

4-Week Offline Workshop on Nanotechnology and Its Applications in Biology

For Undergraduate Students in Biology, Biotechnology, and Chemistry

Workshop Overview

This **4-week hands-on workshop** provides an in-depth exploration of **nanotechnology and its applications in biological sciences**. Students will gain **theoretical knowledge, hands-on laboratory experience, and exposure to nanomaterial characterization techniques**. The workshop covers **nanoparticle synthesis, drug delivery systems, biosensors, nanotoxicology, and biomedical applications**.

By the end of the workshop, students will be equipped with the foundational knowledge and practical skills needed for **nanobiotechnology research, biomedical applications, and industry-oriented careers**.

Workshop Structure & Study Design

Week 1: Fundamentals of Nanotechnology & Nanomaterial Synthesis

✦ **Objective:** Understanding the fundamental concepts and synthesis of nanomaterials.

Topics Covered

- **Introduction to Nanotechnology & Nanobiotechnology**
 - Definition, history, and scope in **biomedicine, agriculture, and pharmaceuticals**.
 - Overview of **nanomaterials** (metal, carbon, polymeric, quantum dots, dendrimers, liposomes, etc.).
- **Synthesis Methods for Nanomaterials**
 - **Top-down vs. Bottom-up approaches**.
 - Green synthesis of nanoparticles using **plant extracts, microbes, and biomolecules**.
 - Chemical and physical synthesis of **gold/silver nanoparticles and quantum dots**.
- **Characterization of Nanoparticles**
 - **UV-Vis Spectroscopy** for nanoparticle confirmation.
 - **DLS (Dynamic Light Scattering)** for size analysis.
 - **TEM/SEM imaging** (theory and demonstration).

 **Hands-on Activities:**

- ✓ **Green synthesis of silver/gold nanoparticles using plant extracts.**
 - ✓ **UV-Vis spectroscopy analysis of synthesized nanoparticles.**
 - ✓ **Assignment:** Interpret spectroscopy data of synthesized nanoparticles.
-

Week 2: Nanoparticles in Drug Delivery & Cancer Therapy

✦ **Objective:** Understanding how nanotechnology is revolutionizing **targeted drug delivery and cancer treatment.**

Topics Covered

- **Nanocarriers for Drug Delivery**
 - Liposomes, dendrimers, micelles, and polymeric nanoparticles.
 - Drug encapsulation techniques and release mechanisms.
- **Nanotechnology in Cancer Therapy**
 - Gold & silver nanoparticles for **photothermal therapy.**
 - Magnetic nanoparticles for **hyperthermia-based cancer treatment.**
- **Targeted Drug Delivery Using Nanotechnology**
 - Functionalization of nanoparticles with **antibodies and ligands.**
 - Role of **biodegradable nanomaterials** in medicine.

 **Hands-on Activities:**

- ✓ **Preparation of a liposome-based drug delivery system.**
 - ✓ **Encapsulation of a model drug into nanoparticles and release kinetics analysis.**
 - ✓ **Assignment:** Propose a nanoparticle-based therapy for a specific disease.
-

Week 3: Nanobiosensors & Diagnostic Applications

✦ **Objective:** Exploring the role of nanotechnology in diagnostics, biosensors, and imaging techniques.

Topics Covered

- **Principles of Nanobiosensors**
 - Electrochemical, optical, and magnetic biosensors.
 - Role of **gold/silver nanoparticles in biosensing.**
- **Nano-based Detection of Biomolecules**
 - Development of **lateral flow assays (LFA)** (e.g., pregnancy test kits, COVID-19 rapid tests).
 - Surface plasmon resonance (SPR) for biomolecular detection.
- **Biomedical Imaging & Theranostics**
 - MRI contrast agents & **quantum dots for fluorescence imaging.**
 - Role of **nanoparticles in real-time disease monitoring.**

Hands-on Activities:

- ✓ **Fabrication of a simple gold nanoparticle-based biosensor.**
 - ✓ **Demonstration of lateral flow assay for biomolecule detection.**
 - ✓ **Assignment:** Design a nano-based biosensor for a specific biomarker.
-

Week 4: Nanotoxicology, Environmental Impact & Future Prospects

✦ **Objective:** Understanding the **safety concerns, regulatory aspects, and future trends** of nanotechnology in biology.

