SIVARAJAVEL IAS ACADEMY
FOUNDER - DIRECTOR OF SMART LEADERS IAS

TOPICS & POINTERS

Exclusively For
UPSC Mains 2022

SCIENCE & TECHNOLOGY

GS-3

MAINS WORK BOOK

METIS 2022

Mentoring and Enabling Through Intelligent Support System

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TOPICS AND POINTERS

2022- MAINS STUDY MODULE

TOPICS & POINTERS

ABOUT

The material aims to equip the aspirants with enough knowledge to attempt mains questions by incorporating various dimensions. This material will be provided every week as per the test module.

HOW TO READ THIS ?

1. Only key points will be provided .
2. Readers are advised to make a synopsis from topics and points given.
3. Make your own chart, diagrams and maps after reading the topics.
4. Understand the topics. Don't try to memorise them but link organically
5. Make sure to complete the module before the Test on Sunday.
6. Revise, Write, Practice- Repeat

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MAINS ANSWER WRITING CHALLENGE

Starting from 13th of June till the end of the test schedule every day two questions will be posted and answers may be provided in the evening.

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HEAD OFFICE :
No.97, AF Block, 4th Avenue, 12th Main Rd,
Shanthi Colony, Anna Nagar, Chennai - 600 040.
✆ : **962636 4444 / 962636 9899**

NELLAI BRANCH
No.106B, 3rd floor, Gilgal Complex,
Trivandrum Road, Palayamkottai - 627002.
✆ : **9626252500 / 9626253300**

TRICHY BRANCH
No.143, 4th Floor, Lakshmi Complex,
Salai Road, Thillai Nagar, Trichy - 620018.
✆ : **9751500300/ 9786500300**

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Previous Year Questions

2021 – Science & Technology Questions in UPSC Mains

1. How is the S-400 air defence system technically superior to any other system presently available in the world? (Answer in 150 words)
2. What are the research and developmental achievements in applied biotechnology? How will these achievements help to uplift the poorer sections of society? (Answer in 250 words)
3. The Nobel Prize in Physics in 2014 was jointly awarded to Akasaki, Amano, and Nakamura for the invention of Blue LEDsin 1990s. How has this invention impacted the everyday life of human beings? (Answer in 250 words)

2020 – Science & Technology Questions in UPSC Mains

1. What do you understand by nanotechnology and how is it helping in the health sector?
2. How is science interwoven deeply with our lives? What are the striking changes in agriculture triggered off by science-based technologies?
3. COVID-19 pandemic has caused unprecedented devastation worldwide. However, technological advancements are being availed readily to win over the crisis. Give an account of how technology was sought to aid the management of the pandemic.

2019 – Science and Technology Questions in UPSC Mains

1. What is India's plan to have its own space station and how will it benefit our space programme?
2. How can biotechnology help to improve the living standards of farmers?
3. Give an account of the growth and development of nuclear science and technology in India. What is the advantage of a fast breeder reactor programme in India?
4. How is the Government of India protecting traditional knowledge of medicine from patenting by pharmaceutical companies?

2018 – Science and Technology Questions in UPSC Mains

1. Discuss the work of 'Bose-Einstein Statistics' done by Prof. Satyendra Nath Bose and show how it revolutionized the field of Physics.
2. Why is there so much activity in the field of biotechnology in our country? How has this activity benefitted the field of biopharma?
3. With growing energy needs should India keep on expanding its nuclear energy programme? Discuss the facts and fears associated with nuclear energy.

2017 – Science and Technology Questions in UPSC Mains

1. Stem cell therapy is gaining popularity in India to treat a wide variety of medical conditions including leukaemia, Thalassemia, damaged cornea and several burns. Describe briefly what stem cell therapy is and what advantages it has over other treatments?

2. India has achieved remarkable successes in unmanned space missions including the Chandrayaan and Mars Orbiter Mission, but has not ventured into manned space missions, both in terms of technology and logistics? Explain critically

2016 – Science and Technology Questions in UPSC Mains

1. What is allelopathy? Discuss its role in major cropping systems of irrigated agriculture.
2. Discuss India's achievements in the field of Space Science and Technology. How the application of this technology has helped India in its socio-economic development?
3. Why is nanotechnology one of the key technologies of the 21st century? Describe the salient features of Indian Government's Mission on Nanoscience and Technology and the scope of its application in the development process of the country.

2015 – Science and Technology Questions in UPSC Mains

1. How can the 'Digital India' programme help farmers to improve farm productivity and income? What steps has the Government taken in this regards?
2. To what factors can the recent dramatic fall in equipment costs and tariff of solar energy be attributed? What implications does the trend have for the thermal power producers and the related industry?
3. What do you understand by 'Standard Positioning Systems' and 'Protection Positioning Systems' in the GPS era? Discuss the advantages India perceives from its ambitious IRNSS programme employing just seven satellites.
4. What are the areas of prohibitive labour that can be sustainably managed by robots? Discuss the initiatives that can propel research in premier research institutes for substantive and gainful innovation.
5. Discuss the advantage and security implications of cloud hosting of servers vis-a-vis in-house machine-based hosting for government businesses.
6. India's Traditional Knowledge Digital Library (TKDL) which has a database containing formatted information on more than 2 million medicinal formulations is proving a powerful weapon in the country's fight against erroneous patents. Discuss the pros and cons of making this database publicly available under open-source licensing.

2014 – Science and Technology Questions in UPSC Mains

1. Can overuse and the availability of antibiotics without doctor's prescription, the contributors to the emergence of drug-resistant diseases in India? What are the available mechanisms for monitoring and control? Critically discuss the various issues involved.
2. Scientific research in Indian universities is declining, because a career in science is not as attractive as our business operations, engineering or administration, and the universities are becoming consumer-oriented. Critically comment.
3. In a globalised world, intellectual property rights assume significance and are a source of litigation. Broadly distinguish between the terms – copyrights, patents and trade secrets.

2013 – Science and Technology Questions in UPSC Mains

1. Bringing out the circumstances in 2005 which forced an amendment to the section 3(d) in Indian Patent Law, 1970, discuss how it has been utilized by the Supreme Court in its judgement in rejecting Novartis' patent application for 'Glivec'. Discuss briefly the pros and cons of the decision.
2. What do you understand by Fixed-Dose drug Combinations (FDCs)? Discuss their merits and demerits.
3. What is a digital signature? What does its authentication mean? Give various salient built-in features of a digital signature.
4. How does 3D printing technology work? List out the advantages and disadvantages of the technology.
5. What is an FRP composite material? How are they manufactured? Discuss their application in the aviation and automobile industries.

1.	**Brahmos in the international arena**	
	– The BrahMos is a ramjet supersonic cruise missile of a short-range developed by the Defense Research and Development Organisation (DRDO) and the Russian Federation's NPO Mashinostroyeniya (NPOM). – When compared to subsonic cruise missiles, BrahMos has three times the speed, 2.5 times flight range and higher range. – Features of BrahMos – Stealth Technology – Advanced guidance system – High Target Accuracy (irrespective of weather conditions) – Constant supersonic speed – Operates on 'Fire and Forget' Principle – BrahMos can be launched from land, aircraft, ships, and even submarines. – One of the heaviest missiles, weighing up to 2.5 tones – The range of the missile was originally capped at 290 km as per obligations of the Missile Technology Control Regime (MTCR). – However, following India's entry into the MTCR club in June 2016, the range is planned to be extended to 450 km and to 600km at a later stage. – Philippines has placed an order of $375 million for the BrahMos supersonic cruise missiles. The Philippines is set to become the first foreign customer for the BrahMos – India has been in talks with several Southeast Asian countries, including Thailand, Indonesia and Vietnam, in recent years to sell them land and sea-based versions of the BrahMos. India has set an ambitious target of achieving defense exports worth $5 billion by 2025. – India's entry to the MTCR club and as a result the range of Brahmos to be increased to 450km and 600km can be seen as a huge success in India's diplomacy and the role India plays in the international arena. – Gaining the privilege after decades shows the global powers have started to realize the inevitability of India in the Global arena – Export of Brahmos to Philippines has become a milestone in the history of modern India where it has marked the point where India elevated itself from an importer of arms to exporter of arms.	

	– While India has achieved and proved herself in commercial space technology, now it has set its foot in the billion dollar business of arms export – This will give a boost to move forward where Tejas, our indigenous submarines are more are on the list.	
2.	**Crime and copyright infringement**	
	– The issue of copyright is worldwide debate and particularly in India where it is often taken lightly. But the recent SC judgment that copyright infringement is a cognizable and non-bailable offense under CrPc has brought to end the age long debate but at the same time raised questions about it – A 'copyright' can be defined as a packet/bundle of rights given by the law to the creators of literary, dramatic, artistic works, and musicals and the producers of cinematographic films and sound recordings. **Can the judgment have any negative consequences?** – It might pave the way for police to impinge on civil liberties. – Many copyright owners, especially in the software and music industries, could use the threat of police involvement to scare potential infringers to extort for police to impinge on civil liberties. – It takes away the right of the accused to post a bail bond with the police and shifts the responsibility on to the courts for judicial determination on a case by case basis. – Section 52 of the copyrights act talks about the fair use that cannot be determined properly by the investigating officer – A cognisable offence is an offence in which the police officer as per the first schedule of the Indian Penal Code or under any other law for the time being in force, can arrest the convict without a warrant and can start an investigation without the permission of the court. Cognizable offences are generally heinous or serious in nature such as murder, rape, kidnapping, theft, dowry death etc. The first information report (FIR) is registered only in cognizable crimes. – Under section 154 Criminal Procedure Code (CrPC), a police officer is bound to register an FIR in case of a cognizable crime. – Some of the examples of a cognizable offence are as follows: – Murder – Rape – Dowry Death	

