

TARGETING TNPSC

GROUP-II 2023

Question with Simplified Answer
Mains Written Exam

SPOT - TEST

Science & Technology

3rd TEST

Marks : 300

Time : 3 Hrs



English Medium



SURESH'
IAS ACADEMY

தூத்துக்குடி

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மதுரை

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TEST

03

வெற்றி ஒன்றே
இலக்கு

Answer Key - English

Unit - 01

1) What is Looming? Explain the Phenomenon behind it. 6

- In the cold places the refractive index increases towards the ground because the temperature of air close to the ground is lesser than the temperature at a height above the surface of earth.
- Thus, the density and refractive index of air close to the ground is greater than for air at a height.
- In the cold regions like glaciers and frozen lakes, the reverse effect of mirage will happen.
- Hence, an inverted image is formed little above the inverted image is formed little above the surface as shown in figure. This phenomenon is called looming.
- It is also called as superior mirage, towering and stooping.

2) Explain Law of conservation of energy 6

- When an object is thrown upwards its kinetic energy goes on decreasing and consequently its potential energy keeps increasing (neglecting air resistance).
- When it reaches the highest point its energy is completely potential.
- Similarly, when the object falls back from a height its kinetic energy increases whereas its potential energy decreases.
- When it touches the ground its energy is completely kinetic.
- At the intermediate points the energy is both kinetic and potential as shown in figure.
- When the body reaches the ground the kinetic energy is completely dissipated into some other form of energy like sound, heat, light and deformation of the body etc.

- In this example the energy transformation takes place at every point. The sum of kinetic energy and potential energy i.e., the total mechanical energy always remains constant, implying that the total energy is conserved.
- This is stated as the law of conservation of energy.
- The law of conservation of energy states that energy can neither be created nor destroyed. It may be transformed from one form one form to another but the total energy of an isolated system remains constant.
- Illustrates that, if an object starts from rest at height h , the total energy is purely potential energy ($U = mgh$) and the kinetic energy (KE) is zero at h .
- When the object falls at some distance y , the potential energy and the kinetic energy remains same as measured at height h .
- When the object is about to touch the ground, the potential energy is zero and total energy is purely kinetic.

3) How are Eddy currents generated? List out its applications 4

Eddy Currents

- According to Faraday's law of electromagnetic induction, an emf is induced in a conductor when the magnetic flux passing through it changes. However, the conductor need not be in the form of a wire or coil.
- Even for a conductor in the form of a sheet or plate, an emf is induced when magnetic flux linked with it changes.
- But the difference is that there is no definite loop or path for induced current to flow way.
- As a result, the induced currents flow in concentric circular paths figure.
- As these electric currents resemble eddies of water, these are known as Eddy currents.

- They are also called Foucault currents.

Application of eddy currents 2

- Though the production of eddy current is undesirable in some cases, it is useful in some other cases. A few of them are
- Induction stove
- Eddy current brake
- Eddy current testing
- Electromagnetic damping

4) Differentiate between LED and photodiode

Light Emitting Diode (LED) 3

- LED is a p-n junction diode which emits visible or invisible light when it is forward biased.
- Since electrical energy is converted into light energy, this process is also called electroluminescence.
- The circuit symbol of LED is shown in figure.
- The direction of arrows indicates that light is emitted from the diode
- When the p-n junction is forward biased, the conduction band electrons on n-side and valence band holes on p-side diffuse across the junction.
- When they cross the junction, they become excess minority carriers (electrons in p-side and holes in n-side).
- These excess minority carriers recombine with oppositely charged majority carriers in the respective regions, i.e. the electrons in the conduction band recombine with holes in the valence band.
- During recombination process, energy is released in the form of light (radiative) or heat (non-radiative).
- For radiative recombination, a photon of energy $h\nu$ is emitted.
- For non-radiative recombination, energy is liberated in the form of heat.
- The colour of the light is determined by the energy band gap of the material.
- Therefore, LEDs are available in a wide range of colours such as blue (SiC), green (AlGaP) and red (GaAsP).
- Now a days, LED which emits white light (GaInN) is also available.

Applications

- The light emitting diodes are used in
- Indicator lamps on the front panel of the scientific and laboratory equipments,
- Seven – segment displays.
- Traffic signals, emergency vehicle lighting etc.
- Remote control of television, air-conditioner etc.

Photodiodes 3

- A p-n junction diode which converts an optical signal into electric signal is known as photodiode. Thus, the operation of photodiode is exactly inverse to that of an LED. Photodiode works in reverse bias condition. Its circuit symbol is shown in Figure.
- The direction of arrows indicates that the light is incident on the photodiode.
- The device consists of a p-n junction semiconductor made of photosensitive material kept safely inside a plastic case.
- It has a small transparent window that allows light to be incident on the p-n junction.
- Photodiodes can generate current when the p-n junction is exposed to light and hence are called as light sensors.
- When a photon of sufficient energy ($h\nu$) strikes the depletion region of the diode, some of the valence band electrons are elevated into conduction band, in turn holes are developed into conduction band, in turn holes are developed in the valence band.
- This creates electron – hole pairs.
- The amount of electron-hole pairs generated depends on the intensity of light incident on the p-n junction.
- These electrons and holes are swept across the p-n junction by the electric field created by reverse voltage before recombination takes place.
- Thus, holes move towards the p-side and electrons towards the n-side.
- When the external circuit is made, the electrons flow through the external circuit and constitute the photocurrent.

- When there is no incident light, there exists a reverse current which is negligible.
- This reverse current in the absence of any incident light is called dark current and is due to the thermally generated minority carriers.

Applications

- The photodiodes are used in
- alarm system
- count items on a conveyor belt
- photoconductors
- compact disc players, smoke detectors
- medical applications such as detectors for computed tomography etc.

5) Short Notes**a) Virtual reality****b) 3D Printing****a) Virtual reality****3**

- Virtual reality is an artificial environment that is created with software and presented to the user in such a way that the user suspends belief and accepts it as a real environment.
- On a computer, virtual reality is primarily experienced through two of the five senses: sight and sound.
- Virtual reality is the term used to describe a three-dimensional, computer generated environment which can be explored and interacted with by a person.
- That person becomes part of this virtual world or is immersed within this environment and whilst there, is able to manipulate objects or perform a series of actions.
- The simplest form of virtual reality is a 3-D image that can be explored interactively at a personal computer, usually by manipulating keys or the mouse so that the content of the image moves in some direction or zooms in or out.
- More sophisticated efforts involve such approaches as wrap-around display screens, actual rooms augmented with wearable computers, and haptics devices that let you feel the display images.
- A three dimensional image can be viewed from a personal computer using pointers to provide a simple form a forward and backward viewing.

- It also provides an opportunity to understand the world of advanced artificial intelligence with wearable listeners.

b) 3D Printing**3****What is 3D Printing?**

- 3D printing uses computer-aided design (CAD) to create three-dimensional objects through a layering method.

Principle

- In 3D printing, a 3D printer makes a three-dimensional object from a CAD (computer-aided design) file.
- The creation of a 3D printed object is achieved using additive processes.
- In an additive process an object is created by laying down successive layers of material until the object is created.
- Each of these layers can be seen as a thinly sliced cross-section of the object.
- 3D printing enables us to produce complex shapes using less material than traditional manufacturing methods.

6) What are the functions of Central Electrochemical Research Institute?**6**

- Established in 1953, CECRI, Karaikudi is one of the largest electrochemical laboratories in the world, carrying out R&D work in the area of electrochemical Science and Technology.
- Three extension centres of CECRI are functioning at Chennai, Mandapam and Tuticorin.
- CECRI Madras Unit, based in Chennai, is a satellite unit of pioneering CSIR-Electrochemical Research Institute of Karaikudi.
- Since 10 years, Unit is dedicated towards the fundamental driven science concept to product delivery and also cater the needs of many industry driven research programmes sponsored by various agencies including government bodies and private sectors.
- CECRI Madras Unit has all the sophisticated electrochemical characterization facilities for basic research to understand the catalytic activity of the electrocatalysts, ionic conductivity of the membranes and fuel cell

test station and assembly units for testing cells and stacks of various capacities which will bring benefits to the Environment, Energy Security and Economic growth.

