International Journal of Pharmaceutical research and Applications
Volume 9, Issue 1, Jan.-Feb. 2024, pp: 1073-1086www.ijprajournal.com ISSN: 2456-4494

Nanobots Revolutionizing Disease Intervention in Future of Medicine

AmolSupekar, SakshiPadole, VidyaShende
AabasahebKakade College of B Pharmacy

The field of medicine has experienced remarkable advancements in recent years, but the development of nanotechnology has the potential to revolutionize disease intervention and redefined the future of healthcare. Nanobots , tiny machines measuring a few nanometers in size, have emerged as a promising tool to diagnose, monitor, and treat diseases at the cellular and molecular levels.

Abstract: This abstract explores the progressive role of nanobots in disease intervention , discussing their applications in early detection, targeted drug delivery, and personalised medicines.

Nanobots have the ability to detect diseases with unprecedented sensitivity and accuracy. Equipped with sensing capabilities, these miniature robots can navigate through biological environments, identifying specific biomarkers that indicates the presence of cancer, infectious diseases, or various other conditions. By utilizing non invasive techniques, nanobots can collect and analyse biological samples at the molecular level, offering swift and precise diagnoses. Consequently , the early detection of diseases allows for timely interventions and significantly improves patient outcomes.

Moreover, nanobots present a promising solution to targeted drug delivery, potentially minimizing side effects and maximizing therapeutic efficiency. These nanoscale robots and be engineered to carry payloads of drugs or therapeutic agents directly to diseased cells or tissues, bypassing healthy areas. By employing sophisticated navigation systems, nanobots can autonomously travel within the body , homing in on the precise location of disease sites. This accurate delivery mechanism offers immense potential for treating various conditions , including cancer, neurological disorders, and chronic infections.

Furthermore, nanobots hold great promise in enabling personalised medicines, tailoring treatments to individual patients based on their specific genetic makeup and health conditions. With minute size and versatile properties, nanobots can provide real time monitoring of patients health parameters and facilitate precise adjustments in treatment strategies. These microscale machines can continuously monitor patient responses to therapy, detect relapses, and initiates appropriate interventions. By integrating nanobots into healthcare systems, medical professionals can optimize treatment plants, improve patient outcomes, and minimize adverse effect.

However, the widespread implementation of nanobots faces several challenges. Researchers need to address concerns regarding the long term safety and biocompatibility of these nanoscale machines. Additionally, the development of cost effective manufacturing processes on a large scale will be vital to ensure accessibility for wide spread clinical applications. Ethical considerations regarding the potential misuse or unintended consequences of nanobots in disease intervention also need to be addressed to ensure responsible and sustainable implementation.

In conclusion, nanobots have the potential to revolutionize disease intervention in the future of medicine. These tiny machines offer advanced diagnostic capabilities, precise targeted drug delivery, and potential for personalised machine. While challenges remain, with continued research and development, nanobots hold tremendous promise in transforming the healthcare landscape, offering improved treatment outcomes, and providing new avenues for tackling various diseases.

Keywords: Nanobots, Disease Intervention, Early Detection, Targeted Drug Delivery, Personalised Medicine.

I. Introduction:

Nanotechnology, defined as the manipulation of material with at least one dimension ranging from 1 to 100 nanometre's (nm), as become a pivotal player in scientific advancements. This field encompasses various research and technologies dealing with unique nanoscale characteristics, utilising the plural forms “nanotechnologies” and “nanoscale technologies” to describe its diverse applications. Initially, nanotechnology focused on manipulating molecules for macroscale production, known as molecular technology.

International Journal of Pharmaceutical research and Applications
Volume 9, Issue 1, Jan.-Feb. 2024, pp: 1073-1086www.ijprajournal.com ISSN: 2456-4494

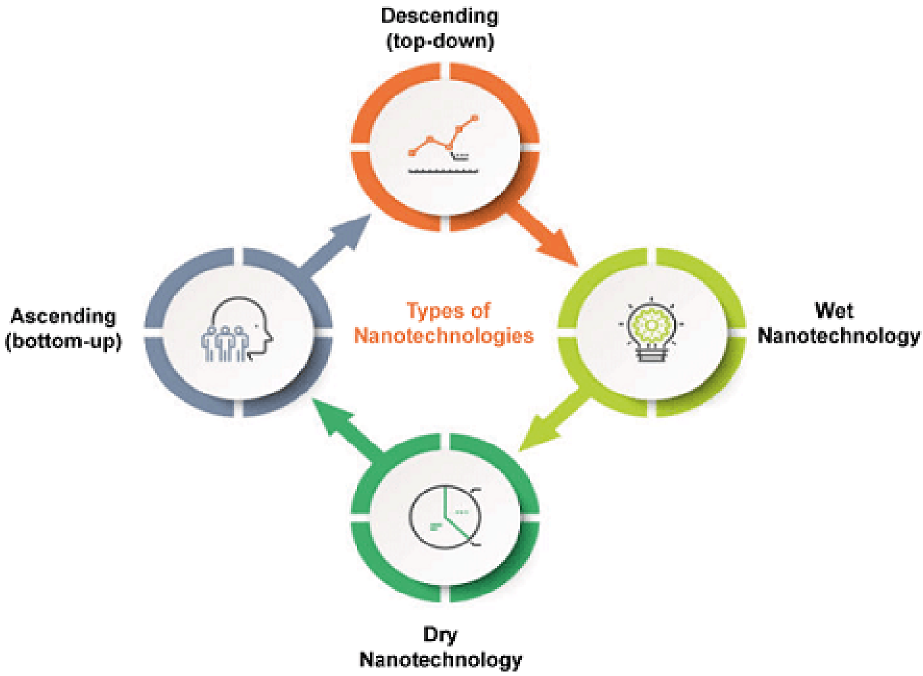

Fig no 1 definition of nanotechnology

Nanobots, measuring 50 to 100 nm, are small robots rapidly advancing in the medical industry. These billionth-of-a-meter-scale micromachines offer novel opportunities for disease intervention and treatment. Scientists explore te potential advantages of nanobots in medicine, ranging from precision cellular surgery to focused drug administration. The capability to work at the cellular and molecular levels presents unprecedented possibilities for illness monitoring, diagnosis, and therapy.

Using nanobots can also lead to cost savings and improved efficiency. For example, in healthcare, nanorobots could be used for targeted drug delivery, which can reduce the amount of medication a patient needs and minimize side effects, there by resulting in cost saving for patients and healthcare providers. Nanorobots could also be used for non invasive surgeries to reduce the need of lengthy hospitals stays and recovery time. Its clear the field of nanorobotics has the potential to bring significant, positive changes in society in numerous ways.

Nanorobotics worked by using robots at nanoscale, which are also known as nanorobots. The design and operation of nanobots can vary depending on their intended use. In general, nanorobots would work by using various technologies like nanoscale sensors actuators.

