

Chapter 3

State of the Art of Immunoinformatics

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DOI: 10.4018/979-8-3693-3192-7.ch003

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ABSTRACT

Vaccinology is the study of vaccines, their development, and their use. Classical vaccinology, practiced for centuries, relies on identifying and isolating a pathogen's protective antigens. Classical vaccinology has successfully developed vaccines against many diseases, including smallpox, measles, mumps, and diphtheria. However, it can be a time-consuming and labor-intensive process. Immunoinformatics offers a new approach to vaccine development that can address some of the limitations of classical vaccinology. This interdisciplinary field combines biology and computer science to explore the immune system's interactions. In the last decade, technological advances, such as big data, machine learning, and artificial intelligence, are enabling new advances in Immunoinformatics, potentially revolutionizing vaccine development. This chapter aims to provide a comprehensive overview of Immunoinformatics, its techniques, and its applications, exploring its foundations, advances, and future perspectives.

INTRODUCTION

Immunization is fundamental to public health, with vaccines playing a vital role in maintaining and preventing various diseases. Since the proper establishment of national immunization programs in several countries, many endemic diseases that were previously a public health problem have been eradicated (Excler et al., 2021). The World Health Organization says these programs save between 2 and 3 million lives annually. Vaccines have been one of the most successful public health achievements (*World Health Organization (WHO)*, n.d.). They are economical and practical tools that have evolved over the decades into many approaches to the production of immunogens, each with its advantages and disadvantages, with the aim of continuous improvement (Hajj Hussein et al., 2015). Vaccines can be divided into three generations according to the composition and strategies used to prepare the active antigen: 1st, 2nd, and 3rd generation vaccines, as shown in Figure 1 (Bagnoli et al., 2011; Zarei et al., 2016).

Throughout history, vaccines have been studied for significant advances to monitor their side effects and benefits relevant to their preventive use in each disease and guarantee their safe use. Vaccination began in at least the 15th century when people

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