CHAPTER 2
BIOMEDICAL APPLICATION OF SUSTAINABLE NANOMATERIALS

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2.1 INTRODUCTION

The world's population has grown significantly over the past few decades, from 7 billion to 8 billion people. This population growth has put significant pressure on the global economy and created a socioeconomic burden, emphasising the need for an upgraded healthcare system to safeguard individuals from potentially fatal illnesses (Zhang et al., 2023). The United Nations (UN) introduced 17 sustainable development goals (SDGs) in 2015 to overcome these challenges. One of these SDG objectives is to address poverty, aiming to improve the healthcare system in various communities (United Nations, 2020). In November 2020, a nanotechnology summit has proposed on how nanotechnology and its applications could contribute to achieving these SDGs goals. (Network4Sustainable Nanotechnology, 2020). Since then, the development of nanomaterials has been anticipated to have a substantial impact on the improvement of the healthcare systems, such as the prevention of infectious diseases like COVID-19 using nanodevices and medical treatment (Figure 2.1). Moreover, their large surface area and unique morphological properties, such as their controlled shape and outstanding physicochemical characteristics, make them suitable materials for various applications, especially in the biomedical field.

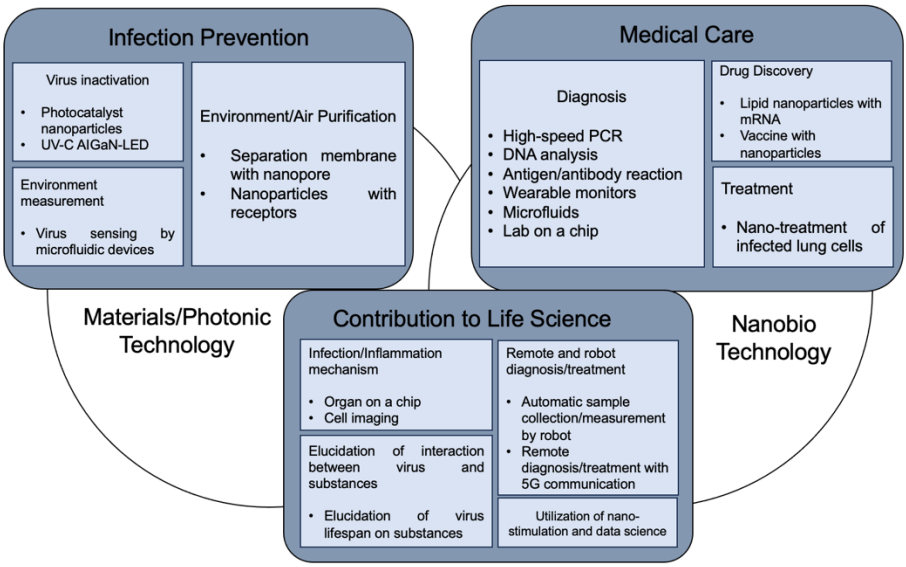

Figure 2.1 Applications of nanomaterials to emerging infectious diseases (Source: Mabrouk et al., 2021)

According to Figure 2.1, various nanomaterials have been developed for many major healthcare-related applications, including the efforts to prevent, detect, and manage diseases. For example, nanomaterials have been applied as a main component in biosensors, integrated with medical devices, and as drug delivery systems to deliver drugs to targeted areas. In addition, nanomaterials have been reported to be developed for vaccines, immunotherapy, and other therapeutic technologies. Therefore, nanomaterials have been acknowledged as next-generation materials with great promise to revolutionise healthcare by providing precise diagnostics, targeted therapies, and regenerative medicine (Figure 2.2) (Mabrouk et al., 2021).

However, the conventional method in the fabrication of nanomaterials may result in the by-product of hazardous waste, threatening both the environment and personnel immediately. Moreover, poor management in the preparation and production of nanomaterials can lead to serious short-term consequences for humans

and the environment. In addition, the widely employed physical and chemical conventional approaches have led to environmental contamination because they generate a significant amount of hazardous by-products and consume a large amount of energy (Chee et al., 2022).

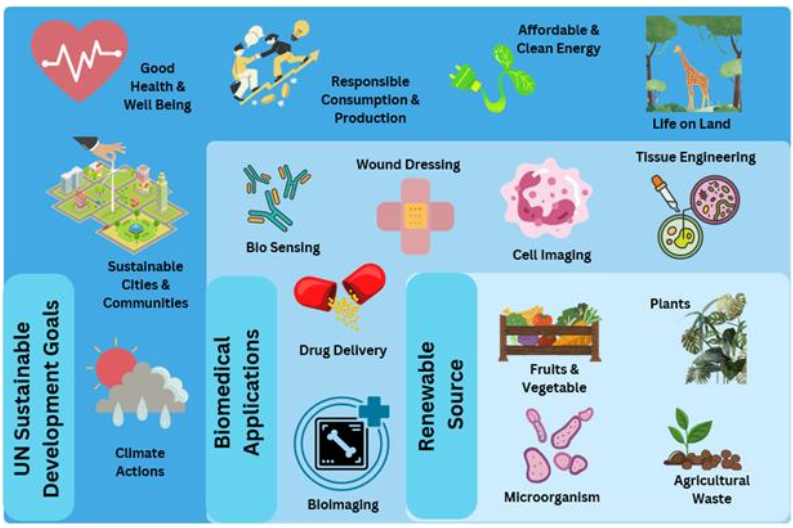

Figure 2.2 Green approaches in the preparation and production of sustainable nanomaterials, along with their applications in the biomedical field to achieve a sustainable future (Source: Mabrouk et al., 2021)

The limitations outlined have hindered the application of nanomaterials in biomedical contexts. Consequently, there is a pressing need for the advancement of green technology, characterised by clean, environment-friendly, and safe systems for nanomaterials generation to produce sustainable materials (Zhang et al., 2023). This method strives to develop nanomaterials with capabilities that align with and contribute to achieving the UNs' SDGs. This chapter will give insight into the promising role of sustainable nanomaterials in advancing SDG three, striving to ensure the health and well-being of individuals across all age groups. By exploring cutting-edge research and innovative applications, we will explore how nanotechnology can revolutionise healthcare,