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Review Article

Different Types of Nano Drug Delivery Systems

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Abstract

The prefix "Nano" has been derived from the Greek word "Nanos", meaning dwarf. Democritus, the Greek philosopher, has been considered the father of nanotechnology and nanoscience. Although the starting and development point of nanotechnology, is not generally apparent, it has been pointed that the pioneer nanotechnologists were medieval glassblowers, who have employed old moulds to shape the glass. However, the glassblowers did not know the reason for colour changes by adding gold to the glass. At that time, nanometre particles of gold have been applied in making church glasses and thus has presented an attractive view.

The colour of these glasses has revealed the fact that Nano-sized materials have not contained the same properties as conventional dimensions. Nowadays, it has been known that this discoloration is since gold particles are naturally yellow, while nanoparticles are red. The outset of the nanotechnology concept has been seen in Feynman's speech at the American Physical Society conference in 1959.

Keywords: *Nanoparticles; Dendrimers; Nanomedicine*

Introduction

Feynman has stated that writing the entire encyclopaedia on a pin and reducing the computer size is possible [1]. In this lecture, further development of nanotechnology has been predicted. Some of the most important historical events in the formation of nanoscience and nanotechnology has been included as the following [2,3]:

- 1857: Discovery of the gold colloidal solution by Michael Faraday 1905: Explanation of the behaviour of the colloidal solutions by Albert Einstein.
- 1932: Creation of atomic thickness of a molecule by Langmuir.
- 1959: Feynman's theory of "large space at low levels" for working with materials in Nanoscale.
- 1974: The term nanotechnology has been introduced by Norio Taniguchi.
- 1985: Discovery of a new structure of carbon, C60.
- 1991: Discovery of carbon nanotubes 1993: Production of the first high-quality quantum dots.

- 1997: Construction of the first nano transistors 2000: Construction of the first DNA engine.
- 2001: Construction of a laboratory model of a fuel cell using nanotubes.
- 2003: Production of laboratory samples of solar Nano cells [4,5].

Methods

Different types of nanomedicine system

Definition of nanotechnology: The nanometre is one unit of length in the metric system and it indicates one billionth of a meter or a thousand of a micron [6]. Most of the available nanoparticles start from 1 to 100 nm in nanometre systems. These include milk (a nanoscale colloid), proteins, cells, bacteria, and viruses [7]. In addition, most of the materials with smooth surface has contained many porosities in nanometre scale. Major differences between nanomaterials and bulk materials [7,8]. Two main factors cause nanomaterials to behave significantly differently from bulk and conventional materials.

1. Surface effects (fraction of atoms on the surface).
2. Quantum effect (Quantum limiting effects on materials with non-stationary electrons).

These factors affect the chemical reactivity of materials as well as their mechanical, optical, electrical, and magnetic properties [9].

Nanoparticles have a higher fraction of atoms on the surface than micro particles or bulk materials.

In nanoparticles, surface atoms have fewer side atoms, therefore as the particle size decreases, the binding energy of the atoms decreases, and results in a decrease of melting point [10]. The electron behaviour of quantum dots is similar to that of single atoms or small molecules, therefore these quantum dots are considered to be similar to synthetic atoms [10,11].

It is noteworthy that the restriction of electrons at quantum points in all three directions of space leads to quantization of the energy spectrum [12]. Ranking of countries in the field of science and nanotechnology: The developments of nanoscience and nanotechnology have been evaluated based on the number of published scientific articles and the number of registered patents in this field, respectively [12].

The evolution and dynamics of nanoscience in recent years have resulted in finding an independent and integrated nature, hence this science does not depend only on the scientific products of other disciplines and provides the required information. Thomas Hines has also reviewed European nanotechnology articles between 1996 and 2001, majoring in materials science (13%), applied physics (10%), physical chemistry (10%), condensed matter physics (8%), and general chemistry (6%) as the most effective disciplines in the production of nanoscience and technology. The fields of biology and engineering are less involved than the mentioned fields. Bascolard has studied 168,000 articles, published between 1999 and 2003, and has stated that chemistry, physics, biology, medicine, and engineering are majors involved in nanoscience and nanotechnology. However, in recent years, the citation of chemistry in nano-articles has been increased [13].

Richard Feynman, the founder of medical nanotechnology, has proposed the first theory of designing a molecular nano machine capable of heart surgery.

Fullerenes: Fullerenes have a conjugated carbon skeleton structure (double carbon-carbon bond), and are often in the form of spherical or hollow elliptical structures. The term fullerene encompasses the entire set of hollow carbon molecules that have a pentagonal and

hexagonal structure, while carbon nanotubes have a hexagonal structure. The most well-known and stable structure of fullerene contains 60 carbon atoms (fullerene C60) [14].