	– Kidnapping – Theft – Criminal Breach of Trust – Unnatural Offenses – So including copyright infringement as a cognizable offence in line with the above heinous crimes should need more discussion. **Copyright Act in India** – In 1914, when the British extended the imperial copyright act, 1911 to India (copyright infringement was punishable only with a monetary fine) – Since 1957, the prison term for copyright infringement has been tripled by Parliament to Three years. – India is a member of some of the most important international conventions, such as the Universal Copyright Convention. These international bodies deal with anything regarding copyright laws. **International convention on copyright** – Article 61 of the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) requires criminal measures to be applied for at least "willful copyright piracy" on a commercial scale. – Copyright piracy itself remains undefined in TRIPS. – India's international law obligations under the TRIPS do not require India to criminalize all kinds of copyright infringement. – While protecting the copyrights is inevitable in a democracy without which creators will cease to exist, we should also take care that it does not impinge on fair use which is as essential as protecting copyright.	
3.	**Nuclear fusion breakthrough**	
	– Scientists have been making efforts to build a fusion nuclear reactor for several decades, but the challenges are high. – Scientists in the United Kingdom have managed to produce the largest amount of energy so far from a nuclear fusion reaction – The reactor produced 11 megawatts of energy over a five-second period. – All current nuclear reactors are based on the fission process – Much more energy is released in the fusion process than in fission. The fusion of atoms of two heavier isotopes of hydrogen — deuterium and tritium — for example, to form a helium nucleus produces four times as much	

energy as is released during the fission of a uranium atom

- One kilogram (kg) of fusion fuel contains about 10 million times as much energy as a kg of coal, oil or gas.
- Fusion produces no carbon emissions, the raw materials are in sufficient supply, and produces much less radioactive waste compared to fission, and is considered much safer.
- Fusion is possible only at very high temperatures, of the order of a few hundred million degrees Celsius, the kind of temperature that exists at the core of the Sun and the stars.
- The materials that will make up the reactor, too, need to be able to withstand such huge amounts of heat.
- There are several other complications. At such high temperatures, matter exists only in the plasma state, where atoms break up into positive and negative ions due to excessive heat. Plasma, which has a tendency to expand very fast, is extremely difficult to handle and work with.
- ITER (International Thermonuclear Experimental Reactor) is being built in southern France with the collaboration of 35 countries, including India which is one of the seven partners, alongside the European Union, the United States, Russia, Japan, South Korea and China.
- Fusion is seen as an answer to the problem of climate change because it produces zero emissions.
- Still, ITER is only an experimental project. The energy it will produce — about 500 MW — would not be in the form of electricity that can be used. It will be a technology demonstration machine that will enable the building of futuristic fusion devices that can be run as normally as the fission reactors today.
- India joined the ITER project in 2005. The Institute for Plasma Research in Ahmedabad, a laboratory under the Department of Atomic Energy, is the lead institution from the Indian side participating in the project.
- The world at the verge of climate change mitigation where IPCC has said we will fail to achieve the 2 degree temperature mask. This breakthrough can be seen as blessing at this moment

4.	**Protecting UPI, a jewel among Indian fintech innovations NITI Aayog**	
	– UPI- a key driver in economic growth – Since UPI's launch in 2017, India has been improving financial inclusion at a CAGR of 5%-plus **Fintech companies** – Areas of FinTech Innovation – Cybersecurity and fintech are intertwined. – Cryptocurrency and digital cash, Blockchain technology, Smart contracts, Open banking, Insurtech, Regtech – Key Growth Drivers of FinTech in India – Widespread identity formalisation (**Aadhar**): 1.2 bn enrolments. – High level of banking penetration through the Jan Dhan Yojana: 1+ bn bank accounts. – High smartphone penetration: 1.2 bn mobile subscribers. – **India Stack**: Set of APIs for businesses and startups. – Growing disposable income of Indians. – Key government initiatives such as UPI and **Digital India.** – Wide middle-class expansion: By 2030, India will add 140 mn middle-income and 21 mn high-income households which will drive the demand and growth in the Indian FinTech space. **Challenges** – Cyber-Attacks – Data Privacy Issue – Difficulty in Regulation – unregulated ground for scams and frauds. – Fintech - Diversity of offerings in services - ddifficult to formulate a single and comprehensive approach. **Way Forward** – Attaining Atma-Nirbharta (Self-Sufficiency) in offensive as well as defensive cybersecurity capabilities. – Educating Consumers – a strong data protection framework in India	
5.	**WHO Report on Assistive Technology for Disabled a Roadmap for India**	
	– Different disabilities require different assistive technologies, and these are designed to help people who have difficulty speaking, typing, writing, remembering, seeing, hearing, learning, or walking. – Global Report on Assistive Technology (GReAT) report	

	– reveals that more than 2.5 billion people need one or more assistive products, such as wheelchairs, hearing aids, or apps that support communication and cognition. – A billion people globally are currently estimated to be in need of assistive technology (AT); this is projected to double by 2050. **Barriers to access and coverage of Assistive technology** – age, gender, type of functional difficulty, location and socioeconomic status of those in need of AT. – safety, performance, quality and standard issues – Repairing, refurbishing, and reusing assistive products – remain below par – Lack of awareness reg. the AT products. – Products are often sub-standard and lead to poorer health outcomes. – Affordability – **Government's schemes** – Assistance to Disabled Persons for Purchase Fitting of Aids and Appliances (ADIP) Scheme – GST concession to PWDs – Unique Disability ID **Way forward** – The positive impact of assistive products goes beyond improving the health, well-being, participation and inclusion of individual users → achieve SDG and UHC.	
6.	**The Role of Technology in Balancing Environmental Protection and Economic Development**	
	– Many technological developments have transformed, reoriented and also broke the hurdles of environment degradation in the path of economic development that became indispensable in the modern era. o RRR policy –Technological changes in Waste minimization – use of less hazardous spares (material substitution) , changed production processes , effective usage of resources – Reduces need for resources o Tracking the waste producing products - extended producer responsibility –specifically in Ewaste from semiconductors and other electronics. Technology aids in these functions o Clean technologies aiding transport and cooling – Air conditioners transition from Chlorofluoro carbons to hydrofluoro carbons - Transition from	

	diesel\ Petrol to Hybrid EV vehicles, alternate fuels such as ethanol, CNG etc. o Bioremediation technology, Microbial treatment of sewage etc., - non toxic treatment facilities o Alternate technologies for waste reduction at source – example :Nano technologies o Technology focused on monitoring the implementation of the laws against violation of environment – eg. Role of technology in Environment impact assessment o Production control and monitoring technologies – Pollution control monitoring technologies – AQMS SYSTEMS o Climate change monitoring technologies – Forecasting climate change levels – preparing mitigation plans such as Net zero etc., - can optimize with the limits of growth **Issues despite technological developments** – Expensive technologies cannot assume its scale – without adoption further R&D becomes inaccessible – Vested interests and cartels of large corporates - Technology not rooted to societal values – Irresponsive to social and economic conditions **Impact of technology in sustainable development** – Incentives to innovative research over such technologies – Minimal changes to the status quo – facilitating growth sustainably – Planned exploitation of resources within the environmentally safer levels – International collaboration on sustainable economic growth with enhanced Information handling systems and databases (Use of Bigdata, cloud computing) – Dissemination of social awareness and socially right behaviors – Employment generation from the environmentally appropriate technologies – Green Jobs	
7.	**Agritech Enabling Farming- as- a- Service (FaaS) in India**	
	Intro – The agritech ecosystem → an ecosystem of companies and startup enterprises → capitalizing on technological advancements to deliver products or services for increasing yield, efficiency → both in terms of time and cost & profitability for farmers across the agriculture value chain	

Agri-tech in India

- The overall agritech ecosystem → revenue growth of 85 percent during FY 2019-20.
- Bain & Company report + Confederation of Indian Industry (CII) → private equity investors have focused on systemic issues in the agritech industry & its sustainable development.
- A surge of agritech start-ups have entered the ecosystem to offer technology-based solutions like
- off take marketplaces
- storage and transportation services
- agronomy advisory services
  while large traditional players → to reduce operational costs & manage scale via in-house solutions and new partnerships with emerging players.
- Global technology giants, like IBM and Microsoft → innovative solutions for crop health monitoring and yield estimates.

Productivity and efficiency in India's agriculture sector through Agritech

- Digital marketplace and physical infrastructure to link farmers to inputs.
- Research on plant and animal life sciences and genomics.
- Farm equipment for rent on a pay-per-use basis.
- Use of geospatial or weather data, IoT, sensors, robotics etc. to improve productivity; farm management solutions for resource and field management, etc.
- Industrial automation using machinery, tools and robots in seeding, material handling, harvesting, etc.
- Farming technologies, such as greenhouse systems, indoor-outdoor farming, drip irrigation, and environmental control, such as heating and ventilation, etc.
- Post-harvest produce handling, quality check and analysis, produce monitoring, and traceability in storage and transportation.
- Digital platform and physical infrastructure to handle post-harvest supply chain and connect farm output with the customers.
- Credit facilities for input procurement, equipment, etc. as well as insurance or reinsurance of crop.
- Information platforms online platform for agronomic, pricing, market information.

