

9th Workshop on Artificial Organs, Biomaterials and Tissue Engineering

OBI - ARARAQUARA



Engineering of Nanoporous and Nanostructured Materials for Biological Applications

This short course aims to present the fundamental principles and recent advances in the engineering of nanoporous and nanostructured materials for biological applications, emphasizing the relationship between synthesis methods, structural properties, and functional performance.

The program is organized into three main thematic areas:

1. Fundamentals of Nanoporous Material Preparation and Characterization

Topics include:

- Sol-gel synthesis routes;
- Templating strategies;
- Synthesis of hybrid materials;
- Practical demonstration of supercritical drying for the production of hybrid and biopolymeric aerogels.

2. Introduction to Metal–Organic Frameworks (MOFs)

Topics include:

- Principles of MOF design and construction;
- Synthesis methodologies;
- Functionalization strategies;
- Applications in drug delivery systems;
- Biomolecule encapsulation;
- Biosensing technologies.

3. Photoactive Nanostructured Materials

Topics include:

- Semiconductor nanomaterials;
- Plasmonic nanoparticles;
- Photonic structures;
- Light–matter interaction mechanisms;
- Applications in optical biosensors;
- Biomedical imaging;
- Light-assisted therapeutic approaches.

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The course methodology combines theoretical instruction with an applied perspective, utilizing recent literature examples and case studies to illustrate the development of functional materials for biological applications.

Whenever feasible, an experimental demonstration of the supercritical drying process will be incorporated into the course, allowing participants to gain practical insight into aerogel fabrication and the relationship between processing conditions and structural properties.

Interactive discussions will be encouraged throughout the course, fostering critical analysis and the development of material-based solutions to current challenges in biological and biomedical applications.

Objective

To introduce the principles of nanoporous and nanostructured materials engineering and their application in the development of functional systems for biological and biomedical contexts.

Expected Outcomes

Upon completion of the course, participants are expected to be able to:

- Identify different classes of nanoporous and nanostructured materials and their synthesis routes;
- Correlate material structure, porosity, and physicochemical properties with specific biological applications;
- Understand the potential of aerogels, Metal–Organic Frameworks (MOFs), and photoactive nanomaterials in biomedical systems;
- Critically evaluate material development strategies for biological and biomedical applications.

Instructors

The course will be taught by the following researchers:

- Elias Paiva Ferreira Neto – Assistant Professor at the Institute of Chemistry of UNESP and specialist in nanoporous materials.
- Sidney José Lima Ribeiro – Full Professor at the Institute of Chemistry of UNESP, CNPq Research Fellow (Level 1A), and specialist in nanostructured and photoactive materials, including biological applications.
- Roberta Pugina – Postdoctoral Researcher at the Institute of Chemistry of UNESP and specialist in photoactive nanostructured materials based on biopolymers and inorganic nanoparticles.
- Marina Abuçafy – Postdoctoral Researcher at the Institute of Chemistry of UNESP and specialist in MOF-based materials and nanostructures for biological applications.