POOL OF DISCIPLINE SPECIFIC ELECTIVES (DSE) COURSES

SEM VI

ZOOLOGY- DSE-14: Nanobiotechnology
ZOOLOGY- DSE-15: Human Endocrinology
ZOOLOGY- DSE-16: Toxicology
ZOOLOGY- DSE-17: Research Methodology

DISCIPLINE SPECIFIC ELECTIVES (DSE-14): Nanobiotechnology
Zoo-DSE-14

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Nano-biotechnology Zoo-DSE-14	**04**	**03**	**Nil**	**01**	**Passed Class XII with Biology/ Biotechnology**	**NIL**

Learning Objectives

The learning objectives of this course are as follows:

- to make the students aware of concept of Nanobiotechnology.
- to acquire the knowledge to introspect and understand the core concepts of nanotechnology.
- to equip the students with the concepts of biotechnology required for understanding the behaviour of nano-biomaterials.
- to develop a holistic understanding of the complex cellular processes occurring after treatment with nanoparticles.
- to provide in-depth knowledge of the body's response to nanotherapeutics.
- to appreciate the potential benefits and challenges of nanomedicine.

Learning Outcomes

By studying this course, students will be able to

- better understand the basics of nanobiotechnology and the nanoscale paradigm in terms of properties at the nanoscale dimension.
- acquire skills to optimize the synthesis of nanoparticles.
- appreciate the interaction between biomolecules and nanoparticle surfaces and theirapplications.
- analyze the process of nanoparticle internalization inside the cell and to evaluate

the process and interactions of nanoparticles within the cells.

- better understand the practical, real world biosensing technologies such as enzyme-based biosensors.
- ability to understand the ethical, societal responsibilities and identify the risk assessments involved in using bio-nanobiomaterials.
- to provide a critical and systematic understanding of cutting-edge technology at the forefront.

SYLLABUS OF DSE-14

UNIT- 1: Introduction to Nanobiotechnology, **2 hrs**

Overview of nanobiotechnology - timelines and progress.

UNIT- 2: Fundamentals of Nanobiomaterials **12 hrs**

Properties of Materials: Bulk materials *vs* nanomaterials, Biomaterials and synthetic materials; Types of nanocarriers/nanoparticles: Metals, Lipids, Polymeric nanoparticles (Liposomes, polymeric micelles, quantum dots, iron nanoparticles, carbon nanotubes), nanoscale assembly of microorganisms (virus, diatoms, bacteria); Nanofabrication: Top-down- Ball Milling; Bottom- up approaches-synthesis of metal oxides by green synthesis and chemical synthesis; nano-herbal formulations.

UNIT -3: Nanocarriers for Drug Delivery **10 hrs**

Drug Delivery Systems (DDS): Oral delivery, Systemic delivery, Controlled drug release; Transdermal drug delivery (Examples: Intranasal Drug Delivery and Ocular Drug Delivery); Active and passive nanocarriers- Concept of targeting, Multifunctional Nanoparticles: Inorganic and organic nanoparticles and their biomedical applications; Improvements in pharmacokinetics, bioavailability, biodistribution.

UNIT- 4: Applications of Nanobiotechnology **14 hrs**

Health and Diseases - Infectious and chronic diseases; Vaccines - Lipid nanoparticles, Viral nanoparticles

Diagnostics: Enzyme Biosensors and Diagnostics, DNA-Based Biosensors and Diagnostics, nano-immunosensors. Improved diagnosis by *in vivo* imaging- detection of tumours and genetic defects.

Environmental Pollution: Environmental Nanoremediation Technology- Thermal, Physico-Chemical and Biological Methods, nanofiltration for treatment of waste removal of organics, inorganics and pathogens.

UNIT- 5 Nanotoxicity: **7 hrs**

Basics of cellular toxicity: Effect of size, shape, surface properties and composition on the toxicity of nanoparticles; genotoxicity and carcinogenicity – Mechanisms and

Tests. Risk assessment of Nanoparticle exposure, Prevention and control of nanoparticles exposure.

Practical **(30 hrs)**

(Laboratory periods: 15 classes of 2 hours each)

1. Biosynthesis of nanoparticles: plants/microbial and its follow up with visible spectroscopy.
2. Synthesis of Iron oxide nanoparticles by using chemical methods.
3. Characterization of nanoparticles: Electron microscopy (scanning and transmission), atomic force microscopy; nanoparticle analyzer, zeta potential measurement, spectroscopic techniques including spectrophotometer.
4. Cell counting and cell viability study of a non-adherent cell (Hepatocyte) culture.
5. Antibacterial studies of nanoparticles by minimum inhibitory concentration (MIC) method.
6. Isolation of DNA and demonstration of apoptosis by DNA fragmentation.
7. Study of cell and nanoparticle interaction (Video demonstration).
8. Enzyme-based biosensors, e.g., the blood glucose sensor (Video demonstration).
9. Array-based DNA "biochip" sensors with fluorescence detection (video demonstration).

Essential/recommended readings

1. Niaounakis, M. (2015) "Biopolymers: Applications and Trends", 1st Edition, Elsevier.
2. Guterres, N., Silvia S., Alves, O. L. (Eds.) (2014) Nanotoxicology: Materials, Methodologies, and Assessments, Springer New York, USA.
3. Hillery, A. M.et al. (2010) "Drug Delivery and Targeting", CRC Press.
4. Torchillin, V. (2006) Nanoparticulates as Drug Carriers, Imperial College Press,

Suggestive readings

1. Kesharwani, P., Singh, K. K. (Eds) (2021) Nanoparticle Therapeutics: Production Technologies, Types of Nanoparticles, and Regulatory Aspects; Academic Press Inc.

2. Pieter Stroeve and Morteza Mahmoudi (2018) Drug Delivery Systems, World Scientific Series: From Biomaterials towards Medical Devices, Vol I.

3. Mao Hong Fan, Chin-Pao Huang, Alan E Bland, Z Honglin Wang, Rachid Sliman, Ian Wright. (2010) Environanotechnology; Elsevier.

4. N. Yao and Z. L. Wang, Handbook of Microscopy for Nanotechnology, Springer New York, NY (2005).

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.