The sensors in nanorobots could detect specific signals or condition like the presence of a certain type of molecule or material, and then transmit this information to the control system. The control system could use this information to decide on the proper action of nanobots. We could use nanorobots actuators to perform a wide range of action including movement, releasing of drug in the human body or manipulation of structure and material.

What are the challenges of nano-robots ?

The development and implementation of nanorobotics faces several challenges, including ;

Technical complexity: designing and operating robots is complicated process that involves many technical difficulties like development of nanoscale components, controlling the movements of nanorobots and ensuring their stability.

Safety concern: The potential for nanorobots in medical applications and the environment raises concerns about their safety. For example, nano robots, design for medical treatment, could harm patients in case of malfunctioning.

Regulatory Issues: there are currently few regulations in place to govern the development and use of nano robots, which may slow their

IJPRA Journal

International Journal of Pharmaceutical research and Applications
Volume 9, Issue 1, Jan.-Feb. 2024, pp: 1073-1086www.ijprajournal.com ISSN: 2456-4494

widespread adoption by public and private sector entities. Funding and resources: The development of nanorobotics is quite expensive and require significant funding and resources, as well as specialized equipment and human expertise .

Scalability: The development and production of large numbers of nanorobots can be challenging due to complex and time consuming nature of the manufacturing process.

Cancer is currently the third leading cause of death worldwide, with about one in every six deaths attributes to it. Projection suggest that by 2030, there will be approximately 26 million new cases of cancer and nearly 17 million death annually. Furthermore, it is anticipated that low-to-middle-income countries will account for the majority of cancer cases, estimated to be around 61% by 2050. The establishment of International Agency for Research on Cancer (IARC) in 1965 aimed to conduct comprehensive research on causes of human cancer through multidisciplinary investigations. Extensive studies, focusing particularly on gene structures, have led experts to conclude that changes in human lifestyle , diet and environmental factors are contributing to the rising incidence of cancer.

The current diagnostic tools, including imaging, molecular detection, and immunohistochemistry (IHC), possess inherent limitations, such as poor accuracy. Nevertheless, researchers have been diligently striving to enhance the effectiveness of anticancer medication delivery systems. The objective is to enable this system to achieve greater precision in targeting tumour cells while minimizing the occurrence of adverse effect associated with traditional chemotherapy. Nonetheless, it is crucial to acknowledge that current advancement alone may not be adequate to meet the increasing demand for more efficient drug delivery system.

One promising emerging technology is development of nanorobots, which are nanodevices specially engineered to perform precise task at the nanoscale(1-100nm). In medical field, nanorobots are intended to operate at the cellular level, executing these specific task. These machine possess the nanoscale intelligence and possess the ability to sense, signal, respond, and process information.

Carbon, due to its inertness, high thermal conductivity, and strength, is the predominant limit used in synthesis of nanorobots. Furthermore, externally passive diamond coating is ethically applied to enhance their functionality.

Recent advancement in this field have lead to the development of nanorobotic delivery systems, including surgical and cellular repair nanobots. In this 1986, Eric Drexler proposed the idea of inserting medical nanorobots into the human body. These nanobots utilize artificial mechanical components such as respirocytes, microbivores , clottocytes. Dr.Youngdojeong and his team of scientist in Korea design a nanorobots capable of infiltrating a cancer cells outer surface and subsequently destroying it from within. These machines nanoparticle, made of gold, have the ability to fold and unfold in order to eliminate cancer cells without the need for anticancer drugs. DNA based nanobots are also being used in treatment of cancer by targeting tumours. Furthermore, a new cancer treatment has been proposed, where in nanorobots composed of DNA fragment not been eradicate cancer cells in the body but also terminate them. Nanorobots, on the other hand, have their advantages including a costly design and manufacturing process, a high degree of complexity, and invisibility and due to high blood viscosity, drug-loaded nanorobots are becoming much more difficult to travel through blood arteries however researchers are attempting to solve this issues.

The current challenge in nanotechnology lies in the utilization of nanodevice with higher complexity and their potential application in the cancer treatment. These nanobots have the capability to enhance treatment efficiency by conducting advanced biomedical therapies through minimally invasive procedures the need for new cancer treatment trials arise from the harsh side-effects of chemotherapy and untargeted distribution of drugs. Presently, the nanobots are designed to identify 12 distinct types of cancer cells. Additionally, the molecular motors within these devices can modify their response to UV light traverse cellular layers, leading to necrosis and facilitating targeted medication delivery to specific areas.

Due to notable advancement in molecular nanotechnology, there as has been a significant expansion in the medical treatment options, thereby reducing risk and costs. DNA nanobots have the ability to identify various types of cancer cells. With further testing and development, these nanobots hold the potential to revolutionized the medical industries for betterment for individuals.

Nanotechnology possesses the potential to enhance the specificity and effectiveness of physical, chemical, and biological approaches in

International Journal of Pharmaceutical research and Applications
Volume 9, Issue 1, Jan.-Feb. 2024, pp: 1073-1086www.ijprajournal.com ISSN: 2456-4494

inducing cells death in cancer cells, while minimizing harm to non-malignant cells. Nanoscale materials are increasingly being utilize for precise targeting of cancer cells. Consequently, the primary objective of this review article emphasise the significance, mechanism, classification and particle application of nanorobots, with special emphasis on there utility in DNA based cancer treatment.

II. Literature survey:

1.Preeti Khulbe: Nanomedicine introduces powerful tools for disease treatment, utilizing molecular knowledge and tools for diagnosis, treatment, and prevention. Nanorobots with their small size, can transverse the human body, offering advantages in drug delivery, targeted therapy, and non invasive techniques.
2.Upadhye SS et.al: Nanorobotics, dealing with machines at the nanoscale, remains a hypothetical concept. This article explore the history, composition, mechanism and application of nanorobots, shedding light on future prospects.
3.V.Ananta Rahul: Provides an overview of nanobots, emphasizing their application in the medical field, including cancer treatments, blood content monitoring, an precise drug delivery.
4.Ved Prakash Upadhyayet.al: Discuss the emergence of Nano-robotic in medicines, especially in the treatment of Alzheimer's disease and cancer. Highlights the potential of Nano-robots as the first Nano-medicines.
5. Rickard Arvidsson and Steffen Foss Hansen: Reviews the risk associated with Nano-robots for biomedical application. Discusses potential hazards, current regulations, and the need for risk related studies to ensure responsible implementation.
6. Micro/Nano-robot: A promising targeted drug delivery system explores the potential of micro/ Nano-robots in medical treatments, focussing targeted drug delivery, surgical operations disease, the need for in-vivo research.
7.Nano-robotics: A Review (Aruntapan Dash):Discusses the potential application, defence, automotive, aerospace, and material science research.

