

Q.1) Consider the following statements regarding Biotechnology Industry Research Assistance Council (BIRAC):

1. It is a not for profit private organization working to bridge the gap between innovation and industry.
2. Its aim is to enhance the strategic research and innovation capabilities of the Indian biotech industry, for creation of affordable products addressing the needs of the largest section of society

Which of the above statements are correct?

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

Q.1) Solution (b)

Biotechnology Industry Research Assistance Council (BIRAC) is a not-for-profit Section 8, Schedule B, Public Sector Enterprise, set up by Department of Biotechnology (DBT), Government of India as an Interface Agency to strengthen and empower the emerging Biotech enterprise to undertake strategic research and innovation, addressing nationally relevant product development needs.

BIRAC is a industry-academia interface and implements its mandate through a wide range of **impact initiatives**, be it providing access to risk capital through targeted funding, technology transfer, IP management and handholding schemes that help bring **innovation excellence** to the biotech firms and make them globally competitive. In its Five years of existence, BIRAC has initiated several schemes, networks and platforms that help to **bridge the existing gaps** in the industry-academia Innovation research and facilitate novel, high quality affordable products development through cutting edge technologies. BIRAC has initiated partnerships with several national and global partners to collaborate and deliver the salient features of its mandate.

Vision

“To Stimulate, foster and enhance the strategic research and innovation capabilities of the Indian biotech industry, particularly start-ups and SME’s, for creation of affordable products addressing the needs of the largest section of society”

Key Strategies

- Foster innovation and entrepreneurship
- Promote affordable innovation in key social sectors
- Empowerment of start-ups & small and medium enterprises
- Contribute through partners for capability enhancement and diffusion of innovation
- Enable commercialization of discovery
- Ensure global competitiveness of Indian enterprises

Q.2) CRISPR – Cas is a tool for gene editing. Which of the following statements are correct regarding CRISPR?

1. It stands for clustered regularly interspaced short palindromic repeats.
2. CRISPR plays a key role in antiviral defence system of organisms.

Select the code from following:

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

Q.2) Solution (c)

CRISPR (clustered regularly interspaced short palindromic repeats) is a family of DNA sequences found within the genomes of prokaryotic organisms such as bacteria and archaea. These sequences are derived from DNA fragments from viruses that have previously infected the prokaryote and are used to detect and destroy DNA from similar viruses during subsequent infections. Hence these sequences play a key role in the antiviral defense system of prokaryotes.

Cas9 (or "CRISPR-associated protein 9") is an enzyme that uses CRISPR sequences as a guide to recognize and cleave specific strands of DNA that are complementary to the CRISPR sequence. Cas9 enzymes together with CRISPR sequences form the basis of a technology known as CRISPR-Cas9 that can be used to edit genes within organisms. This editing process has a wide variety of applications including basic biological research, development of biotechnology products, and treatment of diseases.

Q.3) Recently, a police training dog was cloned in China for the first time. The name given to this dog is

- a) Sherlock Holmes
- b) Goku
- c) Ip Dog
- d) Hancock

Q.3) Solution (a)

Scientists in southwest China's Yunnan province have cloned what they called the "Sherlock Holmes of police dogs" in a programme they hope will help cut training times and costs for police dog.

The dog, named Kunxun, was cloned from a police sniffer dog by the Beijing-based Sinogene Biotechnology Company and the Yunnan Agricultural University, with support from the Ministry of Public Security.

Sinogene is hoping to make it possible to achieve "volume production" of cloned police dogs in order to significantly reduce training time.

Q.4) Bacteria 'Escherichia Coli' is mainly found in

- a) Root nodules
- b) Human intestine
- c) Animal bones
- d) Animal horns

Q.4) Solution (b)

Escherichia coli (E. coli) bacteria normally live in the intestines of healthy people and animals. Most varieties of E. coli are harmless or cause relatively brief diarrhea. But a few particularly nasty strains, such as E. coli O157:H7, can cause severe abdominal cramps, bloody diarrhea and vomiting.

Q.5) Which of the following was the first crop to be genome sequenced?

- a) Wheat
- b) Barley
- c) Rice
- d) Chickpea

Q.5) Solution (c)

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.6) Which of the following plant tissues show totipotency in plant tissue culture?

