

**Nanomedicines: Emergence a New Era in Biomedical Sciences**

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**Abstract**

Nanoscale of materials exhibit unique optical, electronic and magnetic properties which have not been seen at the bulk scale which makes the nanostructures evident for the wide range of applications. The combination of these unique properties at the appropriate size has motivated to commence of nanostructures into the biomedical sciences. Which transform modern medical system broadly in two ways i.e. drug delivery system and diseases treatment. This would be not drug in nanoform but this would be process which diagnoses, treat and prevent disease using molecular tools and molecular knowledge of the human body. Moreover, Nanoparticles are in aggregated form have tremendous functional applications which have been recognized by modern medical scientist and biologists, these nanoparticles aggregate to form some specific structures called Fullerenes, carbon nanotubes, dendrimers, quantum dots, nanoshells and have diverse applications. These nanostructures individually or assembled in a particular order to form the more complex structures or devices such as nanosensors, nanorobots, nanobodies, nanodevices and they have direct applications in all possible area of biomedical science. The present review emphasizes on medical applications of nanostructures, devices and there possible pathway of synthesis. Furthermore, study highlighted how these nanostructure and devices used for drug delivery and treatment tools for curing fetal diseases and disorders.

**Keywords:** Nanomedicine, Immunoisolation, Dendrimers, Nanoparticles, Nanosystems, Nanorobots, and Nanocarriers

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**Introduction**

Nanobiotechnology brings exciting new possibilities in the area of medical biology. Nanomedicines has been defined as the process of diagnosing, treating and preventing disease and traumatic injury, relieving pain, and preserving and improving human health (4), using molecular tools and molecular knowledge of the human body. One can envision nanocarriers that can be targeted to a specific tissue or cells to simultaneously detect and diagnose diseases as well as to

treat them through the delivery of the therapeutics on the targeted organ and tissues (2). In general, miniaturization of our medical tools will provide more accurate, more reliable, more cost-effective and faster approaches to enhance the quality of human life. The aim of Nanomedicine may be broadly defined as the comprehensive monitoring, control, construction, repair, defense and improvement of all human biological systems, working from the molecular level using engineered devices and nanostructures, ultimately to achieve medical benefit and fitness.

## Status of Nanomedicine

Several approaches towards nanomedicine being pursued today are already close enough to fruition that it is fair to say that their successful development is almost inevitable, and their subsequent incorporation into valuable medical diagnostics or clinical therapeutics is highly likely and this may occur very soon (31).

Introduction of Some important nanomedicines are like Nanopores based, Fullerenes based pharmaceuticals, Nanoparticles, Dendrimer based, Liposomes, Nanoshells and Nanorobotics for delivery of drugs to an appropriate site.

### 1. Nanopores

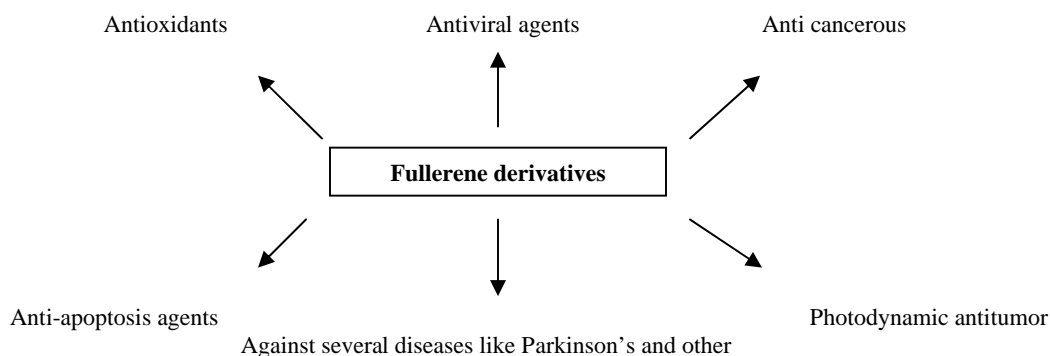
Nanopores are the surface perforated with holes and in nanodimensions. Desai and his coworkers (3) pioneer to fabricate tiny chambers within silicon wafers in which biological cells can be placed. The chambers interface with the surrounding biological environment through polycrystalline silicon filter membranes which are micromachined to present a high density of uniform nanopores as small as 20 nm in diameter. These pores are large enough to allow small molecules such as oxygen, glucose and insulin to pass but are small enough to impede the passage of much larger immune system molecules like immunoglobulins and graft borne virus particles (6). This process is called as 'immunoisolation'. Immunoisolated encapsulated rat pancreatic cells may receive nutrients and remain healthy for several weeks and secretes insulin

through the pores while remaining hidden from the immune system.

Similarly, microcapsules containing pig islet cells could be implanted beneath the skin of some diabetes patients that can restore the body's glucose level. The flow of nanomaterials through the nanopores can also be externally regulated (7). The first artificial voltage gated molecular nanosieve was fabricated by Martin and colleagues (8) in 1995. Martin's membrane contains an array of cylindrical gold nanotubules with inside diameter as small as 1.6 nm (6). Current research is directed towards reliably fabricating pores with specific diameters and repeatable geometries at high precision (9).

