

## Applications of Nanotechnology in Ayurveda: A review

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### ABSTRACT

Ayurveda is thousands of years old medical system in India. Various herbs, metals and non-metals preparations are used as medicine in Ayurveda. In the Ayurvedic description, several metallic preparations called *Bhasma* are in clinical use since 8th century AD. The *Bhasma* (incinerated metals) is obtained by repeating these methods several times. In this process the toxic effects of the metals are not only nullified but are transformed into biologically active nanoparticles. Nanotechnology is the study of extremely small structures which covers the diverse area of matters at dimensions which are approximately between 1 to 100 nanometers. The nanoparticles are a miracle invention of the century that has opened novel avenues of applications in various fields. Nanomedicine is the relevance of nanotechnology in the area of healthcare, diagnosis, cure and prevention of disease which is relatively a new field of science and technology. Nanotechnology is the newly emerging field in the medical sciences. Ayurvedic medications and therapies are getting in trend because of their safety and efficacy. Integration of Ayurveda and nanotechnology may provide the best medicines to treat various life-threatening diseases. Nanotechnology has enormous applications in drug delivery field. Nano drug delivery systems can reduce the drug consumption and side-effects by lowering the deposition of the active agent in the non-targeted sites. This review will give insights on nanotechnology, its applications in health sector and contributions in the field of Ayurveda.

**Keywords** - Ayurveda, *Bhasma*, Nanotechnology, Nanomedicine, drug delivery.

### Introduction

Nanotechnology is one of the most exciting and fast moving areas of science today. Nanotechnology refers broadly to a field of applied science and technology whose unifying concept is the control of matter on

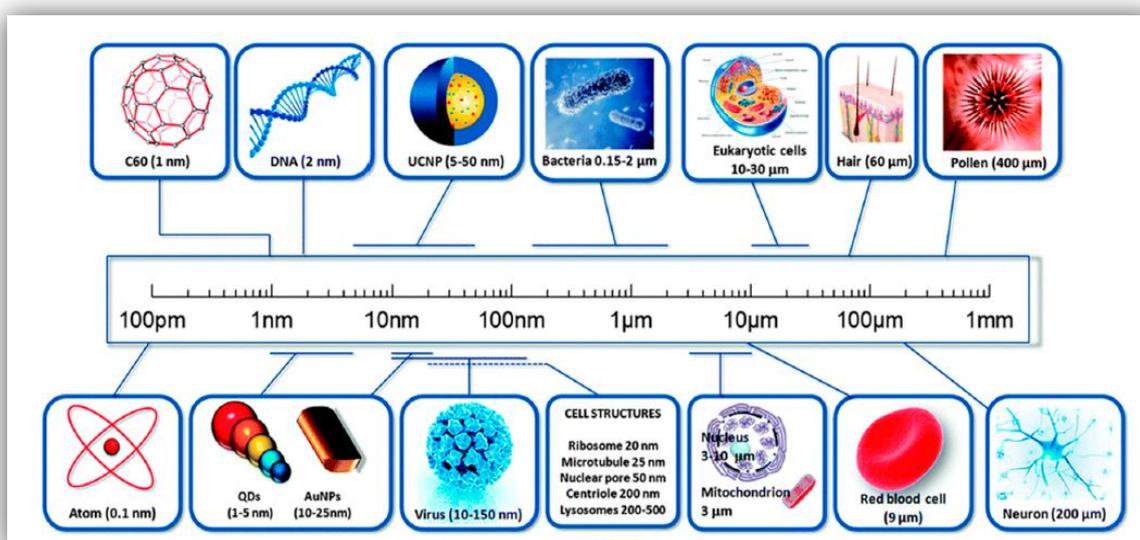
the molecular level in range smaller than 1 micrometer, usually 1 to 100 nanometers. It covers a diverse area of matters at dimensions between approximately 1 to 100 nanometers which has enormous applications in drug delivery field [1].

Ayurveda, or ayurvedic medicine, is a healthy lifestyle system that people in India have used for more than 5000 years and is universally accepted as the oldest system of health care. Ayurveda includes drugs obtained from various sources such as herbal origin drugs, animal origin drugs, marine origin drugs, mineral and metallic origin drugs. It also highlights good health and prevention and treatment of illness through custom practices and the use of herbal remedies [2].

