HEALTH AND TECHNOLOGIES

Section “Further qualifications that may be attached to the application” revised on 18/04/2019
Section “Positions and scholarships” integrated on 11/05/2019
Section “Positions and scholarships” integrated on 15/05/2019

<table>
<thead>
<tr>
<th>Coordinator</th>
<th>Prof. Claudio Borghi</th>
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</thead>
<tbody>
<tr>
<td>Dept. of Medical and Surgical Sciences</td>
<td>via Massarenti 9 - Bologna</td>
</tr>
<tr>
<td><a href="mailto:claudio.borghi@unibo.it">claudio.borghi@unibo.it</a></td>
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<tr>
<td>Starting date of the PhD Programme</td>
<td>01/11/2019</td>
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<tr>
<td>Duration</td>
<td>3 calendar years</td>
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<td>Language of the PhD Programme</td>
<td>Italian and English</td>
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<tr>
<td>Mandatory stay abroad</td>
<td>Yes (3 months)</td>
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<tr>
<td>Research subjects</td>
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<td>- Biomechanics</td>
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<td>- Neurocognitive system</td>
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<td>- Diagnostics</td>
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<td>- Devices and services</td>
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<th>PhD positions and scholarships</th>
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<tr>
<td>Position n.</td>
<td>Financial support</td>
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<tr>
<td>1</td>
<td>PhD Scholarship</td>
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<td>8</td>
<td>Research grant</td>
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<td>PhD Scholarship</td>
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<tr>
<td>10</td>
<td>PhD Scholarship</td>
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Positions linked to specific research subjects: during the oral examination, applicants may express their interest in the positions linked to specific research subjects. Considering the expressions of interest above, the Admission Board will establish if the applicants can be considered eligible for the allocation of the scholarships linked to specific research subjects, taking into account their skills, experience and aptitude and their research project. The positions with scholarships linked to specific research subjects will be awarded on the basis of the eligibility stated by the Admission Board. Should this positions remain vacant, eligible applicants from the general ranking list may be contacted.

Admission requirements
Please, see art. 2 of the Call for applications

Mandatory documents to be attached to the application
Please, see art. 3 of the Call for applications

Further qualifications that may be attached to the application, if in possession of the applicant (only qualifications attested by documents drawn up in Italian, English, French, German and Spanish shall be considered as valid and assessed by the Admission Board)

- Abstract of the second cycle master's degree thesis. Undergraduate applicants may submit the draft of the thesis approved by their supervisor (please, note that abstract cannot exceed 5,000 characters, including spaces and formula possibly used. The above figure does not include: the title of thesis, the outline, and images such as graphs, diagrams, tables etc. - where present);
- No more than 2 reference letters signed by Italian and international academics and professionals in the research field, which do not form part of the Admission Board, attesting the suitability of the applicant and his/her interest for the scientific research.
Please, note that the above letters cannot be uploaded by applicants. When filling the online application form on http://studenti.unibo.it, applicants will be only allowed to provide the email accounts of the requested academic/professional. The latter shall receive an email from the University of Bologna providing for the instructions for uploading. Only letters in pdf format submitted before the expiry date and time of the Call shall be accepted.
- Multi-annual research project, with special emphasis on the activities to be completed during the first-year course, that the applicant would want to carry out within the PhD Programme, regarding one of the research topics described at the bottom of this document in section “PhD positions and scholarships”. The proposal must meet the following requirements:
  o It must indicate in the cover page the research topic of the PhD Programme covered by the research project proposal and for which the applicant is applying;
  o It cannot exceed 20,000 characters, including spaces and formula possibly used. This figure does not include: the title of project, the outline, references and images (such as graphs, diagrams, tables etc - where present);
  o It must include: description of the project; expected results; lead-time for implementation; (proposed) criteria to be used to assess the findings obtained.

The research projects that successful applicants shall carry out during their doctoral career may possibly differ from the project proposed at the application stage. This shall be defined together with the supervisor and approved by the Academic Board.