### 2. Fullerenes based pharmaceuticals

Soluble derivatives of fullerenes such as C<sub>60</sub> have shown great utility as pharmaceutical agents (6). Due to the good biocompatibility and low toxicity, fullerenes derivatives are widely used in medicines. Fullerene compounds may serve as antiviral agents most notably against the (11) HIV (Human immunodeficiency virus). The fullerenes products are the good antibacterial agents (11,12,13), photodynamic anti-tumor (14,15), anticancer therapies (16). These are the good antioxidants and anti-apoptosis agents which may include treatments for amyotrophic lateral sclerosis (17) and Parkinson's disease. Due to the good biocompatibility and low toxicity, fullerenes derivatives are widely used in medicines. Fullerene compounds may serve as antiviral agents most notably against the HIV (Human immunodeficiency virus).



### 3. Nanoparticles

Nanoparticles are the sub-micron sized polymeric colloidal particles with a therapeutic agent of interest encapsulated within their polymeric matrix or adsorbed or conjugated on to the surface (1). Polymeric nanoparticles constitute a versatile drug delivery system, which can potentially overcome physiological barriers, and guide the drugs to specific cells or intracellular compartments (18, 33). It also allows controlling the release pattern of drug and sustaining drug levels for a long time by appropriately selecting the polymeric carriers. Intravenously injected nanoparticles are mostly taken up by the liver and spleen within minutes following drug administration (19). Anticancer drug loaded nanoparticles are mainly concentrated in Kupffer cells in liver on intravenous injection. These cells act as reservoirs and allow prolonged diffusion of anticancer drug into the neighbouring tumor cells.

This approach of passive targeting has been useful for the treatment of hepatic metastasis (20). The uptake of nanoparticles depends on the particle size, surface charge and surface hydrophobicity. Steric stabilization of nanoparticles has been achieved by making the surface of particles more hydrophilic so as to prevent opsonization in the blood stream. This is done either by adsorbing hydrophilic surfactants on nanoparticle surface or using block/branched copolymers (21). Polyethylene oxide (PEO) or Poly ethylene glycol (PEG) is the most successful non-ionic hydrophilic polymer used for this purpose (21, 22). An overview of nanostructures mediated drug delivery technologies (table 1). The biopolymer nanostructures are preferred because they are easily biodegradable and have no toxic side-effects (39).

### 4. Dendrimers

Dendrimers have emerged as an important class of drug encapsulating nanoparticles as a result of their unique architecture and macromolecular characteristics. These are synthetic, highly branched, spherical, monodispersed

macromolecules with an average diameter of 1.5- 14.5 nm (23, 24). A typical dendrimer molecule consists of an initiator core, highly branched layers composed of repeating units, and multiple active terminal groups (25). The architectural design of dendrimers provides a high level of control over the dendrimer shape, size, branching length and surface functionality. Likewise, Starburst dendrimers (6) are the tree shaped synthetic molecules up to a few nanometer in diameter that are formed with a regular branching pattern (26). The peripheral layers of dendrimers can be made to form a dense field of molecular groups that serve as hooks for attaching other useful molecules, such as DNA, which can enter cells while avoiding triggering an immune response, unlike viral vectors commonly employed today for transfection (6). Upon encountering a living cell, dendrimers of a certain size trigger a process called endocytosis in which the cell's outermost membrane deforms into a tiny bubble, or vesicle. The vesicle encloses the dendrimer which is then administered to the cell's interior. Once inside, the DNA is released and migrates to the nucleus where it becomes part of the cell's genome (6). The technique has been tested on a variety of mammalian cell types (27) and in animal models, (28, 29) though clinical human trials of dendrimer gene therapy remain to be done. Drug molecules can be incorporated into dendrimers via either complexation or encapsulation (30) (figure 1).

Baker and his coworkers in 2001 (5) have synthesized multicomponent nanodevices called Tectodendrimers, which have a single core dendrimer to which additional dendrimer modules of different types are affixed, each type designed to perform a function necessary to a smart therapeutic nanodevice. These dendromeric components perform the following functions as disease cell recognition, diagnosis of the disease state, drug delivery, location reporting, and reporting outcome of therapy. This type of the frame structure can be customized to fight a particular cancer simply by substituting any one of much possible distinct cancer recognition or 'targeting' dendrimers, creating a nanodevice customized to destroy a specific cancer type, not other normal cells (31).

Dendrimers can supply a valuable architecture to the realm of nanomedicine, however these conjugates lack complete

control over shape, size and monodispersity (2).