Ways for the small landholders to afford and access technology

- Sustainable food production requires transitioning from resource-intensive, high-input farming methods to long-term, outcome-based services.
- It attracts a new interest from stakeholders — governments, non-government organizations (NGOs), the private sector, and the venture capitalists funding the start-ups. A toll-free number and a mobile app connects farmers to the platform to place their equipment and services orders.
- Digital agriculture uses
- Digital devices
- Artificial intelligence (AI)
- Data analytics allowing farmers to make informed decisions to increase productivity and drive efficiencies.
- It uses high-tech tools to determine machine performance and satellite images to manage crop health and harvesting.
- Involves farm machinery automation, robotics, connected weather stations, satellite data and sensors to monitor the crops, and logistics services to streamline supply chains.
- With the precision application of water and chemicals, digital agriculture acts as a game-changer.

Conclusion

- Some agritech players provide equipment-oriented services at affordable prices, e.g., land preparation, crop harvesting, and management, *Agribolo's* innovative servitised models such as *farm-to-fork* link the farmers with marketplaces, including banks and financial institutions offering lower interest rates.
- Increasing internet penetration in the country & rural regions being the primary driver of this growth, India stands well equipped to adapt to changing methodologies in agriculture and transition from conventional business models to various innovative business models propelled by agritech.
- Since the government has been promoting drones for crop insurance surveys, maintaining land records, and spraying pesticides, widespread adoption requires affordable prices for a win-win solution.

8.	**Microplastics in human Blood**	

Intro

- **Microplastics** → the tiny particles of plastics found in various places → the oceans, the environment and now in human blood. The name is used to differentiate them from "macroplastics" such as bottles and bags made of plastic.

Body

- No universal agreement on the size that fits this bill → the U.S. NOAA (National Oceanic and Atmospheric Administration) and the European Chemical Agency define microplastic as less than 5mm in length
- A recent from Netherlands → found microplastics on the human blood samples → which is used to make food grade bottles → size of the particles → as about 700 nanometres (equal to 0.0007 millimetres)
- Half the samples contained PET plastic, which is commonly used in drinks bottles.
- A third contained polystyrene, used for packaging food and other products.
- A quarter of the blood samples contained polyethylene, from which plastic carrier bags are made.
- The study → most commonly used plastic polymers such as,
- Polyethylene tetraphthalate (PET)
- Polyethylene (used in making plastic carry bags)
- Polymers of styrene (used in food packaging)
- Poly (methyl methylacrylate)
- Poly propylene

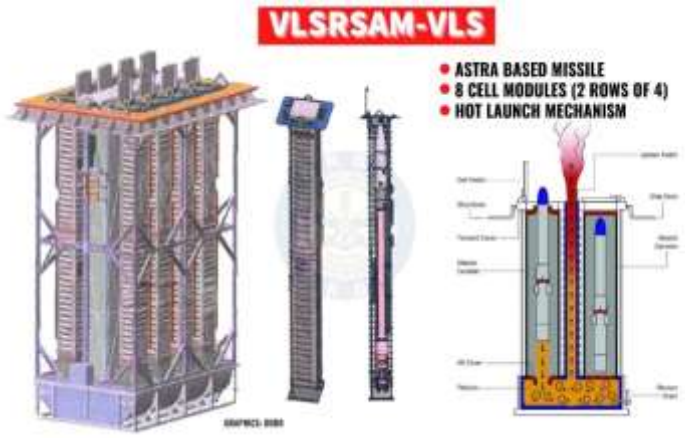
Concerns with microplastics

- It is not yet clear if these microplastics can cross over from the blood stream to deposit in organs and cause diseases.
- The human placenta has shown to be permeable to tiny particles of polystyrene (50, 80 and 24 nanometre beads).
- Experiments on rats where its lungs were exposed to polystryrene spheres (20 nanometre) led to translocation of the nanoparticles to the placental and foetal tissue.
- Microplastics cause damage to human cells in the laboratory and air pollution particles are already known to enter the body and cause millions of early deaths a year.

Govt Initiatives to Tackle Microplastics

- Plastic Waste Management Rules, 2016 state that every local body has to be responsible for setting up

	infrastructure for segregation, collection, processing, and disposal of plastic waste. – Plastic Waste Management (Amendment) Rules 2018 introduced the concept of Extended Producer Responsibility (EPR). – More than 20 Indian States have announced a ban on plastic bags.	
9.	**Hybrid human-machine framework for building smart AI**	
	Intro – Artificial Intelligence (AI) plays a crucial role in multiple aspects of human life, from a chatbot that replies to tax queries to algorithms that diagnose medical conditions and drive autonomous vehicles. **Recent Study** – Researchers at the University of California – Irvine have created a hybrid human-machine framework that they say is key to building smarter artificial intelligence (AI) systems. The study involved a new mathematical model that can improve performance by combining human and algorithmic predictions and confidence scores. – In this research, emphasis is being given to developing artificial intelligence by the hybridization of man and machine. The main basis of this research is that man and machine are each other's strengths and weaknesses. Both depend on each other for necessary information for decision-making. – In this context, the researchers conducted an image classification experiment. In this experiment, human participants and computer algorithms were used separately to correctly recognize distorted images of animals and objects of daily use (chairs, bottles, bicycles, trucks). – The human participants exercised confidence in recognizing each image while the machine classifier generated a continuous score. So it was clear that the results showed a large difference in trust between humans and AI algorithms in images. – In some special cases where human participants were confident while the AI algorithm was somewhat confused. – While in many other classes the AI algorithm was able to confidently assign a label to the object shown, while the human participants were uncertain. – Thus both of them lacked confidence and prediction. But when the two were combined using a Bayesian model, the hybrid model outperformed both of them.	

	– This research will end the critique of artificial intelligence as "one size fits for all" and will leave room for new thinking. This work provides a new direction in demonstrating the potential of combining human and machine predictions. – **Conclusion** – Humans and machine algorithms have complementary strengths and weaknesses. Each uses different sources of information and strategies to make predictions and decisions. And this accuracy is higher than combining predictions from two individuals or two AI algorithms	
10.	**Vertical Launch- Short Range Surface to Air Missile (VL-SRSAM)**	
	About VL-SRSAM – VL-SRSAM is a quick reaction surface-to-air missile, developed by DRDO -> for deployment of Indian Naval warships. – It can neutralize various aerial threats at close ranges including sea-skimming targets. (Sea skimming -> technique used by anti-ship missiles, fighter/strike aircraft -> to avoid radar & infrared detection). – It seeks to replace 'Barak-1' surface-to-air missile system onboard Indian Navy warships. ***Design*** – Missile designed to strike high-speed airborne targets at the range of 40-50 km & altitude of 15 km -> designed based on Astra missile (Beyond Visual Range Air-to-Air missile). – Comprises mid-course inertial guidance through fibre-optic gyroscope & active radar homing during terminal phase. – Has the capability of 'lock on before launch' (LOBL) & 'lock on after launch' (LOAL) -> as a result, it receives mid-course updates via datalink.  –	

Features

- Cruciform wings => 4 small wings arranged like a cross on four sides & give the projective a stable aerodynamic posture.
- Thrust Vectoring: To change the direction of the thrust from its engine, control the angular velocity & attitude of the missile (Thrust -> the force which moves an aircraft through the air).
- Canisterised system: The inside environment is controlled -> thus making its transport & storage easier and improving the shelf life of weapons.
- It will provide the Navy with a 360-degree aerial shield against incoming targets & further enhance the air defence capability of Indian naval ships against aerial threats.

11. 5G Technology in India

About 5G

- 5th generation mobile network technology -> to provide faster & more reliable communication with ultra-low latency (below 10 milliseconds).
- Speed will be around 10+ Gbps (20x of 4G) & utilise much higher radio frequencies of 28 GHz.
- Based on IEEE 802.11ac standard of broadband connectivity.
- 5G uses millimetre wave spectrum -> which enables more devices to be used within the same geographic area (around 1 million/kilometre^2).

Significance for India

- Government-appointed panel report => 5G is expected to create economic impact of $1 trillion in India by 2035.
- Ericsson report => 5G-enabled digitalization revenue potential in India will be above $27 billion by 2026.
- Global telecom industry GSMA => India will have ~70 million 5G connections by 2025.
- World Economic Forum, predicts => by 2023, there will be a staggering 9.1 billion mobile subscriptions.

Evolution from 1G to 5G

- 1G (1980s) -> worked on analogue radio signals -> supported only voice calls.
- 2G (1990s) -> uses digital radio signals -> supports voice & data transmission with 64 Kbps.
- 3G (2000s) -> transmit telephone signals including digitised voice, video calls & conferencing -> speed of 1 - 2 Mbps.
- 4G (2009) -> enables 3D virtual reality -> speed of 100 Mbps to 1 Gbps.

Different Bands of 5G

- 5G mainly works in 3 bands:
- Low Band Spectrum: maximum speed is limited to 100 Mbps -> can use for commercial cellphone users who may not need very high-speed Internet.
- Mid Band Spectrum: offers higher speeds than low band -> has limitations of coverage area & penetration of signals.
- High Band Spectrum: offers highest speed of all 3 bands -> but extremely limited coverage & signal penetration strength => enhances futuristic 5G technology applications.

Benefits of 5G

- Enhanced mobile broadband & new immersive experiences (VR, AR) with faster, more uniform data rates, lower latency & lower cost-per-bit.
- Backbone of emerging technologies such as Internet of Things (IoT), machine-to-machine communications, cloud, big data, Artificial Intelligence & edge computing -> critical enabler of 4th industrial revolution.
- Provides an opportunity for industries to reach out global markets & economic gains for consumers.
- Larger range of critical applications like financial transactions, nuclear energy, defence, space & healthcare (tele-surgery, biotech).
- Helps vehicle-to-vehicle & vehicle-to-infrastructure communication -> ultra-low latency -> more efficient smart transport infrastructure & driverless vehicles.

