A Review on Biological Building Blocks and its Applications in Nanotechnology

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Abstract. Biological building blocks are the basis of living organisms and its potentials are gaining more attention over a wide range of applications. Major biological building blocks that exist in the universe have been taken into consideration in this paper, which are proteins, lipids, carbohydrates and nucleic acids. Due to their small size, they are such molecules which can be considered by the Nano level structures therefore have been incorporated in various applications of nanotechnology and microbiology. Taking into consideration the structural and chemical properties of these biological building blocks, further application on each individual biological building block has been covered in multiple fields, but mainly in the medical and pharmaceutical industry. The applications also concern optical imaging, precision measurement of biomolecules, Nano biomaterial synthesis and biosensors. Despite the various advantages of these applications like improved efficiency of various processes, the shared limitations of these applications stand to be difficult technique for synthesis and development due to Nano size dimension consideration. Thus, the future scope of use of biological building blocks in nanotechnology is very ambitious and promising.

1. Introduction

Biological building blocks are the basis of living organisms. They are the basic molecules that constitute to making macromolecules, cells, tissues, organs and thus organ systems. The smallest particle contributing in the making of a creature is known as a biological building block. Various biological building blocks can be combined together in multiple patterns to obtain the required results. For example, a complex bond of nucleic acid, phosphate and sugar (being the various biological building blocks) will result in the production of a DNA molecule. The wide variety of biological building blocks can be categorized into four main categories, based on their properties and functions. The four main biological building blocks which will be discussing are Lipids, Carbohydrates, Proteins and Nucleic acids. Nanotechnology is the science which pertains to the design and creation of structures and devices in the nano range, with dimensions less than 100nm [1]. With advancements in nanotechnology it is able to manipulate these naturally occurring building blocks, which can be characterised as nanoparticles, to serve specific purposes other than their own. These materials are readily available in nature, and few also show affinity for self-assembly to form structures such as nanotubes and nanowires. By exploiting these
molecules, some of the tedious processes associated with the production of nanoparticles can be eliminated. However, these molecules pose their own set of difficulties. This has led to a wide range of possibilities for new developments in processes, from using carbohydrates in drug delivery to producing nano-electronics using lipid nanostructures. Thus, the term nanobiotechnology is coined, which is the intersection of nanotechnology and biology. This technology usually employs the bottom up approach in contrast to the top down approach of traditional methods in nanotechnology [2]. In this piece, the aim is to give a brief introduction to each of these molecules, and discuss a few applications of each of the building blocks, while also look at how these applications are impacted by the use of these building blocks. Finally, the limitations they possess in their current stage of development, and which new applications could be incorporated in these ever-growing technologies in the future are discussed.

2. Biological Building Blocks

Biological building blocks consist of Lipids, Proteins, Nucleic Acid and Carbohydrates. Lipids are classified as a large group of naturally occurring organic compounds, which are related by their insolubility in water, and solubility in non-polar solvents. Carbohydrates are the sugars, starches and fibres and are the energy source used by muscles. Proteins are formed by links of amino acids, playing an important part in formation of tissues and in defence. Nucleic acids are of two types, DNA which is responsible for storage of hereditary information and RNA which is responsible for expressing said information [3] [4].

2.1. Proteins

Proteins are one of the most vital biological building blocks. Due to its considerably large size, it is considered as a macromolecule. The structure of a protein mainly consists of multiple units of amino acids. Therefore, it can be said that protein is a polymer of structural units of amino acids. Going into the depths of the chemical composition, it is observed that an amino acid is made up of an acidic carboxyl group, amino group and an organic R group. This organic R group helps give each different amino acid its own individual identity. Various types of amino acids are present in nature. A total count of 20 has been made so far. These different types of amino acids can thus be joined together in various different patterns and orders to get the product as a variety of different proteins. The other way around to look at it is that on breaking up proteins one can release the base amino acids to the surrounding. This process of cleavage or breaking of a covalent bond by the addition of a water molecule is known as hydrolysis. Proteins perform an important role in the human body by helping in facilitating various body functions and contributing to body structures. It is a very important nutrient for the human body. Major functions of proteins can be listed as, structure and support- main components of tissues, communication and signalling, defence, regulation, catalysis.