- CECRI- Chennai unit lithium ion battery R&D extremely focus on synthesizing of novel materials like Metal Oxides, Oxyfluorides, Fluorophosphates, Fluorosulfates, NASICON type materials. CECRI- Chennai unit has very good quality and quantity of publications covering a diverse spectrum of materials related to fuel cells, lithium/sodium batteries, supercapacitors etc

7) What is Hyperloop technology? Explain 6

- Theoretical concept of hyperloop is mooted by maverick techno-entrepreneur Elon Musk in 2013.
- Hyperloop technology promises to move people and goods through low-pressure tubes far faster than commercial air travel, within earthly confines, of course.
- In hyperloop transportation, custom-designed capsules or pods are expected to zip smoothly through continuous steel tubes which are held at partial vacuum.
- The pod which sandwiches the passenger compartment between an air compressor upfront and a battery compartment in the rear is supported by air caster skis at the bottom.
- The skis float on a thin layer of air provided under high pressure, eliminating rolling resistance and allowing for movement of the pods at high speeds. These capsules are expected to be driverless with estimated speeds of 1,000 km/h.
- Linear induction motors that are placed along the tube control the speed of the pod. Electronically-assisted acceleration and braking determines the speed of the capsule.

8) Explain key aspects of National Mission for sustainable Agriculture. 6

- It is one of the major missions of the National Action Plan on Climate Change (NAPCC). Change in agricultural practices also plays a crucial role in the mitigation of climate change effects.

Strategy

- Promoting integrated farming system covering crops, livestock & fishery, plantation and pasture based composite farming for enhancing livelihood opportunities, ensuring food security and minimizing risks from crop failure through supplementary/ residual production systems
- Popularizing resource conservation technologies (both on - farm and off - farm) and introducing practices that will support mitigation efforts in times of extreme climatic events or disasters like prolonged dry spells, floods etc.
- Promoting effective management of available water resources and enhancing water use efficiency through application of technologies coupled with demand and supply side management solutions
- Encouraging improved agronomic practices for higher farm productivity, improved soil treatment, increased water holding capacity, judicious use of chemicals/ energy and enhanced soil carbon storage
- Creating database on soil resources through land use survey, soil profile study and soil analysis on GIS platform to facilitate adoption of location and soil - specific crop management practices & optimize fertilizer use;

9) Do the Iron in the blood undergo rusting? Give reason. 6

- Even a small amount of oxygen present in air leads to the rusting of iron, i.e. iron is oxidized to Fe³⁺. But the Fe²⁺ present in hemoglobin which binds oxygen during transport of oxygen from lungs to tissues never gets oxidized. Do you know why?
- The answer lies in the structural features of hemoglobin.

Haemoglobin structure

- Haemoglobin contains four sub units each with a porphyrin ring (heme) attached to the protein (globin) molecule.
- In this structure, the iron (Fe²⁺) forms a co-ordination complex with an octahedral geometry.

- The four positions of the octahedron are occupied by porphyrin rings, fifth position is filled by imidazole ring of a histidine residue and the sixth position is utilized for binding the oxygen molecule.
- Generally the Fe^{2+} in heme is susceptible to oxidation.
- Since the Fe^{2+} ion in haemoglobin is surrounded by the globin protein chain that provides a hydrophobic environment, the oxidation of Fe^{2+} becomes difficult.
- However, 3% of haemoglobin is oxidised to methemoglobin (haemoglobin where the iron is present in Fe^{3+} state and oxygen does not bind to this) daily.
- The enzyme methemoglobin reductase reduces it back to haemoglobin.

10) What are the effects of over fertilization in plants? 6

- Over- fertilization can lead to sudden plant growth with an insufficient root system to supply adequate water and nutrients to the plant.
- Poor root structure reduces the number of flowers and fruit production, and can result in plant growth spurts that won't be supported or sustained.
- Plants die when over-fertilized as a result of dehydration.
- Plants die when over fertilized as a high amount of fertilizer concentration can cause damage to crops and can cause ecological problems such as soil salinization as well.
- Soil salinization will eventually affect the absorption, transportation, and utilization of nutrients by plants, leading to dehydration and then, death of the plant.

11) Why Inert gases do not show greater affinity to Chemical reactions? Explain the reason. 6**Physical Properties**

- As we move along the noble gas elements, their atomic radius and boiling point increases from helium to radon.
- The first ionization energy decreases from helium to radon.

- Noble gases have the largest ionization energy compared to any other elements in a given row as they have completely filled orbital in their outer most shell.
- They are extremely stable and have a small tendency to gain or lose electrons.

12) What is Green chemistry? 2**Green Chemistry**

- Green chemistry is a chemical philosophy encouraging the design of products and processes that reduce or eliminate the use and generation of hazardous substances.
- For this, scientist are trying to develop methods to produce eco-friendly compounds. This can be best understood by considering the following example in which styrene is produced both by traditional and greener routes.

Traditional route

- This method involves two steps. Carcinogenic benzene reacts with ethylene to form ethyl benzene. Then ethyl benzene on dehydrogenation using $\text{Fe}_2\text{O}_3/\text{Al}_2\text{O}_3$, gives styrene.

Greener route

- To avoid carcinogenic benzene, greener route is to start with cheaper and environmentally safer xylenes.

Green chemistry in day-to-day life 4

- A few contribution of green chemistry in our day to day life is given below

1. Dry cleaning of clothes

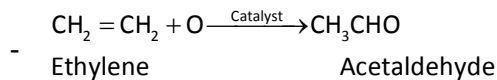
- Solvents like tetrachloroethylene used in dry cleaning of clothes, pollute the ground water and are carcinogenic.
- In the place of tetrachloroethylene, liquefied CO_2 with suitable detergent, is an alternate solvent used.
- Liquefied CO_2 is not harmful to the ground water.
- Now a days H_2O_2 used for bleaching clothes in laundry, gives better results and utilises less water.

2. Bleaching of paper

- Conventional method of bleaching was one with chlorine. Now a days H₂O₂ can be used for bleaching paper in presence of catalyst.

3. Synthesis of chemicals

- Acetaldehyde is now commercially prepared by one step oxidation of ethene in the presence of ionic catalyst in aqueous medium with 90% yield.



4. Instead of petrol, methanol is used as a fuel in automobiles.

5. Neem based pesticides have been synthesised, which are safer than the chlorinated hydrocarbons.

- Every individual has an important role for preventing pollution and improving our environment.
- We are responsible for environmental protection.
- Let us begin to save our environment and provide a clean earth for our future generations.

13) What are the benefits of Herbicide tolerant crops?

Advantages of Herbicide Tolerant Crops 6

- Weed control improves higher crop yields;- Reduces spray of herbicide
- Reduces competition between crop plant and weed
- Use of low toxicity compounds which do not remain active in the soil; and
- The ability to conserve soil structure and microbes.

14) Write short notes on Lethal genes

Lethal Genes 6

- An allele which has the potential to cause the death of an organism is called a "Lethal Allele".
- In 1907, E.Baur reported a lethal gene in snapdragon (Antirrhinum sp.). It is an example for recessive lethality. In snapdragon there are three kinds of plants.

- Green plants with chlorophyll. (CC)
- Yellowish green plants with carotenoids are referred to as pale green, golden or aurea plants (Cc)
- White plants without any chlorophyll. (cc)
- The genotype of the homozygous green plants is CC. The genotype of the homozygous white plant is cc.
- The aurea plants have the genotype Cc because they are heterozygous of green and white plants. When two such aurea plants are crossed the F₂ progeny has identical phenotypic and genotypic ratio of 1:2:1 (viz. 1 Green (CC): 2 Aurea (Cc): 1 White (cc))
- Since the white plants lack chlorophyll pigment, they will not survive. So the F₂ ratio is modified into 1: 2. In this case the homozygous recessive genotype (cc) is lethal.
- The term "lethal" is applied to those changes in the genome of an organism which produces effects severe enough to cause death.
- Lethality is a condition in which the death of certain genotype occurs prematurely.
- The fully dominant or fully recessive lethal allele kills the carrier individual only in its homozygous condition.
- So the F₂ genotypic ratio will be 2: 1 or 1:2 respectively.