Challenges

- Need to upgrade fibre connectivity across India -> presently connects only 30% of India's telecom towers.
- 'Make in India' hardware challenge -> as the ban on certain foreign telecom OEMs (original equipment manufacturer) makes a hurdle.
- India's 5G spectrum pricing is huge than global average => higher investment cost & no surety about Return on Investment.
- Capital augmentation issues -> as many Indian operators are weighed down by debt.
- Tussle between homegrown 5Gi & global 3GPP standards needs to be concluded.
- 5Gi increases 5G India launch costs & interoperability issues for telcos.
- Lack of Government incentives due to increasing pressure on its revenues, especially after pandemic.

	Way Forward – Accelerated deployment of next-generation ubiquitous ultra-high broadband infrastructure with 100% coverage of 10 Gbps across urban India & 1 Gbps across Rural India -> need to align Digital India with 5G technology. – Allocate funds & incentivize domestic design & manufacture of 5G technologies, products (5G chipsets) & solutions in India -> promote 5G start-ups, IPR backing of above designs. – Appropriate test-beds & technology platforms. – Rationalisation of spectrum pricing for adequate revenue generation by government from auction. – Bridging the Rural-Urban gap -> by using low band spectrum with much longer range which is helpful for rural areas. – India is at the cusp of next generation of wireless technology 5G -> catalyst for Digital India -> watershed moment in digital transformation.	
12.	**Rare Earth Elements - A 'rare' opportunity for India**	
	– 17 rare earth elements (REE) include the 15 Lanthanides (Atomic Numbers 57 to 71 in periodic table) + Scandium (21) & Yttrium (39). – REEs => Light RE Elements (LREE) & Heavy RE elements (HREE). – Lustrous silvery-white soft heavy metals -> have unique magnetic, luminescent & electrochemical properties -> make them useful when alloyed/mixed in small quantities with other common metals. – Some REEs available in India: Lanthanum, Cerium, Neodymium, Praseodymium & Samarium, etc. – For other REEs -> dependence on China (leading producer of REEs -> 60% share of global production in 2021). ***Significance*** – Essential component of many modern technologies -> including consumer electronics, mobiles, computer hard drives, networks/communications, telescopic lenses, electric & hybrid vehicle batteries, health care, defence systems, etc. – Used in futuristic & critical technologies -> emerging green energy technologies, high-temperature superconductivity, semiconductors, safe storage, transport of hydrogen for a post-hydrocarbon economy & energy efficiency issues.	

- They work on clean energy -> need of the hour as India shift to clean energy => Target of 80% of the country's 2 & 3 wheelers, 40% of buses & 30-70% of cars -> will be EVs by 2030.
- Traditional uses like Cerium for glass polishing & Lanthanum for car catalysts or optical lenses.
- Neodymium, Praseodymium & Dysprosium -> crucial to the manufacture of magnets used in industries of EVs, wind turbines & Drones.

India's Current Policy on REEs

- Exploration in India -> conducted by Bureau of Mines & Department of Atomic Energy. Mining & processing (Ex: monazite beach sand) -> monopolised by IREL Ltd. (PSU).
- IREL produces rare earth oxides (low-cost, low-reward "upstream processes"), selling these to foreign firms that extract the metals and manufacture end products (high-cost, high-reward "downstream processes") elsewhere.
- IREL's focus is to provide thorium (extracted from monazite) -> to the Department of Atomic Energy.

India's major concerns

- Although they are more abundant -> they are difficult & costly to mine/process cleanly.
- If India is not able to explore/produce REEs -> depend on China to power its energy transition plans to EVs.
- Forming forward & backward supply chains -> will create problems when the reserves are mostly limited to one country.
- Exposure to low-level radioactive element thorium -> increases the risk of developing lung, pancreatic & other cancers.

Way Forward

- India needs to create a new Department for Rare Earths (DRE) -> to regulate & enable for businesses in this space.
- IREL's monopoly & capacity to produce REEs -> growing slowly & nowhere close to international REE conglomerates.
- Indian companies can be encouraged to form junior exploration businesses in the Indian Ocean Region -> to prospect for REEs & feed value-added products into the Indian market.
- India can also coordinate with other agencies to partner directly with groupings such as Quad, building up a strategic reserve as a buffer against global supply crises.

13.	**Digital university: The beginning of new era in Education**	
	– Influx of digital technologies has opened up a lot of new opportunities in various sectors. There was a need for a major reform in higher education and the Budget announcement of setting up of a digital university was of great significance. – The main objective is to ensure world-class quality universal education with a personalised learning experience at doorsteps. The study material will be available in different Indian languages and ICT formats. The University will be built on the hub-spoke model. The best public universities and institutions in the country will collaborate as a network of hub-spokes. **Arguments in favour:** – Inefficient current model of learning have failed to address the diverse needs and interests of the students. Digital University can fill the gaps in faculty development, enrolment in SEDGs, employability enhancing skills, quality learning material in regional languages, formal & non-formal (Recognizing Prior Learning) etc. It also helps in increasing the enrolment ratio. **Challenges:** – Transforming laboratory-related Courses which require Practical Components online would be difficult. There exists a huge digital divide in terms of access to reliable Connectivity, hardware, and access to electricity especially in rural areas which needs to be addressed. The technical know-how of operating electronic gadgets is limited in rural areas for both Students as well as teachers. Research activities require Close Personal interaction and discussion between researchers/Scientists which is not possible to conduct online.	
14.	**Intensified Mission Indradhanush 4.0**	
	– Mission Indradhanush (MI) was launched by the Ministry of Health and Family Welfare (MOHFW) with the aim of expanding immunization coverage to all children across India. Children across socio-economic, cultural and geographical spectrums in India, are being immunized under this program. The Mission Indradhanush aims to cover all those children who are either unvaccinated, or are partially vaccinated against vaccine preventable diseases. – India's Universal Immunisation Programme (UIP) provide free vaccines against 12 life threatening diseases	

against Tuberculosis, Diphtheria, Pertussis, Tetanus, Polio, Hepatitis B, Pneumonia and Meningitis due to Haemophilus Influenzae type b (Hib), Measles, Rubella, Japanese Encephalitis (JE) and Rotavirus diarrhoea. (Rubella, JE and Rotavirus vaccine in select states and districts).

Areas Under Focus:

The following areas are targeted through special immunization campaigns:

- Urban slums with migration
- Nomads
- Brick kilns
- Construction sites
- Other migrants (fisherman villages, riverine areas with shifting populations etc.) and
- Underserved and hard to reach populations (forested and tribal populations etc.)
- Areas with low routine immunization (RI) coverage (pockets with Measles/vaccine preventable disease (VPD) outbreaks).
- Areas with vacant sub-centers: No ANM posted for more than three months.
- Areas with missed Routine Immunisation (RI) sessions: ANMs on long leave and similar reasons

The broad strategy, based on evidence and best practices, will include four basic elements-

- Meticulous planning of campaigns/sessions at all levels
- Effective communication and social mobilization efforts
- Intensive training of the health officials and frontline workers
- Establish accountability framework through task forces

IMI 4.0:

- It will ensure that Routine Immunization (RI) services reach unvaccinated and partially vaccinated children and pregnant women. Children up to two years will be covered in this drive.
- While the pace of routine immunisation has slowed down due to Covid-19 pandemic, IMI 4.0 will immensely contribute in filling the gaps and make lasting gains towards universal immunisation. Three rounds of IMI 4.0 will be conducted in 416 districts, including 75 districts identified for Azadi ka Amrit Mahotsav across 33 States/UTs.

15.	**Biomass – based Hydrogen**	
	– Biomass can be described as all material that was or is a part of a living organism. For renewable energy applications, however, the definition of biomass is usually limited to include only materials that are plant-derived such as agricultural residues. **Biomass sources:** – Wood and wood processing wastes – Agricultural crops and waste materials – Biogenic materials in municipal solid waste – Animal manure and human sewage – ***Biomass Gasification*** is a process that converts organic or fossil-based carbonaceous materials at high temperatures (>700°C), without combustion, with a controlled amount of oxygen and/or steam into carbon monoxide, hydrogen, and carbon dioxide. The carbon monoxide then reacts with water to form carbon dioxide and more hydrogen via a water-gas shift reaction. Absorbers or special membranes can separate the hydrogen from this gas stream. **Advantages:** – ***Reduce GHGs:*** Plants consume carbon dioxide from the atmosphere as part of their natural growth process as they make biomass, off-setting the carbon dioxide released from producing hydrogen through biomass gasification and resulting in low net greenhouse gas emissions. – ***Cost effective:*** Hydrogen produced through the biomass pathway could be a viable, cost effective and efficient alternative for India. – ***Abundant sources:*** India being a predominantly agriculture-based country, the availability of biomass from agriculture residue can be leveraged for producing hydrogen – ***Carbon neutral:*** Hydrogen produced from renewable sources is emission free and is considered a green fuel. One of the promising ways to produce this green hydrogen could be through biomass - a carbon neutral feedstock.	
16.	**Metaverse – Definitions, prospects, significance and challenges**	
	METAVERSE – It can be defined as a simulated digital environment that uses **Augmented Reality (AR), Virtual Reality (VR), and blockchain**, along with concepts from social media,	

to create spaces for rich user interaction mimicking the real world.

- The concept is gradually gaining immense significance with many tech giants have already set in motion the progress for this process, with Facebook and Epic leading the pack.
- Examples – Meta's Metaverse , Microsoft's Mesh, Snap AR photo filters etc.,

Virtual Reality –

- Virtual Reality (VR) is a computer-generated environment with scenes and objects that appear to be real, making the user feel they are immersed in their surroundings. This environment is perceived through a device known as a Virtual Reality headset or helmet

Augmented Reality

- Augmented reality (AR) is the integration of digital information with the user's environment in real time. Unlike virtual reality (VR), which creates a totally artificial environment, AR users experience a real-world environment with generated perceptual information overlaid on top of it.

