Chapter 7
Nanomedicines and Its Applications Beyond

Popat Mohite
https://orcid.org/0000-0002-4536-4444
AET's St. John Institute of Pharmacy and Research, Palghar, India

Roshan Dave
https://orcid.org/0009-0002-8889-9139
AET's St. John Institute of Pharmacy and Research, Palghar, India

Shubham Munde
AET's St. John Institute of Pharmacy and Research, Palghar, India

Anil Raosaheb Pawar
MES's College of Pharmacy, India

Sudarshan Singh
https://orcid.org/0000-0002-7929-3322
Department of Pharmaceutical Sciences, Faculty of Pharmacy, Chiang Mai University, Thailand

Bhupendra Prajapati
https://orcid.org/0000-0001-8242-4541
Shree S.K. Patel College of Pharmaceutical Education and Research, Ganpat University, India

Aarati Budhar
AET's St. John Institute of Pharmacy and Research, Palghar, India

ABSTRACT

This chapter delves into the diverse applications of nanotechnology, focusing on its role in nanomedicines and its potential to revolutionize healthcare. It covers nanocarriers in drug delivery, diagnostic applications, and therapeutic approaches, highlighting nanotechnology's impact on regenerative medicine, as well as its industrial and environmental applications. The chapter also discusses challenges and considerations, such as biocompatibility, toxicity, regulatory frameworks, and ethical implications, providing a comprehensive perspective on nanomedicine complexities.

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INTRODUCTION

Nanomedicine encompasses the utilization of nanomaterials in medicine, spanning from diagnostic to therapeutic uses. While there is no universally agreed-upon definition among scientific and international regulatory entities, a construct is generally considered a nanomedicine if it possesses at least one dimension within the nanoscale range (measured in nanometres, up to 1000 nm) and demonstrates properties influenced by these dimensions, (Abbasi et al., 2014). Nanomedicine constitutes a broad field that encompasses various elements, including nanoparticles that serve as biological mimics (e.g., functionalized carbon nanotubes), "nanomachines" (such as those constructed from interchangeable DNA components and DNA scaffolds like octahedron and stick cube), nanofibers, and polymeric nanostructures utilized as biomaterials (e.g., molecular self-assembly and nanofibers composed of peptides and peptide-amphiphiles for tissue engineering, shape-memory polymers acting as molecular switches, nanoporous membranes). It also involves devices based on nanoscale microfabrication (e.g., silicon microchips for drug release, micromachined hollow needles, and two-dimensional needle arrays created from single-crystal silicon), sensors, and laboratory diagnostics, (Abdollahiyan et al., 2021). The historical development of nanomedicine can be broadly categorized into three stages, as illustrated in Figure 1. The initial stage, spanning 30 years from the discovery of the structure of liposomes in 1964 to the approval of the first nanotherapeutic liposomal drug doxorubicin (marketed under brand names such as Doxil, Adriamycin, and Lipodox) by the Food and Drug Administration (FDA) in 1995, marked significant progress. The second stage, from 1995 to 2007, witnessed certain nanotherapeutics' clinical validation and commercialization. The third stage, from 2008 to the present, has experienced notable advancements, particularly in the rapid expansion of new types of nanotherapeutics, with a focus on intelligent nanotherapeutics, (Abdollahiyan et al., 2021). The evolution of nanomedicine development is shown in Figure 1.