IASBABA

One Stop Destination for UPSC/IAS Preparation

60 Days Week-3&4 Compilation

DELHI

5B, Pusa Road, Karol Bagh, New Delhi –110005. Landmark: Just 50m from Karol Bagh Metro Station, GATE No. 8 (Next to Croma Store)

Ph:0114167500

BANGALORE

#1737/37, MRCR Layout, Vijaynagar Service Road, Vijaynagar, Bangalore 560040. PH: 09035077800 / 7353277800

support@iasbaba.com

www.iasbaba.com

Q.1) CAR-T is a personalized form of treatment for –

a) AIDS
b) Tuberculosis
c) Sickle cell anaemia
d) Cancer

Q.1) Solution (d)

CAR-T

- Personalized form of cancer treatment.
- It is a form of immunotherapy stimulating the body's immune system to help fight cancer.
- Under this, a virus is used to insert genes into T-cells (a special type of immune cell) which then modifies the Chimeric Antigen Receptor (CAR). These engineered CAR-T cells – programmed to recognize and destroy the patient's cancer cells - are multiplied in huge numbers and then infused back into the patient.

Q.2) Which country has recently approved 1st human – animal embryo experiment?

a) China
b) USA
c) Japan
d) France

Q.2) Solution (c)

Growing human organs in animal body

- Recently Japanese researchers have successfully developed functional mouse kidneys inside rats using stem cells.
- In the 1 st step, CRISPR/Cas9 technique was used to genetically silence rat embryos so that the rats did not grow kidney on their own.
- Then the genetically modified blastocysts (clusters of cells formed after egg fertilization), of the rat embryo were inserted with pluripotent stem cells from mice.
- The altered rat embryo was then implanted back into rat wombs to continue fertilization.
- The stem cells then differentiated to form the missing kidney in the rats that was functional.
- This could be replicated in Humans.

Q.3) Which of the following benefit can come out of our understanding of human genome sequence?

1. Genetic disorders like cystic fibrosis or sickle cell anaemia can be identified.
2. Personalised medication can be prescribed.
3. Treatments for common cancers can be developed.

Select the correct option using the codes given below

a) 1 only
b) 1 and 2 only
c) 1 and 3 only
d) All of the above

Q.3) Solution (d)

All the options are deductive in nature.

Q.4) Consider the following statements regarding Gene Drive Technology –

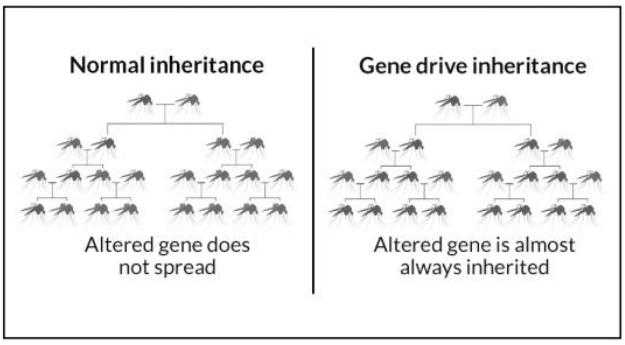
1. It alters the rules of inheritance from parent to offspring.
2. Vector borne diseases can be controlled using the technology.

Which of the above statements is/are correct?

a) 1 only
b) 2 only
c) Both 1 and 2
d) Neither 1 nor 2

Q.4) Solution (c)

Gene drive technology



- In a breakthrough in the global fight for malaria, scientists have wiped out an entire population of malaria-carrying mosquitoes in lab conditions using a CRiSPR gene drive technology.
- Gene drive technology is a genetic engineering technology that can permanently change the traits of a population or even an entire species.
- Gene drives are genetic elements that pass from parents to unusually high numbers of their offspring, thereby spreading quickly.
- Gene drives occur naturally but can also be engineered.

How does it work?

- The gene drive technology is basically designed to introduce a genetic tweak in the population of a species by altering the rules of inheritance from parent to offspring.
- Firstly using CRiSPR gene editing tool, a gene called 'doublesex' in female mosquitoes is disrupted.
- This genetic tweak of double-sex gene follows gene drive inheritance.
- Here the gene drive inheritance makes the female mosquitoes inherit two copies of the disrupted gene.
- When the female mosquitoes inherit two copies of the disrupted gene, they develop like males and are unable to bite or lay eggs.

Q.5) Consider the following statements regarding National Stem Cell Registry –

1. It comes under the ageis of Department of Science and Technology.
2. A person enrolling for Pradhan Mantri Jan Arogya Yojana will be automatically enrolled in National Stem Cell Registry.
3. It will help in treating patients with blood-related disorders.

Which of the statements given above is/are correct?

a) 1 and 3 only
b) 2 and 3 only
c) 3 only

d) All of the above

Q.5) Solution (c)

National stem cell registry

- India is developing a National Stem Cell Registry of its own.
- **It is a government managed database of unrelated bone marrow donors**.
- **It comes under the aegis of Ministry of Health and Family welfare**.
- Main aim is to find matching donors for treating patients with blood-related disorders such as
  - blood cancers (lymphoma, leukemia)
  - thalassaemia,
  - sickle-cell anaemia,
  - haemophilia
- The registration to the database is voluntary.

Importance

- About 3.5-5Lakh people in India suffer from blood-related disorders like thalassaemia which require frequent blood transfusions. The only cure for blood related disorders is bone-marrow transplantation.
- **Matching Donors**
  - For bone-marrow transplantation, the donor and patient should have exactly the same white blood cell type.
  - Siblings usually have the exact match and thus suitable for bone-marrow transplantations.
  - Thus matching donors is extremely low and the database will help connect unrelated matching donor

Q.6) Which of the following is incorrect regarding Protection of Plant Varieties and Farmers' Rights (PPV&FR) Act, 2001?

a) A farmer can produce using any seed protected under the act.
b) Seed Producers will have exclusive rights against the protected variety and criminal remedy in case of infringement of rights.
c) Researcher can use any of the registered variety under the act for conducting an experiment or research.
d) There is provision for compensation to the farmers for non-performance of variety.

Q.6) Solution (b)

<u>Protection of Plant Varieties and Farmers' Rights (PPV&FR) Act, 2001</u>

To give effect to the TRIPS agreement under WTO, India enacted PPV&FRA 2001.

The aim of the act is to encourage the development of new varieties of plant, by protection the rights of farmers and plant breeders.