Pathophysiology of Cancer: Cancer, a complex disease, arises from abnormal cell growth and proliferation. The pathophysiology involves multiple stages, including initiations, promotions, progression, angiogenesis, and metastasis. Understanding these process is crucial for developing effective treatments targeting specific molecular and cellular abnormalities associated with different cancer types.
the physiological and hormonal alteration linked to cancer and paraneoplastic syndrome are part of the pathophysiology of cancer. Cancer refers to a class of disorders characterized by aberrant cell proliferation. Tumour suppresser oncogenes are among the genes linked to the onset of cancer.
The physical effect of cancer on different body tissues includes devastation, blockage , and pressure atrophy (excessive pressure on soft internal tissues). Meningioma, for example, presses against the structure of brain, causing seizures. Furthermore, infections such as peritonitis are brought on by the tearing and destruction of several internal organs brought on by tumours. Inflammation of the membrane lining the organs and abdominal cavity is linked to peritonitis.

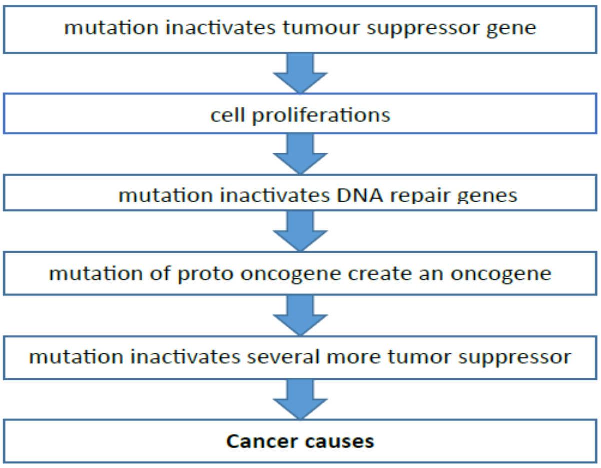

Fig no.2 flow chart of pathophysiology of cancer

International Journal of Pharmaceutical research and Applications
Volume 9, Issue 1, Jan.-Feb. 2024, pp: 1073-1086www.ijprajournal.com ISSN: 2456-4494

The pathophysiology of cancer is complicated. Pathologist are medical professional whose primary focus is on examination of illness in all its manifestation. Included in this are the disease etiology, diagnosis, pathophysiology, mechanism and natural history. They also address the biochemical characteristics, course, prognosis of illness. Once technologies such as immunohistochemistry flowcytometry and molecular biologic approaches to cancel diagnosis were developed, the pathology of malignancy and other complicated experienced a radical shift.

Genetic alternation , gene control a cell's ability to divide mature and die. There are several degrees of genetic alternation. A single point of mutation affecting a single DNA nucleotide or the addition or deletion of entire chromosome are also possible. These changes impact gene that fall into two main categories .

Oncogene are responsible for cancer this could be either mutant or alter normal gene that are expressed at abnormally high level in cancer patients. Alternatively, they could be normal genes. These genes cause malignant tissue alteration in both situations.

Genes known as tumor suppressor typically limit cell division and shield damage DNA carrying cell from surviving. Several tumor suppressor genes are frequently deactivated in cancer suppressor. This is due to genetic alteration that promote cancer. A normal cell must usually undergo changes in numerous gene in order to become a cancerous cell.

Amplified genomes genomic amplification may occurs occasionally. In this case, a cell acquire multiple copies (commonly 20 or more) of a tiny chromosomal locus, which typically contains nearby genetic information and one or more oncogenes.

Point-based alteration; point mutation happens on individual nucleotides. Particularly in the genes promoter regions. deletions and insertion could occurs. The protein that the specific genes codes for get altered as a result. DNA viruses or retro viruses can also integrate their genetic material. Potentially disrupting a single gene. Oncogenes may arise a result of this.

Modes:-

Translocation:

Translocate is yet process when to separate chromosomal regions become abnormally fused, often at characteristic location. A common example is Philadelphia chromosome, or translocation of chromosome 9 and 22, which occurs in chronic myelogenous leukaemia, and result in production of the BCR- abl fusion protein, and oncogenic tyrosine kinase.

Tumor:

A tumor in Latin means a swelling but not all swellings are tumors in the modern sense of the term. Some of them may be cause due to inflammations, infections, cysts or fluid filled lesion or due to benign growth. A cancerous tumor has the capacity to grow rapidly and to metastasize are spread to other tissues. Some tumors like leukaemia's grows as cell suspension but most grows as solids masses of tissue.

Change of location: another process is called as translocation which occurs when two distinct chromosomal regions inappropriately fused together, frequently at a distinctive position Philadelphia chromosome.

Growths:

In Latin word ,a tumor is swelling; however ,not all swelling are considered as tumors in the contemporary understanding of the word .some of them could be brought on by benign growths,cyts,fluid-filled lesions. Inflammation's or infection . A malignant tumor has the potential to spread to other tissues and grow quickly . While leukaemia's and other tumor grow as cell suspension ,the majority of tumors form as solid masses of tissues.

Cancer's pathophysiology consists of many stages. The first stage is called initiation, which occurs when a defect in a cell's DNA leads to the activation of oncogenes (genes that promote cell development) or the inactivation of tumor suppressor genes (genes that inhibit cell development). The second stage is called differentiation, where the mutated cells are encouraged to divide and grow rapidly, resulting in a small group of abnormal cells. The third stage is progression, where the abnormal cells continue to divide and grow, resulting in a tumor that can invade surrounding tissues and spread to other areas of the body via the bloodstream or lymphatic system.

International Journal of Pharmaceutical research and Applications
Volume 9, Issue 1, Jan.-Feb. 2024, pp: 1073-1086www.ijprajournal.com ISSN: 2456-4494

