BIOENGINEERING AND MEDICAL-SURGICAL SCIENCES

Ateneo - Cutting-Edge Bioengineering Solutions for Advancing Organ Transplants

Funded By	Politecnico di TORINO [P.iva/CF:00518460019]

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Context of the research activity	The project concerns the development of advanced bioengineering technologies in the field of transplantation with an emphasis on the use of artificial intelligence and mechanistic modeling for clinical decision support. Research topics relate to optimization of organ preservation and transport, continuous monitoring through innovative devices, and improvement of quality of life of transplant patients through customized and integrated solutions.

	The Piedmontese healthcare system has a strong vocation for transplant activity. The transplant centers of the Azienda Ospedaliera Universitaria Città della Salute e della Scienza di Torino (AOU CSS) carry out most of the transplant activity in the Piedmont Region and are always among the top in Italy in terms of activity volumes and quality, according to sources from the Ministry of Health (https://www.salute.gov.it/). The AOU CSS of Torino, through the Regional Transplant Center of Piedmont and Valle d'Aosta, was among the promoters of the establishment of Fondazione D.O.T. Donazione Organi e Trapianti Onlus, founded in 2017 together with the following founding members: City of Turin, Polytechnic University of Turin, Piedmont Region and University of Turin. D.O.T.'s mission is to implement initiatives of the highest social interest for the development of transplant medicine. Since 2019, a collaboration has been activated between Fondazione D.O.T. and the Polytechnic University of Turin, with the involvement and scientific coordination of the Regional Transplant Center, aimed at the development and implementation of joint research of particular interest for the clinical and technological field in the field of transplant medicine. In this context, this research project aims to use knowledge in the field of bioengineering to address important issues related to the management and improvement of transplantation procedures, such as liver, kidney, heart, and lung transplants. In particular, the application of artificial intelligence (AI) and modeling methods will be essential to aid decision making and improve the quality of life of transplant recipients. One area of research could focus on the development of clinical decision support systems for transplantation. These systems would combine data,

Objectives	medical imaging, and predictive analytics to provide health care providers with tools to make well-informed decisions. For example, the use of integrated platforms with machine learning models can help health care providers determine donor-recipient matches to reduce the risk of failure, identifying patients prone to complications and promptly recommending targeted interventions for prevention and improved long-term outcomes. These technological tools promise to improve patient care and optimize healthcare resources by streamlining transplant management processes. In addition, these systems could be linked to intelligence-driven monitoring technologies for transplant diagnosis, prognosis assessment, and treatment planning. To increase the chances of transplant outcome, research could explore technologies to effectively store and transport transplanted organs. This involves the design of bioreactors to improve temperature control and perfusion systems and the use of preservation methods. The integration of artificial intelligence-driven models will play an important role in optimizing preservation conditions and predicting organ performance during transport. This approach aims not only to preserve organs but also to mitigate potential damage during transport, ultimately leading to better outcomes after transplantation. The collaboration between the D.O.T. Foundation, the Polytechnic University of Turin and the Regional Transplant Center fosters a cutting-edge research environment. This initiative offers an opportunity to apply the knowledge of industrial bioengineering in one of the critical areas of contemporary medicine. To advance this innovation, it is essential to train professionals through international programs and partnerships. By offering courses, seminars and workshops, we aim to share knowledge and best practices in the field of transplant medicine, encouraging research and fostering collaborations between bioengineers, physicians and researchers. Looking to the medium-term future, this research paves the way for two advances in the field of transplantation: ¿ Advances in personalized medicine, through the implementation of intelligence-driven solutions, for transplantation medicine. ¿ Training of professionals to develop a group of bioengineering specialists, with advanced knowledge, in transplant medicine, who can drive progress in the field.

Skills and competencies for the development of the activity	The candidate should hold a Master's degree in Engineering (Biomedical, Mechanical, Electronic…), with skills in programming and modeling, and preferably some knowledge of machine learning methods. Interdisciplinary teamwork abilities, good command of English, and a strong motivation for research and innovation in transplant medicine are required.