Topics Covered

- **Nanotoxicology & Safety Concerns**
 - Interaction of nanoparticles with **cells, tissues, and organs.**
 - Cytotoxicity assays & in vitro evaluation methods.
- **Environmental & Ethical Concerns of Nanotechnology**
 - Biodegradability & toxicity of nanomaterials.
 - Government regulations (FDA, EPA, EU guidelines).
- **Future of Nanobiotechnology**
 - Next-generation **nano-medicine, tissue engineering, and bio-nanomachines.**
 - CRISPR-nanoparticle-based gene therapy.

Hands-on Activities:

- ✓ **Cytotoxicity assessment of nanoparticles using an MTT assay.**
 - ✓ **Literature discussion on recent nanobiotechnology innovations.**
 - ✓ **Final Project:** Propose a nanotechnology-based solution for a biomedical or environmental challenge.
-

Expected Outcomes of the Workshop

- ✓ **Practical knowledge of nanoparticle synthesis and characterization techniques.**
 - ✓ **Understanding of drug delivery mechanisms and biomedical applications.**
 - ✓ **Hands-on experience in biosensor development and diagnostic tools.**
 - ✓ **Ability to evaluate nanotoxicology and environmental impacts.**
 - ✓ **Preparation for careers in nanobiotechnology, pharma, and research sectors.**
-

How to Register?

✉ Email: [Your Email]

☎ Phone: [Your Contact Number]

🌐 Website: [Your Website]

8-Week Offline Internship on Nanotechnology and Its Applications in Biology

For Undergraduate Students in Biology, Biotechnology, and Chemistry

Internship Overview

This **8-week hands-on internship** provides in-depth knowledge and laboratory experience in **nanotechnology and its applications in biology**. The program covers the **synthesis, characterization, and biomedical applications of nanomaterials**, focusing on **drug delivery, biosensors, disease diagnostics, nanotoxicology, and environmental applications**.

Students will gain **extensive hands-on training in nanoparticle synthesis, surface functionalization, bio-nano interactions, and real-world applications in healthcare and environmental biotechnology**.

Internship Structure & Study Design

Week 1: Introduction to Nanotechnology & Basics of Nanomaterials

✦ **Objective:** Understanding nanotechnology fundamentals and different nanomaterials used in biological applications.

Topics Covered

- **Introduction to Nanotechnology & Its Importance in Biology**
 - Definition, scope, and applications in medicine, agriculture, and environmental sciences.
 - Types of **nanomaterials**: Metallic, polymeric, carbon-based, quantum dots, dendrimers, and liposomes.
- **Properties of Nanomaterials**
 - Size-dependent properties of nanoparticles.
 - Surface area-to-volume ratio and its biological implications.

Hands-on Activities:

- ✓ **Introduction to laboratory safety & nanomaterial handling.**
 - ✓ **Demonstration: Morphological & optical properties of nanoparticles.**
 - ✓ **Assignment:** Research and present on recent advancements in nanobiotechnology.
-

Week 2: Synthesis of Nanomaterials for Biological Applications

✦ **Objective:** Learning **top-down and bottom-up approaches** to synthesize nanoparticles for biomedical use.

Topics Covered

- **Synthesis of Nanoparticles**
 - Physical, chemical, and biological (green synthesis) methods.
 - Green synthesis of nanoparticles using **plant extracts, bacteria, and fungi**.
- **Surface Modification & Functionalization**
 - Role of surfactants and stabilizing agents.
 - Functionalization of nanoparticles with **antibodies, drugs, and ligands**.

Hands-on Activities:

- ✓ **Synthesis of gold and silver nanoparticles using plant extracts.**
 - ✓ **Chemical synthesis of iron oxide nanoparticles for drug delivery.**
 - ✓ **Assignment:** Compare the efficiency of different synthesis methods.
-

Week 3: Characterization Techniques for Nanomaterials

✦ **Objective:** Learning **analytical techniques** for nanoparticle characterization.

Topics Covered

- **Characterization Techniques**
 - **UV-Vis Spectroscopy** for nanoparticle confirmation.
 - **Dynamic Light Scattering (DLS)** for size and zeta potential measurement.
 - **Scanning Electron Microscopy (SEM) & Transmission Electron Microscopy (TEM)** for structural analysis.
 - **X-ray Diffraction (XRD) & Fourier Transform Infrared Spectroscopy (FTIR)** for crystallinity and functional group analysis.

