

## Science and Technology

**Notebook:** First Notebook

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### 1. Dark energy and dark matter

- Dark Matter binds the universe together
- Dark energy separates it
- Together explain 96% of universe
- Can help to explain formation of supermassive galaxies and superclusters of galaxies like recently discovered Saraswati by IUCAA

<http://mentalfloss.com/article/68083/whats-difference-between-dark-matter-and-dark-energy#targetText=Dark%20matter%20produces%20an%20attractive,muster%20to%20hold%20galaxies%20together.>  
**[MUST READ]**

### 2. Technological interventions in public health

- mHealth : using mobile phones for retinal scan, blood pressure, surgery, text health related information
- New mHealth initiative in jharkhand to help rural healthcare providers to identify and refer presumptive TB patients to the near sputum test centre
- Telemedicine : interacting with patients through videoconferencing, see online reports of blood tests, digital ECG ,etc
- Doing away of the need for poor patients to travel long distances to towns for serious treatment ailment . Done in Rajasthan

#### 1. 3. CRISPR Cas9

- Gene editing technique
- Bacterial DNA scissors that direct enzyme Cas9 where to cut the gene
- Recently, helped in removing a gene mutation that leads to heart disorder from an embryo
- Gene edited cells for cancer and HIV-1 therapy
- Blood related disorders like Sickle cell anemia, thalassemia

### Ethical issues

- Designer babies
- Vinod khosla thinks they were more dangerous than AI

### Other problems

- Introduces unexpected off-target effects in mice
- CRISPR Cas9 edited cells Might trigger cancer
- Both mouse and human gene edited cells suffered from DNA deletions far from intended sites

### Way Forward

- Rigorous regulatory regime for cosmetics and designer babies and life saving techniques
- Make gene editing trials data public for greater transparency and easy detection if problems by public

### 4. Problems with antibiotic resistance

- One cause: incomplete course once a patient feels better

- Effluents from pharma companies contain high anti biotic concentration that breeds superbugs in rivers and lakes
- People using them to treat even minor diseases like influenza. Doctors yielding to pressure from patients and pharma companies.
- Rules flouted by pharmacists.
- Improper disposal of used anti biotics
- Overuse in animals, especially last-mile colistin
- Dichotomy : many overuse antibiotics, while many do not get access.
- **2 ways of transmitting resistance:** **1.** Genetic mutation. But this is a slow process **2.** Horizontal transfer. Gene from another organism passed on to bacteria. Much faster mode of transmission.

## Way Forward




- Schedule H1: 24 critical antibiotics which are tightly controlled.
- Consumer awareness
- **National Action Plan on Antimicrobial Resistance** aims to repeat successes, as in Australia. (surveillance, rational use, research and international collaboration)
- Using alternative drugs for mild infections, as nearly 90% of antibiotics used to treat mild infections
- Greater surveillance, research, optimizing use in agri,poultry and human use. **Kerala** developing plan on AMR.
- Focus on immunization through **vaccines**, especially for pneumonia through PCV

## 5. Bit coins

- Uses block chain tech
- Enables anonymous transactions online but still allows verification to the users about the genuineness of the transaction. Thus, trust no longer required in the system.
- An interministerial committee currently looking at how to regulate block chain . Probably SEBI will get the mandate
- Can also be used for payment of ransomware
- Though cryptocurrencies seeing large spikes in valuations, it is prone to hacking
- Central Banks issuing CCs but this goes against decentralizing tendency of CCs
- Popularity also due to deflationary nature of the currency. Also, gives control over the currency to the user, instead of the govt
- But blockchain technology can be used for other applications too
- Bit Coin value falling from 19000\$ to 10000\$ (Jan 2017)

**Libra is for everyone**

Moving money around the world should be as easy and cheap as sending a text message. No matter where you live, what you do, or how much you earn.