15) Why electric connections at homes are connected parallelly? Explain 3

- Home wiring are parallel because if one of the devices fail in series you can easily see that there is only one path for current so every device will be affected and it would be like a bulb fused and whole house goes black.
 - This is not the case with parallel as there are many paths from supply.
 - The reasons why different electrical appliances in a domestic circuit are connected in parallel are: **3**
1. All the appliances get their rated voltage so that they function efficiently.
 2. All the components can have their independent switch to control them.
 3. If one appliance gets faulty, it doesn't affect the other appliances.

16) What are the consequences of consuming Iron deficient food in humans? 6

- Without enough iron, your body can't produce enough of a substance in red blood cells that enables them to carry oxygen (hemoglobin).
- As a result, iron deficiency anemia may leave you tired and short of breath.

Consequences

- Extreme fatigue
- Weakness
- Pale skin
- Chest pain
- fast heartbeat or shortness of breath
- Headache, dizziness or lightheadedness
- Cold hands and feet
- Inflammation or soreness of your tongue
- Brittle nails
- Unusual cravings for non-nutritive substances, such as ice, dirt or starch
- Poor appetite, especially in infants and children with iron deficiency anemia

17) Explain the importance of menstrual hygiene 6**Menstrual hygiene**

- Menstrual hygiene is vital for good health, well-being, dignity, empowerment and productivity of women.
- The impact of poor menstrual hygiene on girls is increased stress levels, fear and embarrassment during menstruation.
- This can keep girls inactive during such periods leading to absenteeism from school.
- Clean and safe absorbable clothing materials, sanitary napkins, pads, tampons and menstrual cups have been identified as materials used to manage menstruation.
- Changing sanitary material 4-5 hours as per the requirement, provides comfort, cleanliness and protection from infections. - It also helps in enhancing the quality of life of women during this period.
- Used sanitary napkins should be wrapped in paper and disposed.
- It should not be thrown in open areas or drain pipe of toilets.

- Flushing of sanitary napkins in the drain pipes causes choking of the drainage line leading to water pollution.

18) What are the benefits of Karyotyping? 6**Applications of Karyotyping**

- It helps in gender identification.
- It is used to detect the chromosomal aberrations like deletion, duplication, translocation, non disjunction of chromosomes.
- It helps to identify the abnormalities of chromosomes like aneuploidy.
- It is also used in predicting the evolutionary relationships between species.
- Genetic diseases in human beings can be detected by this technique.

Unit - 02**1) Explain Tamil Nadu R & D Policy 1****Introduction**

- Tamilnadu is one of the most admired and advanced economies in India. Tamil Nadu R&D Policy 2022 is strategic project aimed to achieve a Large scale impact on the society.

Ministry:

- Industries, Investment promotion commerce department.

Objectives:

- Transform Tamilnadu into knowledge based economy by 2030
- Increase private sector R&D expenditure by 2030

Aim

- To double R&D Expenditure in state from Government, Higher Education & Private Sector by 2030.

Special features**1. Fostering Linkages**

- Innovation clusters – Potential to unlock competitiveness
- Hi-Tech corridors – connect existing & upcoming nodes of innovation clusters.
- Knowledge city – High quality human capital.
- Research parks – In collaboration with TIDCO, Sipcot and TANSIDCO

2. Industry 4.0 platform

- To provide information & opportunities
- Platform acts as a rich and up to date repository

3. Work Lab

- Special cells – Guidance to enable a link between industries and academy.
- Offers short term diploma / online course

4. Centre of excellence

- To develop emerging technologies to support industries (sunrise sectors)

5. National & International R & D collaboration

- State researchers to get international exposure.
- Leverage bilateral research cooperation

6. Incentives

- To boost R & D expenditure
- Mainly to increase competitiveness.

7. Enhancing human capital

- Investment in education & Research results in high productivity in human capital
- Atleast 10 high calibre research institute in the state.
- Research capacity building
- 100 talent plan – to attract the scientists / academicians of Tamil origin living abroad.
- Technical transfer office (TTO) – Translate new innovative research into commercial valuable products or service.

8. MSME & Startups

- Regional startup hubs
- Industrial innovation centre -by SIPCOT
- ETNT Hub – Tamil Nadu Technology hub
- MSME Innovation Research program.

9. Funding avenues (For startups)

- TANSEED – Tamil Nadu startup seed Grant fund
- TNESSF – Tamil Nadu Emerging sector seed Fund
- Tamil Nadu Innovation Initiatives support.

Conclusion:

1

- If the policy is applied in the right way it will be easy to achieve 1 Trillion economy by 2030.

2) How 5G Technology is advanced than existing technologies? Explain

5G Technology

1

Introduction

- 5G (Fifth Generation cellular networks) which is the most advanced & fastest wireless technology

Evolution of 5G

1

- 1G – 1980 – Radio Signal + only voice calls
- 2G – 1990 – Radio signal + both voice calls
- 3G – 2000 – Best speed + video calling & Conference
- 4G – 2010 – Peak speed of 100 Mbps – 1 Gbps + 3D Virtual reality
- Relying in present

Speciality of 5G

1

1. High band spectrum used in 5G
2. Internet speeds have been testes to be as high as 20 Gbps (gigabits per second)
3. 5G – Latest upgrade in the long term Evolution (LTE) Mobile Broadband networks
4. It will operate in the millimeter – Wave spectrum (30 – 300 GHZ) – can send large amounts of data at very high speed.
5. It experiences little interference from surrounding signal.

Difference between 4G & 5G

2

Characteristics	4G	5G
Radio Frequency	700 MHZ – 2500 MHZ	28 GHZ
Speed	Low speed with less data transfer	Baster speed with more data transfer
Latency	20 – 30 milli seconds	10 – 10 milli seconds
Supported in	Less number of devices 4000 devices / sq.km	More devices one million sq.km
Coverage	More congestion less coverage	Improves coverage speed & capcaity

Role of 5G in India

4

1. Education

- Smart classrooms (Augmented Reality & Virtual Reality)
- Holographic telepresence

2. Advanced Manufacturing

- Automation & control : Remote assistance robot control & collaborate control
- Maintenance AR Assistance
- Autonomous factory transport

3. Smart Infrastructure

- High – Speed connectivity in public places
- Safe & Security – ND Surveillance Camera
- Smart Utility Service

4. Media & Entertainment

- Immersive Content – AR / VR
- UHD /4k/ 8k – Superior TV viewing Experience- Broadcasting – live broadcasting & Steaming

5. Artificial Intelligence

- Increase the performance
- Helps businesses better understand their customer

6. Life Science & Healthcare

- Digital Hospitals
- Remote Monitoring of Health data
- Remote consultation & diagnostics – 5G based video conferencing

7. Automotive

- HD Maps – Navigation
- Infotainment – Immersive content application UHD / 4G video

Advantages

2

- High speed
- Low Latency
- Increased Bandwidth

Disadvantages

- Limited coverage
- Weak upload speeds
- Battery Damages
- Interference with Airport & Flight operates
- Cyber Security Risk
- High test

Conclusion

1

- There are only 13 cities are now got with 5G services in 2022 (Main cities like – Delhi, Chennai, Mumbai etc.)
- The Govt has to take effective measure to speed the service in all states to make India high in economy. (1 Trillion economy by 2030).

3) Short Notes on**a) Electrostatic Shielding****b) Radar Communication****c) Precision Medicine****a) Electrostatic Shielding**

4

- Gauss law: $\phi_E = \frac{Q}{\epsilon_0}$

- The total electric flux - ϕ_E through the closed surface.

- The total magnetization value of a conductor in an electric field is equal to the product of 16 times its total charge.

- ϕ - charge enclosed spherical shell, both hollow & solid conductors is zero.

- A sensitive electrical instrument which is to be protected from external electrical disturbance can be kept inside this cavity – Electrostatic shielding.

- Faraday cage – demonstrates this effect.

- During Lightning & Thunderstorm, it is safer to sit inside a bus than in open ground or under a tree.

b) Radar Communication

4

- Radio detection and Ranging system.

