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# Expanding the offer of Vaccinology Education with the Master of Science in Immunology and Vaccinology

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**ABSTRACT**

The COVID-19 pandemic revealed the urgency for well-trained professionals in vaccinology. With the purpose of building capacity in the field, the Catholic University of Portugal created the Masters in Immunology and Vaccinology. Here, I describe this innovative program and compare it to the current Vaccinology programs worldwide to reveal its uniqueness, and how it will contribute to reduce the burden of disease, improve disease prevention and promote healthier lives globally.

**KEYWORDS**

Immunology; Vaccinology; Master of Science Degree; Vaccinology training; Immunology training

Vaccination is one of the greatest medical achievements of all time. The administration of vaccines to healthy people to prevent the development of future disease truly represents the essence of preventive medicine. Vaccines are responsible for decreasing infectious disease morbidity and mortality worldwide. It is estimated that vaccination has avoided 154 million deaths in the last 50 years, including 146 million children under 5 year of age. The same study claims that for every death averted, 66 years of healthy life are gained.[1] Recently, the COVID-19 pandemic highlighted the immense potential of vaccines to save lives. In fact, it has been estimated that COVID-19 vaccines saved 20 million lives during 2021 alone.[2] However, the pandemic also revealed barriers like vaccine hesitancy, global distribution inequities, cold-chain requirements, and rapid adaptation of new variants. Vaccine hesitancy, which has affected public trust in vaccines, dates back to the very beginning of vaccination, yet experienced a significant increase about a decade ago.[3] This alarming increase has been sustained by misinformation, and conflicting communications from Public Health authorities. Never in modern history has vaccination been so important and so contested.

Education and training of health professionals in vaccinology are pivotal to addressing all these gaps,[4] and there is a growing demand for experts in vaccinology.[5] The current degrees that award a formal qualification in Vaccinology worldwide are described in Table 1.

To build capacity in the field of Vaccinology, the Universidade Católica Portuguesa (UCP), Portugal, has created the Masters program in Immunology and Vaccinology. This multidisciplinary program considers societal, economic, and ethical questions in combination with the technical and biological challenges involved in the successful design, development, manufacturing, and distribution of vaccines. The first edition of the course will start in October 2025, admitting between 20 and 50 students. The venue is the Faculty of Medicine of UCP in the Lisbon area, and the curriculum will require 2 years to complete the program, including 1 year for thesis-related research which may be conducted in academia, industry, governmental and non-governmental Public Health agencies anywhere in the World. The courses that comprise the Masters program will be taught in English, and the faculty includes local specialists and invited speakers across the globe with extensive experience and knowledge in most areas of Immunology and Vaccinology. The target audience of this course are graduates in medicine, pharmacy, veterinary, biotechnology and biomedical sciences.

The curriculum has been designed to incorporate a logical sequence from basic scientific knowledge to vaccinology instruments to measure safety, immunogenicity, efficacy, and effectiveness of vaccines (Table 2). The program content equip students with the knowledge to understand the process of the

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**Table 1.** Degrees in Vaccinology by country and continent.

| Degree title | Degree level | Duration | Institution | Country | Continent |
|---|---|---|---|---|---|
| Vaccinology PhD/MPhil/MD | PhD/MPhil/MD | Varies | University of Liverpool | UK | Europe |
| International Master in Vaccinology (IMVACC) | MSc | 18 to 24 months | University of Lausanne | Switzerland | Europe |
| Master in Vaccinology and Drug Development | MSc | 2 y | Università di Siena | Italy | Europe |
| Master of Leading International Vaccinology Education (LIVE) | MSc | 2 y | Université Claude Bernard Lyon 1; Université Jean Monnet Saint-Etienne; Universitat Autònoma de Barcelona; Universitat de Barcelona; University of Antwerp | France, Spain and Belgium | Europe |
| MSc in Vaccines and Prevention of Infectious Diseases | MSc | 3 Semesters | University of Crete | Greece | Europe |
| Masters in Immunology and Vaccinology | MSc | 2 y | Universidade Católica Portuguesa | Portugal | Europe |
| Vaccinology and Immunotherapeutics | MSc, PhD | 2 y, 4 y | University of Saskatchewan | Canada | North America |
| Infectious Diseases and Vaccinology MPH | MPH | 2 y | University of California, Berkeley | USA | North America |
| Vaccinology | MSc | 2 y | University of the Witwatersrand | South Africa | Africa |

