

Role of Nanotechnology in medicine

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ABSTRACT

The word ‘Nanotechnology’ is derived from a Greek word “nano” which means “dwarf” (short man). Nanomedicine includes application of nanotechnology for the advantage of health of humans and their well-being. Billionth part of a meter is nanometer. To imagine such a small thing is difficult and it’s very hard to believe that such small things really exist. It’s just like imagining of 1/80,000 the width of our hair.

Introduction:

The word ‘Nanotechnology’ is derived from a Greek word “nano” which means “dwarf” (short man). Nanomedicine includes application of nanotechnology for the advantage of health of humans and their well-being [1]. Billionth part of a meter is nanometer. To imagine such a small thing is difficult and it’s very hard to believe that such small things really exist. It’s just like imagining of 1/80,000 the width of our hair. In a single nano particle ten hydrogen atoms can be easily fitted side by side so we can now imagine the shortness of a nanometer. Width of a red blood cell is about 7000 nm while many large molecules which may include some of the proteins fall in the range of 1nm or larger [2]. Nanotechnology is the creation of useful materials, devices, and systems through the manipulation of matter on this minute scale. This emerging ground of nanotechnology encompasses scientists from various disciplines, including biologists, physicists, engineers and chemists. The terminology ‘nanotechnology’ is relatively new, the “natural version” of nanotechnology was already in pole position with procreation of life itself thousands of millions of years ago. All natural systems and materials begin their groundwork at the nanoscale. Basically, nano particles are the building blocks of any biological entity that have a unique property which is determined by its folding, size and patterns also at nanoscale. DNA (deoxyribonucleic acid) which is the basic genetic material of living beings is made up of 4 nucleotides [3]. These nucleotide basis fall in the range of sub-nanometer scale while the diameter of the double helix structure of DNA fall is range of nanometer. Cell membranes and proteins fall in the same range. The nanometer scale of nanomedicines is considered to be ideal to interact with cells that have dimensions (microns) that allow them to efficiently interact with nanoparticles (10–200 nm). Effectiveness of some drugs can be significantly improved with the help of modern nanotechnology techniques. This allows the appropriate amount of the drug vehicle to reach at the target and show proper response. This will also allow to minimize the off-target effects of the drugs which is not desirable in any situation. Conventional drug delivery system has many other side effects which can be reduced to 100 times by using nano medicines and it also provide very accurate and effective results. To understand the mechanism of actions of these nanomedicines in living beings requires high development of nanotechnology. In spirit, Nanomedicine is latest use of nanofiber, nano-sized particles and nanodevices to distribute drugs to the required target in human body or in animals. Nanotechnology can be used for the diagnosis of various diseases, their treatment and also for the detection of injuries which may happen in cell. It allows minimum damage to the normal and healthy body cells [4].

Synthesis of Nanoparticles

There are mainly 2 methods for the production of Nanoparticles:

1. Top-down technique
2. Bottom-up technique [5]

Top-down technique is to make smaller particles from the larger one by crushing or grinding these large particles. Mostly this technique is used in making parts of electronic devices and computers. Bottom-up technique is to make larger particles from small or short particles we can say it’s to make large particle with the help of building atom to atom or molecule to molecule. This technique is used for the preparation of nanomedicines. Control production of the nanoparticles is a very critical procedure. Bottom-up technique can be done with the help of advanced microscopy techniques which may include atomic force microscopy (AFM) and scanning tunneling microscopy (STM). Mostly nanoparticles are fixed on surface of the material [6].

Composition:

There is a wide range of materials from which nanoparticles can be made of:

1. Metals (include silver or gold)

2. Metal oxides (include SiO₂ or TiO₂)
3. Inorganic materials (include quantum dots and carbon nanotubes)
4. Polymeric materials
5. Lipids etc. [7]

Some other tools are also available in nanotechnology which are given as follows

- Nano shells
- Dendrimers
- Nanocrystals or quantum dots
- Cantilevers
- Nanowires

Diameter of these particles fall in the range of few to several hundred nanometers. These different tools are used to make the products which are used as biomarkers for the diagnosis and treatment therapy. Some of the nanoparticles can be used for encapsulation, formulation and releasing the active agent/compound which may have been derived or extracted from some natural resources.

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- Liposomes
- Quantum dots (Nanocrystals)
- Nano shells
- Cantilevers- A Nanoelectromechanical Sensor (NEMS)
- Dendrimers
- Nanowires [8]

Research & Development in Medical Field

Researchers and developers have been trying continuously on nanotechnology for the treatment of different conditions, diseases and infections like viral or fungal infections, cancer treatment diabetes and most importantly gene therapy. Ultimate benefit for using the nanotechnology for the treatment of various diseases is that we have high safety margin and drugs are targeting the main target cell not the normal human body cells. As we already talked about the contrast studies for the diagnostic purpose nanoparticles are proven very much beneficial [9].

Biological applications of nanoparticles:

There are many uses of nanomaterials in biological field which includes biological fluorescent labels used to label different kinds of samples and experimental processes, gene and the drug delivery system, for detecting pathogens and proteins, tissue engineering, analysis of DNA structure, destruction of tumor through heating, purification and separation of biological cells and molecules, contrast enhancement of MRI studies and phagokinetic studies.

Benefits of Using Nanomaterials:

There are a number of benefits using nanoparticles which includes that they are very less invasive because of the smaller devices, they can be easily implanted in the body of any organism for research or treatment purpose, time of onset of the drugs is very rapid, these devices are very sensitive and faster than any of the typical drug system [10].

Cancer Therapy

Smaller size property of nanoparticles is very much beneficial for oncology (study of cancer). Imaging of the cancer cells can be done very easily with the help of nanoparticles. Extraordinary images can be taken of tumor sites when we use magnetic resonance imaging with the conjunction of quantum dots. This happens due to the brighter property of nanoparticles then any of the other dye. Fluorescent quantum dots have the ability to produce high contrast as compared to any other dye which is also no cost economic, also it needs only one source of light to excite. But there is also a disadvantage using quantum dots that it is made up of some toxic elements. Size of nanoparticles is so small that allows them to accumulate at the site of cancer cells this is

because the cancer cells don't have any proper drainage of lymphatic system [11].

Benefits of Nano Carriers in Drug Delivery Systems

The intracellular uptake is very high and it can easily penetrate in the submucosal members. The microcarriers are mostly present on the lining of epithelium. Main advantage of using nano carriers is that the drug administered into the systemic circulation goes without any problem of being blocked or anything else. Blood capillaries are not blocked [12].

Conclusion:

World is now shifting to nanotechnology and is extensively used in the medicine. There are a lot of benefits using the nanotechnology in medicine. Onset of drug is fast, drug only target the effected cell or tissue, drug do not harm the normal healthy cells of the body, they are cost economic.

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