D.Y. PATIL EDUCATION SOCIETY KOLHAPUR
DEEMED UNIVERSITY

(Declared under section 3 of the UGC act 1956)

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DIPLOMA PROGRAMME

IN

NANOBIOTECHNOLOGY

COURSE CURRICULUM

Diploma (Nanobiotechnology)

BL- DPNB-01 Introduction about course:

Nanotechnology has in recent years become one of the most important and forefront fields for its application in the fields of Physics, Chemistry, Engineering and Biology. The application of nanotechnology to life/ medical science has opened entire new branch of Nanobiotechnology. The branch holds the promise of many breakthroughs that may possibly change the course of future medical advances and our insight. It has been observed that properties such as electronic structure, reactivity, conductivity, melting temperature, optical properties and mechanical properties change as the particles become smaller than a critical size. This dependence of property on size allows for the engineering of nanostructures with varied properties with applications in producing stronger and lighter materials for advanced drug delivery system, tailor-made therapy in pharmaceuticals, piezoelectric materials for wound healing. The development of multifunctional nanoparticles for cancer therapy, DNA transfection, and enzyme immobilization, wound healing are few of the prominent thrust areas of Nanobiotechnology. Diploma Programme in Nanobiotechnology will provide students to understand the current concepts and prospect of world of nanoscience with hands-on experience. The course structure and the syllabi has been tailor made with the aim to enable the student acquire a holistic and inter-disciplinary view of the subjects and their inter-relationship along with the application of the knowledge gained in one course on another. This Program would prepare the students for research in Nanobiotechnology and also opens more job opportunities in similar field.

BL- DPNB-02 Vision Mission Goals:

Vision:

To be a world-class centre of academics and research in Nanobiotechnology by pursuing interdisciplinary ties for the benefit of nation and masses at large.

Mission:

To promote academic and research growth by offering state-of-the- programme in the field of Nanobiotechnology.

Goals:

- To introduce the concept of nanoscience and nanobiotechnology
- To explore nanotechnology characterization technique
- To make understand biomedical applications of nanobiotechnology
- To enable the interdisciplinary research through the Physical science, Medical Sciences and Life sciences

Outcome:

- The student will be well versed with the concept of nanoscience and nanobiotechnology
- The student will learn different characterization technique involved in nanoscience
- The student will lean applications of nanotechnology in life sciences
- Interdisciplinary culture will be seeded through collaborations Physical science, Medical Sciences and Life sciences

Job Opportunities

Research and Development (R&D) sections, Quality Assurance and Quality Control officer in pharmaceutical industry, Testing and Monitoring Manager etc. in various industrial sectors including Pharmaceutical, Drug research, Agriculture.

Eligibility:

- Students with Postgraduate degree in Life sciences / basic Science or Graduates of Medical (M.B.B.S.) /Pharmacy / Agriculture and Veterinary sciences.
- Student perusing their Postgraduate Programme in any of the above discipline are also eligible. In addition working professionals, faculties with above qualifications are also eligible

Course Structure:

DPNB =Diploma program in Nanobiotechnology

Duration: one year

- No. of papers: Four Theory Courses with Practical and Minor project
- Presentation: one Student Presentation

			Internal marks	**External marks**	**Total**
Theory Paper	**Paper 1 (DPNB1):** Introduction to Nanoscience and Nanobiotechnology		20	80	100
	Paper 2 (DPNB 2): Nanotechnology characterization techniques		20	80	100
	Paper 3 (DPNB 3): Biomaterials and Biosensors		20	80	100
	Paper 4 (DPNB 4): Biomedical applications of Nanobiotechnology		20	80	100
Practical	Laboratory Course- I (Practical)		-	50	50
	Laboratory Course- II	Seminar	10	-	50
		Minor Project	-	40	

Paper 1 (DPNB1): Introduction to Nanoscience and Nanobiotechnology (60 h)

Unit I: Fundamentals of Nanotechnology (15 h)

Definitions, Relationship and Differences of Nano and Nature: Nanoscopic Colours (Butterfly Wings), Bioluminescence (Fireflies), Tribology (Geckos sticky feet, lotus leaf effect). Introduction to hydrophilic and hydrophobic materials, Nanotechnology and time line, Future perspectives of Nanotechnology and Nanobiotechnology. Classification of nanomaterials: classification of nanomaterials into 0D, 1D, 2D and 3D, Relationship between dimension and shape of nanomaterials (Quantum dots, Quantum wires, Carbon nanotubes, Bucky balls, Fullerenes).

Unit II: Nanoscale Science (15 h)

Interconversion of units, Introduction to surface area to volume ratio and aspect ratio, Difference between surface area to volume ratio of bulk materials and nanomaterials, Nanomaterials and wavelength of light. Introduction to Self-assembled biological nanomaterials in nature : fundamentals of nanoscale self-assembly process involved in important functional biomolecules such as nucleic acid (DNA and RNA), proteins, enzymes. cell structure and organelles,nanoscale assembly of cellular components.