- a) Xylem tissue
- b) Phloem tissue
- c) Meristematic Tissue
- d) Parenchyma

Q.6) Solution (c)

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

Q.7) 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.7) 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.8) Consider the following statements:

1. Electrophoresis is the motion of dispersed particles relative to a fluid under the influence of a spatially uniform electric field.
2. Gel electrophoresis is a technique used to separate DNA fragments according to their size.

Which of the above statements are correct?

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

Q.8) Solution (c)

Gel electrophoresis

- **Gel electrophoresis** is a technique used to separate DNA fragments according to their size.

- DNA samples are loaded into wells (indentations) at one end of a gel, and an electric current is applied to pull them through the gel.
- DNA fragments are negatively charged, so they move towards the positive electrode. Because all DNA fragments have the same amount of charge per mass, small fragments move through the gel faster than large ones.
- When a gel is stained with a DNA-binding dye, the DNA fragments can be seen as **bands**, each representing a group of same-sized DNA fragments.

Q.9) A physio- chemical reaction between heavy metal ions and microbial surface is called

- a) Bioremediation
- b) Biointeraction
- c) Biosorption
- d) Bioaccumulation

Q.9) Solution (c)

Biosorption is a property of certain types of inactive, dead, microbial biomass to bind and concentrate heavy metals from even very dilute aqueous solutions. Biomass exhibits this property, acting just as a chemical substance, as an ion exchanger of biological origin.

Q.10) Which of the scientists are NOT correctly matched with their biotechnological discoveries?

1. Walter Sutton – Penicillin
2. James Watson – Double helical structure of DNA
3. Alexander Fleming – Chromosomal basis of heredity

Select the code from following:

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

Q.10) Solution (c)

Walter Sutton - Chromosomal basis of heredity

Alexander Fleming – Penicillin

Q.11) Energy given to the nucleus to dismantle it increases the

- a) Kinetic energy of the nucleus
- b) Potential energy of the nucleus
- c) Gravitational energy of the nucleus
- d) Electromagnetic energy of the nucleus

Q.11) Solution (b)

Nuclear binding energy is the minimum energy that would be required to disassemble the nucleus of an atom into its component parts. These component parts are neutrons and protons, which are collectively called nucleons. The binding is always a positive number, as we need to spend energy in moving these nucleons, attracted to each other by the strong nuclear force, away from each other. The mass of an atomic nucleus is less than the sum of the individual masses of the free constituent protons and neutrons, according to Einstein's equation $E=mc^2$. This 'missing mass' is known as the mass defect, and represents the energy that was released when the nucleus was formed.

When energy is provided to the nucleus, it increases the potential energy of the nucleons and makes it unstable.

Q.12) A gamma ray or gamma radiation, is a penetrating electromagnetic radiation arising from the radioactive decay of atomic nuclei. Which of the following statements are correct regarding gamma rays?

- 1. They consist of light negatively charged electrons.
- 2. They are the least penetrating amongst all radiations.

Select the code from following:

- a) 1 only
- b) 2 only

- c) Both 1 and 2
- d) Neither 1 nor 2

Q.12) Solution (d)

A gamma ray or gamma radiation (symbol γ), is a penetrating electromagnetic radiation arising from the radioactive decay of atomic nuclei. It consists of the shortest wavelength electromagnetic waves and so imparts the highest photon energy. Paul Villard, a French chemist and physicist, discovered gamma radiation in 1900 while studying radiation emitted by radium. In 1903, Ernest Rutherford named this radiation gamma rays based on their relatively strong penetration of matter; he had previously discovered two less penetrating types of decay radiation, which he named alpha rays and beta rays in ascending order of penetrating power.

Q.13) The country's first indigenously developed 500-megawatt (mw) prototype fast breeder reactor is being developed at Kalpakkam in Tamil Nadu. Which of the following statements regarding this are correct?

1. Reactor will be using thorium to produce more fissile material.
2. The surplus plutonium (or uranium-233 for thorium reactors) from each fast reactor can be used to set up more such reactors and grow the nuclear capacity in tune with India's needs for power.
3. Bharatiya Nabhikiya Vidyut Nigam (Bhavini), a public sector company under DAE, has been given the responsibility to build the fast breeder reactors in the country.

Select the code form below:

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

Q.13) Solution (b)

The country's first indigenously developed 500-megawatt (mw) prototype fast breeder reactor at Kalpakkam in Tamil Nadu is expected to achieve criticality in 2019.

