

General Science

Short Answers

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Nanotechnology

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CHAPTER 8: NANOTECHNOLOGY

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8.1 INTRODUCTION TO NANOTECHNOLOGY

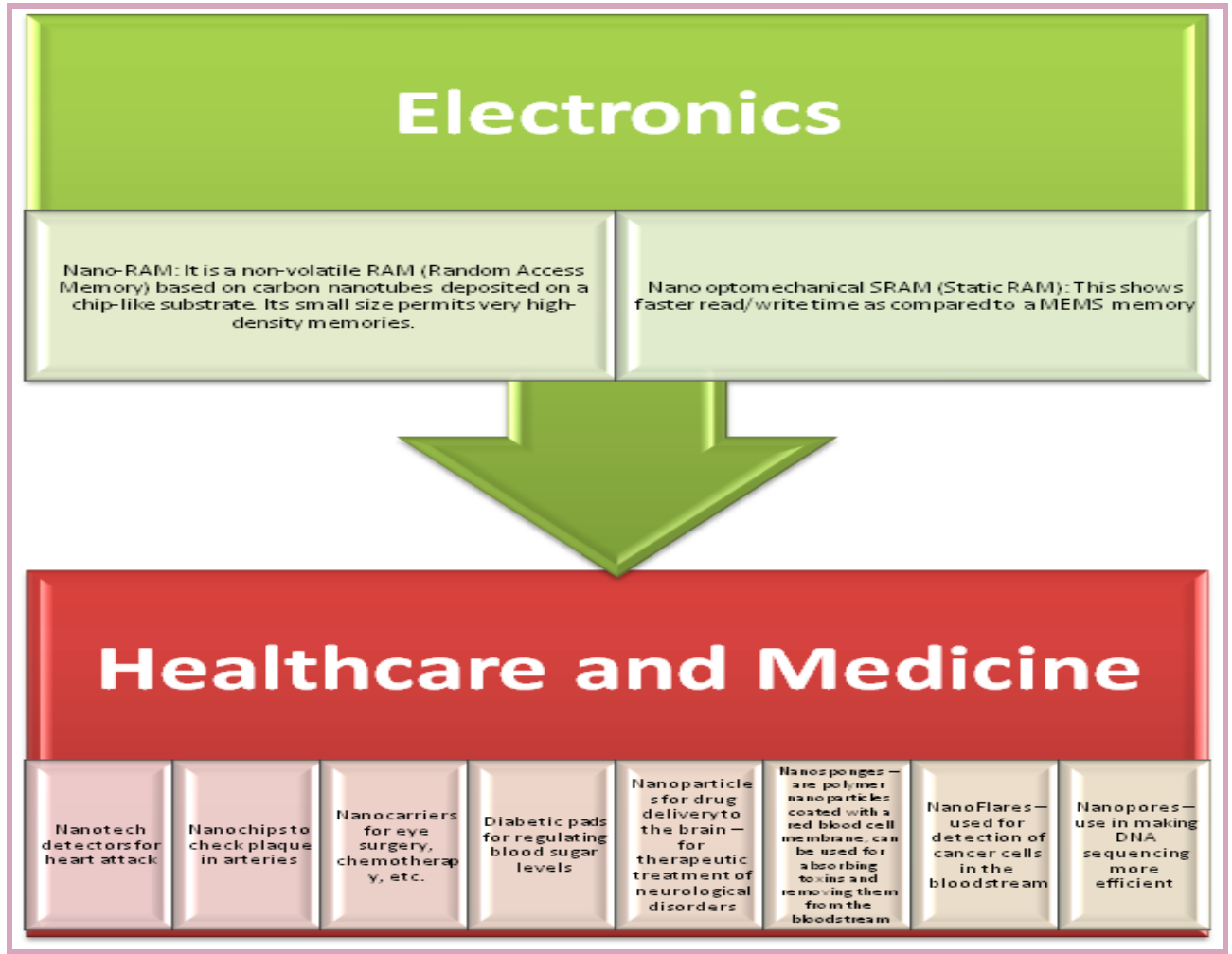
Whenever we visit a zoo or bird sanctuary, we see peacocks dancing with their colourful feathers. We often wonder how the colour of the peacock feather does not fade away for so many years, even we keep peacock feathers in our books and unforgettable memory. This phenomenon of long lasting original colours has come from Nano materials coated in a peacock's feather; and they diffract light. Everything in this universe, from large galaxies to small microorganisms work on a molecular scale. Our internal organs and their processes also occur at molecular level. Therefore, everything in our body and in the physical universe is already based on Nanotechnology. Nanotechnology has helped in transformation and modernization of materials by making possible the manipulation of materials at the atomic level. Nanotechnology, is the ability to work with matter, measured in the length of approximately 1 to 100 nanometers (1 nanometer = 1×10^{-9} m). One nanometer is equivalent to the breadth of three or four atoms (Source: [Recent Advancements in Nanotechnology and their Applications – IJERT](#)).