Information was obtained at each University website.

immune response, in health and diseases, including the usage of bioinformatics tools, artificial intelligence, and machine learning. Students will learn to apply this knowledge to the design, development, and pre-clinical evaluation of vaccines. Scale-up for industrial production, clinical trials, regulatory affairs and licensing, distribution of vaccines, and the Public Health issues associated with vaccination, particularly accessibility to vaccines, and vaccine hesitancy will also be addressed. In this way, students will gain a comprehensive understanding of fundamental, translational, and applied science, in parallel with the practical requirements for successful vaccine implementation in the market, resulting in individuals with a critical mind-set to initiate scientific research and development activities in immunology and vaccinology.[6]

The Master of Science degree adopts a model that combines fundamental theoretical knowledge with the practical and laboratory skills needed to carry out immunology and vaccinology studies. A unique characteristic of this program, compared to others, shown in Table 1, is the strong focus in immunology as the basic knowledge to understand the principles required to improve current vaccines and design new and more effective ones. The first year of the Master's degree is divided into two semesters. In the first, students will take four general Curricular Units (CU) that form the structuring component and one CU of Introduction to Vaccinology.

Data and Biostatistics develops students' ability to independently apply statistics and data analysis tools, including methods for data collection, organization, visualization, and both exploratory and inferential analyses.

Ethics and Scientific Thought for Biomedical Sciences focusses on various approaches to the scientific method, experimental design, data interpretation, the importance of ethics in planning experiments, and discusses how scientific research is carried out in immunology and vaccinology. The course also includes student presentations of scientific papers to develop critical interpretation skills and enhance scientific communication.

Introduction to Vaccinology provides students with their first exposure to the field. It prepares them with knowledge and understanding of the complexity inherent to vaccine development, vaccine evaluation, and vaccine distribution. It also addresses ethical issues related to equitable distribution of vaccines, trust, vaccine hesitancy, and the fight against misinformation.

The aims of the Immunology and Microbiology CU is to provide students with a solid foundation in these disciplines, with a particular focus on basic microbiology, infectious diseases, host–pathogen interactions, the function, history, and evolution of the immune system, innate immunity, antigen presentation,

**Table 2.** The Masters in immunology and vaccinology study plan.

| | Scientific Area | Working Time (h) | Contact Time (h, type) | ECTS |
|---|---|---|---|---|
| **1st Year** | | | | |
| **1st Semester** | | | | |
| Data and Biostatistics | CS | 168 | 50 (34 TP; 16 TO) | 6 |
| Ethics and Scientific Thought for Biomedical Sciences | CS | 168 | 30 (14 TP; 16 TO) | 6 |
| Introduction to Vaccinology | TAS | 168 | 32 (24 T; 8S) | 6 |
| Immunology and Microbiology | FTS | 168 | 36 (30 T; 4 TP; 2S) | 6 |
| Introduction to Research Laboratory of Immunology and Vaccinology | FTS | 168 | 40 (30 PL; 10S) | 6 |
| **1st Year** | | | | |
| **2nd Semester** | | | | **ECTS** |
| Contemporary Epidemiology and Global Health | TAS | 168 | 50 (18 T; 22 PL; 10S) | 6 |
| Virology Research for the Future | FTS | 168 | 45 (15 T; 6 TP; 14 PL; 6 S; 4 TO) | 6 |
| Translational Vaccinology | FTS | 168 | 54 (26 T; 12 TP; 6 S) | 6 |
| Laboratory of Immunology and Vaccine Immunogenicity Analysis | FTS | 168 | 36 (3 T; 30 PL; 3 S) | 6 |
| Dissertation Project/Project Work/Internship Report | FTS / TAS | 168 | 30 (10 TO; 10S; 10 TP) | 6 |
| **2nd Year** | | | | **ECTS** |
| Dissertation/project work/internship report | FTS / TAS | 1680 | 15 (15 TO) | 60 |

Adapted from.[6] ECTS - European Credit Transfer System; CS - Cross-functional Skills; FTS - Fundamental and Translational Science; TAS - Translational and Applied Science; T - Theoretical; TP - Theoretical and practical; PL - Practical and laboratorial; TO - Tutorial orientation; S - Seminar.

self-non-self-discrimination, adaptive immune responses, memory, immune tolerance, hypersensitivity and autoimmunity, congenital and acquired immunodeficiencies, tumor immunology, and transplantation.