Rights under the Act

- Breeders' Rights
  - Seed Producers will have exclusive rights against the protected variety (Section 64)
  - **Civil remedy** in case of infringement of rights
- Researchers' Rights: Researcher can use any of the registered variety under the Act for conducting an experiment or research.
- Farmers' privilege
  - A farmer can produce using any seed protected under the PPV&FR Act, 2001 (section 39)
  - Not entitled to sell branded seeds.
  - Compensation to the farmers for non-performance of variety.
  - Protection to farmer if he is ignorant of legal provision.

Q.7) Consider the following statements with respect to 3–Parent Baby?

1. This technology will protect children from all genetic diseases.
2. It involves gene editing of nuclear DNA of biological mother.

Which of the statements given above is/are correct?

a) 1 only
b) 2 only
c) Both 1 and 2
d) Neither 1 nor 2

Q.7) Solution (d)

Three parent baby

- Apart from receiving the usual "nuclear" DNA from its mother and father, the embryo would also include a small amount of healthy mitochondrial DNA from a woman donor.
- This is resorted to when the actual mother is suffering from an **incurable mitochondrial disease**.

- **Other genetic disease cannot be cured by this technique.**
- This technique involves removing the faulty mitochondrial DNA from the actual mother and nucleus form the mother's egg and the resultant egg fertilizes with the sperm cell of the father outside the body (in-vitro).
- **Note – There is no gene editing involved here.**

Q.8) Which of the following can be considered as a case of allograft?

1. Heart transplant among identical twins.
2. Bone marrow transplant from one cousin to another.
3. Transplants of skin from mother to daughter.

Select the correct answer using the code given below:

a) 1 only
b) 2 only
c) 2 and 3 only
d) All of the above

Q.8) Solution (c)

Allograft

- It is the transplant of an organ or tissue or cells from one individual to another of the same species with a different genotype (genetically non-identical donor) although of a compatible blood type.
- For example, a transplant from one person to another, but not an identical twin, is an allograft.
- Allografts are commonly used in the transplants of skin, corneas, hearts, livers, kidneys, and bone and bone marrow, although transplants of the last often come from relatives.

Q.9) Consider the following statements regarding DNA Data storage technology –

1. The Personal Data Protection Bill, 2018 advocates to legalise its use.
2. It involves the use of DNA to store data as alternate data storage to binary data storage
3. History of genetic disorder in human beings can be traced using this technology.

Select the correct option –

a) 1 and 2 only
b) 2 and 3 only
c) 2 only
d) 3 only

Q.9) Solution (c)

Statement 1 is factually incorrect. There is no such provision in the bill.

Statement 3 is also absurd, clear form the explanation given below.

DNA data storage

- Use of DNA to store data as alternate data storage to binary data storage.
- Encoding and decoding binary data to and from synthesized strands of DNA.
- An alternative to hard drives storage system is progressing in the form of DNA-based data storage.
- DNA—which consists of long chains of the nucleotides A, T, C and G—is life's information-storage material.
- Data can be stored in the sequence of these letters, turning DNA into a new form of information technology.

Q.10) Consider the following statements:

1. Induced Pluripotent Stem Cells can be used to treat blood disease like thalassaemia, sickle-cell anaemia and haemophilia.
2. Meristematic Tissue show totipotency in plant tissue culture.
3. Rice was the first crop to be genome sequenced

Which of the statements given above is/are correct?

a) 1 only
b) 1 and 2 only
c) 1 and 3 only
d) All of the above

Q.10) Solution (d)

INDUCED PLURIPOTENT STEM CELLS (IPS CELLS) AND THEIR SIGNIFICANCE

- iPS are adult stem cells are adult stem cells, like in umbilical cord cells or bone marrow cells, that can be induced to show properties of stem cells.
- They are mostly use in therapeutic cloning to treat degenerative diseases like diabetes, Parkinson's, Alzhiemers etc.
- They are created by stimulating mature, already specialised cells back into a juvenile state without the need for an embryo.

- These can be derived from the patient themselves, making them less likely to be rejected.
- The cells can be transformed into a range of different types of cells, and their use is a key sector of medical research.
- Further owing to ethical issues embryonic cells are banned in countries such as Ireland and in Latin America.
- Therefore use of iPS cells in therapeutic cloning is rather significant.

Merismatic tissues consist of a group of cells that have the ability to divide. These tissues are small, cuboidal, densely packed cells which keep dividing to form new cells. These tissues are capable of stretching, enlarging and differentiating into other types of tissues as they mature.

Meristematic tissues give rise to permanent tissues. Merismatic tissues can be of three types depending on the region where they are present: Apical meristems, lateral meristems, and intercalary meristems.

Rice was the first sequenced crop genome, paving the way for the sequencing of additional and more complicated crop genomes. The impact that the genome sequence made on rice genetics and breeding research was immediate, as evidence by citations and DNA marker use. The impact on other crop genomes was evident too, particularly for those within the grass family

Q.11) Consider the following statements regarding 'IndiGen Initiative' –

1. It is the 1st of its kind whole genome sequencing of Indians.
2. It will enable genetic epidemiology of diseases.
3. Genome sequencing of 1,00,000 Indians were done covering all states and ethnicities.
4. It was carried out by Institute for Stem Cell Science and Regenerative Medicine (InStem) in association with IIT Delhi.

Which of the above statements are correct?

a) 1 and 2 only
b) 1, 2 and 3 only
c) 1, 2 and 4 only
d) All of the above

Q.11) Solution (a)

Indigen Initiative

- **'IndiGen' is the 1st of its kind whole genome sequencing of Indians.**
- IndiGen programme aims to undertake whole genome sequencing of thousands of individuals **representing diverse ethnic groups from India**.

- The objective is to enable **genetic epidemiology** and develop public health technologies applications using population genome data.
- **It was carried out by CSIR to accelerate the study of genomics in India.**
- 'Indigen' is precursor to Genome India project under Bioscience Mission for Precision Health and Optimal Wellbeing of Department of Biotechnology.
- 'Indigen' initiative will go a long way in development of precision medicine, personalized medicine for various diseases and increase awareness of genetic disorders in India.

Q.12) Consider the following statements with respect to artificial leaf –

1. Artificial leaf is a lab-grown leaf using Recombinant DNA technology.
2. It absorbs carbon dioxide from the air and converts it into fuel.