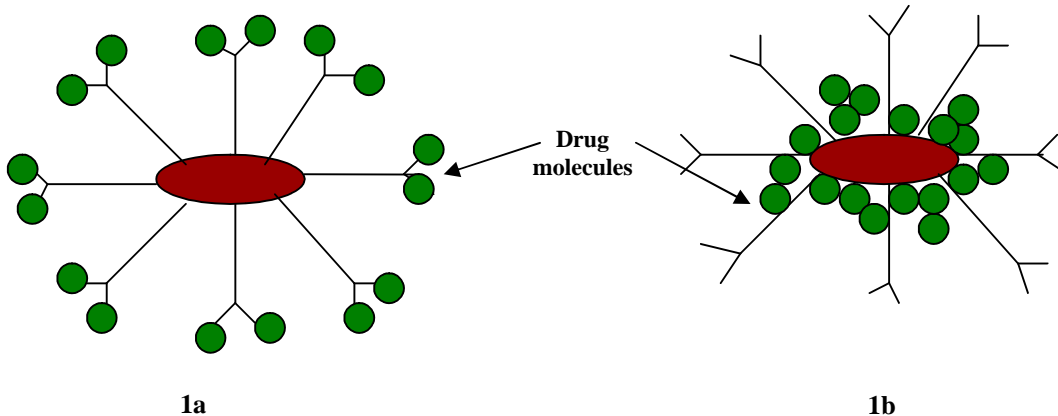


Fig. 1: Scheme of incorporation of drug within a dendrimer structure, 1(a) Complexation – covalent attachment to end groups, 1(b) Encapsulation – trapment inside dendrimer core

Table 1 – Nanoscale drug delivery technologies

| Drug delivery technology    | Materials  | Nanostructure forms                                    |
|-----------------------------|--|--|
| Biologic (Biomolecules)     | Lipids<br>Peptides<br>Nucleic acids<br>Polysaccharides<br>Viruses  | Vesicles, nanotubes, nanoparticles.                    |
| Polymeric                   | Poly(glycolic acid)<br>Poly(lactic acid)<br>Poly(ethylene oxide)<br>Poly(amido amine)<br>Poly(propylene imine) | Vesicles, Spheres, Nanoparticles, Micelles, Dendrimers |
| Carbon based nanostructures | Carbon   | Nanotubes, fullerenes                                  |
| Metallic                    | Gold, Silver,<br>Palladium, Platinum   | Nanoparticles, Nanoshells                              |

## 5. Liposomes

Liposomes are made of amphiphilic unilamellar/multilamellar membranes of natural or synthetic lipids (43). Lipids are characterized by a hydrophilic head group and hydrophobic tail so that hydrophobic and hydrophilic molecules have been encapsulated into liposome NPs. These are investigated as a potential drug delivery system due to enormous diversity of structure and compositions that can be achieved (35). Liposomes can be used to deliver immunomodulators, cytotoxic and microbial agents to the macrophages by means of passive targeting. These are rapidly taken up and accumulated in the tumor cells (18). Selective uptake of unmodified liposomes by the phagocytic cells has also been exploited for intracellular delivery of antimicrobial agents, thereby increasing their therapeutic index and decreasing toxicity substantially (18). Liposomes have been used as carriers for radioisotopes and contrast agents to be used in diagnostic imaging (36). It has been shown that those carrying contrast agents accumulate more in surrounding cells than in tumor cells due to low phagocytic activity of tumor cells. This can be used for tumor imaging, wherein tumor cells are observed as holes within the surrounding background.

Liposomes can also be localized to a particular target tissue by external application of localized heat and use of temperature sensitive liposomes (37). These are also being actively pursued as a potential tool for targeted gene delivery to specific cells in the body. Cationic liposomes can be complexed with polyanionic plasmid DNA to form highly compact nanostructures with a net positive charge called 'Lipoplexes'. This non-viral gene delivery system was designed for gene targeting to liver by conjugating modified galactolipids to the lipoplex (38). Despite the clinical success of liposome, these nanocarriers are limited by the suboptimal stability and drug release profiles *in vivo*. There are still numerous lacunas to be filled before liposomes can be projected as the ultimate nanosystems for targeted drug delivery. Major obstacles include gene transfer to the nucleus of a cell and obtaining a sustained

long term expression of the genes (18).

## 6. Nanoshells

Nanoshells (54) are the dielectric metal nanospheres like gold coated silica. These nanoshells are embedded in a drug containing tumour targeted hydrogel polymer and then injected into the body. They get accumulated near the tumour cells. When heated with an infrared laser, the nanoshell selectively absorbs a specific infrared frequency and the polymer gets melted by releasing the drug payload simultaneously (6). Nanoshells offer advantages over traditional cancer treatments like early detection, more detailed imaging, fast non-invasive imaging and integrated detection and treatment. Using antibody-nanoparticle conjugates of gold nanoshells, whole blood immunoassay can be done (40).