The final CU of the first semester, Introduction to Research Laboratory of Immunology and Vaccinology, equips students with essential laboratory skills to work in immunology and vaccinology research. Particularly, it will offer robust training in laboratory biosafety, and basic laboratory procedures, preparing students for hands-on laboratory practical work in the second semester, especially those unfamiliar with laboratory work.

In the second semester, five specialized CUs are offered, focused on acquiring in-depth knowledge in relevant areas of research. Students will participate in practical laboratory sessions to familiarize with basic methods of immunology and vaccinology in the CU Laboratory of Immunology and Vaccine Immunogenicity Analysis, including 1) Laboratory Techniques in Virology; 2) PCR analysis to quantify viral vector yields; 3) Host-Pathogen Interactions: Infection of macrophages with *Mycobacterium bovis* BCG and quantification of infection by Colony Forming Units assay; 4) Innate Immunology: Analysis of macrophage gene expression after activation by PAMPs; 5) Adaptive Immunology: Analysis of immune cell populations by flow cytometry; 6) Vaccine-induced immunogenicity (Antibodies): Quantification of antibodies by Enzyme-Linked Immunosorbent Assay (ELISA); 7) Vaccine-induced immunogenicity – (T Cells): Quantification of cellular immunity by Interferon-gamma Enzyme-linked immunosorbent spot (ELISpot).

A particular relevant course, Translational Vaccinology, trains students in *in silico* vaccine design, including the selection of a suitable vaccine platform for a particular target. Students will perform database sequence mining, using available bioinformatics tools to identify regions of interest, and determine the most appropriate vaccine types for generating protective responses. Real-world challenges and lessons from the COVID-19 pandemic and similar relevant examples will be used to illustrate applied concepts.

The objectives of the course Contemporary Epidemiology and Global Health are to introduce students to a holistic perspective on current global challenges and computation-based approaches to pathogen transmission, surveillance and control. The goal is to strengthen understanding of the methodological and research landscapes of contemporary epidemiology and global health.

The course Virology Research for the Future offers both theoretical and practical methods in virology, including mechanisms of surveillance and the dynamics of viral transmission, the impact of antivirals and vaccines, and practical computing skills in virology research.

The Dissertation Project on the second semester consists of the preparation of the thesis work to be carried out during the second year.

The second year is fully dedicated to thesis research that can be conducted in an academic setting at the UCP or in an industrial setting. A distinctive feature of this degree is the opportunity for selected students to conduct their thesis work at the pharmaceutical company Zendal. This collaboration allows students to develop their research in an industrial setting, under the joint supervision of a Zendal mentor and a UCP faculty member.

Upon graduation, students will be individuals with scientific independence from the perspective of planning, executing, and analyzing research in Vaccinology, as well as producing and formally presenting scientific data.[6]

Graduates in Immunology and vaccinology will be encouraged to pursue further studies through the PhD Program in Medical Sciences at the UCP, continuing their academic development in the field.

Vaccinology is a timely topic, and a highly beneficial Public Health instrument to combat infectious and noninfectious diseases, and the only available weapon to prevent emerging pandemics in the future. The purpose of the MSc in Immunology and Vaccinology is to contribute to reducing the knowledge gap in Vaccinology, and at the same time, train the much-needed specialized technicians and scientists. The future graduates will work either in academia or industry, contributing actively to improve disease prevention. This will eventually have an impact on the reduction of the burden of disease and consequently promote healthier lives globally.

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## Notes on contributor

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## Author contributions

PJGB conceived and wrote the article.

## Ethical approval

The requirement for ethical approval does not apply to this study.

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