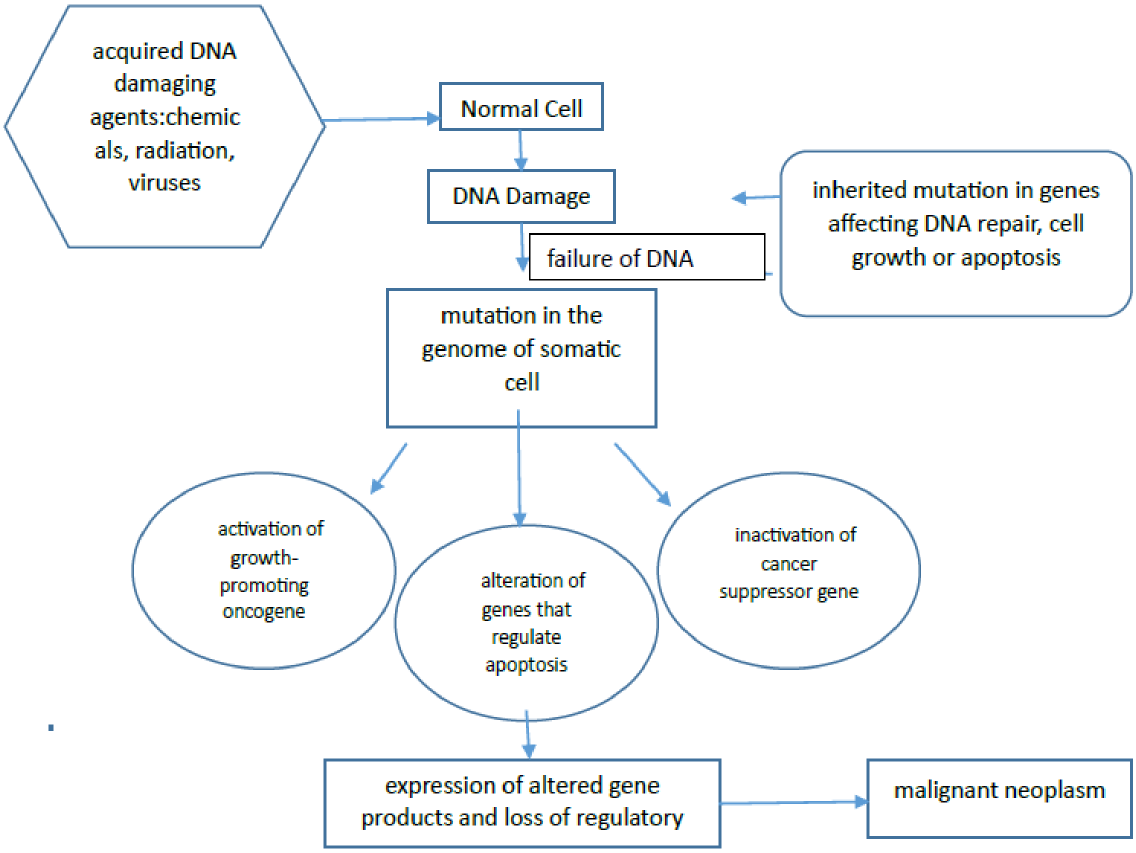

Fig no.3 Etiology of cancer

Making Nanorobots: The development and manufacturing of drug carrying nanorobots have already produced prototypes. Nanobots prototypes use advanced molecular design programs to create nanostructures capable of storing various molecular cargo. DNA nanorobots, created through DNA origami, have faced challenges in movement, activation ,and drug release targeting. Computational capabilities are now employed to provide reliable care to specific diseased cells. [14]

Nanobots are tiny robots that function at the nano size, which is approximately one billionth of a meter. They are sometimes referred to as nanorobots are nanomachines. These little gadgets have the power to completely transform a number of sectors, including manufacturing, healthcare, and environmental cleanup. The enormous intricacy of building a nanobot necessities knowledge in areas like material science, robotics, and nanotechnology. This paper will examine the steps involved in creating nanobots and their difficulties.[15]

Fig no.4 nanobots

1.Design and Planning: Detailed design and planning are the first steps in the creation of nanobots. The precise job that needs to be completed by the nanobots is decided by scientists and engineers, whether it involves building tiny structures , delivering drugs in a targeted manner, or cleaning up contaminants. Choosing the proper components, mechanisms, power sources, and control systems throughout the design phase will enable .

International Journal of Pharmaceutical research and Applications
Volume 9, Issue 1, Jan.-Feb. 2024, pp: 1073-1086www.ijprajournal.com ISSN: 2456-4494

Working of nanobots:
Consider going to the doctor for fever care. Instead of prescribing you a tablet ora shot, the doctor refers you to a special medical team that inserts a tiny robot into your bloodstreams. The robot detects the source of your fever, navigates to the appropriate device, and delivers a dose of medication directly to the infected area. It'ssurpricing to see devices like thi being used in surgical procedures. They're called nanobots, and engineering teams around the world are working to create robot that will eventually be used to treat anything from haemophilia to cancer.

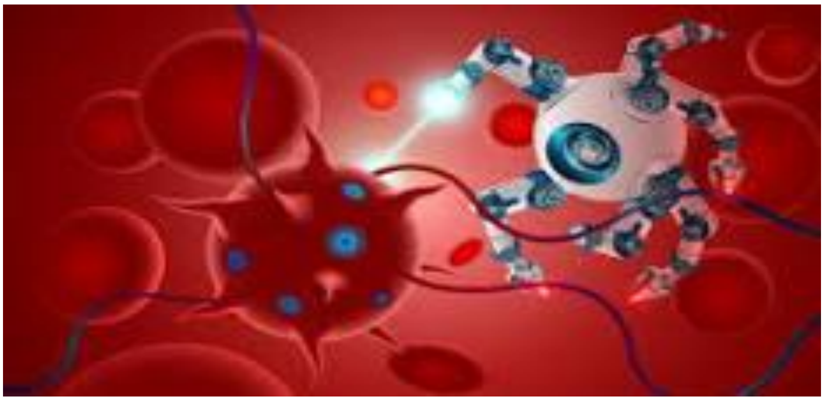

Fig no.5 working of nanobots

Synthesis of nanorobots : To achieve targeted drug release nanorobots are equipped with sensors and propulsion systems. Nanorobots' most important component is the sensor system, which helps to detect targets and achieve the desired goals. In nanorobots, various types of sensors are being used, including magnetic, electrical, biological, optical, and mechanical. Nanorobots' propulsion system is used for movement, and various propulsion mechanisms (self, external stimuli, and biohybrid-based propulsion) are used to fuel them.[17,18]

Dna-based nanorobots: ned seeman was the first to introduce dna nanotechnology, and it has since proven to be a versatile foundation for a variety of applications. Dna is a versatile material for achieving the correct morphologies of nanoparticles due to complementarity and the watson-crick model's ease of assembly. Similarly, certain dna strands can be mixed and arranged into a particular pattern. Consequently, dna-based materials can be designed with specific properties for a variety of potential uses, for example, a biosensor.

Construction of DNA origami : DNA origami is a technique used to make artificial DNA structures. artificial DNA structures are created for scientific purposes by using DNA's specific molecular features. It has many applications in fields such as biology, medicine, and materials science. In 1982, NadrianSeeman established the theoretical foundation for using DNA as a nano-scale building material. This is due to DNA's ability to self-assemble in a programmed fashion and its remarkable stability 104,105. Paul et al. coined the term "scaffold DNA origami," which was used to describe the technique.

