Doctoral Programme in Nanosciences and Advanced Technologies

Main Features of the Programme

The Doctoral Programme in Nanosciences and Advanced Technologies aims to establish a broad teaching and research environment centred on nanosciences and the latest, most innovative chemical and physical technologies, particularly their applications in biomedicine, forensic sciences and materials science.
The Programme brings together long-established scientific and research areas in chemistry, physics and biology at the University of Verona with the most advanced developments in biomedical morphology/morphometry and forensic sciences. Within this framework, particular emphasis is placed on nanosciences and nanotechnologies, whose highly innovative areas of application are attracting considerable international attention. It is worth noting that many faculty members at the University of Verona have already been conducting research in these fields for several years. The strong integration of basic and clinical/applied disciplines enables the development of highly innovative multidisciplinary training pathways with strong employment prospects, not only in academia but also in line with the needs of national and international labour markets in advanced-technology sectors.
The Doctoral Programme in Nanosciences and Advanced Technologies offers three closely integrated curricula, in terms of both teaching and theoretical and experimental research:
1. Morphological and Clinical Nanomedicine
2. Forensic Sciences and Technologies
3. Nanomaterials and Chemical, Physical and Analytical Technologies

Programme Objectives

The training offered by the Doctoral Programme in Nanosciences and Advanced Technologies is closely integrated with scientific research through shared lectures on topics of broad relevance, combined with tutorial-based activities on subjects specific to the three curricula. Research activities are likewise designed to promote specialisation in a given field while maintaining a high degree of interaction and integration among the various areas of knowledge, thereby ensuring a solid core of multidisciplinary expertise.
The foremost objective of doctoral training is therefore the acquisition of theoretical and experimental skills that foster critical thinking and a research mindset, enabling students to advance knowledge independently in frontier topics within their discipline. Students will develop an interdisciplinary/translational research approach spanning chemical, physical, biological, anatomical-morphological and forensic sciences. They will also learn to communicate their findings effectively to both the scientific community and industry.
Students will attend courses based on lectures and practical training, including within specific basic and/or applied research projects, some with a translational focus. Training in these areas

will provide direct experience in experimental design, experimental data collection and analysis, and the preparation of a report and/or scientific publication. In close coordination among the curricula, the training will also cover the communication of results (oral presentations at national and international conferences and the writing of scientific papers) and the procedures and methods for applying for research funding from public and private organisations.

Research Topics by Curriculum

Morphological and Clinical Nanomedicine

- Conventional and advanced *in vivo imaging* techniques for experimental, clinical and forensic biomedical investigation
- Advanced microscopy techniques for biomedical and nanobiotechnological applications
- Imaging techniques for anthropometry and the study of body composition

Forensic Sciences and Technologies

- New mass spectrometry techniques applied to chemical and forensic toxicology and genetic analysis
- New capillary electrophoresis and *massively parallel sequencing* technologies applied to forensic genetics
- New electrophoretic and electrokinetic technologies in forensic sciences
- Novel *biomarkers* of substance abuse
- Imaging in Medicine and Forensic Sciences

Nanomaterials and Chemical, Physical and Analytical Technologies

- Design and development of nanostructured materials as contrast agents for *multimodal imaging*
- Preparation and chemical, physical and electronic characterisation of thin films and thin-film devices for energy and biomedical applications (i.e. photovoltaic cells, sensors)
- Preparation and characterisation of biocompatible and biodegradable nanomaterials based on biopolymers for biomedical and environmental applications
- Design and development of luminescent molecules and materials for biomedical and technological applications
- Preparation and characterisation of nanostructured porous materials for energy, environmental and sensing applications
- Preparation of nanomaterials and characterisation of their interactions with biomolecules for biomedical applications
- Physics applied to cultural heritage and the environment: optical techniques (interferometry and imaging) for surface metrology and materials analysis

The overall three-year requirement is 40 ECTS credits.

1. *the three-year requirement for teaching activities organised by the School is 15 ECTS credits (5 ECTS credits per year for each of the three years of attendance). The School organises activities such as inter-, multi- and transdisciplinary training, advanced language and IT training, as well as activities relating to research management and valorisation.*
2. *the three-year requirement for activities organised by each doctoral programme is therefore 25 ECTS credits; each Academic Board is free to determine how these 25 ECTS credits are distributed over the three years. The School Council has retained the option for each Academic Board to award the additional 5 ECTS credits for 'elective training activities chosen by the doctoral candidate', agreed with the supervisor and approved by the Board.*

In view of the challenges posed by the transitional arrangements for doctoral candidates in the 39th and 40th cycles, whose teaching requirements have been changed while already underway, it is proposed that the 25 ECTS credits be allocated so as not to change the total number of teaching credits (School + Programme) to be earned in each of the three years, which until now has been 16+16+8.

Since the School's teaching-credit allocation is now 5+5+5, it is therefore proposed that the requirements relating to the Programme's teaching credits be distributed as 11+11+3, as shown in the following table:

1 ECTS credit = 4 hours of classes.

39th/40th cycle	1st year			2nd year			3rd year			Total
	Total	School	Doctoral Programme	Total	School	Doctoral Programme	Total	School	Doctoral Programme	
Teaching ECTS	16	5	11	16	5	11	8	5	3	40
Research ECTS	45			45			50			140
Total ECTS	60			60			60			180

*With regard to the allocation of the School's teaching credits for **doctoral candidates from the 41st cycle** onwards, the following arrangement is proposed (see table below):*

1 ECTS credit = 4 hours of classes.

39th/40th cycle	1st year			2nd year			3rd year			Total
	Total	School	Doctoral Programme	Total	School	Doctoral Programme	Total	School	Doctoral Programme	
Teaching ECTS	15	5	10	15	5	10	10	5	5	40
Research ECTS	45			45			50			140
Total ECTS	60			60			60			180

A minimum of 3 ECTS credits from Doctoral Programme courses remains required in both the first and second years, and 2 ECTS credits in the third year. Additional ECTS credits may be obtained from courses offered by other doctoral programmes (subject to approval by the tutor

and coordinator), up to a maximum of 2 ECTS credits per year from external doctoral programmes.

ECTS credits may also be earned through participation in Winter Schools/Summer Schools, conferences/workshops and seminars, according to the following scheme:

	ECTS/day	ECTS/hour
Summer/winter school	2	
Conference	2	
Seminar		0.5

Expected Career Opportunities

The Doctoral Programme in Nanosciences and Advanced Technologies responds to the growing demand for multidisciplinary and advanced scientific and technological expertise, combined with in-depth knowledge of relevant application areas and regulatory frameworks, including the ethical and bioethical issues that future researchers will encounter in their work.
Nanosciences and nanotechnologies are a highly important strategic field for modern technological applications. Their characteristically multidisciplinary and international nature fosters collaboration with prestigious international research institutions. High-level international scientific collaborations are already active among members of the Doctoral Programme's Academic Board.
Graduates of the programme primarily pursue careers in research: not only at universities, private institutions, and major European, national and international research infrastructures, but also within the extensive network of companies engaged in applied research and technological innovation in Italy and abroad. Nevertheless, the training offered by the Doctoral Programme in Nanosciences and Advanced Technologies also opens up new and interesting career opportunities as technology consultants for businesses, officials at government and European agencies, research valorisation and technology transfer specialists, and entrepreneurs.