- Angle, range / velocity of objects invisible to human eye can be determined.

- Uses electromagnetic waves for communication.

Process

- Electromagnetic signal radiated into space by an antenna in all directions.

- Signal strikes the target object

- Signal reflected or reradiated

- Echo signal received by radar antenna

- Delivered to receiver

- Processed & amplified – determine statistic of the object
- Range – calculating time taken by signal to travel from RADAR to target & back.

Applications

- Military: For locating & detecting targets
- Navigation: Shipborne surface search, air search, missile guidance system.
- Meteorological observation: Measure precipitation rates and wind speed.
- Emergency situations: Locate and rescuer people.

c) Precision Medicine 4

- Precision medicine is an emerging approach for disease treatment and prevention that takes into account individual variability in genes, environment, and lifestyle for each person.
- In this medical model it is possible to customize healthcare, with medical decisions, treatments, practices, or products which are tailored to the individual patient.

4) Explain any 3 of the following

a) DRDO

b) CSIR

c) TIFR

d) ICMR

a) DRDO 3

- DRDO works under the administrative control of Ministry of Defence, Government of India.
- It is working to establish world class science and technology base for India and provides our Defence Services decisive edge by equipping them with internationally competitive systems and solutions.

Mission of DRDO:

- Design, develop and lead to production state-of-the-art sensors, weapon systems, platforms and allied equipment for our Defence Services.
- Provide technological solutions to the Services to optimise combat effectiveness and to promote well-being of the troops.
- Develop infrastructure and committed quality manpower and build strong indigenous technology base.

Programmes of DRDO:

- Integrated Guided Missile Development Programme (IGMDP)
- Mobile Autonomous Robot System (MARS)
- Highest Terrestrial Centre in Ladakh
- Other Recent Developments by DRDO:
 - Extreme Cold Weather Clothing System (ECWCS)
 - 'Pralay'.
 - Controlled Aerial Delivery System.
 - Pinaka Extended Range (Pinaka-ER) Multiple Launch Rocket System (MLRS).
 - Supersonic Missile Assisted Torpedo System (SMART).

b) CSIR: 3

- Council of Scientific and Industrial Research (CSIR) is the largest research and development (R&D) organisation in India.
- CSIR has a pan-India presence and has a dynamic network of 37 national laboratories, 39 outreach centres, 3 Innovation Complexes and 5 units.
 - Established: September 1942
 - Headquarters: New Delhi
 - CSIR is funded by the Ministry of Science and Technology and it operates as an autonomous body through the Societies Registration Act, 1860.
 - CSIR covers a wide spectrum of streams – from radio and space physics, oceanography, geophysics, chemicals, drugs, genomics, biotechnology and nanotechnology to mining, aeronautics, instrumentation, environmental engineering and information technology.
 - It provides significant technological intervention in many areas with regard to societal efforts which include the environment, health, drinking water, food, housing, energy, farm and non-farm sectors.

Structure of the Organisation:

- President: Prime Minister of India (Ex-official)
- Vice President: Union Minister of Science and Technology (Ex-officio)
- Governing Body: The Director-General is the head of the governing body.

- The other ex-officio member is the finance secretary (expenditures).
- Other members' terms are of three years.
- CSIR Advisory Board: 15-member body composed of prominent members from respective fields of science and technology.
- Its function is to provide science and technology inputs to the governing body.
- Term- three years.

c) ICMR: 3

- Indian Council of Medical Research (ICMR) is India's supreme body to formulate, coordinate and promote biomedical research.
- It was formed in 1911 when it was known as Indian Research Fund Association (IRFA).
- In 1949, IRFA was renamed ICMR.
- The Government of India funds ICMR.
- It comes under the Department of Health Services (DHS), Ministry of Health and Family Welfare (MoH&FW).
- The headquarters of ICMR is in New Delhi.
- It is neither a statutory body nor a regulatory body.
- ICMR hosts Clinical Trials Registry – India (CTRI). It was established on 20th July 2007.
- Union Health Minister of India presides over the governing body of ICMR.

Achievements:

- 1949, ICMR initiated the National Programme for the control of Filariasis
- ICMR made home-based treatment of Tuberculosis known worldwide.
- 2013, it launched a vaccine against Japanese encephalitis, "JENVAC.
- 2018, Zika, Nipah and Canine Distemper Virus were successfully contained.
- ICMR and COVID-19:
 - RT-PCR and ELISA were developed in 2019.
 - Covaxin has been developed.

d) TIFR 3**About:**

- **Status:** It is a Deemed University and a research institution under the Department of Atomic Energy, Government of India.

- It is country's premier research institute dedicated to basic research in mathematics and the sciences.
- With support from J.R.D. Tata, then chairman of the Tata Group, TIFR was founded on 1 June 1945, and Homi Bhabha was appointed its first director.
- Established in: 1945.
- **Giant Metrewave Radio Telescope (GMRT):** GMRT, located near Pune (Narayangaon) is an array of thirty fully steerable parabolic radio telescopes of 45 metre diameter, observing at metre wavelengths. It is operated by the National Centre for Radio Astrophysics, a part of the TIFR.

5) What are Monoclonal antibodies? Explain its application in medicine.**Monoclonal antibodies (m Abs) 3**

1. Man made proteins act like a human antibody in the immune system
2. **Antibodies:** Proteins produced naturally by immune system that target a specific object (antigen)
3. mAbs are produced by clones derived from a single parent cell- unique white blood cell.
4. **Have monovalent affinity :** Binds only. It is same part of an antigen recognized by the antibody

Applications to Medicine**Diagnostic Applications 9****1. Biochemical analysis.**

- Used in Radio immuno assay (RIA) and EISA
- In pregnancy detection
- Hormonal disorders analysis
- Cancer estimation.

2. Diagnostic Imaging.

- Imaging of diseases
- Radio isotopes are used for Labeling Mab's.- Myocardial Infraction, Atherosclerosis

3. Therapeutic Agents

- Destroying disease causing Organisms enhances phagocytosis
- Immuno suppression of organ transplantation
- to overcome rejection of organ transplantation

- MAbs specific to T-Lymphocyte Surface antigens are and

4. Protein Purification.

- High degree of purification
- MAb can bind to desired protein and helps in out.

5. Treatment:

- Cancer, Multiple Sclerosis, Rheumatoid arthritis, COVID-19.

6) Short Notes

a) Biodiversity Impact assessment

b) Biomonitoring

a) Biodiversity Impact Assessment (BIA) 6

- Biodiversity Impact Assessment can be defined as a decision supporting tool to help biodiversity inclusive of development, planning and implementation.
- It aims at ensuring development proposals which integrate bio- diversity considerations.
- They are legally compliant and include mechanisms for the conservation of bio-diversity resources and provide fair and equitable sharing of the benefits arising from the use of bio-diversity.

Bio-diversity impacts can be assessed by

- Change in land use and cover
- Fragmentation and isolation
- Extraction
- External inputs such as emissions, effluents and chemicals
- Introduction of invasive, alien or genetically modified species
- Impact on endemic and threatened flora and fauna.

b) Biomonitoring 6

- The act of observing and assessing the current state and ongoing changes in ecosystem, biodiversity components, landscape including natural habitats, populations and species.
- An agricultural drone is an unmanned aerial vehicle applied to farming in order to help increased crop production and monitor crop growth.
- Agricultural drones let farmers see their fields from the sky.

- This bird's eye-view can reveal many issues such as irrigation problems, soil variation and pest and fungal infestations.
- It is also used for cost effective safe method of spraying pesticides and fertilizers, which proves very easy and non-harmful.