Spherical fullerenes are sometimes called Bucky balls. Methods of making fullerenes: These structures are usually prepared using methods such as graphite resistive thermal evaporation, simple combustion of hydrocarbons by fuel-rich flames, and ultraviolet laser radiation. A minimum of 12 degrees is required to make fullerenes. Pentagonal fullerene 5*12=60 (60 carbon atoms are required). Hexagonal fullerene 6*12 = 72 (72 carbon atoms are required) [15].

Properties of fullerenes Bucky balls are physically resistant molecules which are able to persist in very high pressures, so that they return to their original shape after resisting a pressure of 3,000 atm. Interactions between Buckley-Ball molecules have been done through very weak forces (van der Waals forces) [16].

These forces are similar to the ones holding the graphite layers which permits the bucky balls, such as graphite, to be lubricated, though these molecules are too small for many applications in result of their adhesion to the gaps [17].

Multi-shell bucky balls known as nano-onions, are larger and more suitable for application as lubricants. The properties of nonlinear photonics can be increased by one or more metal atom outside or inside the fuller structure [18]. Fullerenes are also useful in destroying free radicals damaging living tissues. Hence, their application in cosmetics in order to protect the skin, has been recommended. Besides medicinal properties of Fullerenes, they have also been applied to deliver bacterial, anticancer, anti-apoptosis, antiviral, and antioxidant drugs. Graphite sheets, carbon nanotubes (CNTs), and fullerenes have contained weak van der Waals bonds [19].

Carbon nanotubes: Nanotubes are tubular sheets formed by self-assembly of atoms that may be made of organic or inorganic compounds.

The most popular nanotube structures are carbon nanotubes, which withstand almost a hundred times more tensile strength than steel, have higher thermal conductivity than most known materials, and have copper-like electrical conductivity [20].

Carbon nanotubes are formed by bending graphite sheets. In fact, a carbon nanotube is a long, narrow cylinder of graphite consisting of one or more layers of carbon atoms, the carbons of which are arranged in hexagonal lattices and each layer is associated with its adjacent layer with a weak van der Waals bond [21]. Graphite and carbon nanotubes of atoms have sp2 hybridization and as the hexagons are located on the plates. While carbon atoms in diamond have sp3 hybridization and are interconnected by very strong covalent bonds in three-dimensional space [22].

Types of carbon nanotubes:

1. Armchair: In which graphite sheets have been tubed in width. (Chiral angle = 30º).
2. Zigzag: In which graphite sheets have been tubed in length. (Chiral angle = 0º).
3. Chirality: In which graphite sheets have been tubed in diameter and the position is between two other models. In this type, the angle varies between zero and 30 degrees. Nanotubes have potential therapeutic properties including gene delivery and it has been also indicated that nanotubes can lead to oxidative stress pathways and thus cell death [23].

Nano-liposomes: Liposomes are concentric systems which have been surrounded by two layers of phospholipids formed by dehydration of dry phospholipids.

Nano-liposomes are the same as liposomes in nanometre sizes, which have been divided into two main categories based on the size and number of double layers [24]:

1. Multilamellar Vesicles: They have been composed of several phospholipid layers, which each of the layers have been separated by liquid space. These liposomes are not the same in size and diameter and will vary in 100 - 1000 nm.

2. Unilamellar vesicles: They have been composed of a phospholipid layer. In terms of size, this group has been divided into two groups, small single-layer vesicles with a diameter of about 100 nm and large single-layer vesicles with a diameter larger than 100 nm [25].

Properties of nano-liposomes: In result of Nano-liposomes properties such as being amphiphilic, ease of surface modification, and good biocompatibility the half-life of peptides and proteins in body have been increased [26].

Conclusion

Drug molecules, have been encapsulated in liquid space (hydrophilic drugs) or in a lipid bilayer network (hydrophobic drugs), based on their physical and chemical properties, and through Nano-liposomes attachments to cell membranes (by endocytosis) they have been transferred inside the cell. Nanomicells Micelles are systems which have been formed by the hydration of phospholipid molecules or surfactants, however unlike liposomes, they consist of a single layer [27].

Nano-micelles are the same micelle systems, in a nanometre size and have received a great deal of attention in drug delivery. Among the features of these systems their rapid penetration into body tissues has been noted.

In general, micelles can be formed by hydration of amphiphilic molecules, provided that the concentration of these molecules is higher than the critical limit of CMC3 (critical micelles concentration) itself [8]. Designing reverse micelles has make it possible to carry hydrophilic drugs. These micelles have been formed through placing hydrophilic parts of amphiphilic polymers in the oil phases, to transfer protein drug molecules orally [28].

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