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Microbial synthesis of nanoparticles and their potential applications in biomedicine

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ABSTRACT

Nanotechnology is a multidisciplinary field evolved within past few decades and playing substantial role in environment, industry, agriculture and pharmacology. Integration of nanotechnology and biotechnology has led to the foundation of nanomedicine. It has provided novel breakthroughs in cure of various ailments and disorders, drug delivery systems, detection and diagnostics of different diseases. However, use of microbially synthesized nanoparticles in health and medicine is still limited. This article highlights the green approach of nanomaterials synthesis using microbes and current status of their applications in biomedical field.

Contents

Introduction

Presently, nanomaterials have been widely explored for commercial applications. Another emerging field in current era of advanced nanotechnology and nanorobotics is the nanomedicine. Nanomedicine refers to the use of nanoscale structures for diagnoses, treatment and prevention of diseases thereby aiding in improvement of human health (Patil et al., 2008). Nanomaterials are comparable to the size of cellular organelles including nano size proteins; hence they can be used to target desired sites without interfering with other cellular machinery (Salata, 2004). Properties of nanomaterials vary greatly from macro and micro size materials which play effective role in human health and medicine (Table 1). Nanomedicine aimed to integrate modern nanotechnology with classical molecular tools and biotechnology to develop innovative therapeutics for disease cure and tissue repair, novel drug delivery systems, rapid and ultrasensitive diagnostics tools like biosensors, biopharmaceutics, surgical aids, implantable biomaterials, etc. (Karunaratne, 2010).

Various physical and chemical methods are broadly used for the synthesis of nanoparticles. Though these approaches offer higher production rate and better size control over the synthesized nanoparticles, they are considered unfavorable due to high capital cost, energy requirements, anaerobic conditions, use of toxic reagents and the generation of hazardous wastes. These downsides obscure the down streaming processes, raise production cost, and

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Table 1
Applications of nanotechnology in biomedicine.

Application	Role of nanotechnology	References
Antimicrobial activity	Bactericidal activity Bacteriostatic activity	Seil and Webster (2012)
Cancer treatment	Detection of precancerous and malignant lesions Clinical testing for patients with solid tumors Delivery of therapeutic agents to specific molecular targets	Sanna et al. (2014)
Respiratory medicine	Aid in treatment of lung cancer, tuberculosis, and pulmonary fibrosis Vectors for gene therapy in cystic fibrosis Lung diagnostics with magnetic resonance imaging and computer tomography (CT)	Omlor et al. (2015)
Gastroenterology	Treatment of gastric and colorectal cancer Treatment of inflammatory bowel disease Diagnosis of different gastric diseases Organogenesis and transplant surgery	Brakmane et al. (2012)
Reproductive medicine	For treatment of Endometriosis, Uterine fibroids, Ectopic pregnancy, Genital infections. Sperm-mediated transfer of genes and biological compounds Selection of gametes and embryos Gene therapy of reproductive diseases	Barkalina et al. (2014)
Dermatology	Skin cancer imaging and targeted therapeutics Immunomodulation and vaccine delivery via skin Antimicrobials and wound healing	DeLouise (2012)

cause apprehensions about the environment as well as scale up of such processes on commercial level. Moreover, the chemically synthesized nanoparticles are less biocompatible (Hosseini and Sarvi, 2015) and use of toxic chemicals for synthesis and lack of stability has limited their use in clinical applications. Therefore, development of environmentally safe, economical, and

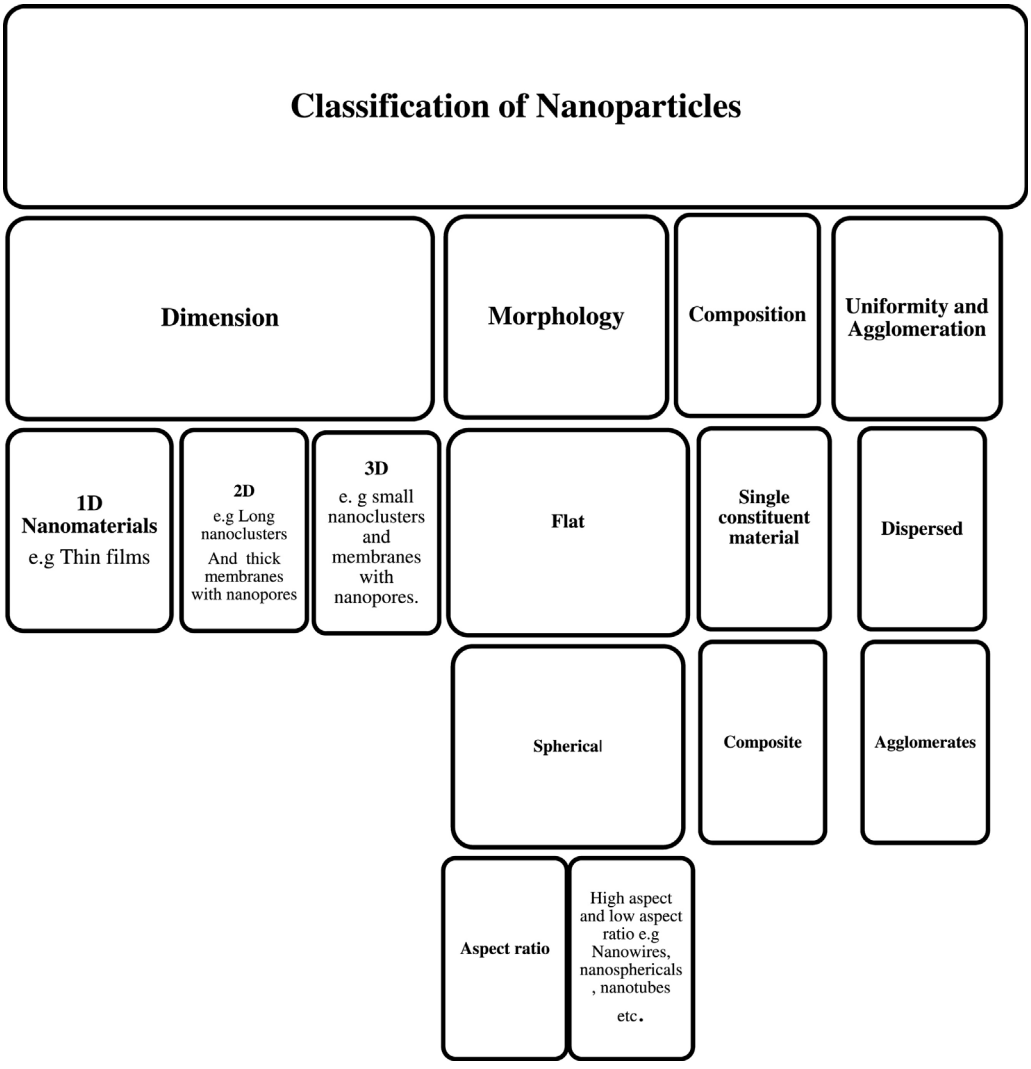

Fig. 1. Classification of nanoparticles.