## 7. Nanorobots

The major development pathway of nanomedicine is the molecular nanotechnology (MNT) or Nanorobotics (42, 43, 44). Ongoing development in molecular fabrication, computation, sensors and motors will enable the manufacturing of nanorobots - nanoscale biomolecular machine system (41). Nanorobots are simply the engineering of complex nanomechanical system for medical application (6). Biomedical interventions and manipulations are automatically performed by these nanorobots. However the idea of placing autonomous self-powered nanorobots inside of us might seem a bit odd, but actually the human body already teems with such nanodevices. For instance, more than forty trillion single-celled microbes swim through our colon, outnumbering our tissue cells almost ten to one (42). Many bacteria move by whipping around a tiny tail, or flagellum, that is driven by a 30 nm biological ionic nanomotor powered by pH differences between the inside and the outside of the bacterial cell (6). Our bodies also maintain a population of more than a trillion motile biological nanodevices called fibroblasts and white cells such as neutrophils and lymphocytes, each measuring about 10 microns in size

These beneficial natural nanorobots are constantly crawling around us, repairing damaged tissues, attacking invading microbes, and gathering up foreign particles and transporting them to various organs for disposal from the body (43). However, these nanorobots cannot be fabricated yet, theoretical and simulation studies defining design strategies, capabilities and limitations, will supply better comprehension of nanorobots behaviour and nanoworld (46, 47). Recent developments in the field of biomolecular computing (48) have demonstrated positively the feasibility of processing logic tasks by bio-computers (49), which is a promising step to enable future nanoprocessors with increased complexity. Studies targeted at building biosensors (50) and nano-kinetic devices (51), required to enable nanorobotics operation and locomotion, have been advancing recently as well (41). Molecular nanotechnology (MNT) or Nanorobotics will allow doctors to perform direct *in vivo* surgery on individual human cells. The ability to design, construct and deploy large numbers of microscopic medical nanorobots will make this possible (6).

Nanorobot manufacturing will undoubtedly require development of break-through technologies in fabrication, computation, sensing and manipulation (41). The nanorobot design is comprised of components such as molecular sorting rotors and a robot arm (telescopic manipulator), derived from biological models (44). The nanorobot exterior shape consists of a diamondoid material, to which may be attached an artificial glycocalyx surface that minimizes fibrinogen (and other blood proteins) adsorption and bioactivity, ensuring sufficient biocompatibility to avoid immune system attack (42). Different molecule types are distinguished by a series of chemotactic sensors whose binding sites have a different affinity for each kind of molecule (42). These sensors also detect obstacles which might require a new trajectory planning (42).

## **Artificial RBC and WBC**

### **A. Respirocytes**

The artificial mechanical red blood cell or 'Respirocyte' is a bloodborne spherical 1-micron diamondoid 1000-atmosphere vessel with active pumping powered by endogenous serum glucose, able to deliver 236 times more oxygen to the tissue per unit volume than natural red cells and to manage carbonic acidity. The nanorobot is made of 18 billion atoms precisely arranged in a diamondoid pressure tank that can be pumped full of up to 3 billion oxygen (O<sub>2</sub>) and carbon dioxide (CO<sub>2</sub>) molecules. Later on, these gases can be released from the tank in a controlled manner using the same molecular pumps. Respirocytes mimic the action of the natural hemoglobin-filled red blood cells (10). Gas concentration sensors on the outside of each device let the nanorobot know when it is time to load O<sub>2</sub> and unload CO<sub>2</sub> (at the lungs), or vice versa (at the tissues). An onboard nanocomputer and numerous chemical and pressure sensors enable complex device behaviors remotely reprogrammable by the physician via externally applied acoustic signals; respirocyte can store and transport 236 times as much gas per unit volume as a natural red cell. So the injection of a 5 cc therapeutic dose of 50% respirocyte saline suspension, a total of 5 trillion individual nanorobots, into the human bloodstream can exactly replace the gas carrying capacity of the patient's entire 5.4 liters of blood. If up to 1 liter of respirocyte suspension could safely be added to the human bloodstream, this could keep a patient's tissues safely oxygenated for up to 4 hours in the event a heart attack caused the heart to stop beating, even in the absence of respiration. Primary medical applications of respirocytes will include transfusable blood substitution; partial treatment for anemia, perinatal/ neonatal and lung disorders; enhancement of cardiovascular/ neurovascular procedures, tumor therapies and diagnostics; prevention of asphyxia; artificial breathing; and a variety of sports, veterinary, battlefield and other uses.

## **B. Microbivore**

An artificial mechanical white cell of microscopic size, called a “microbivore,” has as its primary function to destroy microbiological pathogens found in the human bloodstream using a digest and discharge protocol (32). The microbivore is an oblate spheroidal nanomedical device measuring 3.4 microns in diameter along its major axis and 2.0 microns in diameter along its minor axis, consisting of 610 billion precisely arranged structural atoms in a gross geometric volume of 12.1 micron and a dry mass of 12.2 picograms. The device may consume up to 200 pW of continuous power while completely digesting trapped microbes at a maximum throughput of 2 micron of organic material per 30-second cycle, which is large enough to internalize a single microbe from virtually any major bacteremic species in a single gulp. The nanorobots would be ~80 times more efficient as phagocytic agents than macrophages in terms of volume/sec digested per unit volume of phagocytic agent, and would have far larger maximum lifetime capacity for phagocytosis than natural white blood cells. Microbivores would fully eliminate septicemic infections in minutes to hours, whereas natural phagocytic defenses—even when aided by antibiotics—can often require weeks or months to achieve complete clearance of target bacteria from the bloodstream. Hence microbivores appear to be up to ~1000 times faster-acting than either unaided natural or antibiotic-assisted biological phagocytic defenses, and able to extend the therapeutic competence of the physician to the entire range of potential bacterial threats, including locally dense infections.