2.2 Carbohydrates

A carbohydrate is a biomolecule consisting of carbon (C), hydrogen (H) and oxygen (O) atoms. Carbohydrates are the sugars, starches and fibers commonly found in fruits, grains, vegetables and milk products. Their main task is to provide fuel for the central nervous system and energy for working muscles. They consist of hydrogen and oxygen atom in the ratio of 2:1 (as in water) and thus with the empirical formula Cm(H2O). The carbohydrates are technically hydrates of carbon. Anthracycline antibiotic doxorubicin (DOX) has been used for the past 3 decades as a capable therapeutic agent for the treatment of a lot of human tumours, mainly breast cancer and lymphoma. The carbohydrates are technically hydrates of carbon [5].

2.3 Nucleic Acids

Nucleic acids are big and complex molecules that are present in cells and viruses. They are responsible for storage of hereditary information and expressing said information through protein synthesis. They are made up of small units called nucleotides. Nucleotides are made of 5 carbon sugar attached to a nitrogen-containing aromatic base and phosphate groups. Each nucleic acid has 4 nitrogen-containing bases out of 5 namely adenine(A), guanine(G), thymine(T), cytosine(C) and uracil(U). All nucleic acids contain A, G and C. The presence of T and U depends on the type of nucleic acid [1]. Nucleic acids are of two types
namely DNA and RNA. Figure 1 shows the structure, nucleotides and complimentary pairs in RNA and DNA.

DNA short for Deoxyribonucleic acid is the blueprint of all living organisms. It contains hereditary information (DNA code) and is the ideal genetic material. It is a double helix strand that has thymine(T) as the 4th nucleotide along with A, G and C. They occur in complementary pairs. A and T form a pair using 2 hydrogen bonds whereas G and C pairs [6].

Ribonucleic acid also known as RNA is responsible for decoding the DNA code and interpreting the information. It ‘reads’ the DNA code and formulates it by synthesizing proteins through transcription. It is single stranded and has A, G, C and uracil(U) as nucleotides. The complimentary pairings are same with the exception that thymine is replaced by Uracil [6].

![Fig. 1 Structure, nucleotides and complimentary pairs in RNA and DNA](image)

2.4 Lipids

Lipids are classified as a large group of naturally occurring organic compounds, which are related by their insolubility in water, and solubility in non-polar solvents such as alcohols and ether. Lipids are generally hydrophobic, while some are amphipathic (consisting of both hydrophobic and hydrophilic groups, with the hydrophobic group being larger). Examples of lipids include fatty acids, waxes, triglycerides and steroids. As lipids are very diverse, so are their functions. Lipids are utilized for the storage of energy, protection of internal organs, to forming structural components of cells. Cholesterol is a chain type structure of lipid as shown in figure 2, which is vital for humans, and is used for many processes including production of vitamin D and hormones a. Cholesterol molecules are attached to lipoproteins to enable their travel through the bloodstream, forming packages with lipids on the inside and protein on the outside [8-10].

![Fig. 2 Chain of Fatty acid and Cholesterol](image)

Considering the structural and chemical properties of all the biological building blocks, applications on each individual biological building block have been established, mainly in the medical and pharmaceutical industry. The applications also concern optical imaging, precision measurement of
biomolecules, Nano biomaterial synthesis and biosensors. Further, more significant applications of these categories, which are listed down below.

3. Applications of Biological Building Blocks

3.1 Proteins:

3.1.1 Precision Measurement of Biomolecules and cells:
Previously, measurement of biomolecules and cells has been done using bulk assay. Bulk assay is a method of estimating the concentration of the required substance in a bulk material. This method has been proved to be quite inaccurate in various experiments as it gives no exact estimate due to bulk approach. In turn, the greatly reduced size of nanostructures acts as an advantage for this method, enabling it to probe and read the dynamics of various cells and molecules with great precision giving high resolution results. Structures like biological channels and pores are capable of regulating ion transport to an order of 0.1nm. Nano scale pores are also capable of distinguishing between various molecules on the basis of size and chemical properties. Inspired by this biological functionality, it has been hypothesized that Nano pores could unwind and unzip DNA so that individual nucleotides translocate sequentially in single file.

There are two types of Nano pores that take into consideration for this application, which are biological Nano pores and artificial Nano pores. The first one is a protein based pore known as α-haemolysin (αHL), which has good structured apertures, lacking mechanically stable lipid bilayers. The second one is an artificial Nano pore, thus it does not have a chemical structure like that or organic compounds, due to which they showcase a decrease in selectivity.

