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Review Article

A SHORT REVIEW ON NANOTECHOLOGY- THE NEW TREND IN THE MEDICAL FIELD

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ABSTRACT

Nanotechnology is the new trend in the drug delivery system in the biomedical and pharmacy field. This review deals with the prospectives of nanomaterials application related to biology and medicine and secondly it gives an overview, commercialization and development in the medical field.

Keywords: Nanomedicine, Nanoparticles, Nanotechnology, Nanomaterials.

1. INTRODUCTION

Nanotechnology is derived from the Greek word "nanos" means "dwarf". This term is originated from the physics, chemistry and biology. It is one of the most important technologies in the future [1]. Nanotechnology developed at several levels like materials, devices and systems. In nanotechnology the atomic structures are smaller than 100 nm. In this technology the special properties are used in the creations of a new particulate matter that resist against the scratches or solar irradiation. It is an enabling technology [2] that will be developed at several levels means at material level, devices and systems which is advanced in technology. At present this technology is most advanced which is used scientifically and commercially on large scale due to its size dependent physical and chemical properties [3]. The use of nanoparticles is typically in the building of the living cells and the cells having 10 μm sizes approximately. The each cell part is much smaller than the proteins but in the sub micron size with a typical size of 5 nm as just compared to the manmade nanoparticles. When introducing too much of interference in small probes at the cellular level that gives the idea of using the nanoparticles. The nanoscale is the strong driving force behind the development of the nanotechnology [4]. In biological applications the nanomaterials show the optical and magnetic effects. In today's world the nanotechnology place an important effect on the pharmaceutical industries and in other manufacturing companies. This technology starts in 1959 under the Richard Feyman (1918- 1988) discussed the idea of creating things out of tiny pieces instead of making things smaller. The term nanotechnology was established by Norio Taniguchi in 1974 [5]. Through this technology some scientists gave the new idea that it is some kind of a new production through which high précised small dimension molecules are originated in extreme. Now days the nanotechnology is used in the widened scopes include the devices and systems rather than just materials. The essence of nanotechnology application is preferred by nanoscale and nano dimensions. These materials can be fabricated by using either "bottom up" or "top down" approaches [6]. The nanomaterials structure is regulated by the thermodynamic means in bottom up method in a controlled manner so these technologies are fabricated on the nanoscale. These techniques are also fabricated on the "top down" methodology which includes the photolithography, nanomolding, dip pen lithography and nanofluids. Through these different approaches in the synthesis the nano molecules and nano devices are playing an important role in the field of the nanotechnology. In the chemical engineering the skills mainly understand these molecular events through the modeling and simulation these calculations by using the calculations of thermodynamic and kinetics. Through the top down and bottom up methodology the fabrication processes are having the good ability to understand these strategies of nanotechnology. It is a unique type of a technique in which the different opportunities are provided. The main application of nanotechnology is shown in the "nano medicine" field or "nanobiomedicine" and this should be used in monitoring, diagnosis, treatment, controlling the biological systems [7]. Through this review we discuss about the different techniques used in the nanotechnology and its different applications in various fields of engineering and pharmacy.

2. HISTORY OF NANOTECHNOLOGY

In 1959 Richard Feyman gives the official idea of the beginning of nanotechnology through his dissertation. The main idea behind this concept is the creation of the things out of tiny pieces rather than smaller [8]. The main idea behind the nanotechnology is the structure of an atom. This word was established by the Norio Taniguchi in 1974 [9].

Nanomedicine is defined as the medical application of nanotechnology. Through this approach the nanomedicine ranges from the medical use of nanomaterials, to nanoelectronic biosensors, and even the possible future applications of molecular nanotechnology [10]. A current problem for nanomedicine involved understood the issues related to toxicity and environmental impact of nanoscale materialsdiscuss the hard road to commercialization [11].

3. APPLICATIONS [12]

I. Medical use of nanomaterials

Drug delivery
Cancer
Surgery
Visualization
Nanoparticle targeting

II. Neuro-electronic interfaces

III. Medical applications of molecular nanotechnology

Nanorobots
Cell repair machines
Nanonephrology

4. BIOMEDICAL NANOTECHNOLOGY

Biomedical nanotechnology is one of the fastest-growing fields of research across the world in nanotechnology. However, it is clearly evident in some controversial fields like in cloning and stem cell research [13]. Biomedical Nanotechnology examines developments in three sub-fields: nano drug delivery; prostheses and implants; diagnostics and screening technologies.