The concept behind the principle of Nanotechnology originated in a talk entitled, "There's Plenty of Room at the Bottom" by physicist Richard Feynman in 1959. The term nanotechnology was actually coined by Professor Norio Taniguchi. In 1981, the scanning tunnelling microscope was invented, which made it possible to "see" individual atoms. This and the invention of the atomic force microscope (AFM) made it possible for nanotechnology to become a reality.

Definition

Nanotechnology is the technology that involves the manipulation of matter on atomic, molecular and supramolecular scales. This includes particles of a **scale 1 to 100 nanometers**.

8.2 APPLICATIONS OF NANOTECHNOLOGY



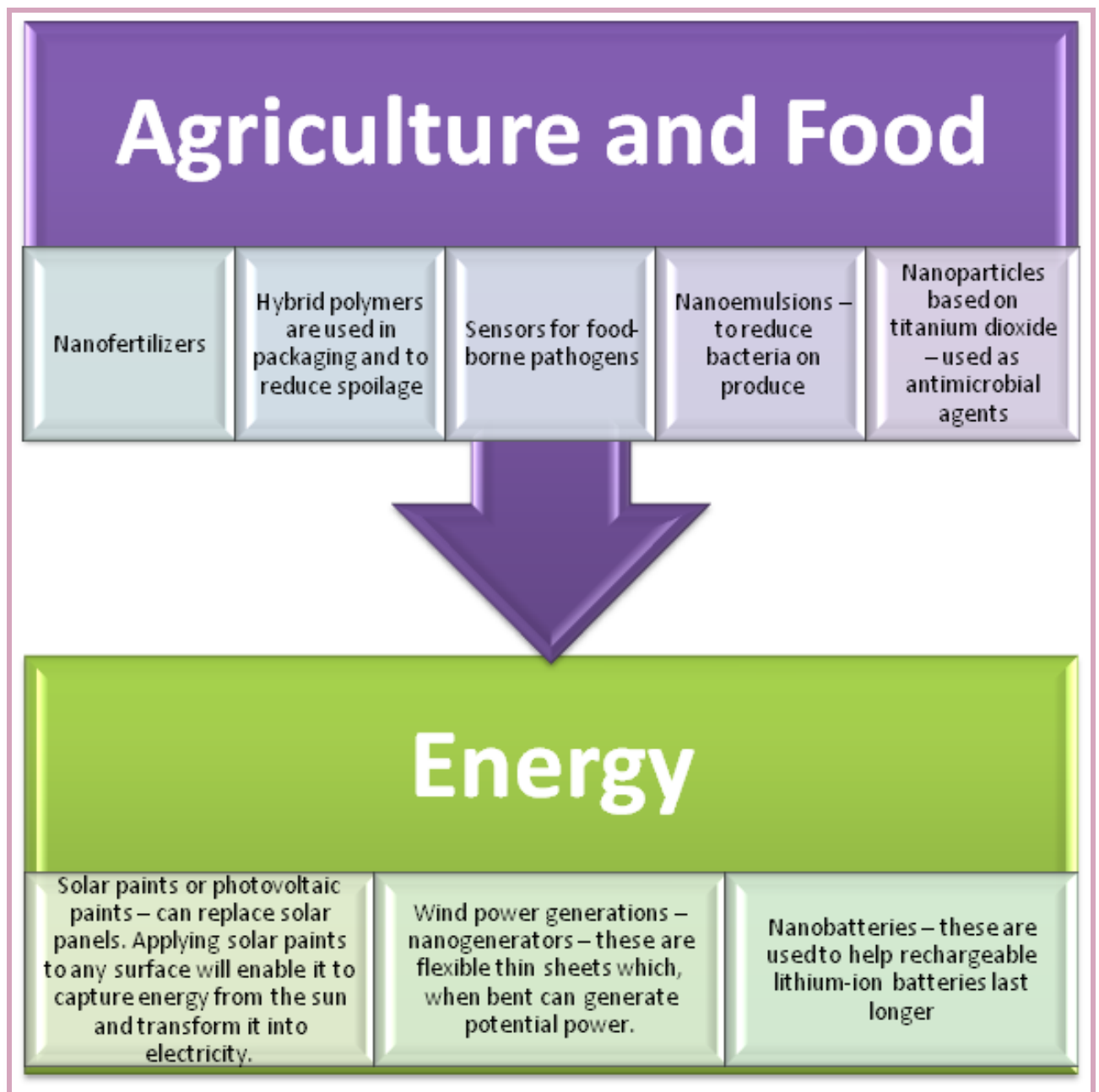