Controllable DNA origami nanomachines : A novel DNA origami nanomachine can be programmed. one of the main objectives of DNA nanotechnology is to produce molecular machines, molecular robots, and electrical devices. Using a moderately rigid 3d origami structure, a robust mechanical device was proposed and produced 106. As shown in fig. ci, it is possible to make three-layer DNA origami, whose structure changes with salinity and temperature. 6a 123. The mechanism is based on the Dedan terminals' – stacking interaction and form-fitting. A structure made up of two pluggable jacks.

Dynamic mechanism of nanobots: A nanorobot with a dynamic mechanism for optimal operation and monitoring of performance, nanorobots require a computer system for their synchronized operation. The nanorobot implanted into the bloodstream reaches tumor cells, inserts them, and targeted drug delivery confirms that the drug is only delivered to the cells that must be destroyed. The nanobots are further organized by an aptamer-encoded logic gate 83, and DNA being a natural substrate has many advantages for a set of logic circuits thanks to input-induced disassembling.[24,25,26]

Composition of nanobots :

1. **Biochip:** Involves the joint use of photolithography, nanotechnology, and biomaterials for nanorobot production. Biochips integrated with nanorobots enable tele-operation and advanced capabilities for medical instrumentation.[1,2]

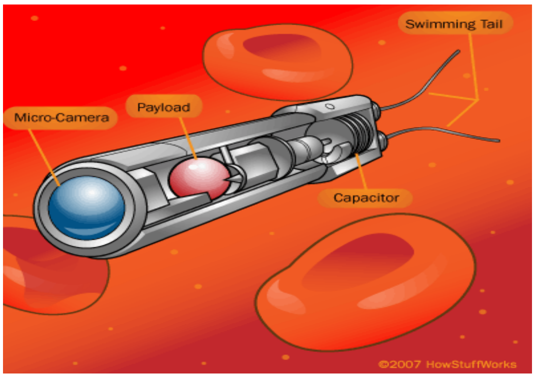

Fig no.6 composition of nanobots

2. Bacteria-Based Method: Utilizes bacterial microorganisms, particularly Escherichia coli, for nanorobot construction. The flagellum serves as a propulsion mechanism, controlled by electromagnetic fields.

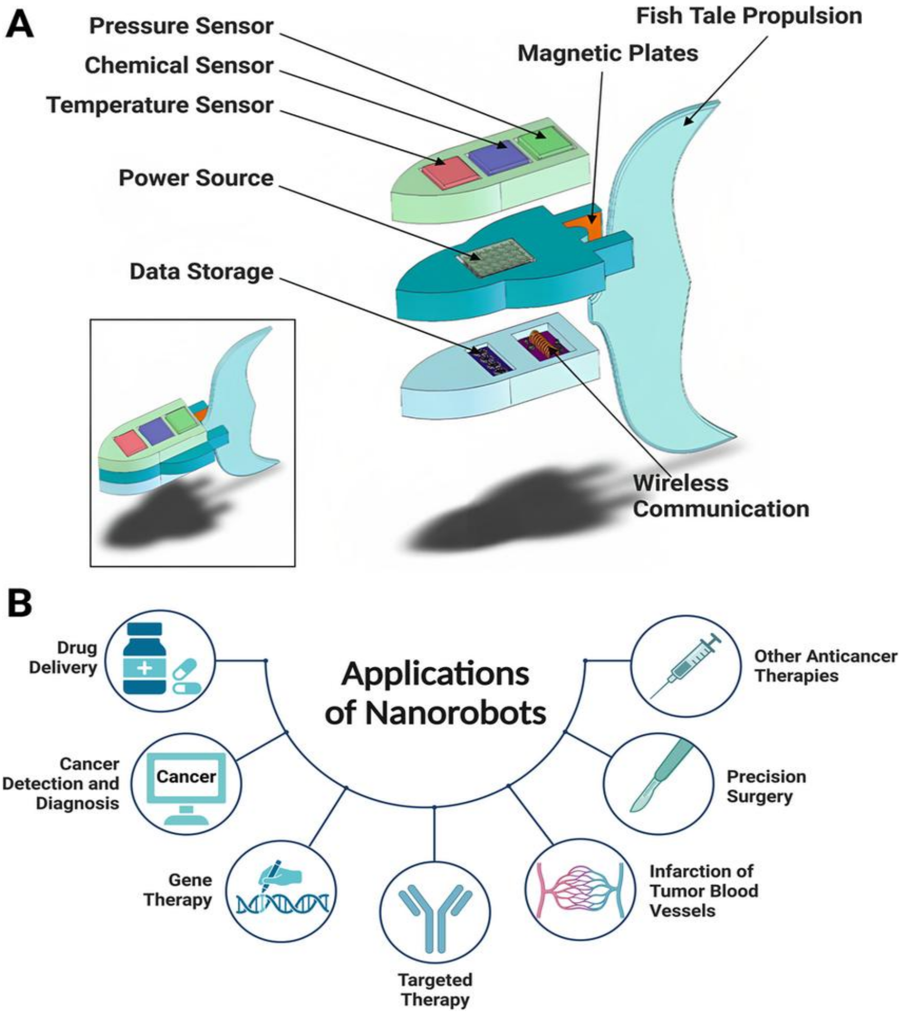

Fig no.7 compositin of nanobots

International Journal of Pharmaceutical research and Applications
Volume 9, Issue 1, Jan.-Feb. 2024, pp: 1073-1086www.ijprajournal.com ISSN: 2456-4494

3. Positional Nano Assembly: A research group focuses on positional-controlled diamond nanofabrication for producing medical nanorobots.

4. Nubots (Nucleic Acid Robots): Nanoscale synthetic robotics devices developed by various research groups, including NYU, Caltech, Duke University, Purdue, and the University of Oxford.

Types of nanobots:
Nanobots are generally divided into two categories i.e. nanobots can be classified into categories. Organic nanobots are also referred to as bio-nanobots and inorganic nanobots. Nanobots used in drug delivery system and therapeutic can also be classified according to purpose described below :