Opportunities –

- Virtual communities, virtual events, virtual workplaces
- Communications and media – Virtual meetings, digital avatars, metaverse games – cross platform interactions
- Industrial training – alternative for expensive industrial trainings
- Educational interactions – next generational classrooms – medical learning
- Retail and commerce – Personalizing shopping experiences
- Banking - high-touch customer care, have a real-time property tour with a mortgage broker, discuss retirement plans with an avatar advisor, attend an investment seminar, or engage in a bank-sponsored community initiative.
- Marketing – Marketing with a customer rather than marketing to a customer

Significance

- Personalized web experience
- Real time interactions
- Shared environment irrespective of their location
- Metaverse is also linked to the concept of web 3.0 – a decentralized internet framework
- It involves process-agnostic automation –where we simulate the humans that perform it on top-of user interfaces of these line-of-business systems

	Challenges – Internet penetration is low – Lack of technology and infrastructure for realizing the metaverse – VR headsets are quite expensive and lack ergonomic sense and are heavier – Psychological impact of double reality may lead to loss of emotional quotient – Issues of data Protection – Legal implications **Way forward** – Development of web 3.0 technologies for data protection, ensuring the development of technologies and infrastructure (through Atmanirbar Bharat, Digital India mission) can act as primary impetus to the development of metaverse in India.	
17.	**Direct to Mobile (D2M) Technology**	
	D2M technology – Direct to mobile technology is based on **the convergence of broadband and broadcast**, using which mobile phones can receive terrestrial digital TV. – It would be similar to how people listen to FM radio on their phones, where a receiver within the phone can tap into radio frequencies. – Using D2M, **multimedia content can also be beamed to phones directly**. **Uses-** – to directly broadcast content related to citizen-centric information. – countering fake news – issuing emergency alerts – offering assistance in disaster management. – to broadcast live sports and news on mobile phones. **Impact of D2M** – D2M **can reduce internet usage** as the consumers can access content from the OTT platforms – It can **increase accessibility** to the rural people to watch the video content – Businesses can shift their video traffic from mobile networks to the broadcast networks. – This will also **improve usage of mobile spectrum** and **free up bandwidth** which will **help reduce call drops, increase data speeds** **Challenges** – Stakeholder acceptance	

	– Lack of infrastructure – The change of technology brings many regulatory changes **Governmental Efforts** – The DoT has set up a committee to study the feasibility of a spectrum band for offering broadcast services directly to users' smartphones. – Band 526-582 MHz is envisaged to work in coordination with both mobile and broadcast services. – DoT has set up a committee to study this band. – At the moment, this band is used by the Ministry of Information & Broadcasting across the country for TV transmitters.	
18.	**James Webb Telescope**	
	– An orbiting infrared observatory - an international collaboration led **by NASA** in partnership with the European and Canadian space agencies – Successor of Hubble's Telescope – It has **longer wavelength coverage** and greatly improved sensitivity enabling it to look much closer to the beginning of time and to hunt for the unobserved formation of the first galaxies – Mission duration is 5 – 10 years – Launched on Ariane 5 ECA – Diameter of the primary mirror – **6.5 m** compared to 2.4 m diameter of Hubble's – Mirror is **beryllium coated** Because it is light and strong, beryllium is often used to build parts for supersonic airplanes and the Space Shuttle. – It is to be placed in **L2 lagrange point.** L2 is a spot in space **near Earth** that lies opposite from the sun; this orbit will allow the telescope to stay in line with Earth as it orbits the sun. It has been a popular spot for several other space telescopes, including the Herschel Space Telescope and the Planck Space Observatory. – Wavelength range – **0.6 – 28 microns** (primarily infra red) – It has sun shields – 5 layered- coated with composite material to protect from the heat and light of the sun **Objectives** To find answers to questions in four areas of modern astronomy: – First light – Assembly of galaxies – Birth of stars and protoplanetary systems – Planetary systems and the origin of life.	

	Significance – Identified stars that formed before our planet formed – Webbs Deep Field – highest resolution infra red image ever captured (galaxy cluster SMACS 0723) taken by Near-Infrared Camera (NIRCam) – Has wider infrared coverage even than Herschel telescope of European space agency – often called time machines because of their ability to view very faraway objects. – The sun shield and mirror are really an engineering marvel	
19.	**Scientific Social responsibility guidelines**	
	– SSR guidelines →to ensure greater integration of S&T with society at all levels. – SSR→**moral obligation** of scientists to give back the benefits of science to society. – The 104th session of Indian Science Congress, 2017 → the need for inculcating SSR for engaging science for societal welfare. **Aim:** – science-society (passing on the benefits of science to meet public needs) – science-science (creating an atmosphere to share ideas) – society-science (working with public to identify needs & develop solutions) **Guidelines:** – **Central Govt** & **states** would plan their SSR in accordance with their respective mandates. – Every **knowledge institution**→prepare its implementation plan consulting a knowledge based institution called "**Anchor Scientific Institution (ASI**)" for achieving its SSR goals code of conduct that ensures transparency, diversity and equity. – All **knowledge workers** would be sensitised by their institutions & ASI about their ethical responsibility. – Every knowledge worker is expected to contribute **at least ten person-days in a year** towards SSR over and above their routine/regular work. – SSR **assessment cell** in each institution & ASI to periodically assess institutional and individual activitiesbased on indicators(to input, process, output/outcomes-short-term, medium-term and longterm)&publish an **annual SSR report**. – SSR activities be adequately incentivised→**necessary budgetary support**(can also be through CSR, NRIs etc).	

	– Individual SSR activities should be given due weightage in performance evaluation of the knowledge worker – SSR activities and projects **would not be outsourced** or subcontracted. **Benefits:** – Bring scientific and **innovative solutions to societal problems**, especially marginalized & disadvantaged sections of society&**Empowering women**→ transforming the country. – Encouraging students into science through handholding and nurturing their interest. – Creating opportunity for**cooperation and sharing of resources** in labs with other researchers in universities – Providing training for **skill development** and upgrading scientific knowledge. – **Helping MSMEs, Start-ups and informal sector** in increasing their productivity. – Scientific intervention **in rural innovation**. – Facilitating actions towards addressing **Technology Vision 2035** targets and Sustainable Development Goals	
20.	**Direct Seeding of Rice**	
	– DSR, also called '**broadcasting seed technique'**, is a water-saving method of sowing paddy. Seeds are directly drilled into the fields by a tractor-powered machine. – This saves groundwater, as opposed to the traditional water-intensive method, under which rice seedlings are transplanted from a nursery to waterlogged fields – There is no nursery preparation or transplantation involved in this method. – Farmers have to only level their land and give one pre-sowing irrigation. – Flooding of fields is not done during sowing, – Chemical herbicides are used to kill weeds. **Advantages:** – It saves labour, – Requires less water, less drudgery, – Low production cost, – Better soil physical conditions for following crops and less methane emission, – Provides better option to be the best fit in different cropping systems **Disadvantages:** – Non-availability of herbicides.	

	– The **seed requirement for DSR is also high,** 8-10 kg/acre, compared to 4-5 kg/acre in transplanting. – L**aser land levelling is** compulsory in DSR. This is not so in transplanting. The **sowing needs to be done timely** so that the plants have come out properly before the monsoon rains arrive.	
21.	**Xenotransplantation**	
	– Recently, doctors replaced the heart of a 57-year-old patient with the heart of a genetically altered pig. After few months patient died. – **Xenotransplantation** is "any procedure that involves the transplantation, implantation or infusion of live cells, tissues, or organs from a nonhuman animal source into a human recipient" – Xenotransplantation is seen as an alternative to the clinical transplantation of human organs whose demand around the world exceeds supply by a long distance. **Advantages:** – Organs will be **available immediately and electively** – **Eliminate illegal organ trafficking and the use of organs from executed prisoners**, – No need **consent** from an animal that can be sacrificed for the organ. But not all agree with such a narrow utilitarian approach, – The **unlimited supply** will allow transplantation procedures in 'borderline' candidates who might otherwise be declined, – The detrimental **effects of brain death on donor organs** will be avoided, – **Eliminate the 'cultural' barriers to donation of organs from deceased human** present in some countries like Japan **Disadvantages:** – **Diseases transmission**: hitherto known and unknown diseases to humans – Sometimes, the disease might occur years after the transplantation. – Many animals like pigs have a shorter lifespan than humans, meaning that their tissues age at a quicker rate – **Medical Implications:** Animal to human transplantation brings with it huge risks for the patient. Even well-matched human donor organs can be rejected after they are transplanted – and with animal organs – **Ethical concerns**: PETA has condemned the pig heart transplant. The molecular incompatibility between pigs	

	and humans can trigger several immune →rejection of the xenograft. **Way Forward:** – **Promote research in xenotransplantation,** ensure adequate trials before approving the xenotransplantation procedures, – **Promote organ donation: India should adopt the Spanish system of "presumed consent"(**everyone, post-death, is considered a donor unless one has opted out of the process during his lifetime). --> plug the Demand supply gap. – **Curb organ trafficking:** Organs made available to patients on the basis of medical need and not based on financial or other needs. – **Giving or receiving payment** (reward/compen.) for organs **be prohibited.** – To pre-empt that situation, genetic engineering to tweak the genome of the pig so as to 'disguise' it, so that the immune system of the human fails to recognise it.	
22.	**Supercomputers in India**	
	What is a Supercomputer? – A **supercomputer** is a computer that performs at or near the **currently highest operational rate for computers.** – Supercomputers are primarily designed to be used in enterprises and organizations that **require massive computing power.** ✓ For example: **weather forecasting, scientific research, intelligence gathering and analysis, data mining** etc. – Globally, **China has the maximum number of supercomputers** and maintains the top position in the world, followed by the US, Japan, France, Germany, Netherlands, Ireland and the United Kingdom. – India's **first supercomputer was PARAM 8000.** – **PARAM Shivay, the first supercomputer assembled indigenously,** was installed in IIT (BHU), followed by **PARAM Shakti, PARAM Brahma, PARAM Yukti, PARAM Sanganak** at IIT-Kharagpur, IISER, Pune, JNCASR, Bengaluru and IIT Kanpur respectively. – In 2020, **PARAM Siddhi**, the High-Performance Computing-Artificial Intelligence (HPC-AI) supercomputer, achieved **global ranking of 62nd in Top 500 most powerful supercomputer systems in the world.**	