About Prototype Fast Breeder Reactor (PFBR)

- The Kalpakkam PFBR is using uranium-238 not thorium, to breed new fissile material, in a sodium-cooled fast reactor design.
- The power island of this project is being engineered by Bharat Heavy Electricals Limited, largest power equipment utility of India.
- The surplus plutonium (or uranium-233 for thorium reactors) from each fast reactor can be used to set up more such reactors and grow the nuclear capacity in tune with India's needs for power.
- India has the capability to use thorium cycle based processes to extract nuclear fuel.
- This is of special significance to the Indian nuclear power generation strategy as India has one of the world's largest reserves of thorium, which could provide power for more than 10,000 year.
- Bharatiya Nabhikiya Vidyut Nigam (Bhavini), a public sector company under DAE, has been given the responsibility to build the fast breeder reactors in the country.

Q.14) Consider the following statements regarding Fissile materials:

1. A fissile material is one that can sustain a chain reaction upon bombardment by neutrons.
2. Thorium is by itself a fissile material which can be used directly in thorium based reactors.

Which of the above statements are correct?

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

Q.14) Solution (a)

Fissile Material:

- A fissile material is one that can sustain a chain reaction upon bombardment by neutrons.
- Thorium is by itself **fertile**, meaning that it can **transmute into a fissile radioisotope [U-233]** but cannot itself keep a chain reaction going.

- In a thorium reactor, a fissile material like uranium or plutonium is blanketed by thorium.
- The fissile material, also called a driver in this case, drives the chain reaction to produce energy while simultaneously transmuting the fertile material into fissile material.
- India has very modest deposits of uranium and some of the world's largest sources of thorium. It was keeping this in mind that in 1954, Homi Bhabha envisioned India's nuclear power programme in three stages to suit the country's resource profile.

Q.15) Which of the following statements are correct regarding India's three stage nuclear program?

1. In first stage heavy water reactors are fuelled by Uranium to produce Plutonium.
2. The second stage would initially be fuelled by a mix of the plutonium from the first stage and natural uranium.
3. The third stage will use thorium and uranium where thorium will transmutate to Uranium 233 which will be used as fuel.

Select the code from following:

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

Q.15) Solution (d)

India's three stage Nuclear Programme:

1. In the first stage, heavy water reactors fuelled by natural uranium would produce plutonium [U-238 will be transmuted to Plutonium 239 in PHWR];
2. The second stage would initially be fuelled by a mix of the plutonium from the first stage and natural uranium. This uranium would transmute into more plutonium and once sufficient stocks have been built up, thorium would be introduced into the fuel cycle to convert it into uranium 233 for the third stage [thorium will be transmuted to U-233 with the help plutonium 239].
3. In the final stage, a mix of thorium and uranium fuels the reactors. The thorium transmutes to U-233 which powers the reactor. Fresh thorium can replace the depleted

thorium [can be totally done away with uranium which is very scares in India] in the reactor core, making it essentially a thorium-fuelled reactor [thorium keeps transmuting into U-233. It is U-233 that generates the energy].

Q.16) India does not have a Civil Nuclear deal with which of the following countries?

- a) USA
- b) France
- c) Japan
- d) Germany

Q.16) Solution (d)

As of 2016, India has signed civil nuclear agreements with 14 countries: Argentina, Australia, Canada, Czech Republic, France, Japan, Kazakhstan, Mongolia, Namibia, Russia, South Korea, the United Kingdom, the United States, and Vietnam.

Q.17) Which of the following statements are correct regarding Moderator in a nuclear reactor?

1. A neutron moderator is a medium that reduces the speed of fast neutrons, thereby turning them into thermal neutrons capable of sustaining a nuclear chain reaction.
2. Boron is the most commonly used moderator in reactors.

Select the code from following:

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

Q.17) Solution (a)

In nuclear engineering, a neutron moderator is a medium that reduces the speed of fast neutrons, thereby turning them into thermal neutrons capable of sustaining a nuclear chain reaction involving uranium-235 or a similar fissile nuclide.

Commonly used moderators include regular (light) water (roughly 75% of the world's reactors), solid graphite (20% of reactors) and heavy water (5% of reactors). Beryllium has also been used in some experimental types, and hydrocarbons have been suggested as another possibility.

Q.18) Control rods are used in nuclear reactors to control the fission rate of uranium and plutonium. How do they control the fission rate?

- a) They absorb the excess energy released by the nuclear reaction.
- b) They control the amount of fissile material available for reaction.
- c) They absorb the extra neutrons generated in the reaction.
- d) They stop the reaction in case of generation of extra energy.

