Eunice EUROPEAN UNIVERSITY

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EUROPEAN UNIVERSITY FOR CUSTOMISED EDUCATION

STUDY GUIDE

Advanced Pulmonary Drug Delivery: Nanomedicine-based Strategies against Antimicrobial Resistance

Organised by

University of Mons (Umons)

b-tu Brandenburg University of Technology Cottbus - Senftenberg · UC Universidad de Cantabria · Università di Catania · Université Polytechnique Hauts-de-France · UMONS University of Mons · University of the Peloponnese · Vaasan yliopisto University of Vaasa · Politécnico de Viseu

1. IDENTIFYING DATA.	
· Course Name.	Inhaled Nanomedicine & the Challenges of Antibiotic Resistance: from Nanocarriers to Biofilm.
· Coordinating University.	University of Mons (UMONS).
· Partner Universities Involved.	/
· Course Field(s).	Pharmaceutical Sciences, Nanotechnology, Microbiology, Public Health.
· Related Study Programme.	Master in Biomedical Sciences; Master in Pharmaceutical Sciences; Master in Health Sciences; Master in Bio-engineering and Master in chemistry
· ISCED Code.	ISCED 7
· SDG.	3.Good Health and well-being 4. Quality education 17. Partnerships for the goals
· Study Level.	M
· EUNICE Key Competencies	• Green – strongly • Orange - moderately • Red – partially • Blank cell - not at all

Problem solving	
Teamworking	
Communication	
Self-management	
Cognitive flexibility	
Digital competence	
Technical competence	
Global intercultural competence	

· Number of ECTS credits allocated.	4
· Mode of Delivery.	Online self-study and online live
· Language of Instruction.	English
· Course Dates.	30/10/26 → 18/12/2026
· Precise Schedule of the Lectures.	2-hour synchronous sessions every Friday for 8 weeks (16 contact hours total). The remaining 14 hours are dedicated to asynchronous self-study and project preparation.
· Key Words.	Inhaled Nanomedicine; Antibiotic Resistance (AMR); Biofilms; Drug Delivery Systems; Nanotechnology.
· Catchy Phrase.	I discovered how nanomedicine solve giant problems by outsmarting bacterial resistance in the lungs.

· Prerequisites and co-requisites.	**Study levels:** Available for Master (M) and Doctorate (D) students in Pharmaceutical Sciences, Biomedical Sciences, Chemistry, or Biology. **Required knowledge:** Basic background in microbiology, biochemistry, or pharmacology. **Required linguistic skills:** Minimum B2 level in English (CEFR) to follow lectures and participate in oral presentations.
· Number of EUNICE students that can attend the Course.	30 students total (to ensure interactive presentation sessions).
· Number of EUNICE students that can attend the course per institution	3
· Course inscription procedure(s).	Standard EUNICE registration process

2. CONTACT DETAILS.	
· Department.	Department of Galenic and biopharmacy
· Name of Lecturer.	Imane Abidli
· E-mail.	Imane.abidli@umons.ac.be
· Other Lecturers.	Francis Vanderbist

3. COURSE CONTENT.
This course explores the critical intersection between nanotechnology and infectious pulmonary diseases. The program is divided into two phases:

1. **Theoretical Phase (5 weeks):** In-depth study of nanocarriers (liposomes, polymeric, lipid nanoparticles…), aerosol physics, and pulmonary biological barriers (mucus, macrophages). A special focus is placed on the pathophysiology of bacterial biofilms and resistance mechanisms.
2. **Seminar Phase (3 weeks):** "Journal Club" sessions and project presentations where students design innovative nanotechnological solutions to address real-world clinical challenges. The course adopts a "research-led teaching" approach, allowing students to engage with cutting-edge concepts derived from current doctoral research.

4. LEARNING OUTCOMES.

Upon completion of this course, students will be able to:

- **Identify and compare** different classes of nanoparticles based on their physicochemical properties and loading capacity.
- **Calculate and optimize** lung deposition parameters (aerodynamic diameter) to target specific alveolar or bronchial areas.
- **Diagram** the interaction mechanisms between nanoparticles and the extracellular matrix of biofilms.
- **Critically evaluate** recent research articles by identifying technological bottlenecks and the limitations of *in vitro*/*in vivo* models.
- **Design** a comprehensive formulation strategy for a specific antibiotic, including the choice of carrier, synthesis method, and inhalation device.

5. OBJECTIVES.

The main objectives of this module are:

- To provide a comprehensive understanding of next-generation **pulmonary drug delivery systems**.
- To raise awareness of the global challenge of **Antibiotic Resistance (AMR)** and the crucial role of nanomedicine in restoring treatment efficacy.
- To develop **experimental design** skills by confronting students with real biological barriers (mucus, mucociliary clearance).
- To foster **international teamwork** and scientific communication through oral presentations and digital posters.
- To create a bridge between academic teaching and **active doctoral research**.