7) Explain Suprarenal glands

Adrenal Gland

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- A pair of adrenal glands are located at the anterior end of the kidneys, hence also called suprarenal glands.
 - Anatomically the outer region is the cortex and the inner region is the medulla. Histologically the adrenal cortex has three distinct zones. Zona glomerulosa, zona fasciculata and zona reticularis.
 - Zona glomerulosa an outer thin layer constitutes about 15% of adrenal cortex, and secretes mineralocorticoids.
 - Zona fasciculata, the middle widest layer constitutes about 75% of adrenal cortex and secretes glucocorticoids such as cortisol, corticosterone and trace amounts of adrenal androgen and oestrogen.
 - Zona reticularis, an inner zone of adrenal cortex constitute about 10% of adrenal cortex and secretes the adrenal androgen, trace amount of oestrogen and glucocorticoids.
 - Laughing is good for health, because it reduces the stress hormone (adrenalin) secretion and makes us to relax.
 - **Adrenal medulla:** It is the central part of adrenal gland and is composed of ovoid and columnar cells, which are found around the network of blood capillaries.
 - Adrenalin (epinephrine) and nor adrenalin (nor epinephrine) are the two hormones secreted by the adrenal medulla. Both adrenalin and nor adrenalin are catecholamines.
- Function of adrenal hormones**
- Glucocorticoids stimulate gluconeogenesis, lipolysis and proteolysis (the life saving activity).

- Cortisol is a glucocorticoid involved in maintaining cardio vascular and kidney functions.
- It produces anti-inflammatory reactions and suppresses the immune response.
- It stimulates the RBC production. It is also known as stress combat hormone.
- Mineralocorticoids regulates water and electrolyte balance of our body.
- Aldosterone stimulates the reabsorption of sodium and water and eliminates potassium and phosphate ions through excretion, thus it helps in maintaining electrolytes, osmotic pressure and blood pressure.
- Adrenal androgen plays a role in hair growth in the axial region, pubis and face during puberty.
- The adrenal medulla secretes the hormones adrenalin and noradrenalin and are referred as "3F hormone" (fight, flight and fright hormone).
- Adrenalin increases liver glycogen breakdown into glucose and increases the release of fatty acids from fat cells.
- During emergency it increases heart beat rate and blood pressure.
- It stimulates the smooth muscles of cutaneous and visceral arteries to decrease blood flow.
- It increases blood flow to the skeletal muscles thereby increases the metabolic rate of skeletal muscles, cardiac muscles and nervous tissue.

8) What is Test tube baby technology? What is its advantage in medical field?

In Vitro Fertilization (IVF) or Test Tube Baby 12

- In this technique, sperm and eggs are allowed to unite outside the body in a laboratory.
- One or more fertilized eggs may be transferred into the woman's uterus, where they may implant in the uterine lining and develop.
- Excess embryos may be cryopreserved (frozen) for future use.
- Initially, IVF was used to treat women with blocked, damaged, or absent fallopian tubes.

- Today, IVF is used to treat many causes of infertility.
- The basic steps in an IVF treatment cycle are ovarian stimulation, egg retrieval, fertilization, embryo culture, and embryo transfer.
- Egg retrieval is done by minor surgery under general anesthesia, using ultrasound guide after 34 to 37 hours of hCG (human chorionic gonadotropin) injection.
- The eggs are prepared and stripped from the surrounding cells. At the same time, sperm preparation is done using a special media.
- After preparing the sperms, the eggs and sperms are brought together.
- 10,000 – 1,00,000 motile sperms are needed for each egg to make fertilization.
- Then the zygote is allowed to divide to form 8 celled blastomere and then transferred into the uterus for a successful pregnancy.
- The transfer of an embryo with more than 8 blastomeres stage into uterus is called Embryo transfer technique.

9) List out the reasons for Biodiversity Loss.

Causes of Biodiversity loss

12

The major causes for biodiversity decline are:

- Habitat loss, fragmentation and destruction (affects about 73% of all species)
- Pollution and pollutants (smog, pesticides, herbicides, oil slicks, GHGs)
- Climate change
- Introduction of alien / exotic species
- Over exploitation of resources (poaching, indiscriminate cutting of trees, over fishing, hunting, Mining)
- Intensive agriculture and aquacultural practices
- Hybridization between native and non-native species and loss of native species
- Natural disasters (Tsunami, forest fire, earth quake, volcanoes)
- Industrialization, Urbanization, infrastructure development, Transport – Road and Shipping activity, communication towers, dam construction, unregulated tourism and monoculture are common area of specific threats
- Co - extinction

10) Explain ISRO's Manned Space Mission and also list out its recent achievements.

ISRO Gaganyaan programme 7

1. Demonstrate human space flight capability
2. Launching: & members to an orbit-400km for 3 days
3. Prerequisites for Gaganyaan mission
 - Human rated launch vehicle.
 - Life Support system
 - Crew emergency escape provision
 - Crew Training, recovery & rehabilitation.
4. Precursor missions planned.
 - Integrated Air Drop Test (IADT)
 - Pad Abort TEA (PAT)
 - Test Vehicle (TV) Flights
5. Launch Vehicle : LVM3-H&VM3
 - Solid Stage, Liquid Stage & Cryogenic Stage- Consists of Crew Escape System (CES).
6. Orbital Module - comprise of
 - Crew Module (CM)
 - Service Module (SM).
7. Collaboration: India & France.
8. Crew Training
 - Classroom
 - Physical Fitness
 - Stimulator
 - Flight suit

Training modules 1

- Micro operating familiarization
- Aero medical Training
- Recovery & Survival

Milestones Achieved so far 4

1. Cryo stage C25- Engine qualification tests
2. Liquid Stage L110 - Engine VIKAS Qualification tests
3. Solid Test Booster H5200 static test.
4. Static tests of crew Escape system (LES) motor
 - High Altitude escape motor (HEM)
 - CES Jettisoning Motor (CJM)
 - Low Attitude Escape motor (LEM)
5. Crew module demonstration model
 - Propulsion characteristics test

6. Service module demonstration model
 - Propulsion Characteristics tests
7. Integrated Main Parachute Air drop test.
 - All the above mentioned test are done and yet several milestones are yet to be achieved to make it a reality.

11) What are Green crackers? Evaluate its importance on environment's impact.

Green Packers / Eco friendly crackers 1

- Environmentally friendly fireworks, reduce the air pollution caused by traditional firecrackers

Green Crackers 3

1. First designed by National Environmental & Engineering research Institute (NEERI) - under CAR, in 2018
2. Replace certain hazardous agents in traditional crackers.
3. Less polluting, reduced noise intensity and emissions.
4. 3 Brands of Green Crackers.
 1. **SWAS** : Safe Water Releaser
 - No potassium nitrate & sulphur.
 - Release water vapour.
 2. **STAR**
 - Safe thermite Cracker
 - No potassium nitrate & sulphur.
 - Reduced particulate matter & found
 3. **SAFAL**
 - Safe minimal aluminium
 - Magnesium instead of aluminium.
 - Low pollutants

Advantages of Green Cracker 3

1. Since they don't contain harmful substance like barium nitrate, sulphur they are environment friendly.
2. These cracker will release water vapour / air as a dust suppressant and dilute for gaseous emission
3. Expected to Cause atleast 30% less air pollution than traditional firecrackers.
4. Manufacturing cost Same or Less

5. Helps in - uplying quality of air, ensure minimum hazardous material is released into atmosphere.

Concerns regarding Green Crackers 4

- Can only be legally manufactured by firms that have signed agreements with the CSIR.
- No small scale business (cottage business horse can manufacture.
- Increased burden of unemployment.
- General Lack of awareness among it the sellers and pubic to identify right green cracker
- Lack of availability
- Customers prefer traditional Crackers.

Conclusion: 1

- Efforts to be increased by government by giving Legal Section to small manufactured to produce green crackers, increase awareness among public to identify the geniusness.

12) Explain Legal measures taken by the government to control air pollution

Legal Protection 3

- The Air (Prevention and Control of Pollution) Act was enacted in 1981 and amended in 1987 for the prevention, control and abatement of Air pollution in India.
- Traffic Emissions Standards: The Government has decided to enforce Bharat Stage VI norms from 2020.
- The Green Bench and the National Green Tribunal (NGT) give judicial safeguard to environmental protection.

