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RESEARCH ARTICLE

NEED TO EMBED EMERGING INTERDISCIPLINARY FRONTIERS OF NANOBIOTECHNOLOGY IN CORE CURRICULA OF INDIAN UNIVERSITIES AND COLLEGIATE SCIENCE

***Dr. Asha Gupta**

Department of Chemistry, Govt. Meera Girls College, Udaipur - 313001, Rajasthan

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ABSTRACT

The continuation of archaic Science Syllabi in State universities and collegiate system in India has become a matter of deep concern. Graduates and Post graduates are without technical skills, creativity, comprehension and futuristic vision. They are not only unemployable, but untrainable. Interdisciplinary programs of teaching and training can reverse this malaise. Initially, Nanotechnology and Biotechnology were treated as separate emerging frontiers of science and technology. However, with increasing volume of information, the two are wedded to become the holistic pivot of channelising new knowledge. *Nanobiotechnology* has numerous, albeit ever expanding components. They relate to issues of development of strategic defense equipment; agriculture, veterinary and biomedical sciences, atomic and sub- atomic sciences, engineering (all sections) etc. There is the need to develop coherent and linked curricula from 10+2 to P.G. level that entails foundation aspects of Nano-biotechnology; and incorporates basic instrumentation training. The areas need to be identified for the purpose of streamlining the curricula, for imparting practical training. This will enable the youth of country to find employment in defense industry, biomedical science, agriculture, engineering etc. New areas of entrepreneurship will also open. This would be globally competitive.

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INTRODUCTION

State universities and collegiate system in India have not been able to include the emerging frontiers of science and technologies for conceptual learning and practical training in their syllabi. This deficit has an impact on students in terms of their knowledge, information, creativity and futuristic vision. The two most important areas that have emerged as interdisciplinary subjects separately are Nanotechnology and Biotechnology[1]. However, in recent times both have grown so much that they have merged into each other as Nanobiotechnology. This has inroads into physical and life sciences and all disciplines of engineering. Nanobiotechnology is a front line area which should be included in undergraduate B.Sc., (I - III year) and post graduate syllabi (special paper) of Indian Universities and colleges. Instrumentation and techniques should be an integral part of such courses. These areas include preparation of nano structures of different kinds and different applications in electronics, information technology, defense studies, agriculture, biomedical science and genomic research etc.

Corresponding author:* **Dr. Asha Gupta,
Department of Chemistry, Govt. Meera Girls College, Udaipur - 313001, Rajasthan.

The object of this presentation is to emphasize the importance of Molecular Nanobiotechnology as a model to be included as introductory as well as an advance course at graduate and post graduate level. It should, however, be clear that there are numerous other areas which can be picked up and used for formation of new syllabi under the domain of a multidisciplinary nanobiotechnology course.

Molecular Nanobiotechnology: involves construction of nanomaterial of different elements, with diverse functional and structural applications[2-4] Manipulation of genetic material; construction of new genome with known properties can have astounding effect on production of biological life in all ecosystems. Similarly, such nano scale material can have unique applications in mechanical engineering, electronics, etc. This course be designed to give information, knowledge and application from 10+2 to P.G. Suitable laboratory skills be marked for practical training e.g. preparation of single molecules; preparation of supramolecules of specific configuration by assembling single molecules of different structure, properties and functions. Preparation of nanotubes, nanocylinders, nanosquares, nanorods, nanopolygons, and nanoparticles, nanocrystals, preparation of molecular switches. DNA nanotechnology has widespread application in

biotechnology, clinical research; pharmaceutical science etc. Synthesis of inorganic and organic molecules of well defined shapes, structure and function has opened up enormous possibilities of science and technology. Enlightening students about the concept of 'dip pen' nano-lithography to deposit a chemical upon a surface in a desired pattern. Molecular "Beam Epitoxy" –a technique that allows for bottom up assemblies of molecules, e.g. semiconductor material used in chip and computing applications etc. Ideas about fabricating micro processes Biotechnology is concerned with use of biomolecules for applications in nanotechnology e.g.

Viruses, lipid assemblies, Nanocellulose, Construction of nano-robots which can be used in medicine, Nanomterials can be used in electronic, biomedical, drug delivery and bio sensor applications. Similar contents can be developed for other courses. A proposed syllabi for B.Sc. is appended as an annexure

Nanobiotechnology Syllabus

B.Sc. I Year: Unit I. Introduction to Nanotechnology and Nanobiotechnology. Basic concepts of nanoscience and nanotechnology – quantum size and scale of nanoparticles, biological nano devices.

Potential uses of these technologies.

Unit II. Biochemical principle of nanobiotechnology, nanomaterials, their size, semi conducting properties and biological uses. Unit III. Construction of nano machines, the raw materials, chemical study of metal nano crystals by reduction, sol-gel synthesis, micro emulsions or reverse micelles, thermolysis routes, microwave heating synthesis, sonochemical synthesis, electrochemical synthesis, photochemical synthesis, synthesis in super critical fluids. Unit IV. Biosensors, biochips, metallic implant materials (stainless steel, cobalt-based and titanium based alloys), polymeric implant materials (polyamides, polypropylene, acrylic resins, hydro gels), Unit IV. Tissue replacements, skin implants, tissue engineering – biomaterials for organ replacement (bone substitutes).

B. Sc. II Year: Unit I. Mechanistic analysis of biological processes, technical approach study electric / electronic (electromechanical stimulations, capacitors, energy storage / batteries). Unit II. Optical (absorption, luminescence, photochemistry), thermal (thermo mutability, thermal management). Unit III. Biological (how cells interact with nanomaterials), molecular (flaws / defects, biosensing, biological mechanism e.g. mechanosensing. Unit IV. Nanoscience of disease (genetic disease, cancerous (organ / tissue failure), computing (DNA computing) agriculture (target delivery of particles, hormones and fertilizers). Unit V. Synthetic and technological applications in nanobiotechnology. Therapy – RF therapy, photo thermal therapy, ultra sound, MRI, imaging techniques, quantum dot methods, UV, fluorescence, phosphorescence, oncology, dialysis, ferromagnetic effect, tissue engineering nanorobots, nanomedicines, stem cell culture, biopolymer design, lipid gel therapy.

B.Sc. III Year: Unit I. Techniques and instrumentation – principles of SEM, TEM, AFM, scanning near field optical microscopy (SNOM), scanning ion conducting microscopy (SCIM), X-ray diffraction, neutron diffraction, and electron diffraction. Unit II. Spectroscopy – Fourier transform spectroscopy (FTIR), UV and visible spectroscopy. Unit III. Thermo gravimetric analysis (TGA), differential thermal analysis (DTA), differential scanning calorimetry (DSC), arthroscopy, dynabeads. Unit IV. Nanobiotechnology – multidisciplinary activities Imaging, Sensing, Blood Purification, Tissue engineering, Medical Devices. Unit V. Regulations and ethics. Future scope.

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