Drug Delivery

Nanomedical approaches to drug delivery enter on developing nanoscale particles or molecules for improving the bioavailability of a drug. Bioavailability refers to the presence of drug molecules where they are needed in the body and where they will do the best absorption. Drug delivery focuses on maximizing bioavailability both at specific places in the body and over a long period of time. This will be achieved by molecular targeting through nano engineered devices [14]. It is all about targeted the molecules and delivery of drugs with cell precision. *In vivo* imaging is another area where tools and devices are being developed. Drug delivery systems, lipid or polymer based nanoparticles, can be designed to improved the pharmacological and therapeutic properties of drugs. The strength of drug delivery systems was their ability to alter the pharmacokinetics and distribution of the drugs [15]. Nanoparticles have unusual properties that can be used to improve the drug delivery. Where larger particles would have been cleared from the body, cells because of their size. Complex drug delivery mechanisms are being developed, including the ability to get drugs through cell membranes and cell cytoplasm. A drug with poor solubility was replaced by a drug delivery system where both hydrophilic and hydrophobic environments existed for the improved solubility. Also, a drug may cause the tissue damage, but with drug delivery, regulated drug release can eliminate the problem. One of the major impacts of nanotechnology and nanoscience will be in leading development of completely new drugs with more useful behavior and less side effects.

5. ECONOMY OF NANOPHARMACEUTICALS

According to a report from NanoMarkets, an industry consulting firm based in Sterling, USA, nanotechnology drug delivery systems will generate over $1.7 billion ($US) in 2009 and over $4.8 billion in 2012. The global drug delivery products and services market is projected to surpass US$67 billion in 2009. Lux Research reported in big Pharma companies are "flat footed" in their initiative about nanotechnology, however, medical devices companies are more aggressive in pursuing the nanotechnological strategies. The nanotechnology shows its impact on design of drug molecule, the benefit of which will be seen in augmented the product life cycle, patent life, along with their therapeutic efficiency [16].

6. RECENT DEVELOPMENTS IN NANOTECHNOLOGY FIELD

Tissue engineering

Natural bone surface is quiet rough in nature and 100 nm in surface size but the artificial implanting of the bone leads to the smoothness which causes the rejection through the body. Because of that smooth surface is likely to cause production of a fibrous tissue covering the surface of the implant. This layer reduces the bone-implant contact, which may be resulted in loosening of the implant and further inflammation. It was demonstrated by creating nano-sized features on the surface of the hip or knee prosthesis could reduce the chances of rejection as well as to stimulate the production of osteoblasts [17]. The osteoblasts are the cells responsible for the growth of the bone matrix and are found on the advancing surface of the developing bone. The effect was demonstrated with polymeric, ceramic and, more recently, metal materials. More than 90% of the human bone cells from suspension adhered to the nanostructured metal surface, but only 50% in the control sample. Titanium is a well-known bone repairing material widely used in orthopaedics and dentistry. It has a high fracture resistance, ductility and weight to strength ratio. Unfortunately, it suffers from the lack of bioactivity, as it does not support cell adhesion and growth well. These coatings were suffered from thickness non-uniformity, poor adhesion and low mechanical strength. In addition, a stable porous structure is required to support the nutrients transport through the cell growth. It was shown that using a biomimetic approach – a slow growth of nano structured apatite film from the simulated body fluid – resulted in the formation of a strongly adherent, uniform nano porous layer. The layer was found to be built of 60 nm crystallites, and possess a stable nanoporous structure and bioactivity. A real bone is a nanocomposite material, composed of hydroxyl apatite crystallites in the organic matrix, mainly composed of collagen. The actual nanoscale mechanism leading to this useful combination of properties is still debated. An artificial hybrid material was prepared from 15–18 nm ceramic nanoparticles and poly (methyl methacrylate) copolymer [18].