For the application, certain properties of both the Nano pores are essential. This lead to the development of a hybrid between the two Nano pores. For the synthesis of this hybrid Nano pore, a αHL is inserted into the structure of an artificial Nano pore. This hybrid leads to an overall improvement of the Nano pore properties as the two Nano pores combine to overcome each other’s drawbacks. The hybrid nanoparticle thus has better selectivity, coming from the biological Nano pore, as well as mechanical stability, coming from the artificial Nano pore.

An issue that this application is yet to overcome is the problem in the synthesis of precise 1nm diameter of Nano pores, which is very difficult to implement. This application has a lot more to achieve, which involves the use of multiple Nano pores in parallel. [12]

3.1.2 Circulating Tumour Cells (CTC) Chips:
Cancer is one of the most fatal diseases that mankind has had to encounter. Till date, a definite cure of cancer has not yet been discovered. Cancer is caused due to various abnormalities of healthy cells of the human body, as a result of a number of causes. The resultant abnormal cell or cancerous cell is thus known as a malignant cell. The reason why cancer is such a fatal disease is not just because malignant cells are difficult to diminish, but also that the means to curb them from spreading to more places of the body is difficult. This is known is metastasis.

Metastasis, in malignant tumours, is caused mainly due to Circulating Tumour Cells (CTC’s). CTC’s are shed by metastatic malignant tumours directly into the bloodstream of the nearby blood vessels. CTC’s can be considered to be extremely rare as their concentration is approximately one per billion in clinical samples, when intermixed with blood cells. This makes it even more difficult to detect these CTC’S, which is why nanotechnology is being approached as a more sophisticated technique to help ease the same.

Now, a biomarker is a molecule which helps identify a particular type of molecule among all the different ones. A well-known biomarker for CTCs is EpCAM, which stands for Epithelial cell adhesion molecule (Transmembrane glycoprotein), which is expressed by cells of epithelial origin but lacking in blood cells.
For better detection of CTC’s, CTC-Chips were devised. CTC-Chips work on the principle of increased surface area as shown in figure 3. Blood is collected from a patient and is pushed through the surface of the CTC Chip pneumatically. Each post is coated with EpCAM antibodies. This thus leads to the required detection. The enhanced surface area is associated with micro/nanostructures for adhesion-based capture using arrays of EpCAM-functionalized micro pillars. The application of CTC Chips was clinically accepted to help track the disease at hand, and to track its growth. This application had some drawbacks due to the practicality of the application with pertaining to its small sized dimension. When the clinical sample is poured over the CTC Chip, due to the small size of the micro pillars, it causes slow mixing. Another limitation of this application is that it cannot be used to detect whole tumours as it would take a long time, over a few years, before a tumour could be diagnosed. Lastly, the production of these nanostructures are very difficult due to the small lengths and specified production techniques [12].

Figure 3: Schematic of working of Circulating Tumour Cells [13]

3.1.3 Biosensors:
Biosensors are devices which are used to detect and quantify chemical and biological substances in a sample. Working principle of biosensor is given in figure 4. They do so by incorporating sensory device with a transducer. As most of the substance to be detected by a biosensor are in the range of nanometres, having biosensors on the same scale makes them more efficient systems. Also, nanoparticles possess a huge surface area to volume ratio because of their size, and thus are extremely sensitive to even small changes on surface [14].

Figure 4: Principle of a biosensor [15]

Proteins and peptides have been tested experimentally to be used as nanowires for biosensing devices, by modifying the electrodes to form a porous nanowire. The required enzyme must be immobilised on the surface of the protein nanostructure by methods such as adsorption and cross-linking the molecules. Such devices have been shown to be capable of detecting glucose and hydrogen peroxide. Although the devices created for each of the above molecules have different methodologies, the basic principle is the same as shown in figure 5.
Protein nanowires can be formed by the self-assembly of naturally occurring fibrous proteins, which makes them easily available in large quantities. As proteins are made up of amino acid chains, there is scope for modification of proteins for desired results. Another benefit of such devices is the biocompatibility of proteins and peptides. However, as this is a developing technology, a lot of further research is needed before these devices can move from experiments to reality.[16]

### 3.2 Carbohydrates

#### 3.2.1 Drug Delivery:

The drug to be supplied to the affected organ is encapsulated in a nano carrier, which is an allotrope of carbon and is supplied to the diseased organ where the drug is released. Nanoparticles are very useful in delivering target specific drugs. This prevents the drug from affecting the non-diseased organs hence reducing unwanted side effects.