- Motivational letter. This must include the reasons prompting the applicant to attend the PhD Programme and those relevant experiences and research interests, that make the applicant suitable for the specific PhD Programme (3,000 characters maximum, including spaces).
- List of the publications (monographs, articles published on scientific journals, volume’s chapters).
- List of the minor publications (conference papers, etc.).
- List of the abstracts and posters presented during national and international conferences, etc.
- Professional Master courses (1st or 2nd level) relevant to the PhD Programme.
- Postgraduate vocational training programmes/specialisation programmes relevant to the PhD Programme.
- Summary of the thesis defended within the framework of Specialization Schools. The summary cannot exceed 1,500 characters
- Teaching activity carried out at university level
- Research activity of any kind - whether basic, applied, translational, etc. - carried out in any capacity, including when covered by research grants, and as a staff member of research projects
- Work activity
- Vocational internships
- Curricular and non-curricular training and guidance internships
- Documents attesting the knowledge of foreign languages
- Study periods completed by students outside their countries of origin (e.g. Erasmus programme or other similar mobility programmes)
- Other qualifications attesting the suitability of the applicants (scholarships, prizes, etc)

Admission exams (art. 4 of the Call for applications)

<table>
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<tr>
<th>Examination type</th>
<th>Schedule (please, note that applicants shall not receive any communication concerning the exams schedule)</th>
<th>Examination results publication (please, note that applicants shall not receive any communication concerning the publication of results)</th>
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<tbody>
<tr>
<td>Qualifications and</td>
<td>Non-presentational.</td>
<td>The results of the qualifications and research project</td>
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<td>Research project evaluation</td>
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<tr>
<td>Date</td>
<td>19/06/2019</td>
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<tr>
<td>Place</td>
<td>Bologna - Via Massarenti, 9 Policlínico S. Orsola-Malpighi Padiglione 11 - Aula Pisi</td>
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<tr>
<td>Time</td>
<td>9:00 a.m.</td>
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Applicants can ask to take the exam remotely using Skype. For further details please refer to the relevant provision laid down in art. 4 of the Call for applications.

### Points criteria

Points will be allocated to applications out of a total of 100 on the basis of the following weighting:

1. **Qualifications and research project**
   - Minimum for admission to the oral exam: 30 points
   - Maximum: 50 points
   
   Only qualifications relating to the last 5 calendar years prior to the calendar year of publication of the Call for applications shall be taken into consideration, with the exception of the University Degree (Diploma di laurea). Please, note that qualifications must be consistent with the PhD Programme.
   
   Points relating to qualifications shall be allocated on the basis of the following criteria:
   - Graduation final mark; undergraduates shall be evaluated on the basis of the Weighted Average Mark (WAM), if possible: max 7 points; score related to the degree mark will be assigned as follows:
     - 110 cum laude: 7 points
     - 110: 6 points
     - from 108 to 109 included: max 5 points
     - from 106 to 107 included: max 4 points
     - from 103 to 105 included: max 3 points
     - from 100 to 102 included: max 2 points
     - from 90 to 99 included: max 1 point
   - Publications: max 8 points
   - Abstract of the second cycle master’s degree thesis or equivalent: max 6 points
   - Letters of presentation: up to 1 point (half point for each reference letter)
   - Research activity, research grants, and participation in research projects: max 3 points
   - Other qualifications: max 2 points
   
   Points relating to the research project shall be allocated on the basis of the following criteria:
   - Scientific value and ground-breaking nature of the proposal: max 18 points
   - description and structure of the proposal: max 2 points
   - proposal feasibility: max 3 points

2. **Oral examination**
   - Minimum for inclusion in the final ranking list: 30 points
   - Maximum: 50 points
   
   Oral examination includes the presentation of the research project and is intended to assess the suitability of the applicant to pursue scientific research as well as the general knowledge of issues connected to the PhD Programme. During the oral examination, knowledge of English language shall be assessed.
   
   The oral examination is carried out in Italian or in English.
   