Q.18) Solution (c)

Control rods are used in nuclear reactors to control the fission rate of uranium and plutonium. They are composed of chemical elements such as boron, silver, indium and cadmium that are capable of absorbing many neutrons without themselves fissioning. Because these elements have different capture cross sections for neutrons of varying energies, the composition of the control rods must be designed for the reactor's neutron spectrum. Boiling water reactors (BWR), pressurized water reactors (PWR) and heavy water reactors (HWR) operate with thermal neutrons, while breeder reactors operate with fast neutrons.

Q.19) Nuclear fusion is a reaction in which two or more atomic nuclei are combined to form one or more different atomic nuclei and subatomic particles. Which of the following statements are correct regarding nuclear fusion?

- 1. Usually heavy elements are used for nuclear fusion.
- 2. Energy in stars is generated through fusion process.
- 3. Much more energy is generated in fusion reaction as compared to nuclear fission.

Select the code from following:

- a) 1 and 2
- b) 2 and 3

- c) 1 and 3
- d) All of the above

Q.19) Solution (b)

In nuclear chemistry, nuclear fusion is a reaction in which two or more atomic nuclei are combined to form one or more different atomic nuclei and subatomic particles (neutrons or protons). The difference in mass between the reactants and products is manifested as either the release or absorption of energy. This difference in mass arises due to the difference in atomic "binding energy" between the atomic nuclei before and after the reaction. Fusion is the process that powers active or "main sequence" stars, or other high magnitude stars.

A fusion process that produces a nucleus lighter than iron-56 or nickel-62 will generally yield a net energy release. These elements have the smallest mass per nucleon and the largest binding energy per nucleon, respectively. Fusion of light elements toward these releases energy (an exothermic process), while a fusion producing nuclei heavier than these elements will result in energy retained by the resulting nucleons, and the resulting reaction is endothermic. The opposite is true for the reverse process, nuclear fission. This means that the lighter elements, such as hydrogen and helium, are in general more fusible; while the heavier elements, such as uranium, thorium and plutonium, are more fissionable.

Q.20) ITER (International Thermonuclear Experimental Reactor) is an international nuclear fusion research and engineering megaproject. Which of the following statements regarding ITER are correct?

1. It will be the world's largest magnetic confinement plasma physics experiment.
2. The aim is to generate 10 times more energy than what is supplied to the reactor for its running.
3. India has been a part of this project since its inception.

Select the code from following:

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

Q.20) Solution (a)

ITER (International Thermonuclear Experimental Reactor) is an international nuclear fusion research and engineering megaproject, which will be the world's largest magnetic confinement plasma physics experiment. It is an experimental tokamak nuclear fusion reactor that is being built next to the Cadarache facility in Saint-Paul-lès-Durance, in Provence, southern France.

The ITER thermonuclear fusion reactor has been designed to produce a fusion plasma equivalent to 500 megawatts (MW) of thermal output power for around twenty minutes while 50 megawatts of thermal power are injected into the tokamak, resulting in a ten-fold gain of plasma heating power. Thereby the machine aims to demonstrate the principle of producing more thermal power from the fusion process than is used to heat the plasma, something that has not yet been achieved in any fusion reactor.

In 1985, at the Geneva summit meeting in 1985, Mikhail Gorbachev suggested to Ronald Reagan that the two countries jointly undertake the construction of a tokamak EPR as proposed by the INTOR Workshop. The ITER project was initiated in 1988. India became an official member of the project in 2005.

Q.21) The ideas and concepts behind nanoscience and nanotechnology started with a talk by Richard Feynman. The talk was entitled –

- a) A powerful Particle
- b) There's Plenty of Room at the Bottom
- c) There is a micro universe
- d) Quantum Realm – A reality

Q.21) Solution (b)

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 statements are correct regarding Atomic Force Microscopy (AFM)?

1. AFM is a type of scanning probe microscopy (SPM), with demonstrated resolution on the order of fractions of a nanometer.
2. The information is gathered by "feeling" or "touching" the surface with a mechanical probe.
3. Piezoelectric elements that facilitate tiny but accurate and precise movements on (electronic) command enable precise scanning.

Select the code from following:

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

Q.22) Solution (d)

Atomic force microscopy (AFM) or scanning force microscopy (SFM) is a very-high-resolution type of scanning probe microscopy (SPM), with demonstrated resolution on the order of fractions of a nanometer, more than 1000 times better than the optical diffraction limit.