Fig.8.1:Applications of Nanotechnology

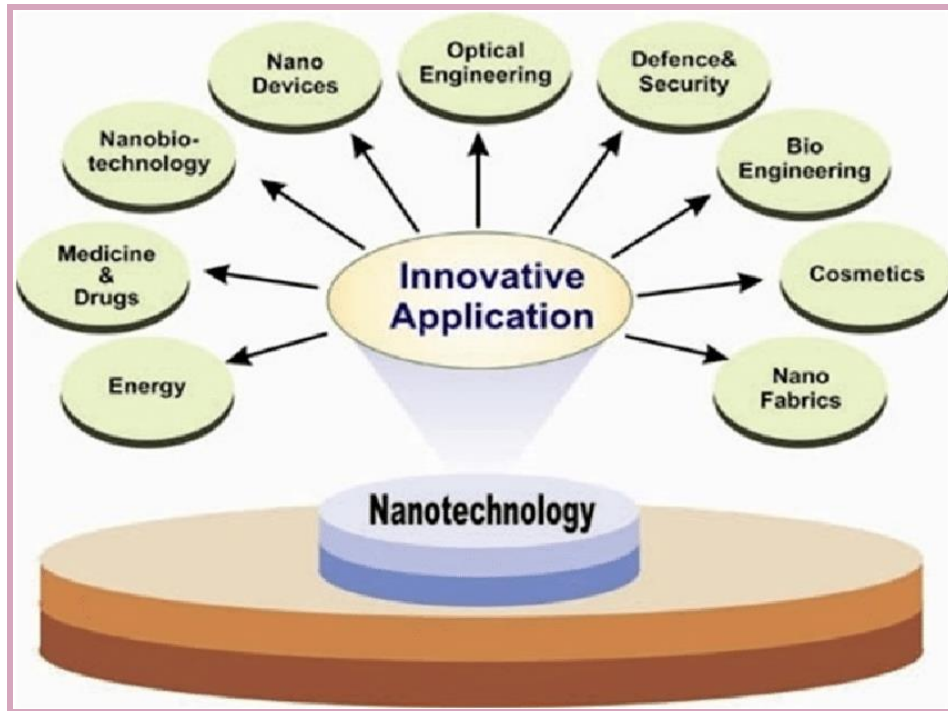


Fig.8.2: Innovative Applications of Nanotechnology

Image Source: Researchgate

8.3 INITIATIVE TAKEN BY THE GOVERNMENT OF INDIA

1. Nano Science Technology Initiative (NSTI)

In 2001, the Department of Science and Technology launched the Nano Science and Technology Initiative (NSTI) in order to focus on R&D in Nano-Science and Nanotechnology. The programme supports R&D projects, strengthening of characterization and infrastructural facilities, creation of a centre of excellence, generation of trained manpower, joint projects between educational institutions and industry for application development, etc.