Cancer therapy

Cancer therapy is based on the destruction of the cancer cells by laser generated atomic oxygen, which is cytotoxic. A greater quantity of a special dye was used to generate the atomic oxygen was taken by the cancer cells when compared with a healthy tissue. Hence, only the cancer cells are destroyed then exposed to a laser radiation. Unfortunately, the remaining dye molecules migrated to the skin and the eyes and make the patient very sensitive to the daylight exposure. This effect can last for up to six weeks. To avoid this side effect, the hydrophobic version of the dye molecule was enclosed inside a porous nanoparticle. The dye stayed trapped inside the Ormosil nanoparticle and did not spread to the other parts of the body. At the same time, its oxygen generating ability has not been affected and the pore size of about 1 nm freely allowed for the oxygen to diffuse out [19].

Multicolor optical coding for biological assays

There was an increasing research in proteomics and genomic generates escalating number of sequence data and requires development of high throughput screening technologies. Various array technologies are currently used in parallel analysis are likely to reach saturation when a number of array elements exceed several millions. A three-dimensional approach, based on optical "bar coding" of polymer particles in solution, was limited only by the number of unique tags one can reliably produce and detect. Single quantum dots of compound semiconductors were successfully used as a replacement of organic dyes in various bio-tagging applications. This idea has been taken one step further by combining differently sized and hence having different fluorescent colored dots, and combining them in polymeric microbeads. A precised control of quantum dot ratios has been achieved. The selection of nanoparticles used in those experiments had 6 different colors as well as 10 intensities. It is enough to encode over 1 million combinations [20]. The uniformity and reproducibility of beads was high letting for the bead identification accuracies of 99.99%.

Manipulation of cells and biomolecules

Functionalized magnetic nanoparticles have found many applications including cell separation and probing. Most of the magnetic particles studied so far are spherical, which limits the possibilities to make these nanoparticles multifunctional. Alternatively cylindrical shaped nanoparticles can be created by employing metal electro deposition into nano porous alumina template. Depending on the properties of these templates, nano cylinder radius can be selected in the range of 5 to 500 nm while their length can be as big as 60 μm. By sequentially depositing various thicknesses of different metals, the structure and the magnetic properties of individual cylinders can be tuned widely [21]. As surface chemistry for functionalization of metal surfaces are well developed, different ligands can be selectively attached to different segments. For example, porphyrins with thiol or carboxyl linkers were simultaneously attached to the gold or nickel segments respectively. Thus, it was possible to produce the magnetic nano wires with spatially segregated fluorescent parts. In addition, because of the large aspect ratios, the residual magnetization of these nano wires can be high. It has been shown that a self-assembly of magnetic nanowires in suspension can be controlled by weak external magnetic fields. This would potentially allow controlling cell assembly in different shapes and forms. Moreover, an external magnetic field can be combined with a lithographically defined magnetic pattern ("magnetic trapping").

Protein detection

Proteins are the important part of the cell machinery and structure, and understanding their functionalities is extremely important for further progress in human well being. Gold nanoparticles are widely used in immune histo-chemistry for identifying protein-protein interaction. However, the multiple simultaneous detection capabilities of this technique are fairly limited. Surface-enhanced Raman scattering spectroscopy was a well-established technique for detection and identification of single dye molecules. By combining both these methods in a single nano particle probe can drastically improves the multiplexing capabilities of protein probes. The nanoparticles are coated with hydrophilic oligonucleotides containing a Raman dye at one end and terminally capped with a small molecule recognition element (e.g. biotin). Moreover, this molecule was catalytically active and will be coated with silver in the solution of Ag (I) and hydroquinone. After the probe attachment to the small molecule or antigen detection, the substrate was exposed to silver and hydroquinone solution. A silver-plating is happening close to the Raman dye, which allows for dye signature detection with a standard Raman microscope. Apart from being recognized small molecules this probe can be modified to contain antibodies on the surface to recognize the proteins. When tested in the protein array format against both small molecules and proteins, the probe has shown no cross-reactivity [22].

