



UNIVERSITY OF KERALA

SYLLABUS FOR M.Phil. DEGREE COURSE

IN

NANOBIOLOGY

Revised syllabus

w.e.f 2015 admission

M. Phil Course in Nanobiology

Regulations, Scheme and Syllabus for the M. Phil. degree course in Nanobiology

1. Regulations:

The M. Phil course may be conducted as per the existing M. Phil reformulated regulations No. Acad.L.3855/R/97 dated 18-11-1997.

2. Eligibility:

The qualification for admission to the M. Phil Degree course in Nanobiology shall be a second class M. Sc Degree in Nanoscience/Nanotechnology/Nanoscience and Nanotechnology/Nanoscience and Technology with Bachelor's Degree in Zoology/ Botany/Biochemistry/Biotechnology, or M.Sc. Degree in Biochemistry/, Biotechnology, Botany, Zoology, Microbiology, or a Post-graduate Degree in Medicine, Pharmacology, Veterinary Science or Dentistry of this University or a Master's Degree in the above subjects from any other University recognized by this University, with not less than 55% marks subject to the rules of relaxation for SC/ST candidates.

3. Admission Procedure:

Admissions to the M. Phil course will be made on the basis of the marks scored in the Entrance Examination and in the qualifying examination in the ratio 50:50.

4. Number of seats:

A total of three (3) candidates will be admitted to the M. Phil course.

M. Phil Course in Nanobiology
SCHEME AND SYLLABUS

Scheme of Examination

			Duration	Max. Marks
Paper	I	RESEARCH METHODOLOGY	3 hrs.	100
Paper	II	INTRODUCTION TO NANOSCIENCE	3 hrs	100
Paper	III	RECENT ADVANCES IN NANOBIOLOGY AND NANOTECHNOLOGY	3 hrs	100
		Dissertation		300
		Viva-voce		100
			TOTAL	700

Distribution of Marks

There will be two parts (Part A and Part B) for the question paper for each of the papers Paper I, Paper II and Paper III. Part A will contain **twelve** short answer type questions out of which **eight** questions will have to be answered. Part B will contain **six** long answer type questions out of which **four** questions will have to be answered. Mark distribution for each paper will be as follows:

Part A	8 questions to be answered	-	$8 \times 5 = 40$ marks
Part B	4 questions to be answered	-	$4 \times 15 = 60$ marks
		Total	100 marks

Marks for Viva-voce based on Dissertation = 100

PAPER I RESEARCH METHODOLOGY

UNIT 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. (ref: 1,2,3)

UNIT II 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. (ref: 1,2,3)

UNIT III 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. (ref: 1,2,3,4)

UNIT IV 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. (ref: 1,2,3)

UNIT V 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. (ref: 1,2,3)

UNIT VI 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. (ref: 5)

UNIT VII 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. (ref: 1,6,7)

REFERENCES

1. Garg. B. L, Karadia. R, Agarwal. F and Agarwal. U. K- An introduction to Research Methodology, RBSA Publ, 2002.
2. Kothari. C. R- Research Methodology: Methods and Techniques, New Age Intl, 1990.
3. Sinha. S. C and Dhiman. A. K- Research Methodology, Vol I & II Ess Ess Publ, 2002.
4. Trochim W M K- Research Methods: the concise knowledge base, Atomic Dog Publ, 2005.
5. Wadehra. B. L- Law relating to patents, trade marks, copyright designs and geographical Indications, Universal Law Publ, 2000.
6. Rudolf J. Freund, William J Wilson, Donna L. Mohr- Statistical Methods (3rdedition), Elsevier, 2010.
7. Yogish. S. N- Statistical Methods, Mangal Deep Publ, 2007.

ADDITIONAL READINGS

1. Anthony. M, Graziano. A. M and M L Raulin. M L, Research Methods: A Process of Inquiry, Allyn and Bacon, 2009.
2. Carlos. C M, Intellectual property rights, the WTO and developing countries : the TRIPS agreement and policy options, Zed Books, New York, 2000.
3. Coley. S. M and Scheinberg. C. A, Proposal Writing, Sage Publ, 1990.
4. Day. R. A, How to Write and Publish a Scientific Paper, Cambridge University Press, 1992.
5. Fink A, Conducting Research Literature Reviews: From the Internet to Paper. Sage 2009
6. Leedy. P. D and Ormrod. J. E, Practical Research : Planning and Design, Prentice Hall, 2004.
7. Satarkar .S. V, Intellectual property rights and Copy right. Ess Ess Publ, 2000
8. Leedy P D, and J E Ormrod, Practical Research: Planning and Design, Prentice Hall, 2004.
9. Smith R V, Graduate Research: A Guide for Students in the Sciences, Univ Washington Press, 1998.

PAPER II INTRODUCTION TO NANOSCIENCE

UNIT 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.

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. (ref. 1-6)

UNIT 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 - FTIR and Raman spectroscopy. Thermal analysis – TGA, DTA and DSC. (ref. 7-10)

UNIT 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 - multifunctional nanoscaffolds - dendrimers as nanodrugs - biocompatibility studies. (ref. 11, 12)

UNIT IV CRYSTAL STRUCTURE

Molecular orbital – bonding and antibonding orbitals – hybridization – types of bonding – ionic, metallic, hydrogen, and Van der Waals bonding- types of crystal structure. (ref.13)

UNIT V NANOBIOLOGY

Overview of cell structure and biomacromolecules - chemical building block of cells. 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.

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.