The term nanotechnology was first elucidated in 1974 by Norio Taniguchi in Tokyo Science University [3]. At present,

this subject of technology has proved to be useful in physical and chemical sciences but also unlocks new areas in medical sciences such as in imaging, sensing, artificial implants, and enhancing drug delivery [4]. Nanotechnology gives opportunity to develop nanoparticles through bottom-up and top-down approaches allowing reengineered materials at nanoscale for evolving novel upgraded outcomes [5].

Different types of nanoparticles are available for various applications. The use of nanotechnology in pharmaceutical field involves development of nanomedicine, nanorobots, biomarkers, biosensors, etc.



**Figure 1.)** A comparison of sizes of nanomaterial [6].

## HISTORY OF NANOTECHNOLOGY

Human dreams and imagination often give rise to new science and inventions. Nanotechnology, a 21st-century invention, was given rise out of such dreams [7].

Although human exposure to nanoparticles has occurred throughout human history, it increased exceptionally during the industrial revolution. The theory of a “nanometer” was first proposed by Richard Zsigmondy.

He coined the term nanometer specifically for characterizing particle size and he was the first person to measure the size of gold colloidal particles using a microscope. Modern nanotechnology was the brain child of Richard Feynman. During the 1959 American Physical Society meeting at Caltech, he gave a lecture titled, "There's Plenty of Room at the Bottom", in which he introduced the concept of manipulating matter at the atomic level. This novel idea demonstrated new ways of thinking and Feynman's hypotheses have since been proven correct. It is for these reasons that he is considered the father of modern nanotechnology. Almost 15 years after Feynman's lecture, a Japanese scientist, Norio Taniguchi, was the first one to use "nanotechnology" to describe semiconductor processes that occurred on the order of a nanometer [8].

## NANOTECHNOLOGY IN HEALTH AND MEDICINE

Nanotechnology is becoming a critical driving force behind innovation in medicine and healthcare, with a wide range of advances including nanoscale therapeutics, biosensors, implantable devices, drug delivery systems, and imaging technologies. In medicine, it promises to revolutionize targeted drug delivery, gene therapy, diagnostics, and many areas of research, development and clinical application.

Up till now various diseases like diabetes, cancer, Alzheimer's disease, Parkinson's disease, cardiovascular diseases and multiple sclerosis as well as different kinds of serious inflammatory or infectious diseases (e.g. HIV) constitute a high number of complex illnesses which are posing a

great problem for the humanity. [9, 10, 11, 12, 13]

Nano-medicine is an application of nanotechnology which works in the field of health and medicine. Nano-medicine makes use of nano materials and nano electronic biosensors. In the future, nano medicine will benefit molecular nanotechnology. The medical area of nano science use has many benefits and is potentially valuable for all human races.

Nano medicine helps in early detection and prevention, improved diagnosis and proper treatment of diseases. Certain nanoparticles are used as markers and labels, biological can be performed quickly, the testing has become more sensitive and more flexible. Gene sequencing has become more accurate with the discovery of nanodevices like gold nanoparticles, which when tagged with short segments of DNA can be used for detection of genetic sequence in a sample.

With the help of nanotechnology, damaged tissue can be reproduced or repaired. These so called artificially stimulated cells are used in tissue engineering, which might transform the transplantation of organs or artificial implants [14].

## AYURVEDA AND NANOTECHNOLOGY

The development of Rasashastra has revolutionized Ayurvedic system of medicine. Numerous pharmaceutical methods are developed like Shodana, jarana and marana by which metals and minerals are changed into quite fine, absorbable, therapeutically most effective and least or non-toxic form of medicines known as Bhasmas [15]. Bhasmas are very fine ayurvedic medicinal powders prepared by the process of calcination of metals, gems or

minerals [16]. The calcination is a process of heating metals at a very high temperature to convert them into their oxides. Bhasma are manufactured with a series of preparation methods which includes detoxification of raw materials, crushing them with herbal juices, making small pieces, drying and heating. The gradual process of preparation may continue for a week to several years. The end product of these long term preparation methods are residues of metals and minerals.