	What is the National Supercomputing Mission? – **In 2015, the National Supercomputing Mission was launched** to enhance the research capacities and capabilities in the country by connecting them to form a Supercomputing grid, with **National Knowledge Network (NKN)** as the backbone. ✓ The NKN project is aimed at establishing a strong and robust Indian network which will be capable of providing secure and reliable connectivity. – It supports the government's vision of '**Digital India**' and '**Make in India**' initiatives. – The Mission is being jointly steered by the **Department of Science and Technology (DST)** and the **Ministry of Electronics and Information Technology (MeitY).** ✓ It is **implemented by** the Centre for Development of Advanced Computing (C-DAC), Pune, and the IISc, Bengaluru. – The mission was planned in **three phases:** ✓ **Phase I** looking at assembling supercomputers, ✓ **Phase II** looking at manufacturing certain components within the country. ✓ **Phase III** where a supercomputer is designed by India. – An **indigenously developed server platform called 'Rudra'** is being tried out in a pilot system, with an interconnect for **inter node communication called Trinetra** also having been developed	
23.	**Cluster Munitions and Vacuum Bombs**	
	– Human rights groups **Amnesty International and Human Rights Watch** accused Russia of using cluster bombs and vacuum bombs in the **ongoing war (on Ukraine).** What are cluster munitions? – A **cluster munition means a "conventional munition that is designed to disperse or release explosive submunitions** each weighing less than 20 kilograms, and includes those explosive submunitions". – Essentially, cluster munitions are **non-precision weapons that are designed to injure or kill human beings indiscriminately over a large area,** and to destroy vehicles and infrastructure such as runways, railway or power transmission lines.	

- They can be dropped **from an aircraft or launched in a projectile** that spins in flight, scattering many bomblets as it travels.
- Many of these bomblets end up not exploding, but continue to lie on the ground, often partially or fully hidden and difficult to locate and remove, posing a threat to the civilian population for long after the fighting has ceased.
- The **Convention on Cluster Munitions** specifically identifies "cluster munition remnants", which include "failed cluster munitions, abandoned cluster munitions, unexploded submunitions and unexploded bomblets"

What is a thermobaric weapon?

- Thermobaric weapons — also known **as aerosol bombs, fuel air explosives, or vaccum bombs** — use oxygen from the air for a large, high-temperature blast.
- A thermobaric weapon causes **significantly greater devastation than a conventional bomb** of comparable size.
- The weapons, which go off in two separate stages, can be fired as rockets from tank-mounted launchers or dropped from aircraft.
- As they hit their target, a first explosion splits open the bomb's fuel container, releasing a cloud of fuel and metal particles that spreads over a large area.
- A second explosion then occurs, igniting the aerosol cloud into a giant ball of fire and sending out intense blast waves that can destroy even reinforced buildings or equipment and vaporize human beings.

Is it legal to use these weapons?

- Countries that have ratified the **Convention on Cluster Munitions** are **prohibited from using cluster bombs.**
  - ✓ As of date, there are 110 state parties to the convention, and 13 other countries have signed up but are yet to ratify it. Neither Russia nor Ukraine are signatories.
- **Vacuum bombs are not prohibited** by any **international law or agreement**, but **their use against civilian populations in built-up areas,** schools or hospitals, could attract action under the **Hague Conventions of 1899 and 1907**.
- Amnesty International said **international humanitarian law prohibits** the use of **inherently indiscriminate weapons such as cluster munitions**.
  - ✓ Launching indiscriminate attacks that kill or injure civilians constitutes a war crime,

	Way Forward – It is these very real dangers that led 122 states at the United Nations to vote in favour of developing the **Treaty on the Prohibition of Nuclear Weapons in 2017**. – The war in Ukraine is the latest reminder that **we must act to eliminate thermobaric, cluster, and nuclear weapons,** under strict international control. – The stakes are simply too high to allow these dangers to remain	
24.	**Impact of Geomagnetic Storms on Satellites**	
	– What is a geomagnetic storm? – A geomagnetic storm is a major disturbance of Earth's magnetosphere that occurs when there is an exchange of energy from the solar wind into the space environment surrounding Earth. – Solar storms are caused by the release of magnetic energy called solar winds from the sunspots – Solar Storms happen when Sun emits large bursts of energy in the form of solar flares and coronal mass ejections. These phenomena send a stream of electrical charges and magnetic fields toward the Earth at high speed. **Space dependent operations:** – Solar storms affect space-dependent services like the Global Positioning Systems (GPS), satellite communications, and radio communications, so on. Operations like flight paths, space exploration programs, and power grids are also vulnerable to impact. – During storms, the currents in the ionosphere, as well as the energetic particles that precipitate into the ionosphere add energy in the form of heat that can increase the density and distribution of density in the upper atmosphere, causing extra drag on satellites in low-earth orbit. – The local heating also creates strong horizontal variations in the ionospheric density that can modify the path of radio signals and create errors in the positioning information provided by GPS. – While the storms create beautiful aurora, they also can disrupt navigation systems such as the Global Navigation Satellite System (GNSS) and create harmful geomagnetic induced currents (GICs) in the power grid and pipelines.	

	– Astronauts on spacewalks face health risks from possible exposure to solar radiation outside the Earth's protective atmosphere. – Since the dependence of the world is increasing on satellites for most activities, it is imperative that space weather forecasts are improved and more efficient measures to safeguard satellites are invented	
25.	**E PASSPORTS**	
	– The government of India has announced that it will soon **start issuing ePassports to citizens applying for a new passport** or renewing their expiring passport. – the e-passport will be a **combination of paper and electronic passport, with a Radio Frequency Identification (RFID) chip.** – An antenna will be embedded as an inlay in the back cover. – The passport's critical information will be stored in the chip and printed on the data page. – The characteristics of the e-passport are specified by the International Civil Aviation Organization, an agency of the United Nations. **What Is Radio Frequency Identification (RFID)?** – Radio Frequency Identification (RFID) -uses radio waves to passively identify a tagged object. – It is used in several commercial and industrial applications, from tracking items along a supply chain to keeping track of items checked out of a library. – Radio Frequency Identification (RFID) is a type of passive wireless technology that allows for tracking or matching of an item or individual. – The system has two basic parts: tags and readers. ✓ The reader gives off radio waves and gets signals back from the RFID tag, while the tag uses radio waves to communicate its identity and other information.	
26.	**BIO RESTORATION OF ART WORKS**	
	– Scientists have started using grime-eating bacteria extensively to restore classical art. – Usually, art restorers have usually employed chemical agents and, more recently laser techniques, to remove dirt, oil, glue, or pollutants from monuments, stoneworks, and paintings. – But in the 1980s, the bacteria Desulfovibrio vulgaris was first used to clean a marble monument at the Cave Hill Cemetery in US.	

	– Since then, the role of micro-organisms has been recognised in protecting the artistic heritage of humanity. – The process of using bacteria to restore classical art is called **Bio-cleaning**. – The living bacterial cells were suspended in a gel and applied to the vertical walls and left for 24 and 48 hours. – When the gel was removed, the inorganic dark brown layer and the other deposits were removed by the bacteria. – The treatment was soft & delicate and didn't show any structural damage. – **Other microbes used** - Pseudomonas stutzeri CONC11 bacterium isolated from the waste of a tannery, Rhodococcus sp. ZCONT that came from soil contaminated with diesel. **Can this method be used to fix the discoloration of Taj Mahal?** • For this, we need to study the marble of Taj Mahal to understand if it is just dust and particulate carbon causing the dark color or if there is a biofilm formation (Biofilms are formed when communities of microorganisms adhere to a surface). • Moreover, a research paper in 2014 has said that calcifying bacteria could be used for remediation of stones and cultural heritage monuments, including the Taj Mahal. • The Archeological Survey of India is also learnt to be exploring the option of employing bio-restoration at the Taj.	
27.	**GAGANYAAN**	
	– Gaganyaan - **Indian Space Research Organisation (ISRO).** – Under the Gaganyaan schedule: ✓ Three flights will be sent into orbit. ✓ There will be two unmanned flights and one human spaceflight. – The Gaganyaan system module, called the **Orbital Module will have three Indian astronauts, including a woman.** – It will circle Earth at a **low-earth-orbit** at an altitude of 300-400 km from earth for 5-7 days. – **Payloads:** ✓ The payload will consist of:**Crew module** - spacecraft carrying human beings and **Service module** - powered by two liquid propellant engines.	