The information is gathered by "feeling" or "touching" the surface with a mechanical probe. Piezoelectric elements that facilitate tiny but accurate and precise movements on (electronic) command enable precise scanning.

The AFM has three major abilities: force measurement, imaging, and manipulation.

In force measurement, AFMs can be used to measure the forces between the probe and the sample as a function of their mutual separation. This can be applied to perform force spectroscopy, to measure the mechanical properties of the sample, such as the sample's Young's modulus, a measure of stiffness.

For imaging, the reaction of the probe to the forces that the sample imposes on it can be used to form an image of the three-dimensional shape (topography) of a sample surface at a high resolution. This is achieved by raster scanning the position of the sample with respect to the tip and recording the height of the probe that corresponds to a constant probe-sample interaction (see section topographic imaging in AFM for more details). The surface topography is commonly displayed as a pseudocolor plot.

In manipulation, the forces between tip and sample can also be used to change the properties of the sample in a controlled way. Examples of this include atomic manipulation, scanning probe lithography and local stimulation of cells.

Q.23) Consider the following statements regarding Tissue Nano Transfection:

1. The process is believed to heal injuries or regrow organs with one touch.
2. A nanochip 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.23) Solution (a)

Nano Transfection

Nanochip 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.24) Which of the following are the bottom – up approaches of preparing Nano material?

1. Molecular Grinding
2. Molecular Self Assembly
3. Molecular Beam Epitaxy
4. Gas Phase Agglomeration

Select the code from following:

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

Q.24) Solution (b)

Top-down and bottom-up methods are two types of approaches used in nanofabrication. The bottom-up approach is more advantageous than the top-down approach because the former has a better chance of producing nanostructures with less defects, more homogenous chemical composition, and better short- and long-range ordering.

A bottom up synthesis method implies that the nanostructures are synthesized onto the substrate by stacking atoms onto each other, which gives rise to crystal planes, crystal planes further stack onto each other, resulting in the synthesis of the nanostructures. A bottom-up approach can thus be viewed as an synthesis approach where the building blocks are added onto the substrate to form the nanostructures.

A top down synthesis method implies that the nanostructures are synthesized by etching out crystals planes (removing crystal planes) which are already present on the substrate. A top-down approach can thus be viewed as an approach where the building blocks are removed from the substrate to form the nanostructure.

Molecular self-assembly is the process by which molecules adopt a defined arrangement without guidance or management from an outside source. There are two types of self-assembly. These are intramolecular self-assembly and intermolecular self-assembly.

Molecular Beam Epitaxy is an evaporation process performed in an ultra-high vacuum for the deposition of compounds of extreme regularity of layer thickness and composition from well-controlled deposition rates.

The agglomeration of metallic nanoparticles can be performed using the well-known inert gas condensation process

Q.25) Which of the following statements are correct regarding Dip Pen Nanolithography?

1. Dip pen nanolithography (DPN) is a scanning probe lithography technique where an atomic force microscope (AFM) tip is used to create patterns directly on a range of substances with a variety of inks.
2. It is a bottom up approach of preparing nano material.

Select the code from following:

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

Q.25) Solution (c)

Dip pen nanolithography (DPN) is a scanning probe lithography technique where an atomic force microscope (AFM) tip is used to create patterns directly on a range of substances with a variety of inks.

DPN is the nanotechnology analog of the dip pen (also called the quill pen), where the tip of an atomic force microscope cantilever acts as a "pen," which is coated with a chemical compound or mixture acting as an "ink," and put in contact with a substrate, the "paper."

DPN enables direct deposition of nanoscale materials onto a substrate in a flexible manner. Recent advances have demonstrated massively parallel patterning using two-dimensional arrays of 55,000 tips. Applications of this technology currently range through chemistry, materials science, and the life sciences, and include such work as ultra high density biological nanoarrays, and additive photomask repair.

Q.26) Which of the following factors are responsible for causing significant difference in properties of nano materials as compared to normal material?

1. Size distribution
2. Specific surface feature
3. Quantum size effects

Select the code from following:

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

Q.26) Solution (d)

Size distribution, specific surface feature and quantum size effects are the principal factor which causes the properties of nanomaterials to differ significantly from other materials.

Q.27) 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.27) Solution (a)

Nanocomposite 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 Nanocomposite 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 nanocomposite 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 macroscale properties of the composite. For example, adding carbon nanotubes improves the electrical and thermal conductivity.