   Points relating to the oral examination shall be allocated on the basis of the following criteria:
   - knowledge of the English language: max 10 points
   - research project presentation: max 20 points
   - general knowledge of issues connected to the PhD Programme: max 20 points
   
   Possible evaluation sub-criteria will be available on the [Unibo website](http://studenti.unibo.it), selecting the relevant PhD Programme → “PhD programme information” at the bottom of the page in the section “Notices”.

### Final ranking list and enrolment (arts. 6 and 7 of the Call for applications)

After the publication of the results of the oral exam, the final ranking list will be available on the [Unibo website](http://studenti.unibo.it), selecting the relevant PhD Programme → “PhD programme information” at the bottom of the page in the section “Notices”.

Following the publication of the final ranking list, successful applicants must enroll on [http://studenti.unibo.it](http://studenti.unibo.it) by the deadline.
RESEARCH TOPICS

1) Effect of pathological pelvic version on the risk of impingement or dislocation in total hip replacement patients (BIOMED degree requested)
A growing number of patients who received a total hip replacement, develop before or after this hip surgery a pathological version of the pelvis. This might be due to vertebral surgery, postural compensation for the spine pathology, etc. Orthopaedic surgeons share anecdotal reports of higher incidence of complications related to the hip range of motion in these patients, but no systematic study has been conducted so far. In this project the candidate will access a large body of outcome data in the RIPO registry, which combined with detailed clinical records of patients treated in the clinical department led by Prof Faldini at the Rizzoli Institute will provide a first robust evidence of such increased risk in this patients’ sub-population. The candidate will then use a CT-based hip surgery simulator developed at the Rizzoli’s Medical Technology Lab to estimate the so-called “safe zone” per acetabular orientation as a function of the pelvic orientation. Last, but not least a prospective study will be conducted on a small group of patients to be recruited in Prof Faldini department. The main outcome of this project will be a clinical recommendation for stratification.

2) New insights on atrial fibrillation from imaging and computational modelling (TECH degree requested)
Atrial fibrillation (AF) is the most common arrhythmia, causing substantial morbidity and mortality. AF is often treated with catheter ablation, but the mechanisms underlying the arrhythmia are incompletely understood and ablation success rates remain low. Recent observations promise to lead to better outcomes: a) atrial fibrosis correlates with the ablation responsiveness b) AF is maintained by electrical rotors and targeting their suppression improves the success rates. However, the lack of a rigorous mechanistic framework of AF pathophysiology limits the values of those studies, which are still debated. This project aims to provide such a framework by exploiting advanced biomedical engineering concepts. AF mechanisms will be first analysed in AF patient data, acquired with state-of-the-art instrumentation. Measured data will be integrated within a multi-scale personalized computational model of the atrium, providing an in-silico environment for personalized ablation planning. Key in the project will be the synergy between state-of-the-art expertise in the fields of medical imaging, computational modelling and clinical electrophysiology.

3) Digital twins for smart hospitals - models, architectures, implementations (TECH degree requested)
The research project is about investigating the application and extension of the Digital Twin concept - as recently used in Industry 4.0 - to clinical environments, as a blueprint for future smart hospitals and Hospitals 4.0. This calls for understanding and conceiving the information technology adopted in a Hospital as a socio-technical system providing both horizontal functionalities across the whole clinical environment (examples are tracking, planning) and vertical functionalities to support the specific daily work practice of the clinical staff, providing a seamless integration of digital technologies and the physical assets. A concrete case study (Bufalini Hospital) will be used to support both the analysis and the validation of the results. The expected results include open-source technologies, as prototype implementation of the Hospital Digital Twin.

4) Electrospun scaffolds for the regeneration of tendons and ligaments (TECH degree requested)
Degenerative or traumatic lesions of tendons and ligaments are difficult to repair. Post-operative failures affect between 15% and 40% of cases (depending on initial indications). We developed a prototype of an electrospun scaffold replicating the hierarchical morphology and the mechanical properties of tendons and ligaments. This PhD project will further develop the prototype by increasing the bioactivity and enhance the integration of the constituent material with the surrounding tissues, and will bring this technical solution towards clinical application.