The nanoparticle/nano carrier encapsulates the drug and delivers it to the pre-designated target area. At 80,000 rpm and a duration of 30 minutes the encapsulation efficiency of Doxorubicin-Dextran Sulfate (DOX-DS) nano-complexes can be analysed by the help of ultracentrifugation of complexes. A free drug solution is used as a control to ensure that the free drug does not precipitate at that high a speed of rotation. Spectroscopic measurement at 480 nm gives the concentration of the remaining DOX. Encapsulation efficiency depends on the nano carrier used. Since DOX is the main drug used in the case of a tumour, the encapsulation capacity of DOX by DOX-DS nano-complexes is taken into consideration and it was observed that it is highly affected by DS/DOX ratio. On increasing the DS/DOX ratio to 0.5, the peak of 95% is achieved as shown in graph.[17]

![Fig. 5 Modified nanowire Biosensing device](image)

Now on approaching the target site, the drug has to be successfully untangled from the nano carrier and affect the infected organ. In-vitro drug release studies depict that 14% of DOX drugs are released from DOX-DS in the first 24 hours, followed by a slower release of 32% in total over the next 15 days. Apart

![Fig. 6 Variation of values of DS/DOX with respect to encapsulation efficiency](image)
from self-assembly, emulsion techniques are interesting and versatile methods for the in situ formation of carbohydrate-based nanocarriers, nanocapsules can be prepared in an inverse miniemulsion.

3.2.2 To overcome the DOX resistance:
Anthracycline antibiotic doxorubicin (DOX) has been used for the past 3 decades as a capable therapeutic agent for the treatment of a lot of human tumors, mainly breast cancer and lymphoma. Many solutions have been devised by the means of nanoparticle carriers. Drug resistance can be overcome by nano carriers by enclosing themselves in an endoscope and then allowing it to enter the cell which helps bypass the P-glycoprotein efflux pump (drug resistant mechanism) and combating the efflux of drug from the affected resistant tumor. With the help of Nanotechnology, the binding of drugs to polymers can be successfully achieved. A positive charge is possessed by DOX and it’s been observed that it forms many complexes with multiple anionic polymers such as polyacrylic acid \( \gamma \)-polyglutamic acid, polyaspartate, polyglutamate, block ionomers of aspartate, benzyl aspartate, benzyl glutamate, and polyethylene oxide. Polyelectrolyte complexes are formed by these polyanions with DOX.

A highly anionic carbohydrate called Dextran Sulfate (DS) has been studied for improving the efficiency of encapsulation of DOX. Janes et al used DS to improve loading of DOX into chitosan nano particle. In further studies DOX was introduced with various other polymer dextrans having different molecular weights to achieve modified cytotoxicity and improved DNA-binding characteristics. Lam et al [18] could successfully show that the DOX-DS conjugate depicted excellent antitumor activity as compared to the free removal rate of DOX from P-glycoprotein over-expressing multi-drug-resistant cells once conjugated to dextran.

3.2.3 Bionanomaterials:
Bionanomaterials are molecular materials that are made up partially or completely of biological molecules (such as proteins, enzymes, RNA, DNA, oligosaccharides, lipids, viruses, and cells etc) which results in molecular structures that have a dimension in nanoscale. Carbohydrates have been reacted with various nanoparticles in order to obtain multiple different bionanomaterials, which are then known as nano-carbohydrates. Nano-carbohydrates can be used in Carbohydrate lectin recognition, Biosensing, Screening, Cell imaging and bacterial detection. Some Nano-carbohydrates that have been synthesized are glycosylated nanoparticles of gold nanoparticles, fullerenes, quantum dots and single wall nanotubes.

Nano-carbohydrate optical imaging is an important application of glycosylated quantum dots. Quantum dots are small (< 10 nm) fluorescent semiconductor nanocrystals. They possess luminescent properties which are unique as compared with more established fluorescent proteins and organic dyes. Their fluorescence emissions are stable and are dependent on the size of the particle [19]. Cadmium selenium–zinc sulphide quantum dots find their application in visualising capillaries which are hundreds of micrometres deep into the skin of living mice. Cadmium-based quantum dots are used to image the cerebral vasculature. Methoxy-PEGylated quantum dots are used to visualise arterioles and capillary networks in mouse hind limb skeletal muscle [20].