 <p><b>Mobile</b></p> <p>Libra will be accessible to anyone with an entry-level smartphone and data connectivity.</p>	 <p><b>Stable</b></p> <p>Libra is backed by a reserve made to keep its value stable.</p>	 <p><b>Fast</b></p> <p>Libra transactions are quick and easy, no matter where you are sending, or spending, your money.</p>
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Libra is built on blockchain and is being pitched as a cryptocurrency for everyone.

## Differences with Bit Coin

- More acceptable as it is launched by Facebook
- Libra Association seeks to play by the regulatory rulebook.
- Not decentralised like Bitcoin, whose creator is still not known.
- Backed by reserve of real assets. So, likely to be less volatile

## Concerns with cryptocurrencies

- Can be used to defraud customers, particularly unsophisticated customers + high volatility
- High energy requirements to keep the server going
- RBI would lose control over monetary policy
- Can be used in ML and terrorist finance
- No grievance redressal mechanism. Plus, every transaction irreversible

## Advantages

- Cryptocurrencies cannot be hacked
- They are verified by third parties through DLT and blockchain
- Democratic

## 6. Examples

- Zooniverse : world's largest and most popular people powered research platform. Part of citizen science project
- Check National Digital Communication Policy 2018

## 7. Problems with social media

- Echo chambers, polarization, hyper partisanship- user homophily and algorithmic filtering reinforcing belief systems
- Spread of false or misleading information
- Conflation of popularity with legitimacy
- Political manipulation
- Manipulation, micro targeting and behaviour change
- Intolerance, exclusion and hate speech (can refer to post truth, fake news, FB's dark posts)
- Short attention span and use of algorithms that dish out similar types of information create further problems.
- Bots used to amplify the situation
- We aren't just consumers of information, but also creators. This gives us misplaced sense of control.
- Fake news is an industry today. Social media giants use ML and AI to prompt you to follow people who hold a view similar to you. As per annual Ipsos **survey: 86%** of internet users being duped by fake news

## Counter argument

- #metoo and other positive stories wouldn't have spread if social media was inherently evil
- Printing press was seen as troublesome by Ottomans
- TV penetration is 835 million, as compared to 300 million smartphone penetration. So, misuse can happen through TV too.
- AI and ML algorithms can now be developed to spot fake news

## Way Forward

- Breaking up the social media monopolies might not be an option as it might get harder to regulate
- Need for fact checking
- Put reminders about the harm of misinformation
- And use algorithms to reduce 'clickbait'. But since business model based on clickbait, might require external regulators to enforce it.

## 8. S&T schemes by govt

- Impacting Research Innovation and Tech (**IMPRINT**): .Cooperation between DST and MHRD. Focus on healthcare, energy, sustainable habitat etc
- **Early Career Research Award** to prevent brain drain by providing early career support to researchers in frontier science and engineering
- **KIRAN** to attract women researchers who left midway because of family responsibilities
- **North eastern centre for ethnomedicinal research**
- **Devasthal optical telescope** in Nainital . Largest steerable imaging telescope with Belgian cooperation
- Facility for Antiproton and ion research (**FAIR**) in Germany
- **NIDHI** to nurture innovations and research into successful startups
- **Science express**
- **INSPIRE Awards Manak Programme**: School children to send innovative proposals to solve social problems to National Innovation Foundation
- S&T communication wing (**Vigyan Prasar**) launches **India Science Technology and Innovation portal** and India science.in for information on science development in India, finding, research organization etc

## 9. Defence application in civilian sector

- Developing aerospace industry
- Farming in high altitude areas
- Multi insect repellent
- Raju-kalam stent
- Biomedical devices like x-ray industrial tomography
- Development of skills in general and research in particular

## 10. Space applications

- **Broadcast**: DTH television and radio
- **Meteorological**: imaging, data collection, disaster warning
- **Communication**: VSAT connectivity
- **Developmental**: tele health, tele medicine , emergency communication
- **Remote sensing**: agriculture, drinking water , land use, monitoring irrigated commands , fisheries

Govt set up Defence Space Research Agency (DSRO) to develop space warfare weapons systems and technologies. Defence Space Agency (DSA) set up to fight space wars, under the command of an Air Vice Marshall, and close-coordination with tri-services.