The following aspects will be investigated: optimization of the polymeric biomaterial and its functionalization to improve cell adhesion, recruiting and differentiation to prevent inflammatory response, optimal technique for effective sterilization; means of surgical attachment to the host tissue.
The collaboration between the technical area (engineering and chemistry) with the clinical counterpart (orthopaedic surgery) will be a key point of this project.

5) Development of new in vitro models to evaluate drug absorption and metabolism (TECH or BIOMED degree requested)
The development of new drugs is characterized by a long and very expensive multistep process with a large failure, potentially exposing patients to possible health risk related to side effects and pharmacological interaction during the registration trials. Traditional in vitro models (monolayer cells) do not strictly represent the complex kinetic of drugs in human tissues. On the other side, animal models are progressively considered unethical and, one more time, not always strictly representative of human physiology and pathophysiology. In this context, the development of new in vitro models reproducing the histological structure and functional activity of tissues are strongly needed, both to improve prediction of drug effects in humans, to plan more targeted clinical trials, and to improve the selection of more bioavailable and safe drugs and drug-association to be clinical developed. This could be particularly useful to evaluate the metabolism of new and old (combined) drugs, especially in bowel and lung tissues.

6) Development of a hydrogel construct engrafted with thrombogenic agents to prevent endoleaks’ occurrence following endovascular abdominal aortic aneurysm repair (BIOMED or TECH degree requested)
Endovascular aortic aneurysm repair (EVAR) is currently the most common method for the elective treatment of abdominal aortic aneurysm (AAA), a common disease of elderly. Although the technical success rate for abdominal aortic endografting is high, reinterventions due to endoleak (EL), a persistent flow of blood into the aneurysm sac after device placement, are
frequent. Since persistent type II EL (ELII) is associated to increased probability of AAA rupture and vascular death, AAA sac embolization with metallic coils is undertaken to reduce its development. This treatment exposes patients to unwanted metallic load and interference, as metal spirals are radiopaque, in diagnostic imaging procedures that are used in post-procedural follow-up.

In the present research project, we propose to develop an innovative injectable, biocompatible hydrogel in which thrombogenic agents are engrafted to augment hemostasis locally. This construct may allow a selective intraprocedural sac embolization to reduce post procedural pELII and possible AAA rupture.

7) Elastomers with tunable degradation as small diameter blood vessel substitutes for peripheral artery disease (BIOMED or TECH degree requested)

The research project aims to develop a small diameter (< 6 mm) synthetic vascular graft suited for arterial revascularization in patients with peripheral arterial disease (PAD) and critical limb ischemia (CLI). To allow limb salvage and prevent vascular death, open surgery bypass revascularization using autologous vein grafts is the gold standard. When it is not possible, any other approach gives unsatisfactory result.

Therefore, developing a tunable synthetic vascular prosthesis made up of new or modified elastomers represents a possible solution. The graft will be composed by a nanofibrous scaffold of elastomers with controlled hydrolysable properties; the scaffold will be biocompatible and will present a fast degrading internal portion and a slow degrading external part for blood contention; a non-thrombogenic surface will be established through plasma ionized gases technology; thanks to its controlled hydrolysable properties a rapid graft integration with human blood and vascular cells will be achieved. The small diameter synthetic vascular grafts should be able to substitute the autologous vein when donor site morbidity and limited autograft availability occur.

8) Patient-specific surgery for severe scoliosis (PS5) (TECH degree requested)

Scoliosis can be extremely threatening: pain, disability, compression of internal organs, breathing problems are just some of the consequences. In the most severe cases, corrective spinal surgery is the only viable option. In young and growing patients, adjustable devices must be used, that are mobilized over the months to correct the spine and follow the patient’s growth. One main challenge for the clinical specialist is to choose the optimal treatment for each patient, for example how to plan the right amount of adjustment over time, so as to achieve the desired correction while avoiding complications and adverse effects. Currently, surgeons are guided only by intuition and experience. The aim of this PhD project is to develop and validate a modelling technology capable of generating patient-specific predictive models of the spine biomechanics that can be used as a treatment planning tools, by simulating different treatment options and predict the occurrence of adverse effects including spinal cord compression, facets impingement, excessive strain of the intervertebral discs, excessive stretch of the muscles.