3.3 Nucleic Acid
3.3.1 DNA Nanotechnology:
The foundation of DNA Nanotechnology was given by Nadrian C. Seeman, an America nanotechnologist and crystallographer who has constructed the first practical Holliday junction. It was realized that DNA bunched junctions can be linked together from their sticky ends into a crystalline 3D material. Thus, assembling of crystals became more precise due to predictable interactions. This formulation started in-depth study in DNA and its uses in nanotechnology. DNA branched junctions are very geometrically flexible and instable because of branch migration due to two-fold symmetry at branch points. Seeman himself reported that Holliday junctions can be made immobile by making arms with unique
sequences/remove symmetry in the assembled molecule. To overcome this issue, Seeman and Erik Winfree developed a more rigid double-crossover (DX) motif. It has two DNA strands, double helix, linked together with two strand exchange rather than a single strand as seen in Holliday junction. These offered the stability that was lacking and hence was used in constructing DNA structures [21].

The first 3D object created was in Seeman’s lab, which was a cube of DNA, also the very first DNA Object. DNA objects are just DNA constructs that can be used to position and orient molecules. The objects can hold macromolecules as guests inside them which are then manipulated to orient them as desired as in figure 7 [22].

Fig. 7 Assembling of macromolecules using DNA constructs

Information in DNA was used to form predesigned crystalline arrays. These arrays are made from DNA tiles made from DX molecules which can grow into 2D crystals that can be categorized by AFM. In the following years, many 2D and 3D discrete DNA structures were reported. It was observed that DNA could be used as a component for molecular machines. Nano mechanical devices were also developed. Various other tile motifs were developed after DX tiles. It was also found that aperiodic crystals can made from DNA [23].

One of the major discoveries was DNA origami. In 2006, Paul Rothemund proposed a method for DNA construction in which a scaffold of a single DNA strand folds into itself to form the desired pattern. Non-periodic 2D structures like a smiley or Map of America were also made. This achievement created surface area of around 100nm to work on [21]. Various molecular machines were also created. Some of them are discussed in this paper.

DNA Tweezer is used for removing drugs from inside parts. It contains three strands: A, B and C. Strand A latches onto half of strand B and half of strand C, and so it joins them all together. Strand A acts as a hinge so that the two "arms" AB and AC can move. The structure floats with its arms open wide. They can be pulled shut by adding a fourth strand of DNA (D) "programmed" to stick to both of the hanging, unpaired sections of strands B and C (other side). The closing of the tweezers was confirmed by tagging strand A at either end with light-emitting molecules that do not emit light when they are close together. To re-open the tweezers add a further strand (E) with the right sequence to pair up with strand D. Once paired up, they have no connection to the machine B-A-C, so float away. The DNA machine can be opened and closed repeatedly by cycling between strands D and E [24].

A DNA walker is a class of nucleic acid nano-machines where a nucleic acid "walker" is able to move along a nucleic acid "track". The concept of a DNA walker was first defined & named by John H. Reif in 2003. DNA walkers have functional properties such as a range of motion extending from linear to 2 and 3-dimensional, the ability to pick up and drop off molecular shipment, performing DNA-template synthesis, and increased velocity of motion. DNA walkers have potential applications ranging from nano-medicine to nano-robotics. Many different fuel options have been studied including DNA
hybridization, hydrolysis of DNA and light. The applications of DNA walkers include nanomedicine, diagnostic sensing of biological samples, nanorobotics.

3.3.2 RNA Aptamer and Apta-sensors:
RNA, just like DNA, can be manipulated and designed. They have different base-pairings than DNA and have large number of loops that makes it easy to manipulate and make complex structures. RNA Nanotechnology can be considered as a subdivision of DNA Nanotechnology however, with the potential in this field, it can be soon regarded as its own discipline [21]. RNA forms an ideal material for various applications due to the versatility of RNA structure, low free energy in RNA annealing, structure control options and self-assembly property. It can be used to construct arrays and superstructures. RNA nanostructures are designed co-transcriptionally. Since, transcription is slow in RNA assembly, nascent RNA strand can be used to get desired shape by using hairpins and RNA-based association motifs. Self-assembly property of RNA ladders can direct arrangement of cationic gold nanoparticles. RNA’s ease of conjugation and biocompatibility can be utilized in tissue engineering [25].