Metallic nanoparticles- amino acid and carboxyl group functionalization - covalent attachment of different moieties using various chemistry. (ref. 11, 14-17)

UNIT VI NANOSCALE MAGNETISM AND BIOMEDICAL APPLICATIONS

Nanoscale magnetism – single domain particles-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.

Ferritin and related proteins – ferritin as a superparamagnetic model system – magnetoferritin – magnetotactic bacterium – magnetosomes. (ref.16, 18, 19)

UNIT VII NANOPHOTONICS

Photons and electrons: similarities and differences - nanoscale optical interactions – nanoscale confinement of electronic interactions - manifestation of quantum confinement - plasmonics – metallic nanoparticles and nanorods - photonic crystals – basic concepts – plasmonic biosensors - photonic crystals sensors – nanoclinic gene delivery – nanoclinics for photodynamic therapy. (ref.20)

References

1. G. Cao - Nanostructures and Nanomaterials - Synthesis, Properties and Applications, Imperial College Press, 2004.
2. Daniel L. Feldheim, Colby. A. Foss - Metal Nanoparticles: Synthesis, Characterization and Applications, Marcel Dekker, NY, 2002.
3. Janos. H. Fendler (Ed) - Nanoparticles and Nanostructured Films: Preparation, Characterization and Applications, Wiley – VCH, 1998.
4. Didier Astruc(Ed) - Nanoparticles and Catalysis, Wiley-VCH, 2008.
5. G.C. Hdjipanayis, R.W. seigel - Nanophase Materials- Synthesis, Properties and Applications, Kluwer Academic Publishers, 1994.
6. Yoon S Lee - Self-assembly and Nanotechnology-A force balance approach, Wiley, 2008.
7. Cullity. B. D and S. R. Stock - Elements of X-ray diffraction, Prentice-Hall, 2001.
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9. Willard H. H., Merrit. L. L., Dean. J. A and Settle. F. A - Instrumental Methods of Analysis, CBS Pub, 1986.
10. Williams. D. B and Carte. C. B - Transmission Electron Microscopy – A text Book of Materials Science, Plenum Press, N. Y, 1996.
11. Challa Kumar(Ed) - Nanomaterials for Medical Diagnosis and Therapy, Wiley-VCH, 2006.
12. Challa Kumar(Ed) - Semiconductor Nanomaterials, Wiley-VCH, 2010.
13. Charles Kittel - Introduction to Solid State Physics, John Wiley & Sons, 2003.
14. Harvey Lodish, Arnold Berk et al. - Molecular Cell Biology, W.H. Freeman& Co., New York, 2008.
15. Geoffrey M. Cooper, Robert E. Hausman – The Cell – A Molecular Approach – ASM Press, Washington, 2007.
16. Challa Kumar (Ed) – Biological and Pharmaceutical Nanomaterials, Wiley – VCH Verlag, Weinheim, 2006.
17. Ralph S. Greco, Fritz B. Prinz and R. Lane Smith (Eds) - Nanoscale Technology in Biological Systems, CRC Press, 2005.
18. K. J. Klabunde - Nanoscale Materials in Chemistry, Wiley, 2001.
19. R. C. O. Handely - Modern Magnetic Materials: Principles and Applications, Wiley, 1999.
20. P. N. Prasad - Nanophotonics, Wiley-Interscience, 2004.

PAPER III RECENT ADVANCES IN NANOBIOLOGY AND NANOTECHNOLOGY

UNIT I BIOSENSORS

Classes of biosensors - methods of biological signalling-methods of signal transduction - cantilever based biosensors - carbon nanotube-based sensors - methods to prepare CNTs-based sensors and biosensors - application of CNTs-based electrochemical sensors and biosensors - biological and electrochemical functionalization of carbon nanotubes – electrochemical application of functionalized CNTs. (ref.1-4)

UNIT II 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. (ref. 5-9)

UNIT III NANOTECHNOLOGY FOR TREATMENT OF DISEASES

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

Nanoencapsulation technologies for diabetes treatment - nanofeatures and nanoparticles in restorative dentistry - nano biology in cardiology and cardiac surgery - nanotechnology in organ transplantation. (ref.8, 10-14)

UNIT IV NANOTECHNOLOGY FOR DRUG DELIVERY

Basic and special pharmacology - 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 - development of nanostructures for drug delivery applications - polymeric nanoparticles - nanofibres- dendrimers - liposome and lipid nanoparticles - nanotubes and fullerenes – nanogels - nanocrystals - protein nanoparticles. (ref. 5-7, 12, 15)

UNIT V 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 - 3D patterning of hydrogels at nanoscale for tissue engineering applications - biomimetic nanoscale scaffolds for orthopedic tissue engineering - self assembled nanomaterials for tissue engineering applications - nanoengineered hydrogels for cartilage tissue engineering - nanocomposites and applications in tissue engineering - nanotechnologies for development of artificial skin substitutes – nanolithography - nanolithographic techniques in tissue engineering. (ref. 5-7, 16, 17)

UNIT VI NANOTOXICOLOGY

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.

(ref.8, 11, 18)

References

1. Challa S.S.R. Kumar (Ed) - Nanomaterials for Biosensors, Wiley-VCH, Verlag, Weinheim, 2007.
2. Challa S.S.R. Kumar (Ed) - Nanosystem Characterization Tools in the Life Science, Wiley-VCH, Verlag, Weinheim, 2006.
3. Arben Merkoci - Biosensing using Nanomaterials. Wiley Publication, New Jersey, 2009.
4. Challa Kumar(Ed) - Semiconductor Nanomaterials, Wiley-VCH, 2010.