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Title-Multidisciplinary approach in researching
Artificial Intelligence, Nanotechnology and Biotechnology

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Dr Dalvinder Singh Grewal
Prof Emeritus, DeshBhagat University
Fatehgarh Sahib district in Punjab,
Email- dalvinder45@yahoo.co.in

ABSTRACT

Nature is a creation in wholesome which a normal human being cannot understand in entirety. Hence, compartmentalization is done in subjects for the study of the nature e.g., physics, chemistry, biology etc. Hence most of the research is in bits and pieces by the experts in limited fields where lot of linking of other fields is left out. For example if we have to study a field where AI, Nanotechnology and biology are interlinked we need an expert who has deep knowledge of all the three subjects. When we use AI and Nanotechnology for solving biological problems we need deep knowledge of all the three without which modern treatments of cancer, BAB, heart, liver etc. cannot be successfully carried out. Not only these three subjects we may have to mathematical algorithms electronic and mechanical methods for preparing nanobots having fundamentals of nanotechnology and control functions of Artificial Intelligence (AI). Keeping this in view this study on multidisciplinary approach is put forward for the scholars.

Key words: Multidisciplinary research, Nanotechnology, Artificial Intelligence, biology

INTRODUCTION

Nanotechnology and Artificial Intelligence (AI) combination is a multidisciplinary field which has started working together recently at a large scale. Its new addition is biotechnology with which there are path breaking researches. Artificial intelligence creates the models through detailed thinking processes and nanotechnology helps to develop stronger and more lightweight metals to creating self-healing materials meeting the exact specifications which mechanical and electronics methods are unable to create. Integrating of the two has new vistas which may change the world scenario in the near future. Biotechnology added these two has increased their sphere further. Artificial neural networks (ANNs) are a type of computer model that draws inspiration from the neural architecture of the human brain. It is made up of layers of networked nodes, or neurons.

These nodes process information, and during training, the network modifies the connection strengths (weights) to learn from the input. This allows the network to identify patterns, anticipate outcomes, and interact with nanoscale materials to perform a variety of machine learning and artificial intelligence problems. In fig(1)This multidisciplinary approach is discussed here.

Nanotechnology is the functional field of engineering at atomic scale where atoms are manipulated from the matter are manipulated with new material devices and machines. (Grewal 2022) [1] It offers scientific progress in a variety of fields, including manufacturing, consumer goods, energy, materials, and medicine. Engineered systems, gadgets, and structures are referred to as nanotechnology. It operates on a length scale of one to one hundred nanometers. At this scale, materials start to show distinctive characteristics that influence their behavior in terms of physics, chemistry, and biology. The core of new technology is the investigation, development, and application of these features. (Grewal 2022)[1]

Interdisciplinary Field

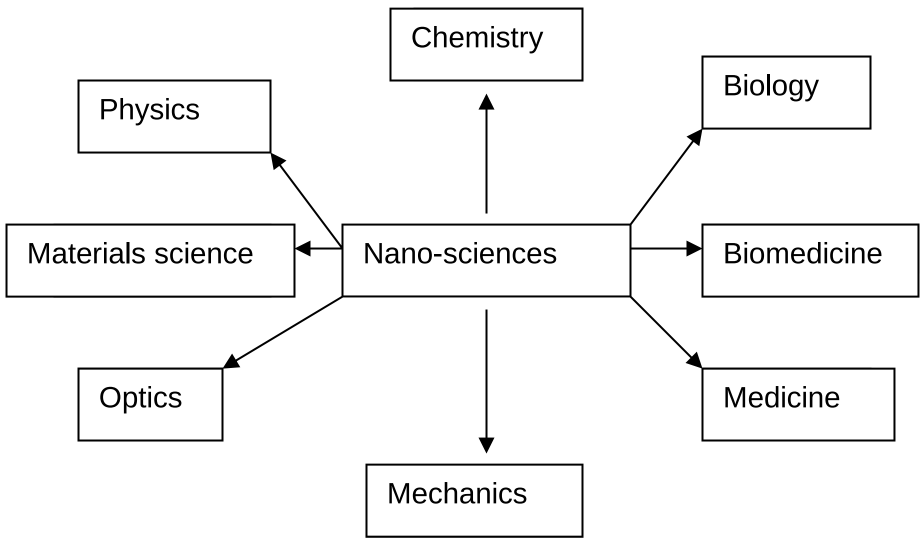

Figure 1: Natural Sciences Related to Nanotechnology.