Commercial exploration

Several companies exploit quantum size effects in semiconductor nano crystals for tagging biomolecules, or use bio-conjugated gold nanoparticles for labeling various cellular parts. A number of companies are applying nano-ceramic materials to tissue engineeringSS and orthopaedics. Most pharmaceutical companies have internal research programs on drug delivery on formulations or dispersions containing components down to nano sizes. Colloidal silver was widely used in anti-microbial formulations and dressings. The high reactivity of titania nanoparticles, either on their own or then illuminated with UV light, was also used for bactericidal purposes in filters. Enhanced catalytic properties of surfaces of nano-ceramics or those of noble metals like platinum are used to destruct the dangerous toxins and other hazardous organic materials [23].

Current application areas

Nanotechnology was already having an impact on products as diverse as novel foods, medical devices, chemical coatings, personal health testing kits, sensors for security systems, water purification units for manned space craft, displays for hand-held computer games, and high-resolution cinema screens [24].

Sustaining the information

World market for nano electronics are worth hundreds of billions of euro and this industry is the driving force behind the current development of nanotechnology. Nano electronics will create the computers and transistors with much greater power use in telephones, cars, domestic appliances and the multitude of other consumer and industrial applications currently microprocessor-controlled.

Improving public health

Through nanotechnology and biological combinations will provide biosensors, biomaterials and new breeds of biochips for treating life-threatening conditions, including cancer and heart disease. Such bioengineered devices, in the form of body implants, will deliver smart drugs or carry new cells to repair damaged tissue.

7. CONCLUSION

Through this review it has been concluded that the nanotechnology created the new trends in the field of drug delivery. Therefore the nanotechnology is a new revolution trend in the field of science and pharmacy through which different dysfunctioning and disabilities have been cured.

8. REFERENCES

1. http://www.drcetiner.com/images/nanotechnology.JPG
2. Ferrari M. *Nat Rev Cancer*, 2005; **5(3):** 161–171.
3. Peppas NA. *Adv Drug Deliv Rev*, 2004; **56(11):** 1529–1531.
4. Sahoo SK, Labhasetwar V. *Drug Discov Today,* 2003; **8(24):** 1112–1120.
5. http://www.nano.gov/html/facts/ The_scale_of_things.html
6. https://www.tab fzk.de/de/project/zusammenfassung/ab92.htm
7. hhtp://www.nanopolis.de/nantechnologie.htm
8. http://sebi.name/~olga/geschichte.php
9. http://en.wikipedia.org/wiki/Buckminsterfullerene#Buckminsterfullerene
10. Reddy RJ, Sagar EG, Chandran SBP, Kumar RB, Madhu C, Chetty S. *J of Global Trends in Ph'ceutical Sci*, 2011; **2(1):**21-30.
11. Mazzole L. *Nature Biotechnol*, 2003; **21:** 1137-1143.
12. en.wikipedia.org/wiki/nanomedicine
13. www.nanoscienceworks.org/publications/books/imported/0824725794
14. www.edinformatics.com/nanotechnology/nanomedicine.htm
15. Pankhurst QA, Conolly J, Jones SK Dobson J. *J Phys D: Appl Phys,* 2003; **36:** R 167- R181.
16. www.nstc.in/programs/nano pharmaceuticals.htm
17. Ma J, Wong H, Kong LB, Peng KW. *Nanotechnol*, 2003; **14:** 619-623.
18. De Lasale Isle, Brostow W, Bujard B, Estervez M, Rodriguez JR, Vargas S, Castano VM. *Materials Res Innovations,* 2003; **7:** 110-114.
19. Roy I, Ohulchanskyy TY, Pudavar EJ, Oseroff AR, Morgan J, Dougharty TJ et al. *J Am Chem Soc,* 2003; **125:** 7860-65.
20. Han MX, Su JZ, Nie S. *Nature Biotech*, 2011; **19:** 631-35.
21. Reich D, Tanase HM, Hultgren A, Bauer LA, Chen CS, Meyer GJ. *J Appl Phys*, 2003; **93:** 7275-7280.
22. Cao YC, Namjin R, Thaxston JM, Mirkin CS. *J Appl Cosm Sci,* 2003; **125:** 14676-77.
23. Gutwein LG, Webster TJ. Effects of alumina and titania nanoparticles on bone cell function American Ceramic Society 26th Annual Muting Conferencing., 2003, in press.
24. ec.europa.eu/research/leaflets/nanotechnology/page_49_en.html