Unit III: Classification and Synthesis methods of Nanomaterials: (15 h)

Introduction to dimensional growth process. Classification of nanomaterials, Types of Nanomaterials, Introduction to size effect with respect to optical properties. Different Synthesis methods for nanomaterials such as top to down and bottom to top, Biological synthesis method. Polymer, Nanocomposites, Supramolecular structures; DNA wires and Dendrimers., Magnetosomes, Protein based Self Assembled Nanostructure

Unit IV: Introduction to Nanobiotechnology (15 h)

Definitions, Scopes, and applications of Biotechnology, Nanobiotechnology, Bio molecular Nanotechnology, Biomedical Nanotechnology, Green Nanobiotechnology, Nanoscale assembly of cellular components (cell membrane and liposomes).Nanoscale assembly of microorganisms (virus).Proteins, Enzymes. Nanoparticles in medicine; Types and Areas of Impact, Drug encapsulation and targeting.

Text/Reference Books

- Elements of Material Science and Engineering-H. Vanvlach (4th Edition)
- Nanotechnology: Principles and Practices., S. K. Kulkarni (3rd Edition) (Springer)
- Fundamentals of Nanotechnolog: Gabor L. Hornyak, John J. Moore, H.F. Tibbals, Joydeep Dutta (2nd edition)(CRC Press)
- Buddy Ratner Allan Hoffman Frederick Schoen Jack Lemons ., An Introduction to Materials in Medicine (Elsevier publication) (3rd edition)

Paper 2 (DPNB1): Nanotechnology characterization techniques (60 h)

Unit I: Introduction to characterization techniques (15 h)

Types of characterization methods: Electron probe methods, Scanning Probe methods, Spectroscopic methods and Non radiative and Nonelectron methods (classification and concepts only). Introduction to techniques such as mechanical extraction, physical methods of homogenization, centrifugation, dialysis, electrophoresis and chromatography techniques for purification of biomolecules
and microscopy.

Unit II: Microscopy Techniques (15 h)

Fundamentals of Microscopy, Types of microscopes: light microscope, compound microscope, bright field and dark phase microscope, inverted microscope, confocal microscopy, scanning electron microscope, transmission electron microscope, atomic force microscope. Applications of microscopy in nanobiotechnology

Unit III: Crystallography and spectroscopic techniques (15 h)

Basics of crystal lattice, crystallinity, Bragg's law, small angle X-ray, wide angle X-ray, powder X-ray, low energy electron diffraction, FWHM method. Applications in Nanobiotechnology. Fundamentals working principle and applications : FTIR, UV-Vis spectroscopy, Raman spectroscopy. Photoemission spectroscopy. Difference between absorbance and surface plasmon resonance (SPR). Applications in Nanobiotechnology.

Unit IV: Magnetic Characterisation techniques (15 h)

Introduction to magnetism, Ferromagnetism, ferrimagnetism, antiferromagnetism, paramagnetism, effect of bulk nanostructuring of magnetic properties, Basics of magnetism, diamagnetic, paramagnetic and superparamagnetic structures. Introduction to induction heating system and its application. Basic principle of SQUID -VSM technique and its application in nanobiotechnology

Text/Reference Books

- Gary D. Christian, Analytical Chemistry, (5th Edition), (John-Wiley & Sons, Inc,)
- D. A. Skoog & D. M. West, Principles of Instrumental Analysis, (2nd Edition) (Holt Reinhart Winston),
- K. A. Robinsons, Chemical Analysis, (1st edition) (Harper Collins Publishers),
- J. Basset, R. C. Denny, C. H. Jaffery and J. Mendhan, Vogel's Text Book of quantitative Inorganic Analysis, (5th Edition), (ELBS)

Paper 3 (DPNB3): Biomaterials and Biosensors (60 h)

Unit I: Biomaterials : Types and Properties (15 h)

Fundamentals of biomaterials science. Concept of biocompatibility. Classes of biomaterials used in medicine: biodegradable materials, hydrogels, polysaccharides, micro- and nanoparticles, mimetic protein networks, ceramics, composites and different types of polymers, micelles, dendrimers, protein conjugation, cross-linking and pegylation. Thin films. Grafts Coatings. Medical fibers and biological functional materials.

Unit II: Biomaterials: Testing of Biomaterials (15 h)

Host reactions to biomaterial: inflammation, wound healing and the foreign body response. Systemic toxicity and hypersensitivity. Blood coagulation and blood-materials interactions. Tumorigenesis and complement activation. Testing biomaterials**:** in vitro and in vivo assessment of tissue compatibility. Testing of blood-materials interactions. Animal model.

Unit III: Biomaterials for Tissue Engineering: (15 h)

Introduction of tissue engineering and implants. Impact of nanotechnology on tissue engineering and implants. Cell transplantation (liver). Nanostructuring/Nanocoating Titanized synthetics . Nano neuro knitting. Development of synthetic polymer Nano- scale patterns for induction of stem cell differentiation. Smart scaffolds. Nano scale tissue engineering & growth of new organs.