Nanotechnology is not an individual field; it has born out of physics, chemistry and biology. Its emerging fields are Nanoelectronics, Nanomechanics, Nanoelectrical, Nanophotonics, Nanoionic, Nanobiotechnology, Nanomedicine, Nanomaterial, Nanocomputers etc., which have the common scale as Nano. Nanotechnology is thus an interwoven multidisciplinary field with many types of inputs and outputs relating to different sciences which need specialized technologies.

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Nanotechnology (fig2)has now emerged as a full-fledged subject and is referred to as convergent technology crossing the boundaries of Science, Engineering and Technology. The qualities and capabilities of natural or man-made particles or artifacts differ from their macroscopic counterparts. Gold can act as a potent chemical catalyst at Nano-scale. Ceramics and powder metallurgy is used for achieving uniform Nano-porosity. (Shanefield, 2016)[9]

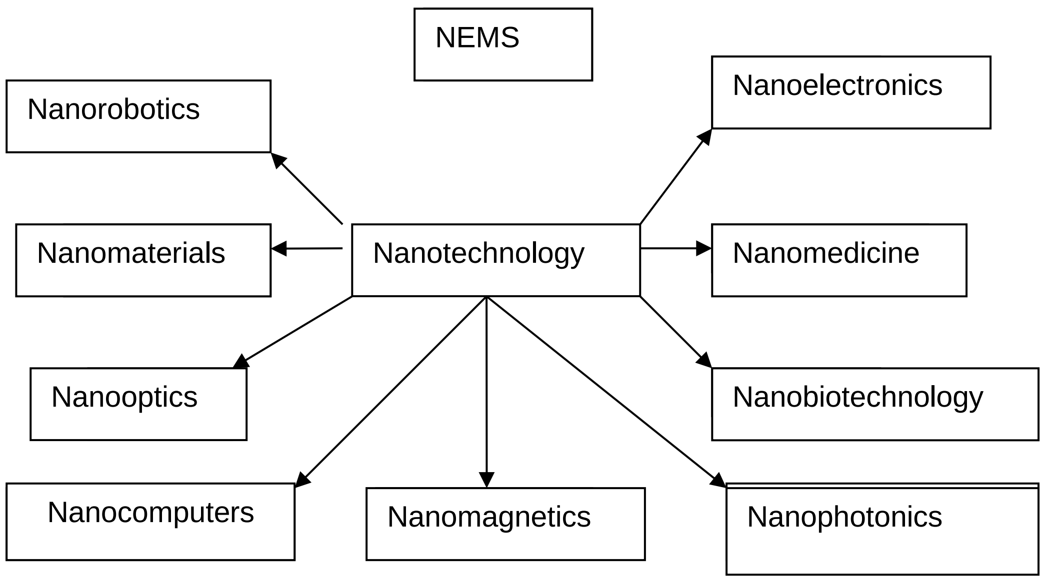

Figure 2: Fields Interwoven with Nanotechnology

Advantages of nanotechnology include[3]

1. Reduced Surface Area Requirement
2. Reduced energy use.
3. Beter medical treatment
4. Lower costs for computing

There are some risks also

1. Environmental risks
2. Privacy risks

Applications (fig 3)