## **Drug targeting: Types, Methods and Mechanisms**

Drug targeting is enabling the delivery of chemotherapy agents directly to tumors, reducing systemic side effects (30). The efficiency of drug delivery to various parts of the body is directly affected by the particle size. Nanostructure mediated drug delivery (34, 52), a key technology for the realization of nanomedicine, has the potential to enhance drug bioavailability, improve the timed release of drug molecules and enable precision drug targeting (55, 56).

Nanoscale drug delivery systems can be implemented within pulmonary therapies (57), as gene delivery vectors (58), and in stabilization of drug molecules that would otherwise degrade too rapidly (59, 60). Additional benefits of using targeted nanoscale drug carriers are reduced drug toxicity and more efficient drug distribution (61).

## **Approaches for drug targeting**

An ideal targeted drug delivery approach would not only increase therapeutic efficacy of drugs but also decrease the toxicity associated with drug to allow lower doses of the drug to be used in therapy (18). A vast array of methods, which can further be classified into two key approaches – active and passive, have been explored for targeting the drugs by means of designing innovative nanosystems (table 2).

### **(i) Passive drug targeting**

This approach refers to the accumulation of drug or drug carrier system at a particular site due to physicochemical or pharmacological factors (62). Rapid vascularization in fast-growing cancerous tissues is known to result in leaky, defective architecture and impaired lymphatic drainage. This structure allows an EPR effect (63), resulting in the accumulation of nanoparticles at the tumour site. For such a passive targeting mechanism to work, the size and surface properties of drug delivery nanoparticles must be controlled to avoid uptake by the reticuloendothelial system (RES).

The maximization of circulation times and targeting ability, the optimal size should be less than 100 nm in diameter and the surface should be hydrophilic to circumvent clearance by macrophages. A hydrophilic surface of the nanoparticles safeguards against plasma protein adsorption and can be achieved through hydrophilic polymer coatings such as PEG, poloxamines, polysaccharides, or through the use of branched or block amphiphilic copolymers (64). The covalent linkage of amphiphilic copolymers (polylactic acid, polycaprolactone, polycyanacrylate chemically coupled to PEG) is generally preferred, as it avoids aggregation and ligand desorption when in contact with blood components (45).

Table 2 – Summary of drug targeting approaches

| PASSIVE TARGETING  | ACTIVE TARGETING   | PASSIVE TARGETING   | ACTIVE TARGETING   |
|--|--|---|--|
| Pathophysiological factors<br><ul style="list-style-type: none"> <li>• Inflammation/Infection</li> <li>• EPR effect</li> </ul> | Biochemical targets<br><ul style="list-style-type: none"> <li>• Organs</li> <li>• Cellular</li> <li>• Organelles</li> <li>• Intracellular</li> </ul> | Physicochemical factors<br><ul style="list-style-type: none"> <li>• Size</li> <li>• Molecular weight</li> </ul>         | Physical /External stimuli<br><ul style="list-style-type: none"> <li>• Ultrasound</li> <li>• Magnetic field</li> </ul> |
| Anatomical approaches<br><ul style="list-style-type: none"> <li>• Catheterization</li> <li>• Direct injection</li> </ul>       | 3. Pretargeting/Sandwich targeting   | Chemical approaches<br><ul style="list-style-type: none"> <li>• Prodrugs</li> <li>• Chemical delivery system</li> </ul> | Promoter/Transcriptional targeting   |

**(ii) Active drug targeting**

Passive drug targeting approaches are limited in their scope and thus, tremendous effort has been directed towards the development of active approaches for drug targeting. Active drug targeting employs specific modification of drug/drug-carrier nanosystems with ‘active’ agents having selective affinity for recognizing and interacting with a specific cell, tissue or organ in the body (65). Drug targeting to specific cells has been explored utilizing the presence of various receptors, antigens/proteins on the plasma membrane of cells and also by virtue of the lipid components of the cell membrane. The receptors and surface bound antigens may be expressed uniquely in diseased cells only or may exhibit differently higher expression in diseased cells as compared to the normal cells.

Active agents, such as ligands for the receptors and antibodies to the surface proteins have been used extensively to target specific cells (18). Active targeting is usually achieved by conjugating to the nanoparticle (Fig. 2) a targeting component that provides preferential accumulation of nanoparticles in the tumour bearing organs. This approach is based on specific interactions,

such as lectin carbohydrate, ligand-receptor, and antibody-antigen (66).