Steps taken by the Central and the State governments in India: 6

- Road traffic rationing, encourage public transport, carpooling
- Increase green cover alongside roads (planting avenue trees)Promoting Swachh Bharat Abhiyan
- Enactment and Enforcement of stricter environmental lawsMaintenance of air standards by proper enforcement and monitoring
- Average humanconsumption of Oxygen per day = 550 L

- Cost of 2.75 L Oxygen cylinder = Rs.6500
- Cost of 550 L of oxygen from tree= Rs.13,00,000
- Oxygen production by one healthy tree per year =1,00,375 L
- Cost of 2.75 L oxygen cylinder= Rs.6500
- Cost of 1,00,375 L of oxygen from one tree / year = Rs.23,72,50,000
- Reducing carbon emissions
- Encourage use of renewable energy
- Limiting the sale of firecrackers and developing eco-friendly crackers
- Make Environmental Impact Assessment mandatory
- Air Quality Index (AQI) is a number used by government agencies to communicate to the public how polluted the air is at a given time.

Air Quality Index 3

AQI	Air Pollution Level	Colour
0-50	Good	Green
51-100	ModerateLight	Green
101-150	Unhealthy for Sensitive Groups	Yellow
151-200	Unhealthy	Orange
201-300	Very Unhealthy	Red
301+	Hazardous	Brown

Unit - 03

1) What is National Green Hydrogen Mission? Discuss how the mission will ensure self sustainability in global energy demand for India.

About: 1

- The Union Cabinet approved National Green Hydrogen Mission

Funding 1

- Initial Outlay -Rs.19,744 crore
- SIGHT Programme Rs.17,490 cr
- Pilot projects: Rs.1,466 cr
- R & D: Rs.400 cr
- Other Mission Components: Rs.388 cr

Guidelines for Implementation 1

- By Ministry of New and Renewable Energy
- Overall Mission Coordination & Implementations

Outcomes by 2030: 2

- Development of green hydrogen production capacity – atleast 5MMT per annum
- Additional renewable energy capacity – 125GW
- Total investments – Rs.8 Lakh crore
- Create over 6 Lakh jobs
- Reduction in fossil fuel imports – Rs.1 lakh crore
- Abatement – 50MMT of annual GHG emission

Benefits 2

- Creation of export opportunity for Green Hydrogen & its derivatives.
- Decarbonization of industrial, Mobility and energy sector.
- Reduction – Imported fossil fuel & feedstock
- Development – Indigenous manufacturing capabilities
- Creation – Employment Opportunities
- Development of cutting edge technologies.

SIGHT Programme 1

- Strategic Interventions for Green Hydrogen Transition Programme
 - 2 district financial incentive mechanism
1. Domestic manufacturing of electrolysis
 2. Production of Green hydrogen

Green Hydrogen Hubs 2

- Regions capable of supporting large scale production and utilization of Hydrogen

Pilot projects:

- Emerging end use sectors
- Production pathways

Research & Development 2

- Strategic Hydrogen Innovation partnership (SHIP)
- Public private partnership framework.
- Coordinated skill development programme.
- Goal oriented, time bound, scaled upto develop globally competitive technologies.

Green Hydrogen 3

- Produced by electrolysis of water using renewables energy (solar, wind)
- Has Lower carbon footprint

- By products, Water & Water usage.
- Brown hydrogen – Using coal, emission released to air
- Gray hydrogen – From Natural gas, emissions released to air.
- Blue hydrogen – From Natural gas, emission are captured using carbon capture and storage.

India's position

- 70% of India's electricity generation comes from coal.
- India is heavily dependent on crude oil for transportation.
- Imports crude oil from abroad.
- India approves green hydrogen project considering environmental impact.
- Thus India fulfills its self requirement

2) Write Short Notes

a) Atomic radius and Ionic radius

b) Ortho and Para Water

c) Carbon nanotubes

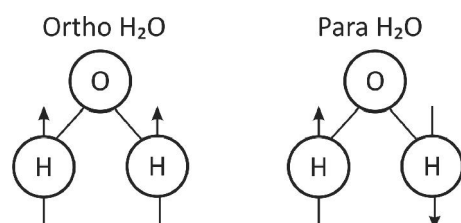
a) Atomic radius 5

- Atomic radius of an atom is defined as the distance between the centre of its nucleus and the outermost shell containing the valence electron.
- It is not possible to measure the radius of an isolated atom directly. Except for noble gases, usually atomic radius is referred to as covalent radius or metallic radius depending upon the nature of bonding between the concerned atoms.

Ionic radius

- It is defined as the distance from the centre of the nucleus of the ion up to which it exerts its influence on the electron cloud of the ion.
- Ionic radius of uni-univalent crystal can be calculated using Pauling's method from the inter ionic distance between the nuclei of the cation and anion.

b) Ortho H₂O and Para H₂O 5



- **Ortho H₂O**: Spin direction of nuclei of hydrogen atoms are parallel.
- **Para H₂O**: Spin direction of nuclei of hydrogen atoms in water are anti parallel
- Like Hydrogen water also classified as ortho & Para water.
- Ortho water - Hydrogen in water molecule spin same direction.
- Para water - Hydrogens in water molecule spin opposite direction.
- At 300k on earth, ortho to para ratio (OPR) of water is 3:1
- Para water is high in Interstellar clouds and comets, OPR of water should be 2:5:1.

c) Carbon Nanotubes **5**

- A carbon nanotube is a carbon allotrope that resembles a tube of carbon atoms. Carbon nanotubes are extremely robust and difficult to break, but they are still light.
- Because of their exceptional mechanical, electrical, and thermal properties, carbon nanotubes are one of the most investigated nano materials.
- Multiwall carbon nanotubes feature several concentric cylindrical lattices of carbon atoms, whereas single wall carbon nanotubes have only one cylinder of carbon atoms.
- Buckytube is another name for carbon nanotubes.
- Two-dimensional graphite is folded or rolled into a cylindrical shape structure to create nanotubes. Inside, nanotubes are hollow. The nanotube has a diameter of 1-3 nanometers.

Applications

- Carbon nanotubes are utilized in energy storage, device modelling, automotive parts, boat hulls, sporting goods, water filters, thin-film electronics, coatings, actuators, and electromagnetic shields.
- Because of their large surface area, CNTs have been successfully used in pharmacy and medicine to adsorb or conjugate a wide range of medicinal and diagnostic substances

3) Explain in detail about genetical disorders due to chromosomal abnormalities.**Chromosomal Abnormalities****3**

- Each human diploid (2n) body cell has 46 chromosomes (23 pairs). Chromosomal disorders are caused by errors in the number or structure of chromosomes. Chromosomal anomalies usually occur when there is an error in cell division.
- Failure of chromatids to segregate during cell division resulting in the gain or loss of one or more chromosomes is called aneuploidy. It is caused by non- disjunction of chromosomes.
- Group of signs and symptoms that occur together and characterize a particular abnormality is called a syndrome.
- In humans, Down's syndrome, Turner's syndrome, Klinefelter's syndrome, Patau's syndrome are some of the examples of chromosomal disorders.

Autosomal aneuploidy in human beings**1**

- Several autosomal aneuploidies have been reported in human beings. eg. Down's syndrome (21-Trisomy), Patau's syndrome (13-Trisomy).

Down's Syndrome/Trisomy - 21**2**

- Trisomic condition of chromosome - 21 results in Down's syndrome.
- It is characterized by severe mental retardation, defective development of the central nervous system, increased separation between the eyes, flattened nose, ears are malformed, mouth is constantly open and the tongue protrudes.

Patau's Syndrome/Trisomy-13**2**

- Trisomic condition of chromosome 13 results in Patau's syndrome. Meiotic non disjunction is thought to be the cause for this chromosomal abnormality.
- It is characterized by multiple and severe body malformations as well as profound mental deficiency. Small head with small eyes, cleft palate, malformation of the brain and internal organs are some of the symptoms of this syndrome.

Allosomal abnormalities in humanbeings 1

- Mitotic or meiotic non-disjunction of sex chromosomes causes allosomal abnormalities. Several sex chromosomal abnormalities have been detected. Eg. Klinefelter's syndrome and Turner's syndrome.

Klinefelter's Syndrome (XXY Males) 3

- This genetic disorder is due to the presence of an additional copy of the X chromosome in male.
- Persons with this syndrome have 47 chromosomes (44AA+XXY).
- They are usually sterile males, tall, obese, with long limbs, high pitched voice, under developed genitalia and have feeble breast (gynaecomastia) development.

