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# Opportunities, Challenges and Applications of Cancer Nanotechnology

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**Abstract: Throughout recent years, significant focus has been paid to the use of nanotechnology towards cancer therapy. Cancer nanotechnology basically known as an interdisciplinary area of science, medicine and engineering research and an emerging field with many broad applications. This offers a unique approach and an integrated cancer technology through the application of early diagnosis, prediction leading to prevention and personalized therapy. Targeted drug therapy and strategies for early pathology diagnosis are the key research areas where nanotechnology plays a vital role. This study focuses on approaches based on cancer nanotechnology for advancing the cancer therapy. Among the leading methods, Nanowires and Nano cantilevers arrays are under development for an early diagnosis of precancerous as well as malignant lesions from biological fluids. These along with other Nano devices can provide major breakthroughs for fighting cancer.**

**Keywords: Cancer, nanotechnology, Nano cantilevers, Nano devices, applications, challenges, opportunities.**

## INTRODUCTION

The key issue involved with cancer therapy is to reach the desired concentration of an agent named the therapeutic agent at various tumor sites, thus killing the cancer cells [1] while minimizing the damage to the normal cells.

With this vision, creating the single agents with the tremendous potential is again imperative to make a significant contribution to the cancer prevention, detection as well as the treatment. In this regard, many ligand-targeted and therapeutic approaches are being developed so as to overcome various problems associated with traditional chemotherapy [2] drugs, including the immunotoxins [3], radioimmunotherapeutics and the drug immunoconjugates, hence providing additional resources in the arsenal of the cancer therapy.

While mentioned conjugated agents have presented promising efficacy compared to the conventional chemotherapy drugs, the delivery limitations of these agents always remain a major problem. Recent developments suggest that the nanotechnology [4] (that involves creating and manipulating nanoscale materials so as to create the products with novel properties) would have a tremendous impact on prevention, diagnosis and treatment of the disease.

As shown in Figure 1, the concept of using nanoscale development material to create more efficient cancer treatments offers a convincing panacea for the preferential cancer cell removal without any kind of serious damage to the normal cells.

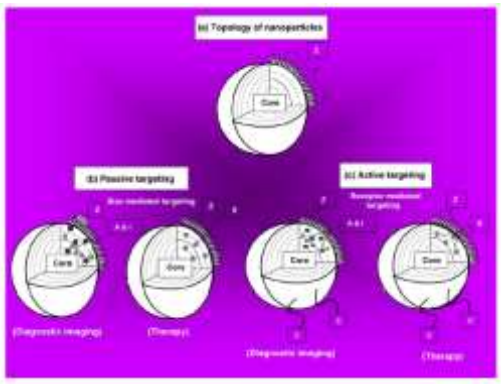

**Fig. 1: Illustration of the Topology and Targeting of Nanoparticles**

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Targeted treatment in context with the cancer treatment has become increasingly desirable, wherein only the cancer cells are killed and the normal cells are not harmed at all. Nanotechnology implementation has brought new technologies and pathways for the treatment responsibilities of the targeted cancer.

Nanoparticles based engineered properties have opened the doors to modern and non-invasive cancer treatment approaches that were not possible previously. This includes nanotechnology-based advanced cancer therapy strategies like the photodynamic therapy [5] (PDT), the radio-frequency therapy and the radiotherapy [6] as presented in Figure 2.

Nanoparticles related engineering is applied to avoid the barriers to biology and biophysics. For both the nano-vectored and the conventional formulations, the trekking of a therapeutic or an imaging agent from administrative point of view to the intended targets is full of dangers.

Biological barriers are likely to arise as tight junctions in between epithelial cells, as is the case with the blood-brain barrier [7] (BBB) that prevents the tissue necrosis of the vascular injected agents. These Nanotechnology-based systems have demonstrated effectiveness in crossing BBB due to the characteristics of their core materials. The co-administration amongst a bradykinin antagonist could improve the endothelial vascular permeability. This suggests a technique for enhancing Nano vectors related EPR targeting.

In relation to the Colocalized distribution of permeation enhancers like zonula-occludens toxin that reversibly opens up the tight junctions enabling of the orally administered biomolecular agents to penetrate into the vascular compartment via an intestinal epithelium serve as a very effective barrier.

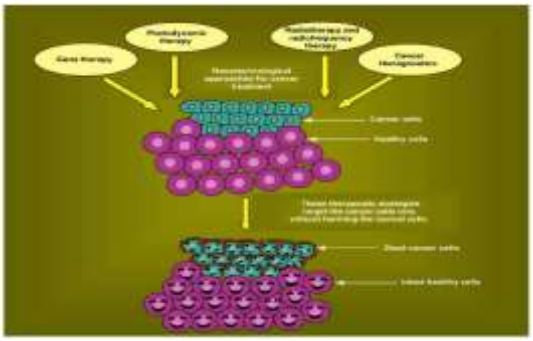

**Fig. 2: Diagram of Approaches Used in Nanotechnology**

Synthetic particles that are engineered to simultaneously hold intestinal-wall-targeting moieties, biological therapeutic agents and the permeation enhancers not only provides an example of the multi-functionality provided by nanotechnology, but also shield the drug from the enzymatic degradation and the also the releasing time delay.