9) Innovative technique to repair osteoporotic fractures with bone substitutes (TECH degree requested)

The second most common site for traumatic fracture in the elderly is the upper limb (proximal humerus and distal radius). Reconstruction of these fractures is currently performed with plates and screws. In both cases, healing failures (mainly pseudo-arthritis) derive from lack of stabilization of the bone fragments, which is particularly frequent in case of poor bone quality and osteoporotic defects. As the current technique is dissatisfactory (adding more screws would not solve the problem) we will explore a different approach. A bone substitute will be used in combination or in replacement of plates and screws. This PhD project consists of three main actions: (i) biomechanical testing of different reconstruction techniques to identify the optimal ones; (ii) definition of surgical guidelines based on ex vivo fluoroscopic imaging (similar to the foreseen surgical protocol), in relation to biomechanical performance; (iii) definition and following of clinical trial on selected fracture cases.

This project originated from the clinical problem encountered by orthopaedic surgeons, will require significant input from the technical area, and will rely on collaboration with a biomedical company.

10) Exploitation of PALs (Plasma Activated Liquids) for antineoplastic pro-drugs activation through exogenous reactive oxygen and nitrogen species (BIOMED degree requested)

Solid tumors are characterized by intense cells proliferation, resulting in enhanced nutrient uptake to support energetic and biosynthetic pathways. Metabolic reprogramming and adaptive responses (such as neoangiogenesis) are considered a hallmarks for cancer aggressiveness. Therefore, it is important to understand its molecular mechanisms and discover novel therapeutic approaches for cancer therapy. This project will focus on the study of an innovative treatment of cancer cells based on plasma activated liquids (PALs). The exposure of liquids to a cold atmospheric pressure plasma (CAP) enables the production of PAL containing reactive oxygen and nitrogen species (RONS) having anticancer activity. At the same time, recent studies have reported that tumorigenic potential can be inhibited by administration of ROS-activated prodrugs. Thus, the use of PALs to trigger ROS-activated prodrugs could be novel and safe adjuvant strategy for the treatment of aggressive cancers.

11) Developing models of schizotypal neurocognitive mechanisms: an integrative use of machine learning, EEG and neurostimulation (BIOMED degree requested)

This research project will provide a novel approach for the investigation of early biomarkers of psychosis, aimed at tailored plans for prevention in the healthy population at risk and interventions in the psychiatric population. A key aspect concerns the study of the neurophysiological underpinnings accounting for individual differences along the schizotypy axis. According to the continuum hypothesis, sensory and attention performance, known to be altered in schizophrenia, will be tested in people with low and high levels of schizotypy. An integration of machine learning, dense EEG signal analysis and innovative neurostimulation protocols will be implemented to test the fronto-parietal functional disconnection hypothesis: machine learning will aim at decoding composite biomarkers best predicting levels of schizotypy, neurostimulation will aim at modulating plasticity of long-range connectivity, dense EEG oscillatory signal analysis will inform Machine Learning and Neurostimulation.
12) Innovative methods for objective pain measurement (TECH degree requested)
Pain is an unpleasant subjective experience. At present, clinicians are using self-report or pain scales to recognize and monitor pain. Objective assessment of pain is a topic of great interest, although relatively unexplored, both in clinical and scientific research. The present PhD project will investigate, design and experimentally validate innovative methods for the evaluation of pain and psychophysical state through measurement of neurophysiological signals recorded by personal health systems.
This project stems from previous methodological research activities carried out at the Personal Health Systems Lab at DEI in the field of wearable devices, and will build its innovation potential on the side by side cooperation with a variety of clinical experts (e.g. cardiologists, neurologists, oncologists, and psychologists), who shall provide their expertise to advance the knowledge and identify solutions for the measurement and relief of specific pain conditions.