Which of the above given statements is/are correct?

a) 1 only
b) 2 only
c) Both 1 and 2
d) Neither 1 nor 2

Q.12) Solution (b)

Artificial leaf

- Device used to harness solar energy and convert it into usable chemical energy.
- Generally a cobalt and silicon coated Perovskite is immersed in water that is split into hydrogen and oxygen in the presence of sunlight.
- The hydrogen so formed is then used to produce 'syngas' (hydrogen and carbon monoxide) which can be compressed to form liquid fuel that is used in vehicles.

Q.13) Scuba Rice that is often seen in news relates to which of the following?

a) Flood-resistant rice
b) Rice fortified with Vitamin A
c) Another name for seaweed
d) Pest-resistant rice

Q.13) Solution (a)

Scuba Rice:

It is a new rice variety tested in India and Bangladesh that can survive up to two weeks of complete submergence in water, providing farmers with protection against short-term flooding. The flood-resistant SUB 1 gene, when transferred into popular rice varieties, allows them to retain their characteristics. This research has led to the official release of flood-tolerant local rice varieties across Asia.

Q.14) CCR5-delta 32, recently in news, is related to which of the following?

a) Gene editing
b) Proton therapy
c) Genetic mutation
d) Organ transplantation

Q.14) Solution (c)

A genetic mutation known as CCR5-delta 32 is responsible for the two types of HIV resistance that exist. CCR5-delta 32 hampers HIV's ability to infiltrate immune cells. The mutation causes the CCR5 co-receptor on the outside of cells to develop smaller than usual and no longer sit outside of the cell.

In 2018 a Chinese doctor for the 1st time performed gene editing on the embryonic stem cell using CRiSPR technique.

- The CRISPR technique was used to modify the CCR5 gene on the embryonic cells of the couples to make them resistant to the HIV virus.
- One of the couples subsequently gave birth to twins – Lulu and Nana.

However CCR5 gene is not just associated with HIV, it may also play an important role in the inflammatory response and in cognitive function.

Q.15) Consider the following statements about the Earth Bio Genome Project:

1. It aims to sequence the genomes of all of earth's currently described eukaryotic biodiversity.
2. It is an open source DNA database.
3. It is funded by Global Environment Facility and supported by host of organisations like World Bank and IUCN.

Which of the statements given above is/are correct?

a) 1 only
b) 1 and 2 only
c) 2 and 3 only

d) All of the above

Q.15) Solution (b)

Earth bio-genome project

- International collaboration to sequence and digitize the genomes of every eukaryotic biodiversity on Earth over a period of 10 years.
- It is an open-source DNA database.
- Will help in planning environmental conservation initiatives.

Issue

- May lead to digital bio-piracy (because it is open-source) which is against the principle of Nagoya protocol to convention of Biodiversity that requires sharing of benefits with the local communities

Q.16) Which of the following statements is/are correct about the IndOBIS?

1. It aims to sequence the genomes of all marine mammal species in the Arabian Sea, Bay of Bengal and the Indian Ocean.
2. It is partly funded by the recovery programme under the Integrated Development of Wildlife Habitats.
3. It is the joint initiative of Ministry of Environment Forest and Climate Change, Earth Bio-Genome Project and IUCN.

Select the correct answer using the code given below:

a) 1 only
b) 1 and 2 only
c) 1 and 3 only
d) None of the above

Q.16) Solution (d)

IndOBIS collects data sets of occurrences of identifiable marine species at a specific time and place collected mainly in the Arabian Sea, Bay of Bengal and the Indian Ocean. (**There is no sequencing of the genomes**) It is one of the more than 20 regional nodes of the **Ocean Biogeographic Information System** (OBIS).

IndOBIS supplies the global scientific community with various types of geo referenced information on the biodiversity of Indian Ocean.
CMLRE, as the Nodal agency, integrate and collate information from sources that lie scattered among several agencies, institutions and individuals within the Indian Ocean region.

Achievements

- 1,10,199 occurrence records of marine organisms reported from Indian Ocean archived and hosted at www.iobis.org
- 1096 voucher specimens of rare deep-sea organisms collected onboard FORV Sagar Sampada maintained at FORV Referral Centre
- All samples are assigned a unique voucher id and a database has been created for the same
- New records of unique deep-sea organisms such as gigantic sea spiders (Ascorhynchus levissimus), enigmatic sea pens (Gyrophyllum hirondellei), echinoderms such as stalked crinoids

The Ocean Biogeographic Information System (OBIS) is a web-based access point to information about the distribution and abundance of living species in the ocean. It was developed as the information management component of the ten year Census of Marine Life (CoML) (2001-2010), but is not limited to CoML-derived data, and aims to provide an integrated view of all marine biodiversity data that may be made available to it on an open access basis by respective data custodians

Q.17) Consider the following statements:

1. DNA finger printing is the process of determining an individual's DNA characteristics, which are as unique as fingerprints.
2. DNA barcoding is a process to identify a species rather than an individual.

Which of the above statements are correct?

a) 1 only
b) 2 only
c) Both 1 and 2
d) Neither 1 nor 2

Q.17) Solution (c)

DNA profiling (also called DNA fingerprinting) is the process of determining an individual's DNA characteristics, which are as unique as fingerprints. DNA analysis intended to identify a species, rather than an individual, is called DNA barcoding.

DNA profiling is a forensic technique in criminal investigations, comparing criminal suspects' profiles to DNA evidence so as to assess the likelihood of their involvement in the crime. It is also used in parentage testing, to establish immigration eligibility, and in genealogical and medical research. DNA profiling has also been used in the study of animal and plant populations in the fields of zoology, botany, and agriculture

Q.18) 'Mitochondrial Eve', recently seen in news, relates to which of the following?

a) Genetic disease due to mutation in mitochondrial genes.
b) Technology used to produce a three parent babies.
c) Common female ancestor from which all humans trace their descent.
d) Genetic changes taking place in mitochondria when females hit menopause.

Q.18) Solution (c)

Mitochondrial Eve

- In human genetics, Mitochondrial Eve is the matrilineal most recent common ancestor for all living humans i-e the most recent woman from whom all living humans descend in an unbroken line purely through their mothers and through the mothers of those mothers, back until all lines converge on one woman.
- The male analog of the Matrilineal Eve is the Y-chromosome ADAM, the individual from whom all living humans are patrilineal descended.