Similarly, complex and smaller, particulates could be engineered for intravascular injection as resented in Figure 3 to increase the capacity of drug extravasation across the cancer lymph vessels endothelium to improve the effects of the spontaneous targeting of EPR or to promote its thermal conduction through the BBB.

## TECHNOLOGY

According to an estimation, the literature has documented several thousands of different types of Nano vectors [8]. Only a fraction of a single minute of their potential applications on cancer have been explored, but they provide technical foundations to address the fundamental problems of cancer nanotechnology as listed below.

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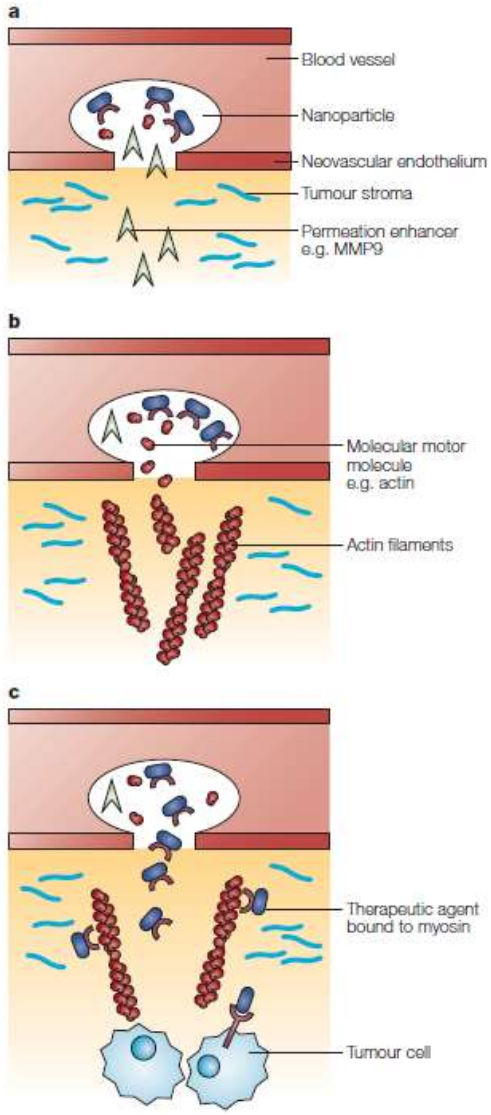


**Fig. 3: Depiction of Future of Multistage Nano Devices**

## MACROSCOPIC DEVICES AND THEIR NANOCOMPONENTS

Diversity of array of the novel instruments, techniques and manufacturing methods emerge beyond the Nano-vectors for possible use against the cancer. This starts with the high-precision based patterning of biological molecules on various substrates.

As a primary example, micro-arrays are often used for the task of molecular diagnostics, the bio marker guided therapeutic targeting as well as genotyping and are produced by synthesizing the single-stranded DNA [9] samples with just one oligonucleotide at a time, in a very spatially controlled manner regulated by the specific ultraviolet irradiation of a substratum through a particular patterned mask as presented in figure 4.

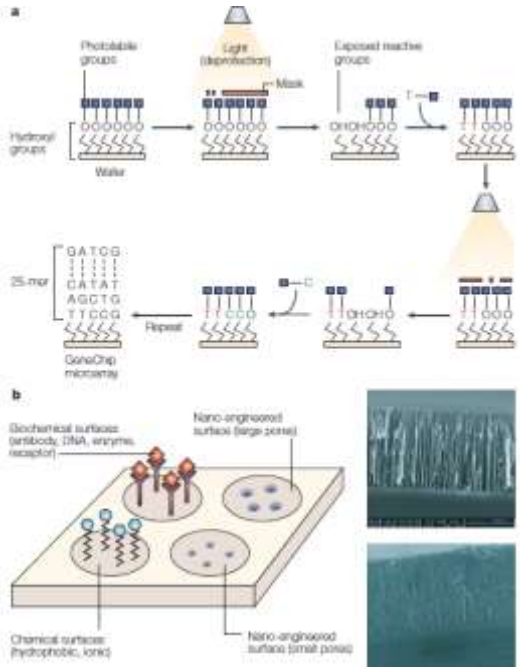


**Fig. 4: Nanotechnology Approach for Detection, Identification and Diagnosis of Biological Molecules**

## RESULTS AND CONCLUSIONS

Nanotechnology plays an important role in the achievement of goal of early treatment by in vivo imaging or the ex vivo study of transforming the cell populations. This shall also allow correct combination of the agents to be selected i.e. based on accurate tumor related biological information), targeting such agents (and meanwhile avoiding the biological barriers) such that to eliminate or contain the early cancer lesions and that too without the collateral effects on the healthy tissue, and tracking the real time effect of done treatment.

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