Turner's Syndrome (XO Females) 3

- This genetic disorder is due to the loss of a X chromosome resulting in a karyotype of 45,X.
- Persons with this syndrome have 45 chromosomes (44 autosomes and one X chromosome) (44AA+XO) and are sterile females.
- Low stature, webbed neck, under developed breast, rudimentary gonads lack of menstrual cycle during puberty, are the main symptoms of this syndrome.

4) Explain in detail about various generation of vaccine.

Vaccines 15

- A vaccine is a biological preparation that provides active acquired immunity to a particular disease and resembles a disease – causing microorganism and is often made from weakened or attenuated or killed forms of the microbes, their toxins, or one of its surface proteins.
- Vaccines “teach” our body how to defend itself when viruses or bacteria, invade it.
- Vaccines deliver only very little amounts of inactivated or weakened viruses or bacteria, or parts of them.
- This allows the immune system to recognize the organism without actually experiencing the disease.

- Some vaccine need to be give more than once (i.e., a ‘booster’ vaccination) to make sure the immune system can overcome a real infection in the future.
- Vaccine initiates the immunization process. The vaccines are classified as first, second and third generation vaccines.

First generation vaccine

- First generation vaccine is further subdivided into live attenuated vaccine, killed vaccine and toxoids (Fig).
- Live attenuated vaccines use the weakened (attenuated), aged, less virulent form of the virus. E.g. Measles, Mumps and Rubella (MMR) vaccine and the Varicella (chickenpox) vaccine, Killed (inactivated) vaccines are killed or inactivated by heat and other methods. E.g. Salk's polio vaccine.
- Toxoid vaccines contain a toxin or chemical secreted by the bacteria or virus.
- They make us immune to the harmful effects of the infection, instead of to the infection itself. E.g. DPT vaccine (Diphtheria, Pertussis and Tetanus).

Second generation vaccine

- Second generation vaccine contains the pure surface antigen of the pathogen. E.g. Hepatitis-B vaccine.

Third generation vaccine

- Third generation vaccine contains the purest and the highest potency vaccines which are synthetic in generation. The latest revolution in vaccine is DNA vaccine or recombinant vaccine.
- The practice of using preventive medicine as curative medicine is called vaccine
- In 1796, Dr. Edward Jenner was the first to develop a vaccine against smallpox.
- Jonas Salk develop vaccine against polio (killed vaccine)
- Dr. Albert Bruce Sabin develop vaccine that one receive it by drops in the mouth.
- Louis Paster (1885) developed vaccine for rabies, Anthrax and cholera.
- Calmette and Guerin develop BCG vaccine against Tuberculosis in France 1908.

5) Explain any two of the following**a) Microbial Fuel cell****b) Bioremediation****c) DNA Vaccine****a) Microbial Fuel Cell (MFC)****5**

- A microbial Fuel Cell is a bio-electrochemical system that drives an electric current by using bacteria and mimicking bacterial interaction found in nature (Fig).
- Microbial Fuel Cells work by allowing bacteria to oxidize and reduce organic molecules.
- Bacterial respiration is basically one big redox reaction in which electrons are being moved around.
- A MFC consists of an anode and cathode separated by a proton exchange membrane.- Microbes at the anode oxidize the organic fuel generating protons which pass through the membrane to the cathode and the electrons pass through the anode to the external circuit to generate current.

b) Bioremediation**5**

- The use of naturally occurring or genetically engineered microorganisms to reduce or degrade pollutants is called bioremediation.
- Bioremediation is less expensive and more sustainable than other remediations available.
- It is grouped into in situ bioremediation (treatment of contaminated soil or water in the site) and ex situ bioremediation (treatment of contaminated soil or water that is removed from the and treated).

Microorganisms involved in bioremediation

- Aerobic microbes degrade the pollutants in the presence of oxygen. They mainly degrade pesticides and hydrocarbons.
- Pseudomonas putida is a genetically engineered microorganism (GEM).
- Ananda Mohan Chakrabarty obtained patent for this recombinant bacterial strain.
- It is multi-plasmid hydrocarbon – degrading bacterium which can digest the hydrocarbons in the oil spills.

- Nitrosomonas europaea is also capable of degrading benzene and a variety of halogenated organic compounds including trichloroethylene and vinyl chloride.

- Ideonellasakaiensis is currently tried for recycling of PET plastics (Fig). These bacteria use PETase and MHETase enzymes to breakdown PET plastic into terephthalic acid and ethylene glycol.

- Anaerobic microbes degrade the pollutants in the absence of oxygen.

- Dechloromonas aromatica has the ability to degrade benzene anaerobically and to oxidize toluene and xylene.

- Phanerochaete chrysosporium an anaerobic fungus exhibits strong potential for bioremediation of pesticides, polyaromatic hydrocarbons, dyes, trinitrotoluene, cyanides, carbon tetrachloride, etc., Dehalococcoides species are responsible for anaerobic bioremediation of toxic trichloroethene to non-toxic ethane.

- Pestalotiopsis fungus capable of breaking down and digesting polyurethane. This makes the fungus a potential candidate for bioremediation projects involving large quantities of plastics.

c) DNA Vaccine**5****DNA Vaccines**

- Genetic immunisation by using DNA vaccines is a novel approach that came into being in 1990.

- The immune response of the body is stimulated by a DNA molecule.

- A DNA vaccine consists of a gene encoding an antigenic protein, inserted onto a plasmid, and then incorporated into the cells in a target animal.

- DNA instructs the cells to make antigenic molecules which are displayed on its surfaces.

- This would evoke an antibody response to the free floating antigen secreted by the cells.

- The DNA vaccine cannot cause the disease as it contains only copies of a few of its genes.

- DNA vaccines are relatively easy and inexpensive to design and produce.
- Vaccines produced by these new techniques have definite advantages like producing target proteins, long lasting immunity and trigger immune response only against specific pathogens with less toxic effects.
- Recombinant hepatitis B vaccine is a subunit vaccine.
- It is produced by combining Hb (Hepatitis B Virus) obtained from a bacteria.
- These are sold under trade names Recambivax and Engerix B.
- After USA, France and Belgium, India is the 4th country to develop its own hepatitis B vaccine.
- The resultant recombinant DNA is cloned in the yeast, *Saccharomyces cerevisiae*.

6) Evaluate in detail about India's Biodiversity conservation measures.

Biodiversity conservation in India 2

- India is one of the 17 mega bio-diverse countries of the world (according to - Conservation International).
- With only 2.4% of the world's land area, 16.7% of the world's human population and 18% of livestock, it contributes about 8% of the known global biodiversity.
- India has a number of globally important endangered species like Asiatic lion, Asian elephant, one-horned rhinoceros, Gangetic river dolphin, snow leopard, Kashmir stag, dugong, gharial, great Indian bustard, lion tailed macaque etc.
- The following steps have thus been taken to protect and manage the wildlife of the country. **13**

1. The Government of India enacted the Wild Life (Protection) Act 1972 with the objective of effectively protecting the wild life of this country and to control poaching, smuggling and illegal trade in wildlife and its derivatives.
2. The National Board for Wildlife (NBWL) chaired by the Prime Minister of India, provides for policy framework for wildlife conservation in the country.

3. The National Wildlife Action Plan (2002–2016) was adopted in 2002, emphasizing the people's participation and their support for wildlife conservation.
4. The Indian Constitution lays the subject of forests and wildlife in the Concurrent list thus laying the responsibility of wildlife conservation on both the Centre and the State.
5. Specialised projects: To save the endangered species of animals, specialised projects are being implemented with international cooperation (WWF, UNDP, UNEP, IUCN) as well as on a stand-alone basis like the following Table.
- More recently, the Black Buck (chinkara) the Great Indian Bustard and the snow leopard have been given full or partial legal protection against hunting and trade throughout India

Specialised projects in India

Sl.No	Name of the Project	Year
1	Project Tiger	1973
2	Operation Crocodile	1975
3	Project Rhinoceros	1987
4	Project Snow Leopard	2009
5	Project Elephant	1988
6	Project Sea Turtle	1999

6. The Protected Areas of India

- Protected areas are those in which human occupation is small and exploitation of resources is limited.
- These are defined according to the categorization Table.
- There are 4 categories of the Protected Areas in India.
- National Parks
- Wildlife Sanctuaries
- Conservation Reserves, and
- Community Reserves.