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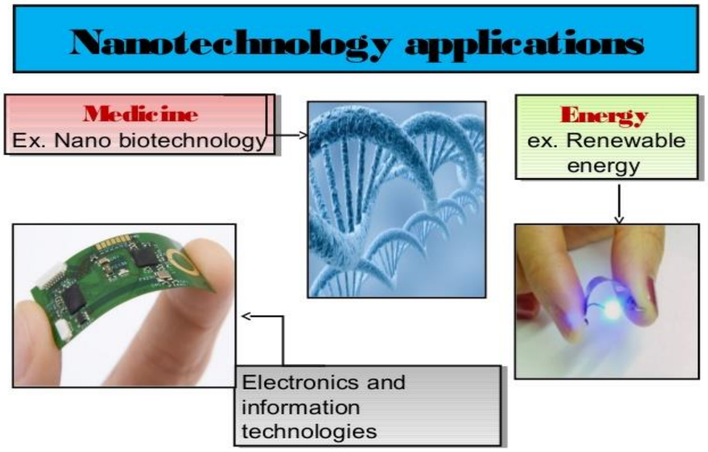

Figure 3: Nanotechnology Applications in General

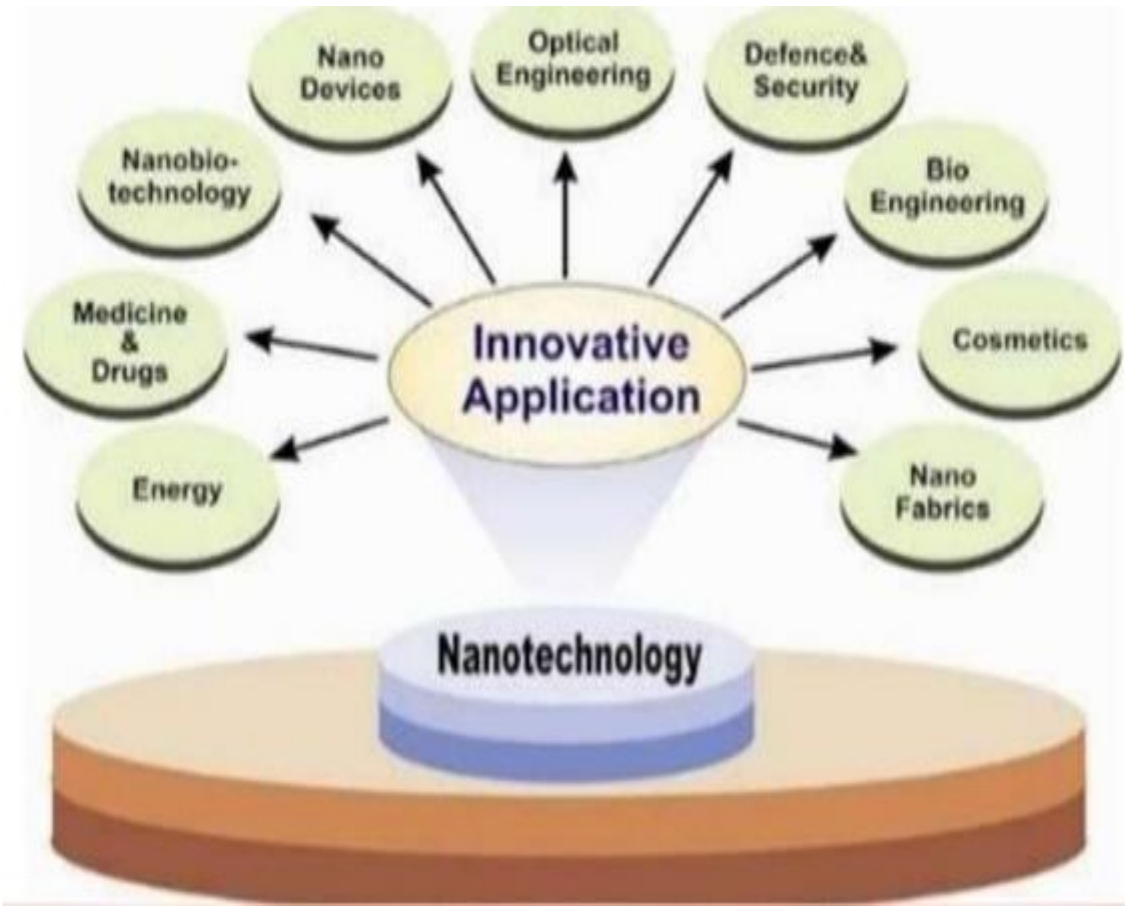

Figure 4: Innovation Applications of Nanotechnology

Nano machines(fig4)