## 11. Nuclear application

- **Medical**: Radiotherapy , radiation imaging (positron emission tomography PET), radio pharmaceuticals , sterilization of medical products
- **Agriculture**: food irradiation, using radiation to bring mutations in plants
- **Hydrogel** for healing burn wounds
- **Tracing groundwater reserves** using isotope hydrology
- **Energy** security

## 12. Micro biome

- Bacteria and other microbes in the gut
- Key role in digestion, fat metabolism and human immunity
- Difference in gut bacteria between different regions, rural-urban, eating habits etc eg: In Ballabgarh sample, abundance of genes that play active role in xenobiotic substances (carcinogens, pollutants, chemicals etc)- probably due to high exposure to industrial or agri chemical fertilisers and pesticides
- Dysbiosis is a problem in the micro biome
- Can lead to IBS, autism, obesity , diabetes, chronic fatigue
- Fecal microbial transplant used to treat patients with diarrhoea causing bug due to excessive antibiotic consumption.

## 13. Reasons for India recording highest dengue cases in 2017

- Reporting of cases getting better
- Dengue becoming endemic due to rapid urbanisation
- As population immunity waxes and wanes, dengue follows a natural cycle.
- **Other problem:** possibility of Antibody Dependent Enhancement (ADE) as one Antibody in response to one strain worsen the case against another strain leading to possibility of Dengue Haemorrhagic Fever.

### Way Forward

- Can introduce vaccine Dengvaxia. But it can be ineffective due to ADE.

### 14. Potential problems in the draft space law

- More concerned with India meeting it's international obligations than in catalysing private sector
- Must trust private sector to act in 'good faith' than go for business unfriendly processes.
- Criteria for getting a license missing
- Separate policies for SatCom, Broadcasting and Remote Sensing. Draft law not clear on the boundaries of these policies
- Conflict of interest as ISRO both a regulator and operator of spacecraft.
- Law seeks to remove the liability of the govt.

### 15. Benefits of electric cars

- No pollution
- No sound from engines
- Quickly ramp up to top speed.
- Regenerative braking (check)
- More efficient than ICE: EVs convert 59-62% of grid energy into power at the wheels. ICE just 20%
- Lifetime costs are lower

### H-CNG

- blend of hydrogen and CNG. 18% H
- Reduce CO emission by 70% over CNG
- 5% saving on fuel
- Not yet opular worldwide, but EPCA advocated its use in Delh"s buses as they are already running on CNG

### Government steps

- FAME
- National Mission on Transformative Mobility and Battery Storage: PMP for setting up large-scae, export-competitive integrated batteries and cell mfg- giga plants in India
- Solar-powered public charging stations set up by BHEL
- Tax benefits on purchase of EVs
- GST reduction
- Steps towards BS VI

### 16. Benefits of net neutrality

- Embraces the concepts of equality and justice.
- Ensures access to information and public good , especially to the poor
- Service providers can still charge different prices for 'specialized services' (like VoIP) which will be determined by the govt. (New TRAI policy on Net neutrality November 2017)

### Concerns

- Although internet a public good, the infrastructure for its access is developed by private sector
- Blanket ban on differential pricing can prevent companies from realising the returns on their investments.
- Functional reason: internet today is monopolised by a few tech cpanies; no longer egalitarian. So, net neutrality argument does not hold.

Telecom Commission - highest decision making body in DoT- upholds Net Neutrality, except for a critical services (which may include autonomous vehicles, digital healthcare, DM)

### **17. Need for more clinical trials in India**

- To deal with the double burden of disease
- India's population is 17.5% of world, but clinical trials account for 1.4%
- We have the required systems in place: English speaking health care professionals, steady economic growth, access to world class tech, strong IT and data management systems, ethnically diverse patients, competitive operational cost.
- Clinical trials help in faster and cheaper drug developments
- More foreign pharma firms conduct research in India
- Need for a less cumbersome regulatory framework

#### **Steps by govt**

- Side effects to be investigated by Drug Controller General of India
- Setting up ethics Committees
- Recognizing centres that conduct clinical trials.
- New policy : single window clearance for trials, transparency, high standards, waiving off clinical trials for those drugs that have proved their efficacy in developed countries.