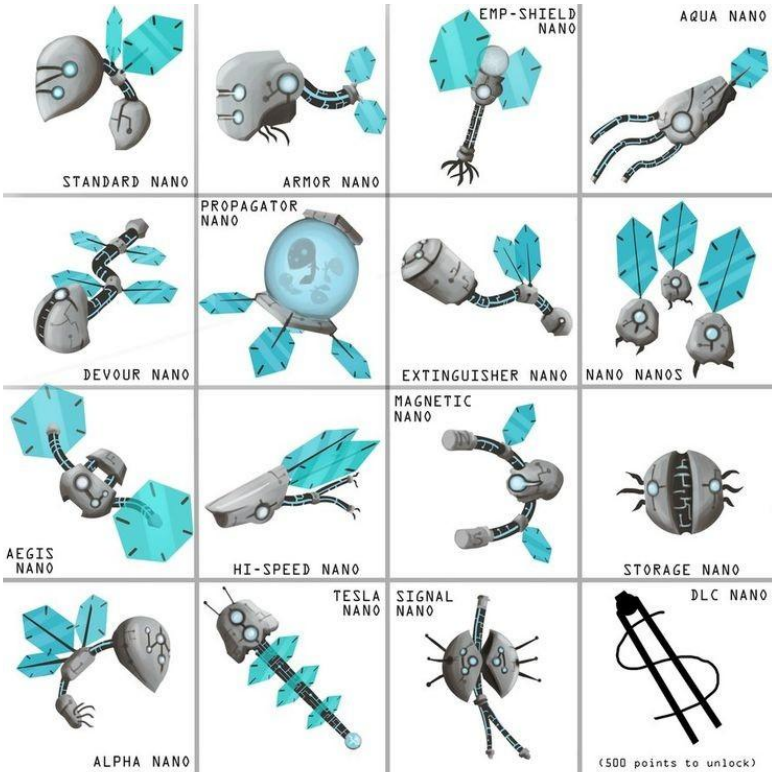

Fig no.8 different type/shapes of nanobots

Pharmacyte: it is a medical nanobot that is used to hold a given drug in the tanks. It is controlled by mechanical systems for sorting pumps. It includes molecular markers or chemotactic sensors for maximum targeting accuracy. The on board power supply is made up of glucose and oxygen extracted from local sources such as blood, intestinal fluid, and cytosol. Nanobots are removed from the environment by centrifuge nanapher- esis .[12,14]

Diagnosis and imaging nanobots: these nanobots have mi-crochips that are designed to send electrical signals when the chip's human molecules detect a disease. They can also be used to monitor the blood sugar level. They have a set price and can be easily altered by manipulation.

Respirocytes: These are a miniature artificial oxygen carriers. Its strength is derived from endogenous serum glucose. This artificial cell can deliver 236 times more oxygen to the tissues per unit volume than rbcs (red blood cells). It is also used to treat acidity.

Microbivore : it is an oblate spheroidal devices for nanomedical application. The nanobots can continually consume power up to 200pW and this power is used to digest trapped microbes. It also has the ability to phagocyte approximately 80 times more efficiently than macrophages agents, in terms of volume/sec digested per unit volume of phagocytic agent.

Clottocytes : This nanobots has the ability for instant hemostasis. They are also called artificial mechanical platelets that are roughly spheroidal nucleus-free blood cells. Platelets join a place of bleeding and are activated. Then they aid in stamping the blood vessel and stop the bleeding.

They also deliver substances that help promote coagulation.

Chromallocytes: they replace entire chromosomes in non-individual cells, thereby reducing the effects of genetic disease and other accumulated damage to our genes and preventing premature ageing. Usually inside a cell, the repair machine scales up the situation by examining the cell's structure and function, and then takes action by going molecule-by-molecule and structure-by-structure.

DNA nanobots: they are used to deliver the drug to the tar-geted cell in order to avoid side effects. Their aim is to develop and produce flexible DNA nanostructures that perform specific tasks by means of state shifts, ranging from the hybridization/denaturing of a single base to the hybridization/denaturing of entire strands. DNA nanobots make DNA origami, in which one long strand of DNA is folded to form the desired shape with the help of smaller staple strands. This method is based on the folding of the large Sydna (usually the 7.3 kilobase genome of the m13 bacteriophage) with an excess of smaller complementary strands (typically 32 strands).These strands are complementary to at least two distinct segments of the long ssdna.to improve the treatments of disease , nanobots are uses to targeted drug delivery system.

challenges for Handling of Nanobots: Nanobots have made significant strides since the development of nanotechnology, ro- botics, biomedicine, and electromechanical science. Nanobots have unique and multivalent capabilities, such as fast movement in complex biological media, a large cargo-towing capacity for quick and long-distance transport, a simple surface functionalized for precise capture and isolation of target subjects, and a high biocompatibility for in-vivo operation. To keep up with the rapid demands of nanobots, we must address the challenges associated with them. Nanobots have unmatched advantages due to their size, but they also face some challenges. When the dimensions are reduced to a nano-scale, the nature of certain physical laws is altered due to changes in the surface area-to-volume ratio and surface area. Forces that are related to the perimeter tend to dominate. Nanobots' behaviour is also highly susceptible to temperature, humidity, and fluids. [19]

nanobots in the field of biomedical research must work with one another to achieve tasks such as the efficient delivery of large therapeutic payloads or large-scale detoxification steps that are impossible with one robot. Mimicking the natural swarm in-telligence communication and synchronized coordination from one to many is a difficult challenge. It is extremely important for enhancing their precision treatment capabilities. It is difficult to achieve simultaneous localization and mapping of nanobots in the human body using the latest optical microscopy techniques. For arbitrary four-dimensional navigation of many- nanobot systems, futuristic biomedical nanobots will require their integration with modern imaging techniques and feedback mechanisms. Nanobots face a second challenge in clinical applications, as well as closing the gap between scientific findings and market demand. Although there are many types of nanobots out there, they are rarely used. Biocompatibility.[17,18]

To unlock the full potential of the nanobots, significant efforts and innovations are required. Future nanobots are expected to resemble the natural intelligence of their biological counterparts, with excellent mobility, adaptable and sustainable operation, pre-cise control, self-evolving, and self-replicating capabilities. For long, biocompatible in vivo operations, we need reliable energy sources. Several chemical fuels and external stimuli have been investigated for nanobot locomotion in aqueous environments . Nanobots have already demonstrated excellent results in viscous biological fluids such as gastric fluid or whole blood . Nanomotors that can be powered by bodily fluid constituents such as blood glucose or urea can be enzymatically functionalized . For effectively implementing them, the efficiency and stability of these motors require further enhancements.

Applications of nanobots :

Because of their small size, nanobots have unique functional characteristics that do not exist in their larger counterparts, such as increased surface area, charge, reactivity, and other physio-chemical properties, which may influence how these nano-particles interact with biological entities. Nanobots are having following potential applications:

For drug delivery: nanobots with the ability to control navigation deliver drugs to the intended of affected areas, thus treating many diseases. They can even penetrate into tissue. These nanobots are usually propelled and/or guided by endogenous or exogenous signals towards the area of concerns. By means of wireless magnetic fields, wire-shaped magnetoelectricnanobots that are designed and manufactured can e precisely directed towards a desired location and can perform on- demand magneto electricity assisted drug delivery to cells.

For surgery : nanobots are developed as a way to solve problems associated with complicated surgical procedures, as well as for ex-tending human surgeons capabilities. Robot-assisted surgery is a rapidly evolving field that allows doctors to perform variety of minimally-invasive procedures with high precision, flexibility, and control. Nanobots are used to navigate to areas that are difficult to reach in human body. They have a variety of health benefits. Re-cent nanobots have made major promises for addressing the limitations of current surgical techniques and for precision surgery. Nanorobotic devices that an be used without cable, ranging from nano-drillers to microgrippers and micro-bullets, have unique capabilities for minimally invading the surgery. Nanobots have a major advantage over high precision minimally invasive surgery because their size is compatible with tiny biological entities that they treat.