Q.28) Ecophagy is a hypothetical end-of-the-world scenario involving molecular nanotechnology in which out-of-control self-replicating robots consume all biomass on Earth while building more of themselves. These multiplying nano robots has been termed as

- a) Green Goo
- b) Grey goo
- c) Nano Goo
- d) Smelly Goo

Q.28) Solution (b)

Grey goo (also spelled gray goo) is a hypothetical end-of-the-world scenario involving molecular nanotechnology in which out-of-control self-replicating robots consume all biomass on Earth while building more of themselves, a scenario that has been called ecophagy ("eating the environment", more literally "eating the habitation"). The original idea assumed machines were designed to have this capability, while popularizations have assumed that machines might somehow gain this capability by accident.

Self-replicating machines of the macroscopic variety were originally described by mathematician John von Neumann, and are sometimes referred to as von Neumann machines or clanking replicators.

Note: A grey goo scenario was shown in a Hollywood movie – G I Joe

Q.29) Which of the following statements are correct regarding 'Solar Paints'?

1. It can be any surface that will capture energy from the sun and transform it into electricity.
2. It glows in the dark and removes the need of artificial lighting.
3. It is essentially a common paint with suspended nano particles which are light sensitive.

Select the code from following:

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

Q.29) Solution (c)

Solar paint, also known as photovoltaic paint. It's a paint that you can apply to any surface that will capture energy from the sun and transform it into electricity. The paint would essentially be your average paint, but with billions of pieces of light sensitive material suspended in it, material that would transform the typical paint into superpowered energy-capturing paint.

The main issue with solar paint is that it's not quite efficient enough to be commercially viable. Solar paint ranges anywhere from 3-8% Efficiency is essentially the percentage of the power of the sun's rays that the technology can capture. If a particular type of solar paint has a 5% efficiency, that means it's capturing only 5% of the total available sun energy. For comparison

sake, traditional silicon solar panels operate at around 18% efficiency. Most experts agree that a solar technology has to surpass 10% efficiency to be viable.

Solar paint is certainly less expensive than solar panels, in terms of both production and installation, but the low efficiency means that it's not quite ready to be taken to market.

The most common type of photovoltaic paint is a paint utilizing colloidal quantum dots. These are semiconductor crystals that are already used in solar panels as well as LEDs and computers. The University of Toronto created an iteration of solar paint wherein they sprayed these dots atom by atom onto a backing. This backing could then be rolled up, sent to the place where it's to be installed, and then applied like a wallpaper. It's not quite the image that you think of when you hear "solar paint", I know that I personally think of a Behr paint bucket filled with futuristic glow-in-the-dark goo paint, but the application is the same – it can cover a surface and provide solar energy. The only issue with the dots technology is that the efficiency is still sitting around 8% and therefore not yet commercially viable.

Q.30) Which of the following statements are correct regarding Fullerenes?

1. It is an isotope of Carbon with molecular mass 60.
2. They can be used to store hydrogen, possibly as a fuel tank for fuel cell powered cars.
3. The antioxidant properties of Fullerenes may be able to fight the deterioration of motor function due to multiple sclerosis.

Select the code from following:

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

Q.30) Solution (b)

Note: Fullerenes are allotropes of Carbon. (Not Isotopes)

Fullerenes are also called Buckyballs due to their shape.

- Buckyballs may be used to trap free radicals generated during an allergic reaction and block the inflammation that results from an allergic reaction.

- The antioxidant properties of buckyballs may be able to fight the deterioration of motor function due to multiple sclerosis.
- Combining buckyballs, nanotubes, and polymers to produce inexpensive solar cells that can be formed by simply painting a surface.
- Buckyballs may be used to store hydrogen, possibly as a fuel tank for fuel cell powered cars.
- Buckyballs may be able to reduce the growth of bacteria in pipes and membranes in water systems.
- Researchers are attempting to modify buckyballs to fit the section of the HIV molecule that binds to proteins, possibly inhibiting the spread of the virus.
- Making bullet proof vests with inorganic (tungsten disulfide) buckyballs.

Q.31) National Electronics Policy has been approved by Union Cabinet. Which of the following statements regarding this are correct?

1. The objective is to Promote domestic manufacturing and export in the entire value-chain of Electronics System Design and Manufacturing – ESDM for economic development.
2. Promote Industry-led R&D and innovation in all sub-sectors of electronics.