### **18. Benefits to India on investing in genomics**

- Collect information on specific illnesses and defects
- Study the genetic diversity of Indian groups, castes and communities due to endogamy.
- Reduce incidence of genetic diseases in future generations. Eg founder group of Ashkenazi Jews almost eliminated Tay-Sachs disease from their population
- Understand basic biological functions of genes
- Commercial enterprises on bio informatics can be set up, providing synergies to IT, biotech, engineering
- Source of employment and prevents brain drain

#### **Way Forward**

- Invest in higher education in biotech
- Create an Indian genetic data bank
- Regulatory framework for public and private participation

### **19. Radio's relevance**

#### **Yes**

- Cheapest medium for connecting to people
- No requirement of wifi, etc
- Helpful in disasters
- Anybody can broadcast and manufacture, not rocket science
- Community radio thriving
- Reaches 99% of population

#### **No**

- News broadcast not allowed. Need permission and pay AIR. So, only songs played
- Huge licensing fee
- Growth of radio market just 2-4% in last 15 years
- Radio possible through internet also
- Internet based videos dominating

### **20. Improving public transport in cities**

- Improve quality of buses
- Real time passenger information
- Provider last-mile connectivity

- Differential pricing based on quality
- Allow more competition

## 21. AI a danger to humanity?

### Yes

- Focus on only one aspect of human species: intelligence. But emotions, love and hate not included. So they may be harmful
- Immediate threat : job losses, discrimination
- May turn out to make human slaves
- An AI economy can radically concentrate wealth and income. So, UBI needs to be provided
- Ai-Da first humanoid robot to make sketches using AI. Can slowly enter the creative domain
- Using AI algorithms, large data generated- which enable companies to achieve collusive outcomes without formal agreement -**tacit algorithmic collusion**. Also the possibility of **feedback loops**.
- Increased ransomware attacks- WannaCry spread without any human intervention as it made use of the EternalBlue- an exploit leaked by Shadow Brokers hacking group.

### No

- Present AI is only 'weak AI' : big data crunching machines with capacity for self correction . But fear from 'strong AI' : thinking machines. That is unlikely to happen now
- Technology has always been embraced by humans
- Can use it for medical purposes, self healing electronic skin, water and energy networks
- Autonomous driving can minimise fatal accidents- 90% of which is caused by avoidable human error, reduce distance between doctor and patient in areas where they are not available

## AI Potential in India

- Versatile platform: Billion+ Aadhar , many services offered through Aadhaar will generate massive amount of data that can train algorithms become more efficient
- Key actors: Global AI majors like Google, FB active in India.
- Microsoft starting MS Cognitive Services: MCS a collection of intelligent APIs that allow systems to see, hear, speak understand and interpret human needs using natural modes of communication. eg: indian chatbot interacts with users like a friend
- Highest IT, entrepreneurial/managerial competence, and huge domestic market for data
- **Abundant applications:** Surveillance of AMR, dengue, chikungunya (MS project Premonition to use mosquitoes for data collection), farming, transport, infrastructure, education, crime prevention.
- NITI Ayog has released a white paper: **National Strategy for AI (See provisions)**

## Challenges

- Getting right participants, talents and skills
- Ensuring privacy and security of data
- Providing capital
- Developing the companies like Google, Amazon or Baidu, AliBaba which can generate AI platforms and use the data to improve its ML applications

Google unveils AI chips 'Edge TPU' and 'Cloud IoT Edge' which can be used by other companies to make their machines intelligent

## Challenges in regulating AI

- Provide a legal definition of AI
- To provide a legal personality to AI- the bundles of rights and responsibilities
- Who is liable for harm caused by AI? Strict liability for the manufacturer or the user can be seen
- Issues over privacy over the data collected by AI
- Changes in criminal law- can robots act as witness or as tool for committing various crimes?