Cancer detection and treatments:nanorobots equipped with chemical biosensors and integrated nano-sensors hols promise for early cancer detection and targeted drug delivery, minimizing side effects.

Nanomedicines: Encompasses applications in early detection, targeted drug delivery, biomedical instruments, surgery, pharmacokinetics, diabetes monitoring, and healthcare. Nanorobots implanted into patients may perform surgery on a cellular level, offering non replicating solutions.

Cryostasis: revives interest in cryonics, where patients are frozen at liquid nitrogen temperatures until advanced surgical technology can restore health. Experimental but hold potential on advancement in medical technology.

For sensing:nanobots have biosensing capabilities because they have autonomous movements, simple surface functionalization, and a simple capture and isolation of target analyst in complex environment. Their sensing ability is based on the motility of artificial nanomotors, which are coupled with different bioreceptors, through the sample to achieve specific biomolecular interactions. The constant movement of receptor functionalized synthetic nanomotors has resulted in built-in solution mixing in microlitre clinical sample, which greatly influence the target binding efficiency and increase the sensitivity and speed of biological assay. Tubular micro-rockets that are ligan-activated aid in the identification and isolation of specific cancer cells. Nanobots internalization and movement within the cells can also be used for intracellular monitoring.

For a precise diagnosis: nanobots have the ability to perform precise diagnosis of diseases thanks to their straight forward surface functionalization and their flexible mobile performance. Mirnas have been used as biomarker candidates for disease diagnosis. A nanomotor-based approach for rapid single-step intracellular biosensing of a target mirna expressed in intact cancer cells at the single-cell level 42 can enable precise and real-time monitoring of intracellular mirna expression by the measure- ment of a fluorescence signal in the cells.

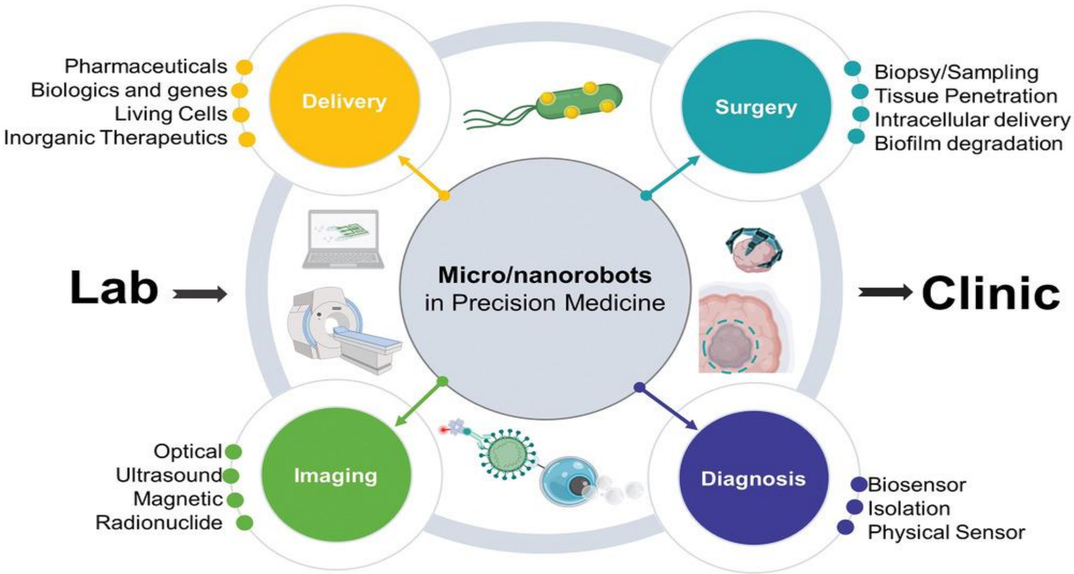

Fig no. 9 application of nanobots

International Journal of Pharmaceutical research and Applications
Volume 9, Issue 1, Jan.-Feb. 2024, pp: 1073-1086www.ijprajournal.com ISSN: 2456-4494

III. Discussion:

Over the past few years, a variety of theoretical and experimental studies have led to the development of various nano-bots that are powered by different mechanisms. Because of the challenges faced by nanobots, the current clinical application is very limited. Nanorobotics have been a part of life sciences in a limited way, but there is still room for its development in other areas. The new nanobots are mainly drug carriers, and their movements depend on blood flow, and once the drug inside is released at the intended site, the nanobots are cleared by our immune system. To broaden the applications, it is necessary to re-use nanobots and enable communication and coordination between nanobots inside the body. The cell's physical characteristics are altered by pathological changes. Therefore, applying physical property detection techniques based on Nano mapping devices to drug efficacy prediction will increase their value.

Nanobots are expected to provide the most significant benefit to the biomedical industry. One of the most important tasks seems to be to shield our body cells from pathogens. Nanobots made of diamond coating and fullerene nanocomposites parts exhibit inertness within the human body from the immune systems. In the near future, a working simulation model of such nanobots is still waiting for validation. Such nanobots' energy sources are expected to be bodily acoustic vibration and glucose metabolism. Onboard, nano-computers act as navigators and signal transmitters. They help to distinguish between cells, orient their way to desired organs, provide feedback to doctors regarding the health of the cell, and they receive instructions from the operator to administer the correct medication to that cell. These nanobots are equipped with chemo active nano sensors that measure the surface antigen of the bio- cells and distinguish between other nanobots and a particular human cell .

IV. Conclusion:

Nanorobots in medicine hold significant promise, offering benefits from disease eradication to reversing the aging process. Advancements in molecular nanotechnology will dramatically improve the efficiency, comfort, and speed of medical therapies while reducing costs and invasiveness. Nanorobots provide advantages in drug delivery, targeted therapy, and non-invasive techniques, making them a transformative force in healthcare. Challenges in safety, biocompatibility, and ethical considerations must be addressed for responsible and sustainable implementation. Nanorobots represent a revolutionary path towards personalized medicine, improved patient outcomes, and transformative healthcare practices.Nanobots' research and application in medicinal chemistry will flourish in the coming years. Researchers must investigate nanobot biocompatibility, storage, toxicity, biodistribution, and therapeutic effectiveness in order to realize the full potential of the device. Our interventions will become more effective and pro-active with nanobots that can perform surgery, targeted drug delivery, and gene therapy, enabling us to treat diseases in ways that are simply not possible today. Nanobots canalso help to create a world where people do not get sick in the first place thanks to monitoring and preventative care that eliminates diseasesand disorders in the bud. Given the promisingresults achievedin the last decade in a variety of fields, from drug delivery to disease prevention, it is worth considering the challenges they pose. Nanobots must now be transformed from a more theoretical perspective to a practical one. Nanobots, on the other hand, will contribute to the ever-changing horizon of medicines in future.