Lectin-carbohydrate is one of the classic examples of targeted drug delivery (67). Lectins are proteins of nonimmunological origin, capable of recognizing and binding to glycoproteins expressed on cell surfaces. Lectin interactions with certain carbohydrates are very specific. Carbohydrate moieties can be used to target drug delivery systems to lectins (direct lectin targeting), and lectins can be used as targeting moieties to target cell surface carbohydrates (reverse lectin targeting).

However, drug delivery systems based on lectin-carbohydrate have mainly been developed to target whole organs (68), which can pose harm to normal cells. Therefore, in most cases the targeting moiety is directed toward specific receptors or antigens expressed on the plasma membrane or elsewhere at the tumor site. The over expression of receptors or antigens in many human cancers lends itself to efficient drug uptake via receptor-mediated endocytosis (Fig. 3). Because glycoproteins cannot remove polymer-drug conjugates that have entered the cells via endocytosis (69), this active targeting mechanism provides

an alternative route for overcoming multiple drug resistance (MDR) (70). The cell surface receptor for folate is inaccessible from the circulation to healthy cells owing to its location on the apical membrane of polarized

epithelia, but it is over expressed on the surface of various cancers, including ovary, brain, kidney, breast, and lung malignancies (71, 54).

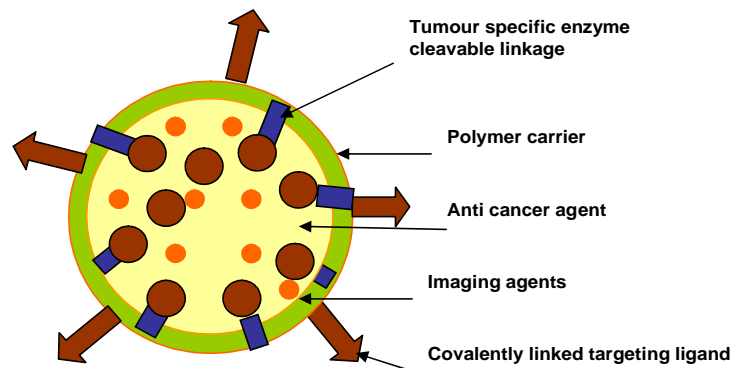


Fig. 2: Multifunctional Nanoparticle for Drug delivery

Surface plasmon resonance studies revealed that folate conjugated PEGylated cyanoacrylate nanoparticles had a tenfold higher affinity for the folate receptor than free folate did (72). Folate receptors are often organized in clusters and bind preferably to the multivalent forms of the ligand. Furthermore, confocal microscopy demonstrated selective uptake and endocytosis of folate-conjugated nanoparticles by tumour cells bearing folate receptors. Interest in exploiting folate receptor targeting in cancer therapy and diagnosis has rapidly increased, as attested by many conjugated systems, including proteins, liposome, imaging agents, and neutron activation compounds.

#### Nanoparticles drug

Therapeutic and diagnostic agents can be encapsulated, covalently attached, or adsorbed onto nanoparticles. The

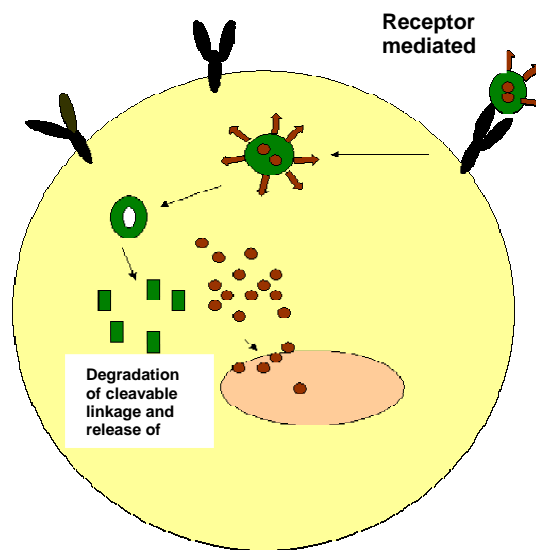


Fig. 3: Hypothetical Concept of Active Drug delivery

main problem in the case of conventional drug system is their solubility. The widely used attempt at enhancing solubility is to generate a salt. For nonionizable compounds, micronization, soft-gel technology, co-solvents, surfactants, or complexing agents have been used. Because it is faster and more cost effective to reformulate the drug than to develop a new one, a broadly based technology applicable to poorly water-soluble drugs could make a tremendous impact. In a new formulation approach used in Abraxane<sup>TM</sup>, recently approved by the FDA to treat metastatic breast cancer, paclitaxel was conjugated to albumin nanoparticles. The formulation is very effective in circumventing side effects of the highly toxic Cremophor EL, which include hypersensitivity reactions, nephrotoxicity, and neurotoxicity (73).

Although the SPACR (secreted protein, acidic, cysteine-

rich, also called osteonectin) protein is believed to improve albumin drug uptake, this nanoparticulate drug still exhibits significant side effects (FDA-Approved Nanoparticle Drug—Abraxane). For enhanced tumour-specific targeting, the differences between cancerous cells and normal cells may be exploited. By virtue of their small size, nanoparticles entail a high surface area that not only paves the way for more efficient drug release but also a better strategy for functionalization. There is a growing body of knowledge of unique cancer markers thanks to recent advances in proteomics and genomics. They form the basis of complex interactions between bioconjugated nanoparticles and cancer cells. Carrier design and targeting strategies may vary according to the type, developmental stage, and location of cancer.