Q.19) Consider the following statements regarding 'Artificial blood' –

1. It performs the function of RBC and platelets but not that of WBC and plasma.
2. Personalised development of artificial blood, making transfusion safe, has been done for the first time in United States recently.
3. It can be used to remove infection in cases of Ebola, SARS etc

Which of the above statements is/are correct?

a) 1 only
b) 2 only
c) All of the above
d) None of the above

Q.19) Solution (d)

Artificial Blood

- Substitute for red blood cells only. [Hence **cannot be used to remove infection in cases of Ebola, SARS etc**]
- It performs the function of RBC only and not of white cells, platelets, and plasma.
- Designed for the sole purpose of transporting oxygen and carbon dioxide throughout the body.
- Produced though synthetic production, chemical isolation, or recombinant biochemical technology.
- **Note – There is no concept of personalised development of artificial blood.** There cannot be such a concept. This is very clear form above oven information.

Q.20) Consider the following statements –

1. MANAV: Human Atlas Initiative is a project to construct a comprehensive map of every tissue of the human body.
2. National genomic grid will facilitate sharing of data on new genome research among government and private institutions.
3. Import of human embryo is completely prohibited in India.

Which of the above statements is/are correct?

a) 1 only
b) 1 and 2 only
c) All of the above
d) None of the above

Q.20) Solution (a)

MANAV: Human Atlas Initiative

- Launched by Department of Biotechnology
- It is a project to construct a comprehensive map of every tissue of the human body.
- It seeks to capture human physiology at the tissue level in natural and diseased state.

Objectives

- To provide better biological insights of human physiology
- To understand the roles of tissues and cells linked to various diseases.
- Develop disease models through predictive computing
- Drug discovery

National Genomic Grid

- **It will collect samples from cancer patients,** through a network of pan-India collection centres by **bringing all cancer treatment institutions on board**.
- This research is carried out through the technique of Genome Sequencing.
- NGG will help to study genomic factors influencing cancer and identifying the right treatment modalities for the Indian population. The grid to be formed will be in line with the National Cancer Tissue Biobank (NCTB) set up at the Indian Indian Institute of Technology, Madras.
- National Cancer Tissue Biobank (NCTB), is a joint initiative of the Department of Science and Technology (DST), Government of India and Indian Institute of Technology, Madras.
- The biobank collects cancer tissue samples with consent from patients diagnosed with cancer.
- The aim is to provide researchers with high quality of cancer tissues and the patient data in order to facilitate cancer research that will lead to improvements in cancer diagnosis and treatment.
- Import of human embryo is prohibited in India, **except for research purpose**.

Q.21) 'There's Plenty of Room at the Bottom' was a famous talk by Richard Feynman. What was subject of the talk?

a) Deep Ocean minerals
b) Geothermal energy
c) Nanotechnology
d) Quantum computing

Q.21) Solution (c)

The ideas and concepts behind nanoscience and nanotechnology started with a talk entitled "There's Plenty of Room at the Bottom" by physicist Richard Feynman at an American Physical Society meeting at the California Institute of Technology (CalTech) on December 29, 1959, long before the term nanotechnology was used. Feynman described a process in which scientists would be able to manipulate and control individual atoms and molecules.

Q.22) Which of the following properties of matter change at the Nano scale?

1. Chemical reactivity
2. Mechanical strength
3. Electrical conductivity.
4. Refractive index
5. Melting point
6. Density
7. Colour

Select the correct option –

a) 1, 2 and 3 only
b) 1, 2, 3 and 7 only
c) 1, 2, 3, 5 and 7 only
d) All of the above

Q.22) Solution (d)

Two principal factors cause the properties of nanomaterials to differ significantly from other materials**:** **increased relative surface area, and quantum effects**. These factors can change or enhance properties such as reactivity, strength and electrical characteristics.

As a particle decreases in size, a greater proportion of atoms are found at the surface compared to those inside.

Chemical reactivity

Gold is considered an inert material in that it doesn't corrode or tarnish. Normally, gold would be a silly material to use as a catalyst for chemical reactions because it doesn't do much. However, break gold down to nanosize (approximately 5 nanometers) and it can act as a catalyst that can do things like oxidizing carbon monoxide.

Density

Density can be generally varied by changing the pressure or the temp. But it has been observed that density changes with the change in the thickness of the layer in nm range . Mass density of Cu,Cr,TiN film on MgO was found to be lower than the corresponding bulk value. SiO2,SiC on stainless steel showed increase in density . Cu, Ag, Au showed no significant change .

Electrical conductivity

Some materials that are conductors in bulk form may become semiconductors or poor conductors at the nanoscale. Some materials that were semiconductors may become conductors or superconductors. The confinement of electrons results in the electrical properties that occur at the nanoscale.

Melting point

At the macro scale, gold has a melting point of 1064 º C. As its particle size decreases to the 100 nm to 10 nm diameter its melting temperatures drops about 100 ºC. As the size reduces to about 2 nm the melting point decreases to about half of the melting point at the macro scales level.

Optical properties and colour

- Optical properties are also size dependent. Electrons cannot move about as freely at the nanoscale and become restricted. The confinement of the electrons causes them to react to light differently. This will affect **refractive Index.**
- Gold for example will appear gold at the macro scale in bulk form. However when it occurs as **Nano-sized particles its color is red**.

Q.23) Which of the following factors are responsible for causing significant difference in properties of nano materials as compared to normal material?

1. Decreased Density
2. Increased relative surface area
3. Increased quantum effects

Select the correct option –

a) 1 and 2
b) 2 and 3
c) 1 and 3
d) All of the above

Q.23) Solution (b)

Two principal factors cause the properties of nanomaterials to differ significantly from other materials**:** **increased relative surface area, and quantum effects**. These factors can change or enhance properties such as reactivity, strength and electrical characteristics.

As a particle decreases in size, a greater proportion of atoms are found at the surface compared to those inside. For example, a particle of size 30 nm has 5% of its atoms on its surface, at 10 nm 20% of its atoms, and at 3 nm 50% of its atoms.

Thus nanoparticles have a much greater surface area per unit mass compared with larger particles. As growth and catalytic chemical reactions occur at surfaces, this means that a given mass of material in nanoparticulate form will be much more reactive than the same mass of material made up of larger particles.

In tandem with surface-area effects, quantum effects can begin to dominate the properties of matter as size is reduced to the nanoscale. These can affect the optical, electrical and magnetic behavior of materials, particularly as the structure or particle size approaches the smaller end of the nanoscale. Materials that exploit these effects include quantum dots, and quantum well lasers for optoelectronics.