Select the code from following:

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

Q.31) Solution (c)

National Policy on Electronics (NPE) – 2019

Cabinet has approved a National Policy on Electronics (NPE) for the Electronics System Design and Manufacturing (ESDM) sector of India. Vision of the NPE 2019 is to position India as a global hub for Electronics System Design and Manufacturing (ESDM) by creating an enabling environment for the industry.

Following are the important objectives of the policy as elaborated in the draft report.

- Promotion of domestic manufacturing in the entire value-chain of ESDM for economic development to achieve a turnover of US \$ 400 Billion by 2025. This shall include targeted production of 1.0 Billion mobile handsets by 2025, valued at US \$ 190 billion (approx. Rs.13 lakh crore), including 600 Million mobile handsets valued at US \$ 110 billion (approx. Rs.7 lakh crore) for export.
- Improve ease-of-doing-business for the ESDM Industry.
- Encourage Industry-led R&D and Innovation in all sub-sectors of Electronics.
- Support a comprehensive Start-up ecosystem in emerging technology areas such as 5G, IoT, Artificial Intelligence, Machine Learning, etc., and their applications in areas such as Defence, Agriculture, Health, Smart Cities and Automation, with special focus on solving real-life problems.
- Provide support for significantly enhancing availability of skilled manpower in the ESDM sector.
- Provide support for export led growth, including significantly enhancing economies of scale in electronics manufacturing.
- Develop core competencies in all the sub-sectors of Electronics, including Electronic components and Semiconductors, Telecommunication equipment, Medical electronics, Defence Electronics, Automotive electronics, Industrial Electronics, Strategic Electronics, etc., and Fabless Chip Design.
- Become a global leader in the Electronics Manufacturing Services (EMS) segment by promoting progressively higher value addition in manufacturing of electronic products.
- Facilitate cost effective loans for setting up and expansion of electronics manufacturing units.

Q.32) Which of the following statements are correct regarding 'Rashmi'?

1. It is a social humanoid robot developed by a Hong Kong based company.
2. Apart from English, it can speak Hindi, Marathi and Sanskrit language

Select the code from following:

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

Q.32) Solution (a)

Ranchi man Ranjit Srivastava,38, has developed Indian version of 'Sophia,' a social humanoid robot developed by a Hong Kong based company, named Rashmi which can speak Hindi, Bhojpuri and Marathi along with English.

Q.33) Students of BITS Pilani had built India's first humanoid robot. The robot has been named

- a) AcYut
- b) AshWath
- c) ArJun
- d) AnGad

Q.33) Solution (a)

AcYut - meaning "The Imperishable" in Sanskrit, is the series of humanoids developed at the Centre for Robotics and Intelligent Systems, BITS Pilani.

AcYut is India's first indigenously designed autonomous humanoid and has been supported by various sponsors, including the Govt. Of India(DEITY) and BITSAA.

AcYut has represented India at various international platforms including RoboCup, RoboGames, CMU, Stanford etc. AcYut is also consistently India's only entry to the highly advanced Humanoid Teen Sized Soccer Leagues at Robocup where robots play soccer autonomously.

Q.34) The Indian Railway Catering and Tourism Corporation (IRCTC) recently launched Ask Disha. Which of the following regarding this are correct?

1. It is an Artificial Intelligence based chatbot.
2. It answers users' queries regarding connectivity of different highways and railways.
3. It is voice enabled and will be able to understand English and several regional languages.

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 (c)

The Indian Railway Catering and Tourism Corporation (IRCTC) recently launched a chatbot to help its users answer various queries . The AI chatbot-- Ask Disha- is powered by artificial intelligence (AI) and it is aimed at facilitating accessibility by answering users' queries pertaining to various services offered by IRCTC.

The first-of-its-kind initiative by IRCTC is live and it is already available on the bottom right corner of IRCTC's revamped website and it will soon be available on IRCTC's Android app. Besides this, the AI chatbot will be voice enabled and it will support several regional languages in the near future.

Q.35) Robot is a bat inspired robot developed by Tel Aviv University. Which of the following statements are correct regarding it?

1. It is a flying robot which uses webbed wings like a bat.
2. It uses sonar to move through novel environments while mapping them based only on sound.

Select the code from below:

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

Q.35) Solution (b)

The "Robot" is a fully autonomous, four-wheeled terrestrial robot with bat-like qualities that uses echolocation, also called bio sonar, to move through novel environments while mapping them based only on sound. It was developed at Tel Aviv University (TAU).

