



PhD in BIOINGEGNERIA / BIOENGINEERING - 40th cycle

Number of scholarship offered	5
Department	DIPARTIMENTO DI ELETTRONICA, INFORMAZIONE E BIOINGEGNERIA

Description of the PhD Programme
<p>The PhD Programme aims at developing scientific profiles who intend to practice their major activities in the field of Bioengineering. It addresses theoretical and experimental activities in 4 major research areas: Biomimetic Engineering and Micro-nano Technologies, Rehabilitation Engineering and Technology, Technologies for Therapy, and Physiological Modelling and non-Invasive Diagnostics. More specific areas include, but are not limited to: Molecular and cellular engineering, Biomaterials, Tissue engineering, Bio-artificial interfaces and devices, Neuro-prostheses, Movement analysis, Cardiovascular and respiratory system bioengineering, Central nervous system signal and image processing for rehabilitation, Biomechanics, Computational fluid dynamics, Computer assisted surgery and radiotherapy, Artificial organs, Implantable devices, Biomedical signal and image processing, E-Health, Bioinformatics, functional genomics and molecular medicine. Research focuses both on theoretical models, methods and technologies to support design of applications, software and hardware systems, together with tools and prototype device development. The involvement of industrial and clinical partners reinforces the mix between theory and application which is the strength of this PhD. Stage periods in distinguished research institutes in Italy and abroad are an essential feature of the PhD candidate training. Scientific and research activities of PhD Bioengineering candidates are strongly grounded on research laboratories located inside and outside the Departments in cooperation with other research institutions and university hospitals. Publications in scientific peer-reviewed journals, participation to international projects and the numerous collaborations confirm the excellence level of the activities carried out in this PhD programme.</p>



PhD in BIOINGEGNERIA / BIOENGINEERING - 40th cycle

OPEN SUBJECT Research Field: BIOINGEGNERIA / BIOENGINEERING

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0
In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	<p>The PhD programme in Bioengineering aims at developing scientific profiles who intend to carry on most of their professional activity in the field of Bioengineering. It addresses theoretical and experimental activities in four major research areas:</p> <ul style="list-style-type: none"> • Biomimetic Engineering and Micro-Nano Technologies • Rehabilitation Engineering and Technology • Technologies for Therapy • Physiological Modelling and non-Invasive Diagnostics. <p>More specific areas include, but are not limited to:</p> <ul style="list-style-type: none"> • Molecular and cellular engineering • Biomaterials • Tissue engineering • Bio-artificial interfaces and devices • Neuroprostheses • Movement analysis • Cardiovascular and respiratory system bioengineering • Central nervous system signal and image processing for rehabilitation • Biomechanics • Computational fluid dynamics • Computer assisted surgery and radiotherapy • Artificial organs • Implantable devices • Microfluidic and lab-on-a-chip systems • Biomedical signal and image processing



	<ul style="list-style-type: none"> • E-Health • Bioinformatics, functional genomics and molecular medicine • Artificial intelligence in medicine. <p>More information available at:https://www.phdbioengineering.polimi.it/</p>
<p>Methods and techniques that will be developed and used to carry out the research</p>	<p>Research focuses on theoretical models, methods and technologies to support the design of applications, software and hardware systems, together with tools and prototype device development. The involvement of industrial and clinical partners strengthens the mix between theory and application, which is the strength of this PhD programme. Internships at prestigious research institutes in Italy and abroad throughout the world are essential elements in the training of doctoral students. The scientific and research activities of doctoral students are strongly rooted in research laboratories located inside and outside the Departments, in collaboration with other research institutions and university hospitals.</p>
<p>Educational objectives</p>	<p>The supervisor and his research team support the development of the research. Seminars and courses encourage an interdisciplinary approach. The laboratory activity completes the research programme. Students are also encouraged to spend a period of study abroad (with the availability of additional financial support). More information available at: https://www.dottorato.polimi.it/en/</p>
<p>Job opportunities</p>	<p>Employment opportunities include research positions both in academic and private institutions, in Italy and abroad, and in industry. Spin-offs and startups from research results are encouraged. Employment in this sector offers several interesting opportunities.</p>
<p>Composition of the research group</p>	<p>17 Full Professors 24 Associated Professors 15 Assistant Professors 165 PhD Students</p>
<p>Name of the research directors</p>	<p>Any faculty member can act as research director</p>



Contacts

PhD Coordinator:

Prof. **Gabriele Dubini**

Dept. of Chemistry, Materials and Chemical Engineering "Giulio Natta"

email: gabriele.dubini@polimi.it

phone: +39 02 2399 4254

PhD Programme BIO Secretary:

Marco Simonini

Department of Electronics, Information and Bioengineering

email1: phd-bio@polimi.it

email2: marco.simonini@polimi.it

phone: +39 02 2399 3632

Chiara Zitta

Department of Electronics, Information and Bioengineering

email1: phd-bio@polimi.it

email2: chiara.zitta@polimi.it

phone: +39 02 2399 9091

Additional support - Financial aid per PhD student per year (gross amount)

Housing - Foreign Students	--
Housing - Out-of-town residents (more than 80Km out of Milano)	--

Scholarship Increase for a period abroad

Amount monthly	700.0 €
By number of months	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information

The PhD student will be involved in educational activities along with teaching assistantship covering topics of imaging in small animal models and bioengineering of the respiratory system. A shared desk and computer will be given to the student for the time needed to carry out the research.