As the size of their structural components decreases, there is much greater interface area within the material; this can greatly affect both mechanical and electrical properties.

For example, most metals are made up of small crystalline grains; the boundaries between the grain slow down or arrest the propagation of defects when the material is stressed, thus giving it strength. If these grains can be made very small, or even nanoscale in size, the interface area within the material greatly increases, which enhances its strength. For example, nanocrystalline nickel is as strong as hardened steel.

Q.24) Claytronics, an evolving concept, is related to which of the following?

a) Quantum computing
b) Programmable matter
c) Soil testing
d) Robot to scoop matter from celestial body

Q.24) Solution (b)

CLAYTRONICS

- It is the next-generation manufacturing technology based on **programmable matter**.
- It basically entails merger of physical and computational world.
- It combines nanoscale robotics and computer science to create individual nanometer-scale computers called Claytronics atoms, or catoms, which can interact with each other to form tangible 3D objects that a user can interact with.
- The programmable matter called C-Atoms or catoms, are the building blocks of Claytronics which interact with each other using electrostatic forces to form tangible 3D objects.

Q.25) Consider the following statements regarding 'Smart Fertilizers' –

1. Nutrient is released only on-demand by the crop
2. It has designer molecule that allows sustained release of nutrients by a plant-root activated mechanism.
3. Each molecule is a Nano-bot that helps in elimination of unwanted microorganisms from the soil.

Which of the statements given above is/are correct?

a) 1 only
b) 2 only
c) 1 and 2 only
d) 2 and 3 only

Q.25) Solution (c)

Smart Fertilizers have water-insoluble molecules that allow controlled release of nutrients by a plant-root activated mechanism. The molecule is water-insoluble but has a "smart" feature so that nutrient is released only on-demand by the crop. This is a designer molecule that allows sustained release of nutrients by a plant-root activated mechanism. The fertilizer molecule functions like a nutrient storehouse providing a continuous nutrient supply throughout the crop growth period.

With the Smart Fertilizers, **nutrient release is under the control of the plant itself**.

The farmer pays less per acre but gets more yield than with the current fertilizers - farmers' income will increase by 15-20%. Government can save hugely on phosphate imports. In combination with an environment-friendly nature, the Smart Phosphate and Micronutrients provides a win-win situation for all-farmers, Governments and environment.

Statement 3 is not true in the present scenario.

Q.26) Which of the following statements are correct about the Microdot patches?

1. This involves spraying of body parts of vehicles with invisible microdots, which give a unique identification.
2. They will reduce road accidents.
3. They will reduce vehicle thefts.

Select the correct answer using the code given below:

a) 1 and 2 only
b) 1 and 3 only
c) 2 and 3 only
d) 1, 2 and 3

Q.26) Solution (b)

The Ministry of Road Transport & Highways has issued a draft notification amending Central Motor Vehicle Rules, allowing motor vehicles and their parts, components, assemblies, sub-assemblies to be affixed with permanent and nearly invisible microdots that can be read physically with a microscope and identified with ultra violet light source.

Microdot technology involves spraying the body and parts of the vehicle or any other machine with microscopic dots, which give a unique identification. Use of this technology **will help check theft of vehicles** and also use of fake spare parts.

The microdots and adhesive will become permanent fixtures/affixation which cannot be removed without damaging the asset, that is the vehicle itself.

[Note – Microdots patches is not a nanotechnology based application]

Q.27) In which of the following areas Nano Technology has application?

1. RO filtration technology
2. Fuel Cell
3. Cloud Seeding
4. Solar cells
5. Quantum Computing

Select the correct answer using the code given below

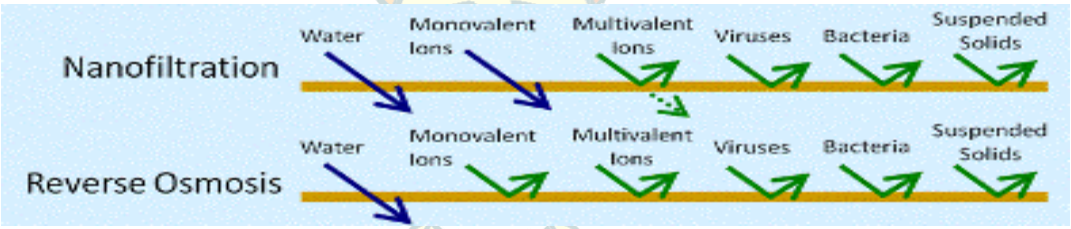
a) 1, 2, 3 and 4 only

b) 2, 3 and 4 only
c) 2, 3, 4 and 5 only
d) All of the above

Q.27) Solution (c)

1. Reverse Osmosis (RO) and Nanofiltration (Nano) are two very similar technologies. In appearance they are virtually identical and both use essentially the same technology to remove impurities from water or other liquids. In both systems, Membrane Elements (or membranes, or elements) are used to separate a liquid from contaminates.

   For better water purification or treatment processes nanotechnology is preferred. Nano was developed primarily for drinking water applications because RO was found to remove some of the minerals in water that are considered beneficial for human consumption. Nano allows these minerals to pass through the membrane with the water, but the Nano membrane will "block" pesticides and other contaminates that can be harmful to people.



2. Fuel cells contain membranes that allow hydrogen ions to pass through the cell but do not allow other atoms or ions, such as oxygen, to pass through. Nanotechnology is used to create more efficient membranes; this will allow them to build lighter weight and longer lasting fuel cells.

3. Nanotechnology has opened up the possibility of engineering unique cloud seeding particles to make the process of water condensation and rain precipitation more efficient. The UAE recently has run a new method of cloud seeding to increase rainfall. In this method, a new kind of nanomaterials is being sprayed into clouds to determine whether or not they are more effective than traditional materials.

4. Various advances have incorporated nanotechnology into solar panels to simultaneously improve efficiency while also reducing associated manufacturing and installation costs.

5. Many nanomaterials exhibit quantum properties which can then be utilized for many quantum technology applications, such as quantum computing, quantum electronics and quantum photonics. In this article, we look at why nanomaterials can be used in quantum technology and some of the quantum applications out there today.