With increasing importance of nanotechnology in medicine and healthcare sector [17], the emergence of engineered nanoparticles in therapeutics is disturbing due to their possible harmful effects [18]. The early utilization of nanomedicine was in the form of Ayurvedic Bhasma which is comparatively safer for usage of humankind [19-21]. The use of nanoparticles of metals in medicinal field has been a general practice in Ayurveda. Bhasma, which precisely means ash, is a distinctive Ayurvedic mixture containing herbs, minerals and metals. They are usually 5-50 nm in dimensions [22].

The nature of mineral/metal based drugs is that they function best when changed from their original state to its oxide state. The process of making is very organized and complicated, called "Bhasmikanana" which converts the metal to a form with higher oxidation state. This eliminates the toxic nature of metal and imparts high medicinal value to it [23].

During Bhasmikanana, metals/minerals are treated to different processes of purification and incineration which aims to reduce the particle size [24]. This process helps in converting them into biocompatible, bio-

digestible, absorbable and a suitable form for the human body. Bhasma nanoparticles are organo-metallic or organo-mineral compounds having improved stability, performance, absorption, assimilation, bioavailability, biocompatibility, effectiveness and targeted delivery of the element [19, 25, 26]. It is quite significant that Ayurvedic Bhasma is considered very safe and inexpensive in comparison to current metal based nanomedicines. [1, 27]

All Bhasma have some familiar features such as *Rasayana* (immunomodulation and anti-ageing property), *Yogavahi* (target drug delivery), *Alpamatra* (given in minimal doses, i.e., 15-250 mg/day), *Rasibhava* (readily absorbable, digestible and non-toxic), *Shigravyapi* (spreads quickly and fast acting) and *Agnideepana* (increases metabolism at cellular level and acts as a catalyst). Non-antigenicity is one of the most important properties of Bhasma [28].

## NANOTECHNOLOGY IN TARGETED DRUG DELIVERY

Nanomedicine and nano delivery systems are comparatively new but fast growing science where substances in the nanoscale size are utilized to assist as a means of diagnostic tools and therapeutic agents to specific targeted sites in a very controlled manner [29]. Nanotechnology proves quite beneficial in treating various diseases by site-specific and target-oriented delivery of precise medicines [30].

Drug delivery system picked up a novel approach to overcome the drawbacks of the traditional methods of drug delivery. The treatment of chronic diseases such as cancer is the newest achievement in the pharmaceutical drug delivery field.

Nano materials are searching their way in the form of drug carriers because of large surface area of materials and small size by which it is easily transported into cells and nuclei and specifically to the target site as desired. This is obtained by 3 different ways, i.e. 1.)Nano spheres 2.)Nano capsules 3.)Nano pores [31].

Nano carriers are used as a transport module for another substance such as drugs. They are used as DDS. Commonly used nano carriers include liposomes, dendrimers, polymeric nanoparticles, silicon or carbon materials, magnetic nanoparticles and nano emulsions. [32, 33]

Some common advantages of the drug delivery system using nanoparticles are to increase bioavailability, improve solubility, reduce the toxicity and enhance the pharmacological activity [34, 35, 36].

## CONCLUSION

As a conclusion to this review, I would like to say that nanotechnology is a brand new technology that has just begun; it is a revolutionary science that will change all what we knew before. Nanotechnology will substantially change the manufacturing process of almost every product in existence. The Ayurvedic system of medicine is very safe that can help in reducing the huge burden of mortality and morbidity caused by the various side effects of traditional prescribed drugs. The application of Ayurvedic drugs and formulations in the nanocarriers will increase its potential to treat many chronic diseases. With the help of nanotechnology principles, various dose-related adverse effects can be prevented as it has been able to reduce the amount of drug that needs to

be given. This will also help to increase the potency and safety issues related to Ayurvedic drugs and formulations. These formulations will effectively increase the bioavailability and stability and will also minimize the dose of various potent drugs.

There is no doubt that Ayurveda is one of the oldest systems of medicine and no medical system can stand for such a long period of time if it was not effective. Hence, *Bhasma* may be considered as nanomedicine and are free from toxicity in therapeutic doses. Therefore, proper scientific normalization of *Bhasma* should be done to maximize the therapeutic potential and properly designed randomized clinical trials should be done to demonstrate the efficacy. Herbal constituents play an important role in overall therapeutic efficacy of the *Bhasma*. There is an urgent need for the practitioners of Ayurveda, scientific research institutions and the industry to work in collaborations to analyze the risk-benefit aspect of these herbo-mineral/metal based medicines.

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