PhD in BIOINGEGNERIA / BIOENGINEERING - 40th cycle

THEMATIC Research Field: MICROSTRUCTURAL AND RADIOBIOLOGICAL MODELLING IN PERSONALIZED EXTERNAL BEAM RADIOTHERAPY” – MINIONS ERC

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0
In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	<p>External-beam radiotherapy has been established as best practice care in different cancer cases, although current models applied in the clinics to tune the treatment plan dosimetry, as a function of the expected tumour response and radiation-induced toxicity, do not make use of patient-specific information, but rely on radiobiological parameters typically derived from in-vitro experiments, thus abdicating from describing the in-vivo complexity of the pathology. The ERC project MINIONS is a cutting-edge research programme that investigates and integrates a set of activities to implement patient-specific microstructural and radiobiological models in personalized radiotherapy treatment planning and adaptation towards a detailed description of tumour characteristics of each patient and thus significantly improved tumour control probability. The main challenge of MINIONS is to create, for the first time, a fast patient specific model able to describe the microscopic characteristic of the tumour and its interaction with the radiation beam.</p> <p>The main purpose of the PhD project, which will be part of MINIONS, will be therefore to develop a vast library of in-silico cellular substrates with high level of complexity, comprehensive of biological structures at different scales (micro and nano scales) to simulate tumour microstructure, and to integrate these with simulations of magnetic resonance signals and radiation interactions. The simulations will be personalized and evaluated relying on patient-specific data collected at the</p>



	<p>collaborating clinical institutions.</p>
<p>Methods and techniques that will be developed and used to carry out the research</p>	<p>In-silico cellular substrates will be firstly simulated starting from simple meshes (spheres or ellipsoids) and then augmented with more complex details, including cell morphology specific of targeted pathologies, nucleus, vessels and other biological structures, also down to the nanoscale (e.g. DNA).</p> <p>This library of substrates will also consider histological data (collected at the clinical institutions or available from open source platform) as input to improve the realism of the in-silico simulations.</p> <p>The library of substrates will be then used to perform monte-carlo simulations of magnetic resonance signals and radiation-tissue interactions.</p> <p>For these simulations, open-source software will be adopted such as Camino (http://camino.cs.ucl.ac.uk) and Geant4 (https://geant4.web.cern.ch/).</p> <p>Dedicated simulations will be also considered relying on in-house implementations.</p> <p>The personalization and evaluation of the substrates will be performed by using retrospective magnetic resonance imaging data acquired at the collaborating clinical institutions, and by defining a dedicated prospective acquisition protocol with advanced imaging sequences.</p>
<p>Educational objectives</p>	<p>Educational objectives include that:</p> <ul style="list-style-type: none"> •The PhD student will be involved in educational courses provided by the PhD school of Bioengineering at Politecnico di Milano; •By working in a collaborative environment involving different high-standing research units, the PhD students will be able to interact with professionals coming from different sectors to make the most of microstructural and radiobiological models available for applications in external beam radiotherapy. •The PhD student will be able to understand the main concepts of cellular morphology and biology, diffusion magnetic resonance imaging and radiation interactions •The PhD student will learn how to implement and validate



	<ul style="list-style-type: none"> •The PhD student will learn how to implement and validate microstructural models. •The PhD Student will participate in national and international conferences and schools. •He/she will be also involved in producing manuscripts to be submitted in top-ranked peer-reviewed indexed journals.
Job opportunities	<p>After the PhD, different job opportunities will be available as Postdoc or Research Scientist in national or international institutions.</p> <p>Positions as bioengineer will be also possible within clinical institutions making use of the developed tools to improve patient care and clinical workflows.</p> <p>Jobs as data scientists big data engineers and computer scientists will be additional opportunities.</p>
Composition of the research group	<p>0 Full Professors 1 Associated Professors 2 Assistant Professors 2 PhD Students</p>
Name of the research directors	Prof. Chiara Paganelli

Contacts	
Prof.ssa Chiara Paganelli chiara.paganelli@polimi.it	

Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents (more than 80Km out of Milano)	--

Scholarship Increase for a period abroad	
Amount monthly	700.0 €
By number of months	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
Educational activity: The student will be encouraged to attend to courses at POLIMI or abroad 2 / 3 in International Schools.