RNA aptamer is a family of oligonucleotides with functions similar to that of antibodies in their ability to recognize specific ligands through the formation of binding pockets. These can be used as inhibitors or in targeted therapeutic delivery. They have various advantages being used as targeting agents. They are low cost and are convenient to synthesize and modify, have rapid tissue penetration and long term stability. RNA aptamers are incorporated into RNA nanoparticles by sequence fusion. Many RNA aptamers are present for targeting cell surface. These aptamers can be used for in vitro diagnosis. Apta-sensors, aptamer based biosensors, detect small molecule targets and peptide markers. Using apta-sensors can lead to early detection and diagnosis [26].

3.4 Lipids:
3.4.1 Nanoelectronics:
Nanoelectronics is a field of nanotechnology which deals with electronics with sizes in the range of nanometres. These electronic devices can be incorporated in a wide range of applications including telecommunications and information processing. Human biological systems are capable of handling tasks such as material and information transport, and thus can be useful for the production of novel nanoelectronics. By designing electronics based on biological systems and processes, it can incorporate biological building blocks such as lipids to create nanoelectronics devices.

In this respect, lipids have been used to create electronics such as batteries and rectifiers by combing lipids bilayers with protein pores. Transistors are one of the most promising devices to be influenced by the new generation of nanoelectronics. Transistors have been produced by the combination of lipid bilayer shells with proteins, and the combination lipids and graphene. Lipid nanotechnology has proven to be useful as lipids are biologically inert, and also form nano sized containers by self-assembly. Although lipids in nanoelectronics are exciting prospects for the future, the scalability of these designs for high production rates are under consideration [27].

3.4.2 Drug delivery:
As discussed earlier, drug delivery is one such application where the induction biological building blocks provides interesting findings. Like carbohydrates, lipids can also be used for drug delivery. This is achieved with the formation of a lipid-drug conjugate, which is a drug molecule modified by lipids. Drugs have been modified with steroids, fatty acids, glycerides and phospholipids, where lipid nanoparticles can be used as a delivery system. Drugs are encapsulated in the lipophilic core of the lipid nanoparticles. Both solid and liquid nanoparticles have been used for these purposes, with solid nanoparticles showing better loading and delivery to specific organs.

Promising results have been seen in cancer treatment, where lipid-drug conjugates have been used to improve tumour targeting and to overcome drug resistance. Tumour cells have a high uptake of
cholesterol, thus drugs modified with the lipid cholesterol show better targeting of tumour cells than free drugs. Lipid-drug conjugates have also been used in orally administered drugs, and have shown an improvement in performance of the drug, by increased interaction with cell membranes and increase in uptake and permeation of the drug [28].

4. Conclusion and discussions

The importance of nanotechnology in biology is unique and its amalgamation has brought about advances that were not possible before. In this paper, it has seen their various applications though not all due to space constrictions. However, there are limitations to using this technology at this date. Due to increased surface area, chemical reactivity of these particles increase immensely and hence, their behaviours in different conditions cannot be predicted. This increased reactivity produces reactive oxygen species (ROS) that can damage DNA, membranes and proteins. They are highly depended on their environment causing disintegration or aggregation leading to decrease in quantity or variations in sizes. Since nanomedicine or nano-devices will be and is currently employed worldwide, the conditions across the world are not same and hence their stability has become a topic of discussion. The major issue in this field now is accurate target delivery, thermodynamic instability and high production cost among others. The production costs can be overcome with more availability of the technology and its advances.

Researchers are still working on designing lipid molecules that have better functions than natural lipids. Few have already been incorporated in gene delivery. Profiling of proteins and their interactions has led to advances in biomarker identification, development of vaccine and profiling in immunology. Proteins have also been used in development of Nano devices which still need more research to be attain their potential. New Applications of Nano-carbohydrates are emerging due to their efficiency, some of them in bacteria detection, screening and bio sensing. Nucleic acid based nanomaterials are being used in drug delivery in cancer therapeutics. They still have major shortcomings and hence, can’t be used in various fields. It has been highly believing that with the advancement of nanotechnology in the future all shortcomings seen in this paper can be overcome. This domain is still relatively new and with more research can become the one of the most prominent and impactful field.

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