THE INTERNATIONAL JOURNAL OF SCIENCE & TECHNOLEDGE

Cancer Nanotechnology as Emerging Field of Cancer Research

Rajesh Kumar Meher
Student, P.G. Department of Biosciences and Biotechnology, Fakir Mohan University, Balasore, Odisha, India
Namita Nayak
Student, P.G. Department of Biosciences and Biotechnology, Fakir Mohan University, Balasore, Odisha, India
Samarpita Sethy
Student, P.G. Department of Biosciences and Biotechnology, Fakir Mohan University, Balasore, Odisha, India

Abstract:
The goal of nanotechnology is to use of nanopartcles in the field of science engineering and medicine for benefits of mankind. At present for diagnosis and treatment of some diseases, like cancer, face major limitations. So current aim of researcher is to use of nanoparticles or nanotechnology to treat cancer like disease. Cancer nanotechnology is emerging as a new field of interdisciplinary research, cut- ting across the disciplines of biology, chemistry, engineering, and medicine, and is expected to lead to major advances in cancer detection, diagnosis, and treatment . Nanoparticles used in diagnosis and treatment include semiconductor, quantum dots, iron oxide nanocrystals, nanoshells, nanosomes, have optical,magnetic or structural properties. When this nanoproperticles attached with the monoclonal antibodies or peptides, it can be used to target the tumor antigens with high specificity. With the help of bioaffinity nanoparticle probes, we can detect the cancer easily and earlier. How much nanotechnology is safe, no one can defined fully. But definitely, it will play a very important role in future treatment.

1. Introduction

1.1. Cancer Problem

Cancers figure among the leading causes of morbidity and mortality worldwide, with approximately 14 million new cases and 8.2 million cancer related deaths occurring. Human cancer is caused by genetic instability and molecular alterations. Present diagnostic system cannot show the complete clinical heterogeneity of tumors and insufficient to make predictions for successful treatment and patient outcome. In most of the cases we can not differentiate between normal cells and cancer cells with the help of anticancer agents. That's why it leads to very critical and adverse effects. Cancer is often diagnosed too late, when the cancer cells have already spreaded into other parts of the body. At this stage, therapies are limited with respect to effectiveness. Due to these problems, the death rate in cancer is increasing all over the world.

1.2. Cancer Nanotechnology

Cancer nanotechnology is a new field of research and is expected to lead to major advances in cancer detection, diagnosis, and treatment. The important thing is that metal, semiconductor, and polymeric particles have novel optical, electrical, magnetic, and structural properties that are often not available from individual molecules. Recent research technique has developed nanoparticles that are linked to biological molecules such as peptides, proteins, nucleic acids, or small-molecule ligands. Now superparamagnetic iron oxide nanoparticles are used as agent for lymph node prostate cancer detection. The use of metal and semiconductor nanoparticles are also under development for molecular profiling studies.

2. Different Therapies in Nanotechnology

2.1. Liposomes

Liposomes discovered in 1960. These are the models of nanoscaled drug delivery devices. These are spherical nanoparticles, it's membrane is made of lipid bilayer and interior is aqueous.

These are used as safe and effective drug delivery devices, especially for toxic drugs like anti-cancer drugs and amphotericin-B. Lipid soluble drugs are packed in lipid bilayer while the water soluble drugs are loaded in aqueous compartment. Liposomes target to a specific organ or tissue by active or passive methods. The liposomal drug gets accumulated into the tumour site passively and produce enhanced effects. In active method immunoliposomes or ligand directed liposomes are used. Immunoliposomes are liposomes conjugated with an antibody target to the tumour antigen. The antibody can be conjugated to the surface of a stealth liposome, the polyoxyethylene coating of a stealth liposome or on the surface of a non stealth liposome. When these

immunoliposomes injected into the body, it reaches the target tissue and gets accumulated at its site of action. In ligand bearing liposomes, a specific ligand is conjugated with the liposomes and is directed towards the target tissues. For example, ovarian cancer cells have over expression of folate receptors. So the liposomal drug can be conjugated with folate so as to direct the anti-cancer drug molecule to the tumour.