Bats use echolocation to map novel environments, navigating them by emitting sound then extracting information from the echoes reflected by objects in their surroundings. Many theories have been proposed to explain how bats harness sonar in order to navigate, but few attempts have been made to build a robot that mimics a bat's abilities.

The Robot is equipped with an ultrasonic speaker that produces frequency-modulated chirps at a rate typically used by bats, as well as two ultrasonic microphones that serve as the robot's ears. The time delay of the echo tells Robot how far away objects are.

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 statements are correct about Serial Manipulator Robots?

1. Serial manipulators are the most common industrial robots and they are designed as a series of links connected by motor-actuated joints.
2. Often they have an anthropomorphic arm structure described as having a "shoulder", an "elbow", and a "wrist".
3. They are usually used for large calculations in industries.

Select the code from following:

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

Q.37) Solution (a)

Serial manipulators are the most common industrial robots and they are designed as a series of links connected by motor-actuated joints that extend from a base to an end-effector. Often they have an anthropomorphic arm structure described as having a "shoulder", an "elbow", and a "wrist".

Serial robots usually have six joints, because it requires at least six degrees of freedom to place a manipulated object in an arbitrary position and orientation in the workspace of the robot.

A popular application for serial robots in today's industry is the pick-and-place assembly robot, called a SCARA robot, which has four degrees of freedom.

Q.38) Which of the following is not one of the five basic components of Robots?

- a) Controller
- b) Arm
- c) Drive
- d) CPU

Q.38) Solution (d)

A robot generally consists of 5 basic components:

1. Controller

Every robot is connected to a computer controller, which regulates the components of the arm and keeps them working together. The controller also allows the robot to be networked to other systems, so that it may work together with other machines, processes, or robots. Almost all robots are pre-programmed using "teaching" devices or offline software programs. In the future, controllers with artificial intelligence (AI) could allow robots to think on their own, even program themselves. This could make robots more self-reliant and independent.

2. Arm

The arm is the part of the robot that positions the end-effector and sensors to do their pre-programmed business. Many are built to resemble human arms, and have shoulders, elbows, wrists, even fingers. Each joint is said to give the robot 1 degree of freedom. A simple robot arm with 3 degrees of freedom could move in 3 ways: up and down, left and right, forward and backward. Most working robots today have 6 degrees of freedom to allow them to reach any possible point in space within its work envelope. The human arm has 7.

3. Drive

The links (the sections between the joints) are moved into their desired position by the drive. Typically, a drive is powered by pneumatic or hydraulic pressure, or electricity.

4. End-Effector

The end-effector could be thought of as the "hand" on the end of the robotic arm. There are many possible end-effectors including a gripper, a vacuum pump, tweezers, scalpel, blowtorch, welder, spray gun, or just about anything that helps it do its job. Some robots can change end-effectors, and be reprogrammed for a different set of tasks.

5. Sensor

The sensor sends information, in the form of electronic signals back to the controller. Sensors also give the robot controller information about its surroundings and lets it know the exact position of the arm, or the state of the world around it. One of the more exciting areas of sensor development is occurring in the field of computer vision and object recognition. Robot sensors can detect infrared radiation to "see" in the dark.

Q.39) In robotic the function of 'Actuator' is

- a) To provide movement
- b) To grip an object
- c) To act as a joint between two parts
- d) To memorise the function of robot

Q.39) Solution (a)

An actuator is a component of a machine that is responsible for moving and controlling a mechanism or system, for example by opening a valve. In simple terms, it is a "mover". An actuator requires a control signal and a source of energy.

Q.40) Scientists have developed an AI software called SurfNet. Which of the following is a correct function of SurfNet?

- a) It can guess the needs of the user and open web pages according to the need.
- b) It can create 3D models from 2D images.
- c) It can connect home appliances with the phone and allows to control them from a distance.
- d) None of the above

Q.40) Solution (b)

A group of scientists including one from Indian origin with AI have come up with a software called '**SurfNet**'.

The features listed below:

- This analyses 2D shapes and converts them to 3D models
- This software can only be used to convert but can also be used to merge two shapes in one
- After complete development, it can also make notable changes in the field of 3D searches
- This can enable robots to navigate the real world
- It can be used in self-driven cars and robotics
- The virtual world can also be improved with this software as it will guide it to convert standard 2D images to 3D content