1. Switch-A DNA machine, externally triggered by protons, based on fluorescent resonance energy transfer (FRET)
2. Functions as pH (A measure of acidity)

3. Sensor
4. Nanorobots (Naznobots)
5. Drug Delivery
6. BBB

Nanotechnology in Drugs

In the field of medicine, nanotechnology is being used for diagnostic, drug delivery, tissue engineering etc. Examples of the use are

1. Azithromycin or Zithromax
2. Sun Screen
3. Suspensions Nano to Nanoparticles

Quantum dots are semiconducting Nano-crystals that help enhance biological imaging for medical diagnostics.(fig 5)

Drug Delivery

The current process of drug delivery to cancer patients is through radiotherapy or chemotherapy. Chemotherapy causes a lot of damage.This fails to precisely identify the target cells they aim. Nanotechnology has become a nanoimpeller by innovating nanotubes made of light-sensitive silica which carried cancer killing drugs which target only cancer cells injected into human cancer cells in vitro. When light strikes silica tiny tails inside the tubes wag back and forth it creates a current that releases the drug out of the tube, and provides new options for drug delivery and drug therapies. It makes it possible to administer medications exactly where they are needed in the body and to release dosages according to a scheduled schedule for the best possible care. The medication is affixed to a nanoscale carrier. They become localized at the site of the disease, such as an artery blockage cleared by nanorobots.

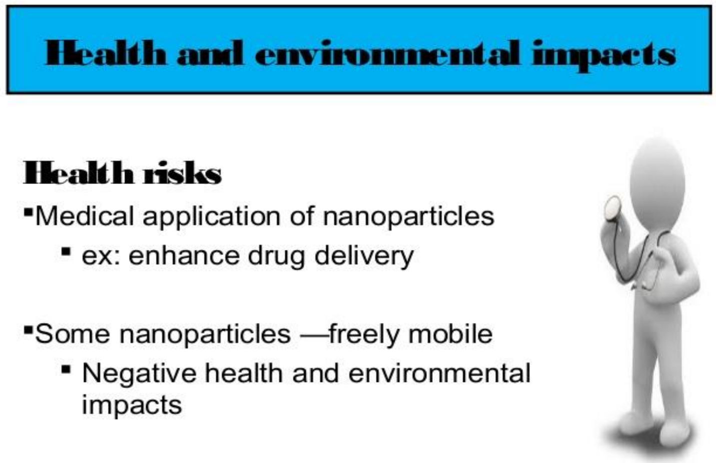

Figure 5: Nanotechnology in Health and Medicine

Nanorobotics

Artificial Intelligence combined with nanotechnology has resulted in extremely intelligent but small robots, or nanobots. Currently, these small machines are able to perform tasks that are beyond the scope of their larger counterparts. These nanobots become more adaptive, capable of learning, and have coordinated functionality thanks to AI, which also increases their overall efficacy.

With previously unheard-of precision, nanobots move through the human body to deliver drugs or repair damaged tissue. The ability of AI to facilitate coordination and adaptability among these nanobots represents a major advancement in robotics.[5]

The combined synergy of artificial intelligence (AI) and nanotechnology is at the forefront of scientific and technological advancements, from the creation of novel materials with previously unheard-of properties to the development of sophisticated nanorobotics and sustainable solutions for global challenges.

The revolutionary uses of nanomedicine in addition to personalized

The tangible impact on our daily lives is highlighted by the revolutionary applications in nanomedicine as well as customized material solutions.

Nanotech Robotic Systems

Manufacturing of nano-robots capable of sophisticated symmetric behaviours is potentially feasible. They will either do so by working independently or by coming together to form groups. One example is the ability of high-resolution video screens to self-repair by placing a tiny robot at each screen element. These "pixelbots" would have the ability to generate light. These will be intelligent enough to take themselves out of the video array if they don't work. The pixelbots will sense any gaps left by malfunctioning devices and reorganize themselves to cover them. The latest development is the integration of chemically safe autonomous "nurse" robots into the human body, which are able to eradicate cancer cells directly from their source. The "nurse-bots" would operate on their own and continuously repair tissue in ways that go beyond what is currently possible. In a similar vein, a computer that has a blown transistor will be able to repair itself automatically through self-optimization of its silicon memories or processors.