2. Nano Mission

The Government of India launched the Nano Mission in 2007 under the Department of Science and Technology. Its objectives:

- Basic Promotion of Nanotechnology
- Infrastructure Development
- Establishment of R&D in Nanoscience Applications
- Establishment of Development Centre for Nanosciences

- Human Development in Nanotechnology
- International Collaborations

India has been able to **rank amongst the top 5 countries in the world** for Scientific Publications in Nanoscience & Technology due to the efforts led by the Nano Mission.

The Nano Mission has established national dialogues to promote R&D in the development of standards for nanotechnology and for laying down a **National Regulatory Framework Road-Map for Nanotechnology** (NRFR-Nanotech).

3. COVID-19 Nano Coating

The Department of Science and Technology and the Science and Engineering Research Board (SERB) called for a Short-term Research Grant for Nano Coating COVID-19 in April 2020.

This rapid project was necessary for the emerging health care requirements in order to combat the COVID-19 Pandemic. The goals of the project are to focus on the following areas:

- **Antiviral Nano-coatings:** It will be coated/used on the appropriate material for producing anti-COVID-19 Triple Layer Medical masks and N-95 respirator or better masks in large quantities.
- All components of Personal Protective Equipment (PPE).

4. ICONSAT 2020

The International Conference on NanoScience and NanoTechnology (ICONSAT) is a series of biennial international conferences held in India under the aegis of the Nano Mission, Department of Science and Technology (DST).

ICONSAT 2020 was organized during 5th-7th March at Kolkata (West Bengal).

Objectives of ICONSAT

- Bringing out Cutting Edge Nano Technology for the development of Physics, Chemistry and Material domains.
- **Integration of 5Ms – Mechanical, Material, Machines, Manufacturing and Manpower with the help of NanoScience and NT.**
- Integration of NT with Sustainable Development.

- Emphasizing the need to create a network of experts in nanoscience and to collaborate the knowledge across sectors like energy, agriculture, transport, health and so on.
- Providing a potential platform for young researchers and students from within the country and abroad to keep pace with the latest development in the emerging areas of Nano Science and Technology.

Indian Nanoelectronics Users Programme (INUP) initiated by Ministry of Electronics and Information Technology (MeitY) is being implemented at Centre of Excellence in Nanoelectronics (CEN) at IISc and IIT Bombay and has provided a great opportunity for R&D community all over the country for accessing a state of the art nanofabrication facilities for undertaking research and skill development in Nanoelectronics.

8.4 BLACK GOLD DEVELOPED BY INDIAN SCIENTIST

Scientists at Tata Institute of Fundamental Research (TIFR) used gold nanoparticles and by rearranging size and gaps between them developed a new material, which has unique properties such as capacity to absorb light and carbon dioxide. Gold does not have these properties, therefore ‘black gold’ is being called a new material. In appearance it is black, hence the name ‘black gold.’

The Scientists believe that it can be potentially used for **applications** ranging from solar energy harvesting to desalinating seawater. One of the most fascinating properties of the new material is its **ability to absorb the entire visible and near-infrared region of solar light**. It does so because of inter-particle plasmonic coupling as well as heterogeneity in nanoparticle size. Black gold could also act as a catalyst and could **convert carbon dioxide into methane at atmospheric pressure and temperature using solar energy**

8.5 CONCERNS RELATED TO NANOTECHNOLOGY

- India spends only a fraction of the amount spent by countries such as the USA, China, Japan, etc. on nanotechnology.
- The quality of research needs to be improved significantly. Only 16% of the papers from India figured in the top 1% publications in 2011.
- Only 0.2% of the patents filed in the US Patent Office is from India in this field.
- Although the target number of PhDs in nanotechnology is 10000 per year by the Ministry of HRD, the current number is just 150 per annum.
- The contribution of the private sector is minimal in this domain.