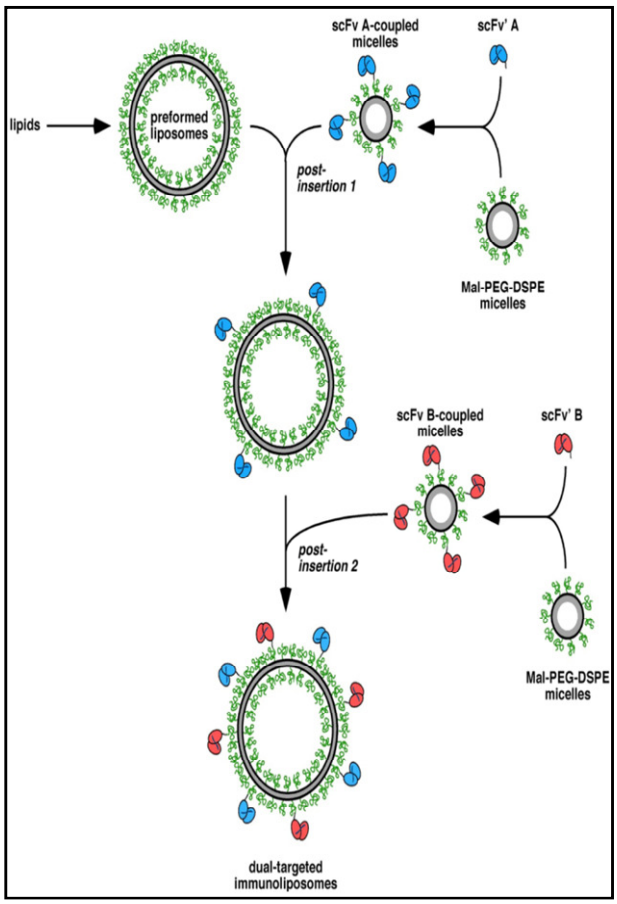

Figure1: Immunoliposomes

2.2. Nanobubbles

Anti-cancer drugs can also be incorporated into the nanobubbles. The nanobubbles can be targeted to the tumour tissue and deliver the drug selectively under the influence of ultrasound exposure. It also enables additional benefit that tumour can be visualized by means of ultrasound.

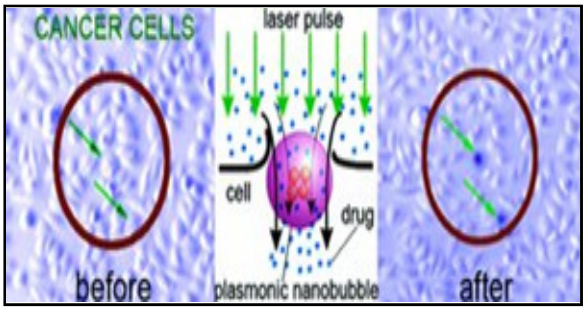

Figure 2: Nanobubbles

2.3. Nanoprobes

Magnetic nanoprobes are used for cancer therapy. Iron nanoparticles coated with monoclonal antibodies directed to tumour cells can be made to generate high levels of heat after they accumulate at their target site by external application of alternating magnetic field. This heat kills the cancer cells selectively. This method has been designed by Triton Biosystems and entered clinical trials in 2009.13 Nanoprobes also allow detection of tumour markers even at molar concentration.

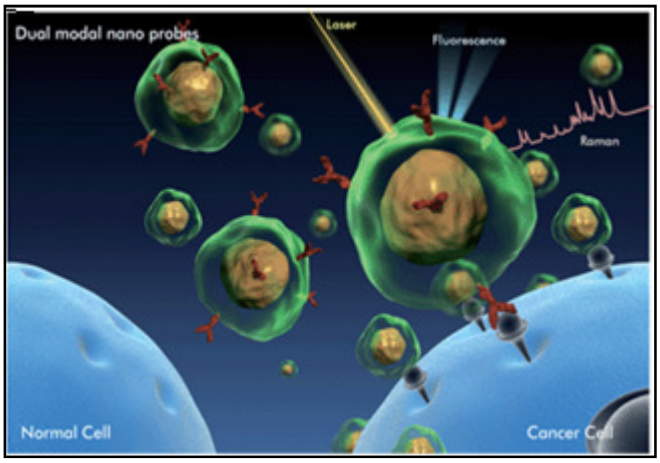

Figure 3: Illustration of cancer marker detection using fluorescence-SERS dual modal nanoprobes (DMNPs). Functional DMNPs are selectively targeted onto cancer

2.4. Nanotubes

Carbon nanotubes discovered in 1991 are tubular structures like a graphite sheet rolled into a cylinder capped at one or both ends by a bucky ball.15 Nanotubes can be single walled carbon nanotubes(SWCNT) or multiwalled carbon nanotubes(MWCNT) in concentric fashion. These vary in their length ranging from one to few micrometer.16 Nanotubes have greater strength and stability and hence, can be used as stable drug carriers. Cell specificity can be achieved by conjugating antibodies to carbon nanotubes with fluorescent or radiolabelling.17 Entry of nanotubes into the cells may be mediated by endocytosis or by insertion through the cell membrane. Amphotericin B nanotubes have shown increased drug delivery and efficacy into the cells compared to Amphotericin B administration without nanotubes.18 And these nanotubes were found to be effective on strains of fungi which are usually resistant to Amphotericin B alone. Further, there was reduced toxicity to mammalian cells with Amphotericin B nanotubes. Nanotubes can also transport DNA across cell membranes and hence can be used in gene therapy. DNA can be attached to the tips of nanotubes or can be incorporated within the nanotubes. Prato et al18 showed greater expression of beta-galactosidase marker gene through nanotubes compared to naked DNA. This confers the advantage of non-immunogenicity in contrast to viral vectors used for gene transfer.