Thus, research on autonomous self-assembling systems needs to be focused and committed. At Los Alamos National Laboratory, efforts are being made to create very affordable macro-scale robots. These tiny robots are capable of the following:

(a) Sensing and responding to their surroundings,

(b) integrating with other robots to carry out activities like finding and marking the position of detonated land mines, or identifying and marking the location of detonated land mines with a three-inch diameter by using self-assembled robots.

(c) These robots are inexpensive, run on solar energy, and lack a CPU, which makes application or downsizing challenging. (Low and Tillen)
These will open up new avenues for the vast majority of low-cost nanomachines to become microscopic building blocks for previously unthinkable functions. These intelligent cellular systems have easily scaled down capabilities, such as creating "nano-lego" for the new millennium with unique, unexplored market potential.

Nanosensors

Nanoelectronic sensors can occasionally determine the quality levels of a solution by interacting with nanoparticles included in the paint film. A closed loop paint control process can guarantee unachievable quality levels. Furthermore, the nanoparticles may be specifically engineered to function as catalysts. Biosensors based on Nanoelectronics will simplify and accelerate measurements at the nanoscale. It will be acceptable to detect incredibly low concentrations of proteins, antibodies, or cell structures. Better diagnostics will be available, new health insights will be generated, and ultra-sensitive sensors will be better manufactured, designed, and handled. The Nano biosensors will also stimulate the development of smart implants, micro-laboratories, and noninvasive health control.[7]

Food safety will be improved by combining such biosensors with intelligent tagging. Continuous control of quality will be provided; speed will be detected and tracing of sources of infection and disease will also be traced.

The LSPR spectrum controls the size, material, and shape of the nanoparticle as well as the external environment, making noble metals extremely valuable as possible materials for nano-sensors. The local refractive index varies as target molecules cling to the metal nanoparticles. Since LSPR spectra are extremely sensitive to these changes in the refractive index the shift produced in the LSPR spectra can be used to detect molecules. When the antibody is present and it binds to the antigen, a change in local refractive index occurs in a silver nanoparticle spectra interpretable as an ‘on’ (presence) or ‘off’ (absence) position resulting in a shift in the LSPR.

Artificial Intelligence

The ability of a machine to carry out tasks that are typically associated with human intelligence, like inference and experience-based optimization, is known as artificial intelligence. This system is a mechanical simulation that gathers knowledge and information, processes the intelligence of the universe (by gathering and interpreting data), and then distributes them in the form of valuable data the results to those who qualify for. (Grewal, 2014) [2]

Applications of Artificial Intelligence in Robotics

Artificial Intelligence plays a practical role in nanoscience research by helping to design nanomaterials and devices and by interpreting experimental techniques. In the context of nanotechnology research, machine learning techniques—like artificial neural networks—are excellent at navigating complex data[6].

Artificial Intelligence (AI) is used to analyze large datasets, find patterns, and make predictions. The development and improvement of nanomedical instruments are therefore guided by these realizations. AI algorithms, for instance, are used in the creation of nanoparticles that specifically target cancer cells while sparing healthy tissues. This combined effect raises the safety factor of cancer treatments while also improving their efficacy. (Sahota Neil, 2023)[4]

AI, Nanotechnology and Biotechnology combined work towards treatment of cancer cells. Other important fields are use of nanorobots (nanobots) for detecting and treating diseases within biological bodies and drug delivery and the removal of blood-brain barriers (BBB) by nanobots. (Neil Sahota, 2023)[4]

Materials with exceptional thermal and electrical conductivity, as well as high strength, have been made possible by nanotechnology. By modeling their behavior in a variety of scenarios and offering direction for experiments, AI speeds up the discovery and development of these materials.

Materials specifically designed for energy storage, electronics, and aerospace are expected to be produced as a result of this collaborative effort.