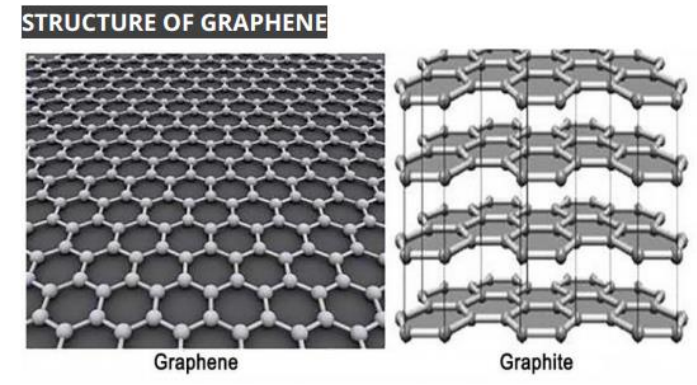
Q.28) Consider the following statements regarding Graphene –

1. It is the thinnest and lightest material known to man.
2. It exhibits both electrical and thermal conductivity.
3. It is optically Transparent.

Which of the statements given above is/are correct?

a) 1 only
b) 1 and 2 only
c) 1 and 3 only
d) All of the above

Q.28) Solution (d)



SINGLE-LAYER GRAPHENE

Next-generation wonder material that will revolutionize material science.

- 'Graphene is a 1-atom thick layer of carbon atoms arranged in a hexagonal ring shape.
- The carbon-atoms in graphene are laid out flat making it effectively a 2-D crystal.
- Imagine graphite (used in pencil) to be made up of billions of layers of carbon atoms, one such layer is what represents graphene.
- The way the carbon atoms are arranged in graphene gives it the unique combination of properties.

UNIQUE COMBINATION OF PROPERTIES

- Strength: It is a 2-d crystal stronger than diamond and 300 times stronger than steel.
- Thickness: Thinnest material known, million times thinner than human hair.
- Light: Being 1-atom thick layer, it is extremely light
- Conductor: It exhibits both electrical and thermal conductivity.

- Optically Transparent
- Flexible
- Hydro-phobic

POTENTIAL APPLICATIONS

- Aerospace, ship building and Automotive
    - Next-gen materials for aircraft bodies and ship hulls.
    - Being light and strong; it will reduce the drag of the aircraft or ship hulls, thereby increasing their fuel efficiency.
    - For the same reason mentioned above graphene may be useful automotive bodies.
- High-speed electronics: As a result of super-conductivity, it is ideal for high-speed electronics.
- High-speed computers
    - The speed and performance of any computer depends on the size of the microprocessors inside it.
    - Graphene may potentially replace silicon chips used to make transistors in microprocessors.
- Flexible Screens, sensors: Graphene may also revolutionize touch-screen technology due to its flexibility. (flexible foldable screens)
- Thermo-electric devices: Due to thermal conductivity, graphenes may be used in thermo-electrical devices which can convert heat wasted in many devices like computers, automobile etc into electricity.
- Solar panels
- Graphenes can potentially be used to make photovoltaic cells.
    - Currently P-V cells undergo degradation upto 30% a year due to exposure to radiation from sun.
    - Energy Storage: Graphenes can make the size of batteries extremely small.

Q.29) Consider the following statements –

1. The new division of 'New and Emerging Strategic Technologies (NEST)' has been established under Ministry of Science and Technology.
2. It will spearhead collaboration with foreign partners in the field of 5G and artificial intelligence.
3. It will encourage more public-private collaboration and funding to cutting edge private research.

Select the correct option –

a) 1 only
b) 2 only
c) 1 and 2 only
d) 2 and 3 only

Q.29) Solution (b)

New and Emerging Strategic Technologies (NEST)

Ministry of External Affairs has announced the setting up of a new division on New and Emerging Strategic Technologies (NEST).

The division will act as the nodal point in India's foreign ministry for all matters connected to new and emerging technologies including **exchange of views with foreign governments and coordination with domestic ministries and departments**. (**No funding of private research**)

Objective

- Assessing foreign policy and international legal implications of emerging technology and technology-based resources.
- Facilitating negotiations to safeguard Indian interests at multilateral forum like the United Nations or the G20.
- Creation of HR capacity within the ministry for technological diplomacy work.
- **Collaboration with foreign partners in the field of 5G and artificial intelligence.**

Q.30) Which of the following is planning to launch a four-armed robot, Chaser, to clean up Earth's orbit in 2025?

a) NASA
b) JAXA
c) European Space Agency
d) Roscosmos

Q.30) Solution (c)

CLEARSPACE-1 MISSION

- The European Space Agency (ESA) is planning to launch a four-armed robot, Chaser, to clean up Earth's orbit in 2025.
- Chaser is to be developed by a Swiss start-up ClearSpace under ClearSpace-1 mission.

- Once launched into space, it will grab the chosen piece of space trash, one at a time, using its robotic arms and fall back towards Earth in a controlled descent.
- The target is a piece of junk called Vespa, around 800km above the Earth.
- Earth's orbit is home to more than 3,500 defunct satellites and an estimated 750,000 smaller fragments.
- All of these pieces are flying at a velocity of around 20,000km/h.
- More debris could lead to more collisions - a cascade effect known as the Kessler syndrome which may render space eventually inoperable for important services like navigation, communications, weather forecasting etc.

Q.31) Which country has recently sent the humanoid robot to International Space Station to assist astronauts?

a) U.S.A
b) Japan
c) China
d) Russia

Q.31) Solution (d)

Relevant Information

- Recently, Russia sent the humanoid robot Fedor, also known as Skybot F850 to International Space Station. It will spend 10 days in space to assist astronauts.
- Fedor is Russia's first robot in space.
- Previously in 2011 NASA sent up Robonaut 2, a humanoid developed with General Motors and in 2013 Japan sent up a small robot called Kirobo, developed with Toyota which holds conversations in Japanese

Q.32) Consider the following statements –

1. The International Conference on Nano Science and Nano Technology (ICONSAT) is organised under the aegis of Nano Mission by Department of Science and Technology.
2. India is amongst the top five nations in the world in terms of scientific publications in Nanoscience and technology.

Which of the statements given above is/are correct?

a) 1 only
b) 2 only
c) Both 1 and 2
d) Neither 1 nor 2

Q.32) Solution (c)

The International Conference on Nano Science and Nano Technology (ICONSAT) under the aegis of **Nano Mission,** Department of Science and Technology (DST) is being held at Kolkata focusing on **the recent advances in this frontier research field.**

Key Points

- The conference intends to bring out cutting-edge developments in the domain of physical, chemical, materials as well as biological sciences with the help of nanotechnology.
- The event emphasised on 5Ms – Mechanical, Material, Machines, Manufacturing and Manpower, and integration of these 5 Ms with nano-science and technology.
- It also aimed to integrate nanotechnology with sustainable development and new technology (machine learning, artificial intelligence and so on).
- It emphasized the need to create a network of experts in nano-science and to collaborate the knowledge across sectors like energy, agriculture, transport, health and so on.
- It also aims to provide 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.