Teaching assistantship: There are various forms of financial aid for activities of support to the teaching practice.

The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations.

Computer and desk availability: the student will be allowed to access facilities of the DEIB and those of the MINIONS project



PhD in BIOINGEGNERIA / BIOENGINEERING - 40th cycle

THEMATIC Research Field: PERSONALIZING AND ACCELERATING MONTE-CARLO SIMULATIONS OF RADIATION-TISSUE INTERACTIONS AT DIFFERENT SCALES IN EXTERNAL BEAM RADIOTHERAPY - MINIONS ERC

Monthly net income of PhDscholarship (max 36 months)

€ 1400.0

In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity

Motivation and objectives of the research in this field

External-beam radiotherapy has been established as best practice care in different cancer cases, although current models applied in the clinics to tune the treatment plan dosimetry, as a function of the expected tumour response and radiation-induced toxicity, do not make use of patient-specific information, but rely on radiobiological parameters typically derived from in-vitro experiments, thus abdicating from describing the in-vivo complexity of the pathology. The ERC project MINIONS is a cutting-edge research programme that investigates and integrates a set of activities to implement patient-specific microstructural and radiobiological models in personalized radiotherapy treatment planning and adaptation towards a detailed description of tumour characteristics of each patient and thus significantly improved tumour control probability. The main challenge of MINIONS is to create, for the first time, a fast patient specific model able to describe the microscopic characteristic of the tumour and its interaction with the radiation beam.

The main purpose of the PhD project, which will be part of MINIONS, will be therefore to develop and accelerate monte-carlo simulations of radiation-tissue interactions at different scales (from macro, to micro and nano scale) on a library of in-silico cellular substrates. Simulations of radiation-tissue interactions will be integrated with simulations of magnetic resonance signals to grant personalization, and accelerated relying on artificial



	intelligence strategies.
<p>Methods and techniques that will be developed and used to carry out the research</p>	<p>Monte-carlo simulations of radiation-tissue interactions will be performed on a library of in-silico cellular substrates, relying on open-source simulation toolkit such as Geant4 (https://geant4.web.cern.ch/).</p> <p>Simulations will be performed on different scales also relying on the extended Geant4-DNA platform (http://geant4-dna.org/). Among the simulations, various particle types, such as conventional X-rays, protons or carbon ions, as well as exceptional particle beams (e.g., helium or oxygen) will be considered, along with different energy levels. The different parameters will be also tuned according to clinical protocols adopted at the collaborating clinical institutions.</p> <p>Monte-carlo simulations of radiation-tissue interactions will be then integrated with monte-carlo simulations of magnetic resonance signals in order to estimate radiobiological and microstructural characteristics within the in-silico cellular substrates, respectively.</p> <p>This integration will allow personalizing the treatment by feeding the simulations with magnetic resonance imaging data collected and acquired on patients at the collaborating clinical institutions.</p> <p>The simulation environment will be then combined with artificial intelligence strategies to speed up, in the order of seconds, the derivation of patient-specific microstructural and radiobiological information.</p>
<p>Educational objectives</p>	<p>Educational objectives include that:</p> <ul style="list-style-type: none"> •The PhD student will be involved in educational courses provided by the PhD school of Bioengineering at Politecnico di Milano; •By working in a collaborative environment involving different high-standing research units, the PhD students will be able to interact with professionals coming from different sectors to make the most of monte-carlo simulations available for applications in external beam radiotherapy. •The PhD student will be able to understand the main



	<p>concepts of monte-carlo simulations of radiation-tissue interactions and magnetic resonance imaging</p> <ul style="list-style-type: none"> •The PhD student will learn how to implement and evaluate monte-carlo simulations. •The PhD Student will participate in national and international conferences and schools. •He/she will be also involved in producing manuscripts to be submitted in top-ranked peer-reviewed indexed journals.
Job opportunities	<p>After the PhD, different job opportunities will be available as Postdoc or Research Scientist in national or international institutions. Positions as bioengineer will be also possible within clinical institutions making use of the developed tools to improve patient care and clinical workflows.</p> <p>Jobs as data scientists big data engineers and computer scientists will be additional opportunities.</p>
Composition of the research group	<p>0 Full Professors 1 Associated Professors 2 Assistant Professors 2 PhD Students</p>
Name of the research directors	Prof. Chiara Paganelli

Contacts	
Prof.ssa Chiara Paganelli chiara.paganelli@polimi.it	

Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents (more than 80Km out of Milano)	--

Scholarship Increase for a period abroad	
Amount monthly	700.0 €
By number of months	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information



Educational activity: The student will be encouraged to attend to courses at POLIMI or abroad 2 / 3 in International Schools.

Teaching assistantship: There are various forms of financial aid for activities of support to the teaching practice.

The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations.

Computer and desk availability: the student will be allowed to access facilities of the DEIB and those of the MINIONS project.