Combining AI with nanotechnology guarantees a more focused and effective approach to material design, pushing the bounds of what is practical. (Sahota Neil, 2023)[4]

DNA computing with Artificial Intelligence (AI)

One method of creating nanocomputers is DNA computing. It creates DNA logic gates and molecules using a bottom-up methodology. Instead of using conventional silicon-based computer technology, DNA computing makes use of biological materials like DNA, biochemistry, and molecular biology. DNA computing, also known as biomolecularcomputing, is a rapidly emerging field. To gain a deeper understanding of DNA computing's theory, experiments, and applications, research is ongoing.[10]

The novel materials include transition metal dichalcogenides metal dichalcogenides (TMDs), graphene, xenesgraphyne, borophene, germanene, silicene, Si2BN, stanenephosphorene, bismuthenemolybdenite and 2D aloys and 2D supracrystals, 3D topographical structures (foams, aerogel substances and materials) and aerographite

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Bio-mimetics

The architectures, mechanisms, functions, and principles of biological systems serve as the inspiration for bio-mimetics systems and technologies. For instance, one gram of DNA might contain all of the information from the world's largest library. With roughly 1014 interconnects and 1016 operations per second, the human brain is equipped with an immune system and a self-healing mechanism that helps people recover from illnesses using ultra low power and imprecise computing elements. It will be possible to design and launch space probes on missions that are currently unfeasible as devices get lighter, smaller, and consume less power.[12]

Bionanotechnology Using Nano-Chip Sensors:

Significant changes are anticipated in a number of public interest domains, including national security, law enforcement, healthcare, and food safety. These will enable much easier and more affordable access to chemical and biological information. A global endeavor is underway to shape the future of chemical analysis that is widely accessible through the development of "ChemLabTM-on-a-chip" technology. We perform an analysis of μ-TAS, or micro-total analysis systems. It differs from simple sensors in that an answer is produced when a raw mixture of chemicals is injected. An μChemLabTM demonstrator that is handheld will analyze chemical warfare agents that are carried in the air as well as explosives that are liquid-based. It is being worked on at National Laboratories in Sandia.[8]

This is a novel architecture for nanotechnology (nano-TAS). Developing materials with molecular functions that can be switched on and off is a novel way to handle chemical separations, pumps, valves, and detection. Without a preset architecture, surface energy could be controlled to direct fluid streams through physical channels. Mechanical valves might be replaced with switchable molecular membranes and similar devices. Nano-TAS will enable greater functionality in much smaller, lower power total chemical analysis systems. It will do away with the requirement for the intricate fluid networks and tiny parts that are currently employed in μ-TAS initiatives. (National Laboratory for Sandia)

Computer-Based Nano-Bio-Cells

The U.S. Department of Energy is building on tiny organisms to create a new generation of tiny machines for electronic and photonic devices. It is possible for Sulfolobusshibatae to form rings of cells that are only 10 to 20 nanometers in diameter. A bacterium known as chaperoning, which inhabits geothermal hot springs, uses a heat-tolerant protein from them to produce each cell, which is similar to an array of cells, using lithographic techniques for computer chips. Even the most advanced contemporary methods can only go so far—roughly 100 nm. Future uses of these biologically based arrays of nanoparticles in computer memories, sensors, or logic devices may be anticipated. These arrays are created by applying the chaperoning to a silicon substrate. They form a repeating hexagonal pattern by self-assembly.Gold nanoparticle slurry and cadmium selenide-zinc sulphide, a semiconducting substance, are added to it. The materials produce an exact, regular array of nanoparticles that stick exclusively to the active sites surrounding each protein ring's hole. [11]

Conclusion

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There are many aspects in Nano-manufacturing where all three disciplinary fields have to work together. The research in this interdisciplinary field has new vistas, hence their study as interdisciplinary subjects is need of the hour. All these three subjects are of science hence the person who has studied PG in Science studying Physics, chemistry and biology together and done research in science will be the right person for this type of research. Nature is a multidisciplinary. We cannot compartmentalise the nature into various subjects, research them separately and then joining them haphazardly. It has to be a conclusive study where the expert has knowledge of all these subjects or who has a wider perspective of life.

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