References :

[1]. Gayathri, T., Bose, S.S.S. and Poornima, T., 2020. Nanorobots and their biomedical applications. Int. J. Eng. Res. Technology, 9(10.17577).

[2]. Mishra, S., Bhatt, T., Kumar, H., Jain, R., Shilpi, S. and Jain, V., 2023. Nanoconstructs for theranostic application in cancer: Challenges and strategies to enhance the delivery. Frontiers in Pharmacology, 14, p.1101320.

[3]. Bhandari, G., Dhasmana, A., Chaudhary, P., Gupta, S., Gangola, S., Gupta, A., Rustagi, S., Shende, S.S., Rajput, V.D., Minkina, T. and Malik, S., 2023. A Perspective Review on Green Nanotechnology in Agro-Ecosystems: Opportunities for Sustainable Agricultural Practices & Environmental Remediation. Agriculture, 13(3), p.668.

[4]. Sharma, A., Vijayakumar, P.S., Prabhakar, E.P.K. and Kumar, R. eds., 2022. Nanotechnology applications for food safety and quality monitoring. Academic Press.

[5]. Singh, G.P. and Sardana, N., 2022. Smartphone-based surface plasmon resonance sensors: a review. Plasmonics, 17(5), pp.1869-1888.

International Journal of Pharmaceutical research and Applications
Volume 9, Issue 1, Jan.-Feb. 2024, pp: 1073-1086www.ijprajournal.com ISSN: 2456-4494

[6]. Boholm, Å. and Larsson, S., 2019. What is the problem? A literature review on challenges facing the communication of nanotechnology to the public. Journal of Nanoparticle Research, 21, pp.1-21.
[7]. Kafle, U., Agrawal, S. and Dash, A.K., 2022. Injectable nano drug delivery systems for the treatment of breast cancer. Pharmaceutics, 14(12), p.2783.
[8]. Giri, G., Maddahi, Y. and Zareinia, K., 2021. A brief review on challenges in design and development of nanorobots for medical applications. Applied Sciences, 11(21), p.10385.
[9]. Manjunath, A. and Kishore, V., 2014. The promising future in medicine: nanorobots. Biomedical Science and Engineering, 2(2), pp.42-47.
[10]. Kong, X., Gao, P., Wang, J., Fang, Y. and Hwang, K.C., 2023. Advances of medical nanorobots for future cancer treatments. Journal of Hematology& Oncology, 16(1), p.74.
[11]. Muthukumaran, G., Ramachandraiah, U. and Samuel, D.H., 2015. Role of nanorobots and their medical applications. Advanced Materials Research, 1086, pp.61-67.
[12]. Mazumder, S., Biswas, G.R. and Majee, S.B., 2020. Applications of nanorobots in medical techniques. IJPSR, 11, p.3150.
[13]. Devasena, U., Brindha, P. and Thiruchelvi, R., 2018. A review on DNA nanobots: A new techniques for cancer treatment. Asian J Pharm Clin Res, 11(6), pp.61-4.
[14]. Tasciotti, E., 2018. Smart cancer therapy with DNA origami. Nature biotechnology, 36(3), pp.234-235.
[15]. Wang, W. and Zhou, C., 2021. A journey of nanomotors for targeted cancer therapy: principles, challenges, and a critical review of the state-of-the-art. Advanced Healthcare Materials, 10(2), p.2001236.
[16]. Eskandar, K., 2023. Revolutionizing biotechnology and bioengineering: unleashing the power of innovation. J ApplBiotechnolBioeng, 10(3), pp.81-88.
[17]. Haleem, A., Javaid, M., Singh, R.P., Rab, S. and Suman, R., Global Health Journal. nanotechnology, 11, p.13.
[18]. Haleem, A., Javaid, M., Singh, R.P., Rab, S. and Suman, R., 2023. Applications of Nanotechnology in Medical field. Global Health Journal.
[19]. Widjaja, G., Kumar, A., Chandrasekar, V., Shankar, B.B. and Nayak, B.B., 2023. Artificial Intelligence and the Contributions of Nanotechnology to the Biomedical Sector. Handbook of Research on Advanced Functional Materials for Orthopedic Applications, pp.65-92.
[20]. Malik, S., Muhammad, K. and Waheed, Y., 2023. Emerging applications of nanotechnology in healthcare and medicine. Molecules, 28(18), p.6624.
[21]. Malik, S., Muhammad, K. and Waheed, Y., 2023. Nanotechnology: A revolution in modern industry. Molecules, 28(2), p.661.
[22]. Patel, G.M., Patel, G.C., Patel, R.B., Patel, J.K. and Patel, M., 2006. Nanorobot: a versatile tool in nanomedicine. Journal of drug targeting, 14(2), pp.63-67.
[23]. Chowdhury, A., Kunjiappan, S., Panneerselvam, T., Somasundaram, B. and Bhattacharjee, C., 2017. Nanotechnology and nanocarrier-based approaches on treatment of degenerative diseases. International nano letters, 7, pp.91-122.
[24]. Alok, A., Panat, S., Aggarwal, A., Upadhyay, N., Agarwal, N. and Kishore, M., 2013. Nanotechnology: A boon in oral cancer diagnosis and therapeutics. SRM Journal of Research in Dental Sciences, 4(4), pp.154-160.
[25]. Zhang, Z., Wang, L., Chan, T.K., Chen, Z., Ip, M., Chan, P.K., Sung, J.J. and Zhang, L., 2022. Micro-/Nanorobots in Antimicrobial Applications: Recent Progress, Challenges, and Opportunities. Advanced Healthcare Materials, 11(6), p.2101991.
[26]. Sharma, K.R., 2010. Nanostructuring operations in nanoscale science and engineering. McGraw-Hill Education.
[27]. Sharma, K.R., 2012. Nano-structuing of Nano-robots for use in Nano-medicine. International Journal of Engineering & Technology, 2(2), pp.116-134.
[28]. HANUMANAIK, M., SRIDEVI, B., SAISREE, B.H., SAI, K.B., MADDIBOYINA, B. and SUDHAKARARAO, G., AN OVERVIEW ON APPLICATION OF NANO TECHNOLOGY IN ENVIRONMENT AND MEDICAL.
[29]. Regan, B.C., Zettl, A.K. and Aloni, S., 2011. Nanocrystal powered nanomotor. U.S. Patent 7,863,798.

[30]. Sharma, K.R., 2012. Nano-structuing of Nano-robots for use in Nano-medicine. International Journal of Engineering & Technology, 2(2), pp.116-134.