effects of other novel nanoparticles - ethical issues related to nanoparticles.

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- Tuan Vo-Dinh - Nanotechnology in Biology and Medicine: Methods, Devices, and Applications, CRC Press, 2007.

Semester : II

Course Code : NBY- 721

Course title : DISSERTATION

Credits : 20

Aim: The aim of this course is to enable students to develop an understanding and obtain practical experience of the research process and research skills required to undertake a supervised research project.

Students will be required to identify relevant information on a topic and critically review the research of others. A range of approaches should be used in the field of Nanoscience and Nanobiology

Objective: This course aims to develop an understanding of the processes and skills required to undertake a supervised research project at M.Phil level, and to write it up as dissertation.

The objectives are

- develop research skills commensurate with the accomplishment of a degree
- develop skills in independent inquiry
- produce a coherent and logically argued piece of writing that demonstrates competence in research and the ability to operate independently
- address issues of research design, methodology, ethics and theoretical arguments, and apply these to research