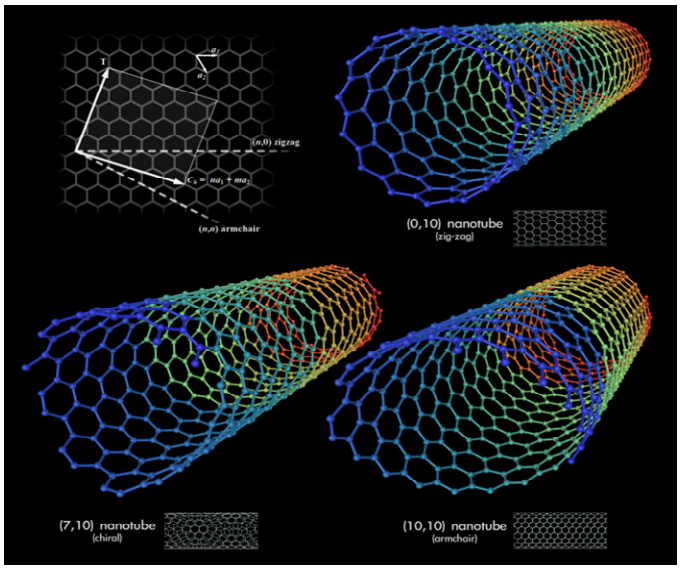

Figure 4: Carbon nanotubes

3. Future Directions

Nanotechnology has become an emerging technology for cancer research in diagnosis,and therapy .The various products of nanoparticles using in cancer diagnosis and treatment in some aspect nanoparticle also using as drug. Looking into the future, there are a number of research themes or directions that are particularly promising but require concerted effort for success. The first direction is the design and development of nanoparticles with monofunctions, dual functions, three functions, or multiple func tions for cancer and other medical application. However, it is expected that nanomedicine would play a crucial role in diagnosis and treatment of human cancer and other diseases in future.

4. References

i. Medina C, Santos-Martinez MJ, Radomski A, Corrigan OI, Radomski MW. Nanoparticles: pharmacological and toxicological significance. Br J Pharmacol 2007; 150:552-8.

ii. Caruthers SD, Wickline SA, Lanza GM. Nanotechnological applications in medicine. Curr Opin Biotechnol 2007;18:26-30.

iii. Gregoriadis G, Ryman BE. Fate of protein containing liposomes injected into rats: an approach to the treatment of storage diseases. Eur J Biochem1972; 24:485-91

iv. Forssen E, Willis M. Ligand-targeted liposomes. Adv Drug Del Rev 1998; 29:249-71.

v. Klibanov AL. Microbubble contrast agents: targeted ultrasound imaging and ultrasound-assisted drug-delivery applications. Invest Radiol 2006;41:354- 62.

vi. GolubTR,SlonimDK,TamayoP,HuardC,GaasenbeekM,etal.1999.Molec- ular classification of cancer: class discovery and class prediction by gene expres- sion monitoring. Science 286:531–37

vii. Ross DT, Scherf U, Eisen MB, Perou CM, Rees C, et al. 2000. Systematic variation in gene expression patterns in human cancer cell lines. Nat. Genet. 24:227–35

viii. Alizadeh AA, Eisen MB, Davis RE, Ma C, Lossos IS, et al. 2000. Distinct types of diffuse largeB-celllymphomaidentifiedbygeneexpressionprofiling.Nature 403:503–11

ix. PerouCM,SorlieT,EisenMB,vandeRijnM,Jeffrey SS,et al.2000.Molecular portraits of human breast tumours. Nature 406:747–52 30. Bittner M, Meitzer P, Chen Y, Jiang Y, Seftor E, et al. 2000. Molecular classifi- cation of cutaneous malignant melanoma by gene expression profiling. Nature 406:536–40

x. Lynch TJ, Bell DW, Sordella R, Gurubhagavatula S, Okimoto RA, et al. 2004. Activating mutations in the epidermal growth factor receptor underly- ing responsiveness of nonsmall-cell lung cancer to gefitinib. N. Engl. J. Med. 350:2129–39

xi. Paez JG, Janne PA, Lee JC, Tracy S, Greulich H, et al. 2004. EGFR mutations in lung cancer: correlation with clinical response to gefitinib therapy. Science 304:1497–500