6. COURSE ORGANISATION.

UNITS

1.	Nanotechnology Fundamentals: Comprehensive classification of nanocarriers (Liposomes, Polymers, Lipid and Metallic NPs), their synthesis, and specific physicochemical properties.
2.	Pulmonary Delivery Systems: Mechanisms of lung deposition (impaction, sedimentation, diffusion), aerosol physics, and technical operation of nebulizers, DPIs, and pMDIs.
3.	Overcoming Biological Barriers & Biofilms: Impact of the mucus layer, macrophage evasion, and the pathophysiology of bacterial biofilms in the context of Antimicrobial Resistance (AMR).
4.	Smart Design & Clinical Translation: Stimuli-responsive release, targeted therapies, nanotoxicology, and regulatory pathways from lab research to clinical applications.

LEARNING RESOURCES AND TOOLS.

Scientific Databases: PubMed, ScienceDirect, Web of Science… for literature reviews.
Course Materials: Interactive digital slides and recorded Friday lectures.
Design Tools: Graphic design software (e.g., BioRender or Inkscape) for scientific poster creation.
Case Studies: Recent high-impact research articles and clinical trial reports.

PLANNED LEARNING ACTIVITIES AND TEACHING METHODS.

Lectures: 2-hour sessions held every Friday focused on theory and research-led data.
Seminar-style Presentations: "Journal Club" where students present and critically evaluate recent papers.
Independent Research Project: Asynchronous work dedicated to designing a nanoparticle-based solution for a specific AMR challenge.
Interactive Q&A: Collaborative debate on current technological bottlenecks in inhaled therapies.

7. ASSESSMENT METHODS, CRITERIA AND PERIOD.

Assessment Methods: The course is **Graded**. Evaluation is based on an **Oral Presentation** of a "Nano-Solution" project (50%) and a **Written Summary/Poster** (50%).
Criteria: Technical accuracy of the formulation, critical analysis of biological barriers, innovation in targeting strategies, and quality of scientific communication.
Period: Continuous assessment during the final 3 seminar sessions of the semester.

OBSERVATIONS.

This module is designed using a **research-led teaching approach**, directly integrating data from current PhD research at UMONS.
Active attendance is required to facilitate intercultural exchange and peer-review between EUNICE partner students.

8. BIBLIOGRAPHY AND TEACHING MATERIALS.

Core Literature (Required Reading)

- Global Context of Antibiotic Resistance: Brown, E. D., & Wright, G. D. (2020). *Antibacterial drug discovery in the resistance era*. Nature Reviews Microbiology. https://www.nature.com/articles/s41579-020-0420-1
- Fundamentals of Nanotechnology in Medicine: Patra, J. K., et al. (2018). *Nano based drug delivery systems: recent developments and future prospects*. Journal of Nanobiotechnology. https://link.springer.com/article/10.1186/s12951-018-0392-8
- Advanced Biological Mechanisms (PhD Focus): [Reference Article], (2025). *Mechanistic insights into advanced drug delivery*. The FASEB Journal. https://faseb.onlinelibrary.wiley.com/doi/full/10.1096/fj.202502624R
- Pulmonary Drug Delivery Systems: Karami, S., et al. (2024). *Harnessing the Potential of Nanoparticles for Pulmonary Drug Delivery*. Pharmaceutics. https://pmc.ncbi.nlm.nih.gov/articles/PMC11223148/
- Biofilm Engineering and Treatment: [Current Trends], (2025). *Innovative strategies against bacterial biofilms*. Current Opinion in Biomedical Engineering. https://www.sciencedirect.com/science/article/pii/S2590097825000370
- Next-Generation Nanomaterials: [Advanced Research], (2025). *Emerging nanotechnological applications in healthcare*. Nanoscale. https://pubs.rsc.org/en/Content/ArticleLanding/2025/NR/D4NR04774E

Case Study (Recommended Reading)

- **Arikayce Case Study:** European Medicines Agency (EMA). *"Arikayce Liposomal: EPAR - Public assessment report"*. Available on the EMA official website.
- **Clinical Review:** Shirley, M. (2019). *"Amikacin Liposome Inhalation Suspension: A Review in Mycobacterium avium Complex Lung Disease"*. Drugs.

Teaching Materials

- **Lecture Slides:** Comprehensive slide decks provided by the lecturer after each Friday session via the EUNICE Moodle.
- **Scientific Databases:** Students are expected to use **scientific databases** for their independent research projects.
- **Software:** Recommended use of **BioRender** (free version) for the design of the final scientific poster.