Scope for potential

- A team from IIT Madras used nanotechnology to decontaminate arsenic from water.
- A team from IIT Delhi has engineered a self-cleaning technology to be used in the textile industry.

8.6 AUGMENTED REALITY

Definition

Augmented Reality (AR) is the technology which superimposes an image onto a user's view of the real world and enhances it with sound, touch, and even smell. It is a combination of the real scene viewed by the user and a virtual scene generated by the computer. AR is a technology which is going to blur the lines of reality.

Augmented Reality has moved beyond headsets and gaming and permeated into numerous industries. It is increasingly being adopted for a variety of uses like assembly, maintenance, repair, education, training, retail showcasing and diagnostics.

AR makes workers more efficient by providing them with an additional layer of knowledge and insights. Augmented Reality remote assistance can improve training in situations where new hires need assistance. This tech enables real-time collaboration between field personnel and remote experts.

Applications

Defence	Health
It helps in improving the situational awareness of the soldiers using AR technology. The tech is named as Tactical Augmented Reality (TAR). This tech has an eyepiece that assists soldiers on the battlefield to precisely locate their positions in addition to the location of others (friends and enemy soldiers).	Traditionally handheld ultrasound scanners are used in reconstruction surgery for locating blood vessels, and bones. However, AR technology has the potential to replace ultrasound scanners as it will help in locating the blood vessels very accurately and in a shorter time span.
Pharmaceuticals	Logistics

<p>Augmented Reality tools can help scientists to picture the structure of complex molecules. Drug developers usually work with static models. The AR will help the developers to step inside the molecule and see how it moves and responds to different stimuli and situations. This will reduce errors and reduce the years-long drug development cycle.</p>	<p>AR will benefit logistics industries at multiple levels of their operations.</p> <ul style="list-style-type: none"> ● Optimizing warehouse operations ● Optimizing transportation ● Last-mile delivery ● Enhanced value-added services
<p>Advertisement</p>	<p>Miscellaneous</p>
<p>For example, Jaguar Land Rover put prospective car buyers in the virtual driver's seat of its latest models without making the visit to the dealership. Consumers could launch the AR capability directly from a banner ad without any need to install an app. Customers can see the outside view seated at the driving seat through transparent windows.</p>	<ul style="list-style-type: none"> ● Various filters on Snapchat and Instagram are an example of Augmented Reality. ● Scanning your QR code using your phone's camera provides additional information on the screen. ● Google Glass and other Head-up Displays (HUD) put Augmented Reality directly into the glasses. These glasses could be used as reminders for patients undergoing medication. ● Retail companies use it to help customers envisage aesthetics when new furniture is placed to redesign the interiors of their homes. ● Gaming – Pokemon is one of the most famous games to hit a big chord with the public. ● AR is used in the field of language translation. ● Law enforcement agencies can use

AR tech to recognize criminals in huge crowds.

- If a car breaks down, people can fix their cars using AR tech, repair and maintenance can be carried out without the help of mechanics. This tech will recognize the vehicle parts via object recognition, describe and picture all required repair and maintenance steps in detail and real-time, along with information about any equipment requirements.

8.7 RECENT DEVELOPMENTS IN INDIA

The government launched an Augmented Reality application named 'Sakaar':

- Sakaar consists of 3D models of MOM, RISAT, rockets (PSLV, GSLV Mk-III); videos of INSAT 3D-predicting cyclones, GSLV D5/Cryo, Mars Orbiter Mission (MOM) orbit insertion, launch video of MOM, 360 degrees animated view of MOM; Anaglyph of Mars surface.

First Augmented Reality Centre in India:

- For education and training institute, to be set up in Varanasi.
- It will be established in a tie-up with Eon Reality.