Mission on Nano Science and Technology (Nano Mission)

- The Government of India launched the Nano Mission in **2007** as an **"umbrella capacity-building programme".**
- It is being implemented by **the Department of Science and Technology (DST)** under the Ministry of Science and Technology.
- The objectives of the mission are:
    - Basic research promotion
    - Infrastructure development
    - Nano applications and technology development
    - Human Resource development
    - International collaborations
- As a result of the efforts led by the Nano Mission, today, India is amongst the **top five nations in the world** in terms of **scientific publications in Nanoscience and technology** (moving from 4th to the 3rd position).

- 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).**

Q.33) Consider the following statements regarding Tissue Nano Transfection:

1. The process is believed to heal injuries or regrow organs with one touch.
2. A Nano-chip injects genetic code into skin cells, turning those skin cells into other types of cells required for treating diseased conditions.
3. It first converts the skin cells into pluripotent cells and then converts them into functional cells.

Which of the above statements are correct?

a) 1 and 2
b) 2 and 3
c) 1 and 3
d) All of the above

Q.33) Solution (a)

Nano Transfection

Nano-chip could heal injuries or regrow organs with one touch. A tiny device that sits on the skin and uses an electric field to reprogramme cells could be a breakthrough in the way we treat injured or ageing tissue. A novel device that reprogrammes skin cells could represent a breakthrough in repairing injured or ageing tissue. The new technique, called tissue nanotransfection, is based on a tiny device that sits on the surface of the skin of a living body.

An intense, focused electric field is then applied across the device, allowing it to deliver genes to the skin cells beneath it – turning them into different types of cells. It offers an exciting development when it comes to repairing damaged tissue, offering the possibility of turning a patient's own tissue into a "bioreactor" to produce cells to either repair nearby tissues, or for use at another site. It avoids an intermediary step where cells are turned into what are known as pluripotent stem cells, instead turning skin cells directly into functional cells of different types. It is a single step process in the body. The new approach does not rely on applying an electric field across a large area of the cell, or the use of viruses to deliver the genes.

Q.34) Which of the following statements are correct regarding Nano Composites:

1. It is a combination of a bulk matrix and nano-dimensional phase(s) differing in properties.
2. Nanocomposites differ from conventional composite materials due to the exceptionally high surface to volume ratio of the reinforcing phase.
3. Nano composites are not found in nature.

Select the code from following:

a) 1 and 2
b) 2 and 3
c) 1 and 3
d) All of the above

Q.34) Solution (a)

Nanocomposites is a multiphase solid material where one of the phases has one, two or three dimensions of less than 100 nanometers (nm), or structures having nano-scale repeat distances between the different phases that make up the material.

The idea behind Nanocomposites is to use building blocks with dimensions in nanometre range to design and create new materials with unprecedented flexibility and improvement in their physical properties.

In the broadest sense this definition can include porous media, colloids, gels and copolymers, but is more usually taken to mean the solid combination of a bulk matrix and nano-dimensional phase(s) differing in properties due to dissimilarities in structure and chemistry. The mechanical, electrical, thermal, optical, electrochemical, catalytic properties of the Nanocomposites will differ markedly from that of the component materials.

Nanocomposites are found in nature, for example in the structure of the abalone shell and bone. The use of nanoparticle-rich materials long predates the understanding of the physical and chemical nature of these materials.

In mechanical terms, Nanocomposites differ from conventional composite materials due to the exceptionally high surface to volume ratio of the reinforcing phase and/or its exceptionally high aspect ratio. The reinforcing material can be made up of particles (e.g. minerals), sheets (e.g. exfoliated clay stacks) or fibres (e.g. carbon nanotubes or electrospun fibres). The area of the interface between the matrix and reinforcement phase(s) is typically an order of magnitude greater than for conventional composite materials. The matrix material properties are significantly affected in the vicinity of the reinforcement.

This large amount of reinforcement surface area means that a relatively small amount of nanoscale reinforcement can have an observable effect on the macro scale properties of the composite. For example, adding carbon nanotubes improves the electrical and thermal conductivity.

Q.35) Which of the following is correct description of 'Vyommitra', recently in news?

a) ISRO's humanoid robot that will test-flight Gangayaan
b) ISRO's humanoid robot that will go to International Space Station.
c) Large robotic air purifiers developed indigenously by CSIR.
d) Drones installed with air guns for scattering of smog.

Q.35) Solution (a)

VYOMMITRA

- ISRO's humanoid robot that will test-flight Gangayaan in December 2020.
- It is a Gynoid (female humanoid).
- Vyom Mitra was built by ISRO's Inertial Systems Unit, Thiruvananthapuram.

OBJECTIVES

- To perform panel operations on board the spacecraft
- Act as companion to astronauts capable of recognizing, conversing and responding to their queries
- To test the Environmental Control & Life Support System of Gaganyaan in order to detect environmental Changes

Q.36) Which of the following statements are correct regarding 'Automated Guided Vehicle' Robots?

1. They are portable robots that follow along marked lines or wires on the floor.
2. They are most often used in industrial applications to transport heavy materials around a large industrial building, such as a factory or warehouse.
3. It uses lasers, camera, Electromagnetic radiation or Magnetism to navigate.

Select the code from following:

a) 1 and 2
b) 2 and 3
c) 1 and 3
d) All of the above

Q.36) Solution (d)

An automated guided vehicle or automatic guided vehicle (AGV) is a portable robot that follows along marked lines or wires on the floor, or uses radio waves, vision cameras, magnets, or lasers for navigation. They are most often used in industrial applications to transport heavy materials around a large industrial building, such as a factory or warehouse. Application of the automatic guided vehicle broadened during the late 20th century.

Q.37) Which of the following best describes Quantum Dots?

a) Interstitial spaces, at the nanoscale, in the crystal of a metal.
b) Basic units of quantum computing.
c) Nanoparticles made of Semiconductor materials.
d) Electronic state forbidden in materials at the Nano scale.