	✓ It will be equipped with emergency escape and emergency mission abort. ○ **Launch:** – **GSLV Mk III**, also called the **LVM-3 (Launch Vehicle Mark-3,)** the three-stage heavy lift launch vehicle. – **Significance:** ✓ It will help in **enhancement of science and technology levels** in the country and **help inspire youth.** ✓ It will help in **improvement of industrial growth**-Recently, the Government has announced a new organisation, **IN-SPACe,** part of reforms **to increase private participation in the space sector.** ✓ It will help in **development of technology for social benefits.** ✓ It will help in **improving international collaboration-** Regional ecosystems will be needed and Gaganyaan **will focus on regional needs: food, water and energy security.**	
28.	**Starlink in India**	
	Intro: Starlink is a satellite-based broadband network → objective building a low-cost, broadband network capable of delivering internet access to the entire globe. **Body:** • Currently, fibre optic cables or wireless networks through mobile towers provide internet services. • The idea of space internet system is not new → existing space-based Internet systems → Geostationary Satellite for selective users. • With Starlink Project, SpaceX intends to put a "constellation" of satellites in low earth orbit for providing high-speed, cable-like internet. <u>Pros</u> • Available nearly everywhere. • Broadband-level speeds possible. • Cost effective compared to mobile hotspots. • Quick recovery post-disaster. • You don't need a phone line for satellite internet. • Satellite internet connections can handle high bandwidth usage, so your internet speed/quality shouldn't be affected by lots of users or "peak use times."	

	Cons • High latency • Slower than cable and fiber • Vulnerable to bad weather • Won't support a VPN **Conclusion:** According to World Economic Forum (WEF), 50% of people in India don't have internet access. India has also been one of the fastest growing markets in terms of new adoption with number of internet users growing by 23% between 2019 and 2020. Satellite internet has a lot of potential in India as it can transcend geographical barriers.	
29.	**Zero Tillage Technology**	
	Intro: A farming system that promotes maintainence of a permanent soil cover, minimum soil disturbance and diversification of plant species. Process where the crop seed will be sown through drillers without prior land preparation and disturbing the soil where previous crop stubbles are present. **Body:** It enhances biodiversity and natural biological processes above and below the ground surface → contributes to increased water and nutrient use effieciency → improved and sustained crop production. No Till approach started from 1960s by farmers in India → followed in the Indo-Gangetic plains where rice-wheat cropping is present. Advantages of zero tillage • Reduction in the crop duration → early cropping →get higher yields. • Reduction in the cost of inputs → saving of around 80%. • Residual moisture can be effectively utilized → irrigations can be reduced. • Dry matter and organic matter get added to the soil. • Environmentally safe → Greenhouse effect will get reduced due to carbon sequestration. • reduces the compaction of the soil and reduces the water loss by runoff → prevent soil erosion. • No Till lands have more useful flora and fauna.	

	Need: • Facilitates good agronomy. • Conservation agriculture is base for sustainable agriculture production intensification. • Options for integration for production sectors → crop-livestock integration and integration of trees and pastures into agricultural landscapes. **Conclusion:** The natural resources are precious and therefore demand an effective and sustainable use. Zero tillage is a potential technology in this scenario.	
30.	**National Blockchain Strategy**	
	MeitY has released a national strategy on blockchain for adopting the technology in government systems, especially for e-governance services. **Body:** A National Blockchain Framework (NBF) will be set up with three types of participants- i) confident user of technology (application developers), ii) provider or operator of technology (infrastructure and services, Blockchain as a service), iii) complete technology stack builder (IP creator). potential areas of using the technology → education, governance, finance & banking, healthcare, logistics, cybersecurity, media, legal, power sector, etc. Advantages of Blockchain Technology • Blockchain can be set up in either Public / Permissionless or Private / Permissioned configurations. • Blockchain applications of National interest include: Property Record Management - Pharmaceutical supply chain - Farm Insurance - Public Service Delivery - e-Voting - Vehicle lifecycle management - Electronic Health Record Management. • value addition in e-Governance → allow seamless transfer and exchange of data over different departments • create and enable smart contracts, supply chains for various government processes, trusted inter-department communication and tamper-evident storage.	

	Challenges in India • Technological challenges. • Storage → demands very heavy resources and may become an issue as the chain of blocks grow. • Skillset and Awareness Issues – Manpower who knows both Domain & Technology is required for blockchain technology management. • Security, Privacy and Regulation. • Legal Challenges – RBI's restriction to virtual currencies based on Blockchain technology. • The ministry identified five areas of weakness in the technology– scalability, security, interoperability, data localisation and disposal of records. **Conclusion:** – Globally and nationally various efforts are being made in implementing Blockchain-based applications. – So, Blockchain technology improves transparency, immutability and efficiency aspects, which make it unique and potential to use in various application domains.	
31.	**Aircraft Carriers in India**	
	– Recently, the **Indigenous Aircraft Carrier (IAC)** 1, which will be called **INS Vikrant** once it enters service with the Indian Navy, began another set of sea trials. – INS Vikrant is the **largest and most complex warship to be built in India.** – **About Aircraft Carrier:** – An aircraft carrier is "**a large ship that carries military aircraft** and has a long, flat surface where they take off and land." ✓ These **floating air bases** are equipped with a full-length flight deck capable of **carrying, arming, deploying and recovering aircraft.** – They act as **command and control** of a naval fleet in times of war and peace. – A **carrier battle group** consists of an aircraft carrier and its escorts, together making the group **Aircraft Carrier in India:** – **INS Vikrant (decommissioned):** Beginning with INS Vikrant which served India from 1961 to 1997. ✓ India acquired the **Vikrant from the United Kingdom in 1961**, and the carrier played a stellar role in the **1971 war** with Pakistan that led to the birth of Bangladesh.	

	– **INS Vikramaditya:** – It is the **Indian Navy's largest aircraft carrier** and warship converted from the **Russian Navy's decommissioned Admiral Gorshkov/Baku.** – **INS Vikrant:** ✓ In order to commemorate the legacy of INS Vikrant **(decommissioned)**, the **First IAC will be named as** INS Vikrant. ✓ It is built at **Cochin Shipyard Limited**. ✓ It is currently **undergoing sea trials and is likely to be commissioned in 2023.** ✓ Its construction propelled India into a select group of countries having capabilities to **build state-of-the-art aircraft carriers.** ✓ **Operational Modalities:** According to the Indian Navy, the warship will operate **MiG-29K fighter jets**, **Kamov-31 helicopters**, **MH-60R multi-role helicopters** and the **indigenously manufactured Advanced Light Helicopters (ALH).** **Significance of Aircraft Carriers:** – Currently, most of the world powers are operating or building technologically **advanced aircraft carriers** to safeguard their maritime rights and interests. – **Thirteen navies across the world now operate aircraft carriers** ✓ Aircraft Carrier for India, provides a **deterrent naval capability,** that is not only essential but **a strategic need.** ✓ This is because India's area of responsibility ranges from the **east coast of Africa to the Western Pacific.** – **Future Endeavours:** ✓ Since 2015, the Navy has been seeking approval to build a third aircraft carrier for the country, which, if approved, will become **India's second Indigenous Aircraft Carrier (IAC-2).** – This proposed carrier, **to be named INS Vishal,** is intended to be a giant 65,000-tonne vessel, much bigger than IAC-1 and the INS Vikramaditya.	
32.	**Worlds First Malaria Vaccine**	
	– Recently, the **World Health Organisation (WHO) endorsed the world's first Malaria Vaccine** in the hope that it will spur stalled efforts to curb the spread of the parasitic disease.	

- **Malaria** is a life-threatening disease **caused by parasites** that are transmitted to people **through the bites of infected female Anopheles mosquitoes.** It is **preventable and curable.**
- **About:**
  - ✓ **RTS,S/AS01, trade name Mosquirix,** is **an injectable vaccine targeting P. falciparum,** the most prevalent malaria strain in Africa. It is the **first and only vaccine to show partial protection in young children.**
- It was developed by British drugmaker GlaxoSmithKline in 1987.
  - ✓ The active substance in Mosquirix is **made up of proteins found on the surface of the Plasmodium falciparum parasites (PFP).**
  - ✓ RTS,S **aims to trigger the immune system to defend against the first stages of malaria** when the PFP enters the human host's bloodstream through a mosquito bite and infects liver cells.
  - ✓ It also helps **protect against infection of the liver with the Hepatitis B virus.**

How significant is this?

- Malaria is certainly a major global public health challenge.
- According to the WHO, malaria remains one of the world's leading killers, claiming the life of a child every 2 minutes.
- Most of these deaths are in Africa, where more than 2,50,000 children die from the disease every year.
- Children under the age of 5, and poorest children among them, are at greatest risk from its life-threatening complications.
- Worldwide, malaria kills 4,35,000 people a year, most of them children.
- Moreover, with global warming on the rise, there are predictions of vectors such as mosquitos seeing an explosive rise the world over.
- These include areas where they are traditionally not found.
- The malaria vaccine thus has the potential to save tens of thousands of lives, especially of the children.
- **Potency:**
  - ✓ The **vaccine's effectiveness at preventing severe cases of malaria in children is only around 30%**, but it is the only approved vaccine.