National Park

- National parks in India are IUCN
- Category II protected areas

Protected Areas of India (Jan 2017)

Protected Areas	Number	Total Area in sq Km	% of the Country
National Parks (NPs)	103	40500	1.2
Wild life Sanctuaries (WLSs)	537	118005	3.6
Conservation Reserves (CRs)	67	2350	0.1
Community Reserves	26	47	0.01
Total Protected Areas (PAs)	733	160902	4.91

- A National park is an area with ecological, geomorphological and natural significance with rich fauna and flora, designed to protect and to develop wildlife or its environment.
- Activities like grazing, hunting, forestry or cultivation etc. are strictly prohibited.- No human activity is permitted inside the national park.
- India's first national park was established in 1936 as Hailey National Park, now known as Jim Corbett National Park, Uttarakhand.
- There are 103 national parks in India (National Wildlife Database, April 2015).

Wildlife Sanctuary

- The difference between a Sanctuary and a national park lies mainly in the rights of people living inside.
- In a Sanctuary, certain rights are allowed but in a national park, no rights are allowed for grazing of any livestock.
- In a wildlife Sanctuary, the Chief Wildlife Warden may regulate, control or prohibit certain activities.
- There are a total of 537 wildlife sanctuaries in India.

Conservation reserves

- These terms denote the protected areas of India which typically act as buffer zones between established national parks, wildlife sanctuaries and reserved and protected forests of India.
- They are called as 'Conservation Reserves' if they are uninhabited and completely owned by the Government of India but used for subsistence by communities.

Community Reserves

- They are called 'Community Reserves' if a part of the land is privately owned.

7. Biosphere Reserves

- A biosphere reserve is an area of land or water that is protected by law in order to support, sustain and conserve ecosystems.
- Biosphere Reserves of India protect very large areas of natural habitat that are much bigger than national parks or wildlife sanctuaries.
- Biosphere reserves may cover multiple national parks, sanctuaries and reserves which are contiguous.
- Example, the Nilgiri Biosphere covers: Bandipur National Park, Mudumalai Tiger Reserve, Silent Valley National Park, Nagarhole National Park and Mukurthi National Park.
- Biosphere reserves are traditionally organized into 3 interrelated zones, known as: 1. Core area, 2. Buffer zone, 3. Transition zone.
- Presently, there are 18 notified biosphere reserves in India. Ten out of the eighteen biosphere reserves are a part of the World Network of Biosphere Reserves, based on UNESCO's Man and the Biosphere (MAB) Programmed list.

8. Some Other Important Conservation Sites

- Tiger Reserves – Project Tiger was launched by the Government of India in the year 1973 to save the endangered species of tiger in the country.
- Starting from nine (9) reserves in 1973 the number has now grown to fifty (50) in 2016. Table gives a list of conservation sites and their numbers in India.

9. Role of communities

- Communities are playing a vital role in the conservation and protection of wildlife in India, example:

- **Sariska Tiger Reserve:** In Sariska tiger reserve Rajasthan villagers have fought against mining by citing the wildlife protection act. In many areas, villagers themselves are protecting habitats and explicitly rejecting government involvement.
- **Bhairodev Dakav Sonchuri:** The inhabitants of five villages in the Alwar district of Rajasthan have declared 1200 hectares of forests as the

- **Bhairodev Dakav Sonchuri** declaring their own set of rules and regulation which do not allow hunting, and are protecting the wildlife against any outside encroachments.
- **Bishnoi villages :** In and around Bishnoi villages in Rajasthan, herds of blackbuck, nilgai and peacocks can be seen as an integral part of the community and nobody harms them.

Important Conservation Sites In India (Dec 2016)

Reserves/Conservation Sites	Numbers	Total Area in Sqkm.
Tiger Reserves	50	71027
Elephant Reserves	32	69583
Biosphere Reserves	18	57492
RAMSAR Wetland Sites	26	12119
Natural World Heritage Sites	07	11756
Important Coastal and Marine Biodiversity Areas	107	10773
Marine Protected Areas	131	9801
Potential/ Important Bird Areas	563	-

7) Explain the functions of Institutions involved in India's disaster research.

Disaster

1

- Disruption. on a massive scale, either natural or man made, occurring in short or long Periods
- Institutions involved in disasters Research in their functions

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1. National Institute of disaster management:

- Statutory organization under National Disaster management Act 2005.
- Under Ministry of Home Affairs

Functions:

- Planning, promoting training and research in disaster management documentation & development of national level information relating to du outer management policies
- Develop training module, undertake researches documentation, organize training programmer.
- Provide assistance to national policy formulation.
- Promote awareness among stake holder.
- Develop educational material for disaster management

2. National Centre for Seismology.

- Nodal agency for earthquake monitoring
- Under Ministry of Earth Sciences.

Functions:

- Earthquake monitoring on 24 x 7 basics
- Operation & maintenance of national Seismological network
- Maintenance of Seismological data center & information Services
- Seismic hazard microzonation Studies
- Public Outreach.
- After Shock / Earthquake swarm survey

3. Indian Tsunami Early Warning Centre:

- Established at Indian National Centre for Ocean Information Science (INCOIS)
- Under Ministry of Earth Science

Functions

- Approved Tsunami Service provider of Indian Ocean Tsunami Warning & Mitigation system (10 TWMS)
- Operates 24 * 7 rapidly detect large earthquakes assessing Tsunamis potentials.

4. Cyclone Warning and Research centre:

- Established by IMD 1982

- At Regional Meteorological Centre, Chennai.

Functions

- Carryout research works - Structure, Intensification, movement and development of Tropical cyclones
- Develop Storm surge model for Indian Coast
- Awareness about damage to life & property due to cyclone disturbance.
- Advice government authorities for Planning contingency measures
- Preparation of brief materials, progress reports in International Sessions.

5. Centre for climate change Research:

- Established at Indian Institute of Tropical Meteorology, Pune.

Functions

- Develop high resolution Earth System models (FSM)
- Use regional climate models to produce projections of Indian Monsoon
- Study Monsoon Variability & predictability
- Develop hydrological model for estimation of run off and soil moisture.

8) What is Genetic engineering? What are its importance in medical field? 1**Genetic engineering / Genetic modification**

- Direct manipulation of an organisms genome using bio technology.

Genetic Engineering: 2

- Manual addition of a new DNA into an organism that are not originally found.
- Helps to create Genetically Modified organisms (GMO), treat Genetic disorders.
- First recombinant DNA molecules created by an American Biochemist, Paul Berg.

Applications:Benefits 1

- Medicine
- Research
- Industry

- Agriculture

Medical Biotechnology: 11**1. CRISPR**

- Technology utilizes as a protein as molecular scissors.
- To alter DNA and modify gene functions
- Applications - Correcting genetics defects, treating disease, preventing spread of disease, Improving crops.

2. Recombinant DNA Technology

- Inserting new DNA into host organisms

Applications

- Biopharmaceutical
- Energy applications - Biofuel
- Modified fruits & Vegetables
- Recombinant medicine Insulin

3. Hormone therapy:

- Stimulating the Secretion of Human growth Hormone.
- Follicle stimulating hormone.
- To correct genetics disorder due to hormonal malfunction.

4. Vaccines

- HPV Vaccine - Human papilloma Virus
- For cervical Cancer
- DNA and RNA vaccine for COVID - 19.

5. Genetic Testing

- Help people understand their heritage genetics & heritage
- Identify Breast Cancer, Parkinsons and Alzheimers.
- 6. Manufacturing of drugs, Human albumin, monoclonal antibodies
- 7. Creation of model animals that mimic human. Conditions - Therapeutic cloning.
- 8. Disease Such as Malaria, dengue can be eliminated by sterilising the mosquitoes using genetic engineering.