### **Conclusion**

The future of technology is in some ways easy to predict, computers will become faster, materials will become stronger, and medicine will be cure more diseases. Nanotechnology is a broad interdisciplinary area of research, development and industrial activity that has been growing rapidly worldwide for the past decade it works on the nanometer scale of molecules and atoms, will be a large part of future, enabling great improvements in all technologies.

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This has four broad areas such as nanomedicine, nanofabrication, nanometrology and nanomaterials (NM's) or nanoparticles (NP's). NPs are 1-100 nm in size and regularly shaped and also exist in fused, aggregated or agglomerated forms. Some of the most promising application of biologically inspired nanoparticle has so far in nanobiotechnology and in tissue, cell specific drug-delivery system, Clinical achievements of nanotechnology are well known viz; nanostructured drug delivery carriers and nanorobots. Moreover liposome's, dendrimers, fullerene, nanoshell, nanorobots, nano-surgeon are other potential application of the nano medicines.

Furthermore nanomedicine can heal at the molecular or cellular level. Surgical tools that were molecular both in their size and precision, we could develop a medical technology that for the first time would let us directly heal the injuries at the molecular and cellular level that are the root causes of disease and ill health. With the precision of drugs combined with the intelligent guidance of the surgeon's scalpel, we can expect a quantum leap in our medical capabilities. In general, miniaturization of our medical tools will provide more accurate, more reliable, more cost-effective and faster approaches to enhancing the quality of human life.

**References**

1. Brydson, R. M. and Hammond, C. *Generic methodologies for nanotechnology: classification and fabrication*. Chichester, Wiley, UK. 2005.
2. Euliss, L. E. et al. *Chem. Soc. Rev.* 2006. 35. 1095-1104p.
3. Desai, T. A. et al. *Biomed. Microdev.* 1999. 2. 11p.
4. Jain, K. K. *Expert Rev. Mol. Diagn.* 2003. 3. 153-61p.
5. Baker, J. R. et al. *Biomed. Microdevices.* 2001. 3. 61-9p.
6. Freitas, R. A. *J. Comput. Theor. Nanosci.* 2005. 2(1). 1-25p
7. Lee, S. B. and Martin, C. R. *J. Am. Chem. Soc.* 2002. 124. 11850p.
8. Nishizawa, M. et al. *Science.* 1995. 268. 700p.
9. Storm, A. J. et al. *Nat. Mater.* 2003. 2. 537p.
10. Freitas, R. A. Jr. *Artif. Cells, Blood Subst. and Immobil. Biotech.* 1998. 26. 411p.
11. Tsao, N. et al. *Antimicrob. Agents Chemother.* 1999. 43. 2273p.
12. Tsao, N. et al. *Antimicrob. Agents Chemother.* 2001. 45. 1788p.
13. Bosi, S. et al. *Bioorg. Med. Chem. Lett.* 2000. 10. 1043p.
14. Tabata, Y. et al. *Fullerene Sci. Technol.* 1997. 5. 989p.
15. Tabata, Y. et al. *Jpn. J. Cancer Res.* 1997. 88. 1108p.
16. Miyata, N. and Yamakoshi, T. *Fullerenes: Recent advances in the Chemistry and Physics of Fullerenes and Related Materials*. 1997. Electrochemical Society, Pennington NJ. 345p.
17. Dugan, L. L. et al. *Fullerenes: Chemistry, Physics, and Technology*. 2000. John Wiley and Sons, New York. 467p.
18. Vasir, J. K. et al. *Current Nanoscience.* 2005. 1. 47-64p.
19. Juliano, R. L. *Adv. Drug Deliv. Rev.* 1998. 2. 31-54p.
20. Leroux, J. C. et al. *Microencapsulation methods and industrial applications*. 1996. Marcel Dekker, New York.
21. Storm, G. et al. *Adv. Drug Deliv. Rev.* 1995. 17. 31-48p.
22. Lee, J. H. et al. *J. Biomed. Mater. Res.* 1989. 23. 351-68p.
23. Chen, P. et al. *Nano Lett.* 2004. 4. 1333- 7p.
24. Schinazi, R. F. *Antimicrob. Agents Chemother.* 1993. 37. 1707- 10p.
25. Lee, C. C. et al. *Nature Biotechnol.* 2005. 23. 1517p.
26. Kukowska-Latallo, J. F. et al. *Proc. Natl. Acad. Sci.* 1996. USA. 93. 4897-902p.
27. Kukowska-Latallo, J. F. et al. *Jr. Hum. Gene. Ther.* 2000. 11. 1385p.
28. Nakanishi, H. et al. *Gene Ther.* 2003. 10. 434p.
29. Vincent, L. et al. *Int. J. Cancer.* 2003. 10. 419p.
30. Hughes, G. A. *Nanomedicine: Nanotechnology, Biology, and Medicine.* 2005. 1. 22-30p.
31. Frietas, R. A. *Nanomedicine: Nanotechnology, Biology, and Medicine.* 2005. 1. 2-9p.
32. Freitas, R. A. *J. Evolution Technology.* 2005. 14. 1-52p.
33. Frietas, R. A. *Immobilation biotechnology.* 1998. 26. 411-30p.
34. Jain, K. K. *Drug Discovery Today.* 2005. 10(21). 1436p.
35. Mathiowitz, E. ed. *Encyclopedia of controlled drug delivery.* 1999. Wiley, New York.
36. Lasic, D. D. *Liposomes: from physics to applications.* 1993. Elsevier: Amsterdam, New York.
37. Weinstein, J. N. et al. *Cancer Res.* 1980. 40. 1388-95p.
38. Arangoa, M. A. et al. *Gene. Ther.* 2003. 10. 5-14p.