UNIT IV: Biosensor and Nanobiosensor: **(15 h)**

Introduction to biosensor and nanobiosensor: basic concepts, characterization, perception. Enzyme– metal nano particle (NPs) hybrids for biosensing. Biomolecule– semiconductor NPs for biosensing. Different types of nanobiosensors. Nanobiosensors for medical diagnostics. Nanoprobes for analytical applications

Texts/Reference Books:-

- K. Youell and Firman, Nanotechnology perception.,Comprehensive overview of motors in biology 3 (2007) 75-96.
- Itamar Willner, Bernhard Basnar and Bilha Willner Nanoparticle–enzyme hybrid systems for nanobiotechnology FEBS Journal 274 (2007) 302–309
- Stuart Lindsay Introduction to Nanoscience, (Oxford university press) (2nd edition)
- Meyer, U. and J., Wiesmann,. Fundamentals of Tissue Engineering and Regenerative Medicine (springer publication) (2009) (1st edition)
- Buddy Ratner Allan Hoffman Frederick Schoen Jack Lemons ., An Introduction to Materials in Medicine (Elsevier publication) (3rd edition)

Paper 4 (DPNB4): Biomedical Applications of Nanobiotechnology(60 h)

UNIT I: Cell labeling and Enzyme Immobilization (15 h)

Concept of functionlzation, Functionalized inorganic nanoparticles. Surface Modification methods. Applications in cell imaging, lebeling and cell tracking. Active targeting via molecular recognition ligands. Enzyme immobilization: advantage of nano immobilization. Bacteria detection and capturing using functionalized nanoparticles

Unit II: Diagnostic Applications (15 h)

Different methods of diagnosis, (MRI, CT etc.). Role of contrast agent in diseases diagnosis, development of NPs for diagnostic application, inorganic materials based NPs for MRI/CT/PET contrast agent, Gd based chelates. Advantages of magnetic NPs over Gd based chelates. FDA approved contrast agents and their types.

UNIT III: Pharmaceutical Applications (15 h)

Introduction to drug delivery system in Pharmaceutics: inorganic drug delivery carriers, polymeric delivery systems, liposomal drug delivery system. Different potential system for proteins and peptide drugs. Toxicity issues and challenges in targeted drug delivery systems. Concept of thermo sensitive and pH sensitive drug delivery system. Stealth particles and targeting by ligands and receptor mediated delivery.

Unit IV: Application in Hyperthermia-based Therapy and Controlled Drug Delivery (15 h)

Introduction to hyperthermia: types and its physiological effects, different methods of hyperthermia. Tumor Physiology. Mechanism of nanomaterials-based hyperthermia. Magnetic nanomaterials for hyperthermia and drug delivery system. Core shell magnetic nanomaterials/ inorganic NPs for hyperthermia-based therapy, NP-based cancer theranstics. Current challenges and opportunities of setting hyperthermia therapy in clinics.

References:

1. Nguyen TK Thanh: Magnetic Nanoparticles: From Fabrication To Clinical Applications Book, (1st edition) (CRC Press)
2. Role of Functionalization: Strategies to explore potential Nano-Bio applications of magnetic nanoparticles. Raghvendra Bohara, N. D. Thorat , Shivaji H Pawar., RSC Advances 6 (50), 43989-44012
3. Alina Maria Holban Alexandru Grumezescu, Nanoarchitectonics for Smart Delivery and Drug Targeting", (1st edition) (Elsevier)

Laboratory course- I Practical

1. Preparation of Plant extract (Organic and aqueous), Crushing, grinding, maceration, homogenization, Filtration, Centrifugation, cold percolation extraction, hot extraction, using Sohxlet apparatus
2. Synthesis of gold NPs for plants extracts
3. Synthesis of Iron oxide nanoparticles by using chemical methods
4. Study of FTIR spectroscopy for materials characterization
5. Study of UV-Vis spectrophotometer for materials characterization
6. Surface modification Nanoparticles with polymers
7. Synthesis of Ag nanoparticles using sodium borohydride (Creighton's method).
8. Cell counting and cell viability study
9. Estimation of particle size using particle size analyser

Laboratory course- II Seminar and Minor Project

BL- DPNB-04 Examination details

1. Scheme of Examination and Passing

1. This course will have 20 % Internal Assessment (IA) and 80% external (University written examination of 3 hours duration for each course paper and practical examination of 3 hours duration). T
2. Internal assessment- IA (20%) and University examination (80%) - shall have separate heads of passing (i.e. 8 Marks for passing in IA and 32 Marks for passing in University examination
3. To pass, a student has to obtain minimum grade point E.
4. The University (external) examination for Theory and Practical shall be conducted at the end year
5. The candidate shall prepare and submit for the practical examination a certified journal based on the practical course carried out under the guidance of a faculty member.
6. The candidate shall present minor project and presentation (separate passing for laboratory course-II minimum 50 % passing)

Standard of Passing for University Examinations:

As per ordinances and regulations prescribed by the University for semester based credit an d grading system.

Standard point scale for grading:

Grade	Marks	Grade Points
O	70 & above	7
A	60-69.99	6
B	55-59.99	5
C	50-54.99	4
D	45-49.99	3
E	40-44.99	2
F(Fail)	39.99 & below	1