	✓ The **European Union**'s drugs regulator approved it in 2015, saying its benefits outweighed the risks. ✓ Its **side effects are rare**, but sometimes include **a fever that may result in temporary convulsions.** – **Challenges:** ✓ **Inconvenient**: A child must receive four injections before age 2, sometimes at intervals that do not match the routine vaccine schedules for most other diseases. ✓ **Partly Effective**: Testing in more than 10,000 African children from 2009 to 2014 showed that, even after four doses, the vaccine prevented only about 40% of detectable malaria infections. ✓ **Not Long Lasting**: It is unclear how long even those relatively low levels of protection last; previous trials followed vaccinated children for four years. Experts also worry that parents whose children are vaccinated will become less vigilant about using mosquito nets, and less likely to seek medical care when their children develop fevers. ✓ **Develop Resistance**: The vaccine reduced the occurrence of severe malaria by about 30%, and the occurrence of **severe anemia** - a complication that often kills children - by about 60%. It did not protect well against parasite strains that were poor genetic matches, raising a concern that, over time, parasites could evolve resistance to the vaccine as they have to drugs. **Way Forward** – The next steps for the WHO-recommended malaria vaccine will include **funding decisions from the global health community** for broader rollout in endemic countries, and **country decision-making on whether to adopt the vaccine** as part of national malaria control strategies	
33.	**Digital Vaccines**	
	– Digital Vaccines are a subcategory of digital therapeutics, which are evidence-based prevention approaches that use digital technologies (applications delivered via smart-phones, tablets, etc.) for nudging positive human behavior via neurocognitive training.	

	They are gamified, digital interventions that draw from principles of neuroscience, psychology, Artificial Intelligence (AI), persuasive computing and behavioral economics to provide safe and low-risk mechanisms for dynamic neuro-behavioral-physiological modulation. ***Challenges*** – Despite the promise of digital vaccines, there are a few challenges like privacy and regulation issues. Privacy is a major concern for digital vaccines interventions, in particular for those that influence behaviour change through intensive monitoring of personal data, such as location, movement, and purchase data. – Large amounts of aggregated health data may be valuable to third parties (state or non-state actors), incentivizing digital vaccine platforms to sell the data. This can increase the security and privacy risks of the patients. – Digital vaccine platforms could bypass regulations by not directly mentioning the management of chronic conditions but through claims of tackling habit-based challenges like weight loss, smoking, alcohol consumption, and mental distress. The exponential surge in chronic diseases, however, demands approaches that differ from those provided by current medical systems. Therefore, with significant technological advancements and innovation in computer and behavioural science, the opportunities for digital vaccines as tools to address our modern day medical problems are immense.	
34.	**Genome India Project**	
	– **Genome (sequence of genes in a cell):** Refers to all of the genetic material in an organism. The human genome is mostly the same in all people, but a very small part of the DNA does vary between one individual and another. – **Genome Sequencing**: finding out the order of base pairs in the nucleotides in the DNA. This sequence contains the information for building an organism. 1. **Clone-by-clone** approach: first breaking the genome up into relatively large chunks 2. **Whole-genome** method: breaking the genome up into small pieces, sequencing the pieces, & reassembling the pieces into the full genome sequence. **Aims**: – To ultimately build a grid of the **Indian "reference genome"**, to fully understand the type and nature of	

diseases and traits that comprise the diverse Indian population.
- The mega project hopes to form a grid after collecting 10,000 samples in the first phase from across India, to arrive at a representative Indian genome.

Need for Genome India Project(GIP):
- It is inspired by the Human Genome Project (**HGP** of 2003) - an international programme that led to the decoding of the entire human genome but it was mostly sourced from white people and didn't represent all humans.
- 8% of DNA was left unsequenced by HGP, in the area called heterochromatin, which is a smaller portion of the genome, and does not produce protein.
- GIP will add to the available information on the human species and advance the cause, both because of the scale of the Indian population and the diversity present.
- Precision medicine: will help in the development of personalised medicine, anticipating diseases and modulating treatment according to the genome of patients. Can play a significant role in Targeted Drug Delivery.

Issues
- **Discrimination**: Discrimination based on genetic makeup in case of health insurance, employment etc. is possible → provides a genetic angle to existing issues of indigenous population, race/caste-based politics and origin tracing → scientific racism.
- **Inequality**: Limited access to genetic testing and preventive medication could further the prevailing inequality and create social tensions.
- **Medical ethics**: Genome editing is changing the DNA to change physical traits. For ex: while gene therapy can treat several diseases, there are ethical concerns on if it could lead to genetic enhancement.
- **Privacy**: Issues like consent of research participants, usage of the findings and associated risks. Existing knowledge and cultural barriers to fully understand the potential benefits and identifying risks attached to gene mapping.
- **Security**: Question of storage and protection of data needs to be addressed considering the possibility of misuse of data.

Way forward
- Interventions on the abovementioned issues:
- Laws prohibiting DNA data collection and usage without the consent of participants; restricting usage of genetics

	to prevent diseases and not to enhance human capability; prenatal genetic screening; – Genomic data sharing policy – to address privacy issues. – Inclusion of people from across different social dimensions to avoid any further social inequalities and discrimination. – Setting up training centres, programs, funding research in genetic studies. – All the potential benefits and risks must be carefully analysed before formulating policies on genetics.	
35.	**Automation**	
	– Automation describes a wide range of technologies that reduce human intervention in processes. Human intervention is reduced by predetermining decision criteria, sub-process relationships, and related actions — and embodying those predeterminations in machines. – It can also mean the use of computers to control a specific process in order to upturn consistency and efficacy thereby reducing human labour. **Evolution:** – Ancient: Water wheels used by Greeks & Romans: semi-automation. – 9th century: Mill machinery advancement. Ex: windmills to grind grains. – Industrial revolution: Steam engines, IC engines, Control theory, etc – Early 20th century: Electrification and Industrial controllers. – 20th & 21st century: Computers, AI, robots, IoT and home automation. **Impacts:** **Employment** – Pros: Replace hard physical labour; increased productivity; replaces trivial jobs like data entry → enhanced liberty of individuals; used in dangerous environments like fire, space, etc → increased safety; increased competitiveness; decreased labour crises. – Cons: Rise of unemployment due to large scale job losses. **Skill development** – Pros: Higher flexibility of skills and better quality - eliminates the mindless, manual, clerical tasks that are routine and boring → more focus on creative and cognitive skills. – Cons: Loss of certain skills like that of artisans' → loss of some arts.	

Production

- Pros: Improved quality since human error gets eliminated, better optimisation, increased speed, high reliability, compliance consistency and increased throughput time.
- Cons: More pollution than human production, small errors can cause massive production failure, when machines become outdated they need to be completely replaced unlike humans who can learn.

Cost

- Pros: Lowers the cost of production
- Cons: High capital expenditure – high initial cost, cost of maintenance, repair etc

Society

- Pros: Removes existing social order by replacing certain jobs like manual scavenging; break gender roles – robots for household chores → may reduce social inequality.
- Cons: Job losses due to automation may disproportionately impact the vulnerable sections more; potentially decimates the jobs of middle class → socio-political tensions: for ex, Captain Swing riots in rural England in 1830s.
- **Security**
- Pros: Better security since human errors can be overcome
- Cons: Vulnerable to hacking since any security system can be breached after some time, data theft, fear of man-machine conflict.
- **Ethical concerns**: Is automation ethical? Privacy vs Surveillance; manipulation of behaviour; opacity of AI systems, bias in decision making; human robot interaction; machine ethics; artificial moral agents(responsibility and rights), etc.
- Facts: Over 88% of finance and insurance executives, and 76% of IT executives reported an increased implementation of automation since the pandemic. Over 40% in the world and 51% activities in India can be automated.

Policy measures:

- All India Council for Robotics and Automation (AICRA) launched a new initiative the '**Tech Start-up Program'** → Acts as incubation environment for start-ups and other early stage adopters working on robotics and Robotics Process Automation (RPA) in India.

  RPA: Builds the bots itself to emulate human actions to complete back-office tasks, such as extracting data or filling out forms.

Tech Start-up program provides help in administrative, financial and technical support. Also helps in pre-funding issues like

36. Dark web

- The dark web is the World Wide Web content that exists on darknets: overlay networks that use the Internet but require specific software, configurations, or authorization to access.
- Through the dark web, private computer networks can communicate and conduct business anonymously without divulging identifying information, such as a user's location. The dark web forms a small part of the deep web, the part of the Web not indexed by web search engines.

Why it was developed?

- Originally conceived by US Department of Defence in their efforts to create an anonymous, encrypted network to protect the sensitive communication of US spies.
- The idea was used by researchers who focused on anonymity for human rights and privacy.
- Then came TOR(The Onion Router) network that gave many layers of encryption that guard passing information. Tor lives on the fringe of the internet and serves as the underlying technology of the dark web—a collection of hidden sites inaccessible via a regular browser and not indexed by search engines such as Google.
- **Threats**: (Virtual equivalent of black market)
- Illegal activities: Ex: Silk Road marketplace, a website used for the buying and selling of a variety of illegal items, including recreational drugs and weapons.
- Protects the identity of internet criminals like hackers, money launderers, data thieves etc
- Used by terrorists and extremists to communicate, recruit and radicalize, to spread propaganda, raise funds, and to coordinate actions and attacks and also for purchase of explosives and weapons, using virtual currencies like crypto.
- Encourages new age crimes since tools like ransomware, hacking and phishing software and worms are sold cheaply in dark web.

Challenges in regulation:

- **Encryption technique and anonymity**: difficult to attain sufficient information that could help combat cybercrimes and track criminals who exploit this space.

	– **Crypto-currency**: Most financial transactions on the dark web are performed in cryptocurrencies based which provide further anonymity. It uses blockchain technology → makes it difficult or impossible to modify or hack the system. – **Discrete transactions** have facilitated all kinds of illegal activities by cybercriminals and terrorists on the dark web and this has made it extremely difficult for law enforcement agencies to follow the trail of money to gather evidence of a crime. Regulation of cryptocurrencies is possible only concerning their legitimate use while a large portion of them can still be used for illegitimate purposes. – **Way forward**: – Governments should cooperate and strengthen their Cyber security Framework to deal with the threats posed by dark net. For ex: **Cyberdome**, Kerala Police's facility dedicated to prevent cybercrime and mitigate cyber security threats to the State's critical information infrastructure.	