Hands-on Activities:

- ✓ **UV-Vis spectroscopy for gold and silver nanoparticle confirmation.**
 - ✓ **Demonstration of SEM/TEM for nanoparticle morphology analysis.**
 - ✓ **Assignment:** Interpretation of characterization data.
-

Week 4: Nanotechnology in Drug Delivery & Cancer Therapy

✦ **Objective:** Exploring **nanocarriers and targeted drug delivery mechanisms**.

Topics Covered

- **Nanocarriers for Drug Delivery**
 - Liposomes, polymeric nanoparticles, and dendrimers.
 - Controlled drug release mechanisms.

- **Cancer Nanomedicine & Photothermal Therapy**
 - Gold nanoparticles for **targeted cancer therapy**.
 - Magnetic nanoparticles in **hyperthermia-based cancer treatment**.

 **Hands-on Activities:**

- ✓ **Encapsulation of a model drug into nanoparticles and its release kinetics.**
 - ✓ **Development of a gold nanoparticle-based drug carrier for cancer treatment.**
 - ✓ **Assignment:** Propose a nanoparticle-based drug delivery system for a specific disease.
-

Week 5: Nanotechnology in Diagnostics & Biosensors

✦ **Objective:** Understanding **nano-biosensors for disease detection**.

Topics Covered

- **Nanobiosensors for Disease Detection**
 - Principles of electrochemical and optical biosensors.
 - Development of **lateral flow assays (LFA)** (e.g., COVID-19, pregnancy test kits).
- **Nanoparticles in Biomedical Imaging**
 - Quantum dots and magnetic nanoparticles for disease imaging.
 - Surface-enhanced Raman scattering (SERS) for biomolecule detection.

 **Hands-on Activities:**

- ✓ **Fabrication of a gold nanoparticle-based biosensor.**
 - ✓ **Demonstration of a lateral flow assay for biomarker detection.**
 - ✓ **Assignment:** Design a nanotechnology-based diagnostic tool for a selected disease.
-

Week 6: Nanotoxicology & Environmental Applications

✦ **Objective:** Evaluating **nanotoxicity and its impact on human health & the environment**.

Topics Covered

- **Nanotoxicology & Safety Concerns**
 - Cytotoxicity assays for evaluating biocompatibility.
 - **Biodistribution & elimination** of nanoparticles from the body.
- **Environmental Applications of Nanotechnology**
 - Role of nanomaterials in **water purification & pollution control**.
 - Use of nanotechnology in **agriculture and food safety**.

 **Hands-on Activities:**

- ✓ **Cytotoxicity assay (MTT assay) to determine nanoparticle biocompatibility.**

- ✓ **Demonstration of nanomaterial-based water purification methods.**
 - ✓ **Assignment:** Discuss the ethical and environmental implications of nanotechnology.
-

Week 7: Emerging Trends & Real-World Applications

✦ **Objective:** Understanding recent developments in **bio-nanotechnology & tissue engineering.**

Topics Covered

- **CRISPR-nanoparticle-based gene editing.**
- **3D bioprinting using nanomaterials for tissue engineering.**
- **Nanorobots for precision medicine.**

Hands-on Activities:

- ✓ **Literature discussion on cutting-edge nanomedicine advancements.**
 - ✓ **Presentation on latest nano-based therapeutics.**
 - ✓ **Assignment:** Develop a research proposal on an emerging nanotechnology application.
-

Week 8: Final Research Project & Career Guidance

✦ **Objective:** Applying acquired knowledge to **independent projects & career preparation.**

Final Research Project

- Each student will design and execute a **mini-research project** using nanotechnology in biology.
- **Presentation & Report Submission** on research findings.

Career Guidance Session

- **Opportunities in Nanotechnology Research & Industry.**
- Resume writing, internships, and job prospects in nanobiotechnology.

Final Assessment & Certification

- ✓ **Presentation of final projects.**
 - ✓ **Submission of lab reports & project findings.**
 - ✓ **Awarding of certificates upon successful completion.**
-

Expected Outcomes of the Internship

- ✓ **Comprehensive knowledge of nanotechnology principles and biological applications.**
- ✓ **Hands-on experience in nanoparticle synthesis, characterization, and functionalization.**
- ✓ **Understanding of nanomedicine, biosensors, diagnostics, and environmental nanotechnology.**
- ✓ **Ability to conduct nanotoxicity studies and propose sustainable nano-based solutions.**
- ✓ **Preparation for careers in research, pharma, biomedical industries, and academic pathways.**

How to Register?

✉ Email: **[Your Email]**

☎ Phone: **[Your Contact Number]**

🌐 Website: **[Your Website]**