39. Brigger. I. *Adv. Drug delivery review*. 2002. 54. 459-468p.
40. Hirsch. L. R. et al. *Science*. 2003. 301. 1884p.
41. Cavalcanti. A. et al. *IEEEICECS Int'l Conf. on Electronics, Circuits and Systems*. 2004. Tel-Aviv. Israel
42. Freitas. R. A. Jr. *Nanomedicine, Volume 1: Basic Capabilities*. 1999. Landes Bioscience Georgetown. TX.
43. Freitas. R. A. Jr. *Nanomedicine, Volume 11A: Biocompatibility*. 2003. Landes Bioscience. Georgetown. TX
44. Drexler. K. E. *Nanosystems: Molecular Machinery, Manufacturing, and Computation*. 1992. John Wiley and Sons. New York.
45. Kreilgaard. M. *Adv Drug Deliv Rev*. 2002. 54. S77-S98p.
46. Cavalcanti. A. *IEEE Transactions on Nanotechnology*. 2003. 2(2). 82-87p.
47. Cavalcanti. A. and Freitas. R. A. *Int'l J. Nonlinear Science Numerical Simulation*. 2002. 3(4). 743-746p.
48. Adleman. L. M. *Dimacs Series in Discrete Mathematics and Theoretical Computer Science*. 1996. 44. 1-2p.
49. Hagiya. M. *Proc. 6<sup>th</sup> DIMACS Workshop on DNA Based Computers. The Netherlands*. 2000. 198-204p.
50. Sun. J. et al. *Journal of Nanoscience and Nanotechnology*. 2001. 1(2). 133-136p.
51. Stracke. R. et al. *Nanotechnology*. 2000. 11(2). 52-56p.
52. Langer. R. and Khademhosseini. A. *Nanobiotechnology*. 2006. 1. 38-42p.
53. Nie. S. et al. *Annual review of Biomed. Eng*. 2007. 9. 12.1-12.32p.
54. West. J. L. and Halas. N. J. *Current Opinion Biotechnology*. 2000. 11. 215-17p.
55. Dubin. C. H. *Mech. Eng. Nanotechnol*. 2004. 126. 10-2p.
56. Dass. C. R. and Su. T. *Drug Delivery*. 2001. 8. 191-213p.
57. Courier. H. M. et al. *Crit Rev Ther Drug Carrier Syst*. 2002. 19. 425-98p.
58. Senior. K. *Mol. Med. Today*. 1998. 4. 321p.
59. LaVan. D. A. et al. *Nat. Rev. Drug Discovery*. 2002. 1. 77-84p.
60. LaVan. D. A. et al. *Nat. Biotechnol*. 2003. 21. 1184-91p.
61. Ravi Kumar. M. N. *J. Pharm. Pharm. Sci*. 2000. 3. 234-58p.
62. Garnett. M. C. *Adv. Drug Deliv. Rev*. 2001. 53. 171-216p.
63. Ducan. R. *Nat. Rev. Drug Discovery*. 2003. 2. 347-60p.
64. Park. H. J. *Trends food science technol*. 1999. 10. 254-60p.
65. Nishioka. Y. and Yoshino. H. *Adv. Drug Deliv. Rev*. 2001. 47. 55-64p.
66. Allen. T. M. *Nat. Rev. Cancer*. 2002. 2. 750-63p.
67. Kannagi. R. et al. *Cancer Sci*. 2004. 95. 377-84p.
68. Yamazaki. N. et al. *Adv. Drug Delivery Rev*. 2000. 43. 225-44p.
69. Bennis. S. et al. *Eur. J. Cancer*. 1994 30A. 89-93p.
70. Links. M. and Brown. *Expt. Rev. Mole. Med*. 1999. 1-2p.
71. Leamon. C. P. and Reddy. J. A. *Adv. Drug delivery Rev*. 2004. 56. 1127-41p.
72. Stella. B. et al. *J. Pharmaceut. Sci*. 2000. 89. 1452-64p.
73. Garber. K. *J. Nat. Cancer. Inst*. 2004. 96. 90-91p.