Q.37) Solution (c)

A quantum dot is a nanoparticle made of any semiconductor material such as silicon, cadmium selenide, cadmium sulfide, or indium arsenide. They are essentially small crystals of nanometer-size dimensions – they're about 20,000 times smaller than the width of a human hair. They are each one

million times smaller than a millimeter. They have distinctive electrical conduction properties that are determined by the incredibly small size and structure.

Quantum-dot therapy and drug administration

Bacteria rely on "redox" reactions, those involving the addition or removal of oxygen (reduction and oxidation, respectively). And when several Quantum dots are "excited" nearby, they produce chemicals that are able to be reduced or oxidized by reactive compounds within the bacteria. This effectively interferes with their intercellular processes, disrupts their cell growth, and kills them. In a lab-grown culture, this method has been shown to kill 92% of a variety of drug-resistant bacterial cells, while leaving other cells alone.

As the superbugs evolve, adapt and fight back, the quantum dots can be tuned, or customised, with an atom added or subtracted to create a new material, property or therapy, while using data from related clinical trials or drugs.

Q.38) There is some concern regarding the nanoparticles of some chemical elements that are used by the industry in the manufacture of various products. Why?

1. They can accumulate in the environment, and contaminate water and soil.
2. They can enter the food chains.
3. They can trigger the production of free radicals.

Select the correct answer using the code given below.

a) 1 and 2 only
b) 3 only
c) 1 and 3 only
d) 1, 2 and 3

Q.38) Solution (d)

Statement 1 and 2 are correct

Nanoparticle toxicity is described in the diagram below

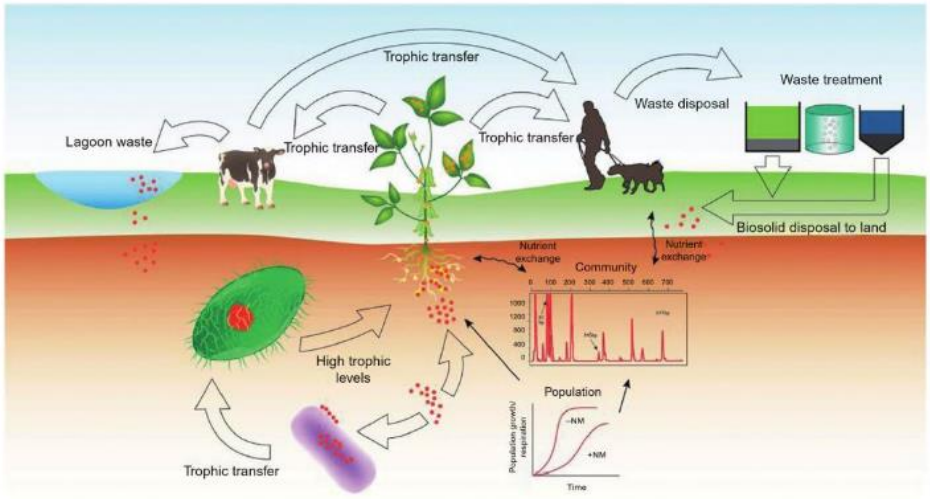


Figure 3.3 Schematic diagram showing the concept of ecological nanotoxicity. Engineered nanomaterials (red dots) entering bacteria (purple) existing in soil below ground can pass to protozoa (green). These nanomaterials can also enter plant systems via the roots. In the food chain, engineered nanomaterials propagate upwards in the ecosystem (Holden et al., 2013).

Statement 3 is also correct – Nanoparticles of titanium dioxide and Zinc oxide used in large number of cosmetics, sunscreens and personal care products are photoactive, producing free radicals and causing DNA damage to human skin cells. In fact free radical production is one of the main mechanism of nanoparticle toxicity.

Q.39) Which of the following are prospective applications of Nanotechnology?

1. Gene sequencing
2. Tissue engineering
3. Neuro-electronic devices
4. Stem Cell Technology

Select the correct option –

a) 1 and 2 only
b) 1, 2 and 3 only
c) 1, 2 and 4 only
d) All of the above

Q.39) Solution (d)

Nanotechnology is science, engineering, and technology conducted at the nanoscale, which is about 1 to 100 nanometers. Physicist Richard Feynman is the father of nanotechnology.

Applications of nanotechnology in the medical field

Nanomedicine is an application of nanotechnology which works in the field of health and medicine. Nanomedicine ranges from the medical applications of nanomaterials and biological devices to nanoelectronics biosensors and even possible future applications of molecular machines.

- **Targeted drug delivery** – the required drug dose and side-effects are minimised.
- **Tissue Engineering** - damaged tissue can be reproduced or repaired.
- **Antibacterial Treatments** - gold nanoparticles and infrared light can be used to kill bacteria.
- **Wound Treatment** – bandage can apply electrical pulses to a wound using electricity produced by nanogenerators.
- **Cell Repair** - Nanorobots could be programmed to repair specific diseased cells functioning similar to antibodies.
- **Cancer Treatment** - Iron nanoparticles or gold shells are finding important application in cancer treatment.
- **Imaging** - Using nanoparticle contrast agents, images such as ultrasound and MRI have improved contrast.
- **Blood purification** - the purification with nanoparticles allows specific targeting of substances.
- **Neuro-electronic interfacing** is a visionary goal dealing with the construction of **nanodevices that will permit computers to be joined and linked to the nervous system**.
- **Gene sequencing** - nanodevices like gold nanoparticles can be used to tag and detect short segments of DNA.
- **Stem Cell Technology**: magnetic nanoparticles (MNPs) have been successfully used to isolate and group stem cells.

Q.40) Consider the following statements –

1. Indian Nanoelectronics Users Programme (INUP) is being implemented at Centre of Excellence in Nanoelectronics (CEN) at IISc and IIT Bombay.
2. It has been initiated by Ministry of Electronics and Information Technology (MeitY).

Which of the statements given above is/are correct?

a) 1 only
b) 2 only
c) Both 1 and 2
d) Neither 1 nor 2

Q.40) Solution (c)

A unique initiative for accelerating research and development in nanoelectronics in India has been launched in August 2008 at the Centers of Excellence in Nanoelectronics (CEN) at Indian Institute of

Science, Bengaluru (IISc) and Indian Institute of Technology Bombay (IITB). The Indian Nanoelectronics Users Program (INUP) intends to facilitate experimentation of research ideas of Indian researchers in the general area of nanoelectronics.

The program, funded by the Department of Information Technology (DeitY), the Ministry of Communications and Information Technology (MCIT), Govt.