## Way Forward

- Researchers need to include ethicists in AI research

- Need some regulation. Germany has brought out ethical regulations for autonomous driving
- AI must be inclusive: shouldn't be used to increase profits but to improve lives of people
- We also need to hold the tech giants like Google, Amazon, Facebook accountable for their failure to control fake news etc
- **Tax Robots:** 1. To get the revenue to pay for social security, 2. Since income taxes not applied on machines and depreciation deductions are allowed, firms invest more in robots. Taxing them will bring level-playing field.

## 22. Internet of things

- ATMs, sensors that track our heart beat, pulse, etc, CCTV, smart sensors to detect traffic violations
- A lot of Big Data will be generated
- 90% of cars connected to IoT by 2020. Size of industry will rise to \$7 trillion

### Concerns

- Security and privacy threats
- Hacking can disrupt entire systems
- Smart appliances can be uncontrollable

## 23. Potential uses of blockchain tech

- Property transactions can go paperless
- Financial services like loan taken from bank
- Keeping track of patient health records
- Health insurance
- Prevent sale of spurious drugs by keeping track of the supply chain network
- Education: repository of pass out and job records
- Agriculture: soil testing data and climate forecasting
- Allow people to share extra space and computational powers to create a **global supercomputer** accessible to everyone
- Can facilitate **nano-payments** proportionate to an individual's contribution and value-creation in the internet
- Trace the origin of food
- Fact-checking by journalists.
- Many countries using it: Russia for land registry, Dubai for visa applications and license renewals
- NITI aayog looking at adopting this tech in India
- MEITY and C-DAC setting up first Centre of Excellence in blockchain tech in Hyderabad. To secure and digitise land records in Telangana

### Distributed Ledger Technology (DLT)

DLT refers to technologies that involve the use of independent computers (also referred to as nodes) to record, share, and synchronise transactions in their respective electronic ledgers. Keeping such distributed ledgers obviates the need for keeping the data centralised, as is done in a traditional ledger. All virtual currencies use DLT.

### Why less popular

- Aren't easily available to non tech-savvy consumers through an app store
- Technical problems including scalability and slowing down of network if more people use it

### Way Forward

- Can follow EU Guidelines called AMLD5- all cryptocurrencies and wallets have to register with authorities and implement strict KYC norms
- Ethereum is a blockchain based start up- Will give users control over their data unlike present scenario under Google or Amazon

## 24. Benefits of Open Government Data



- OGD: publishing information collected by govt in its entirety . Eg: budgets, spending records, climate records, agro produce statistics
- Data collected by govt for citizen welfare: so they have implicit right over this data
- Increase transparency and build trust
- Helps in development of tech led innovations
- PwC research : 1.5% of GDP can be added by OGD . Eg: Transport for London has digitised 80 data sets
- GOI also working on OGD: MEiTy has a policy on OGD, 1.6 lakh data resources released and published 4000 APIs across 100 depts

### **Way Forward**

- Completeness of data by making it machine readable put direct APIs
- Make various data sets available at the same time. Eg:, agri data sets to have data on soil, rainfall, crop production as well as market rates
- Clustering of relevant data sets and APIs. Eg: combining data sets that can lead to applications such as insurance from crop, weather, soil data
- Aadhar API can be leveraged to create other applications . Eg AEPS, DBT
- Set up governance framework. Open Data Council with cross-sector representation to monitor, regulate and usage after proportional oversight and privacy

### **25. NITI new AI policy**

- Make India the 'AI Garage' of the world. Provide 40% of the world's AI solutions
- 5 sectors: health, education, agriculture, infrastructure and transport
- Create a network of basic and applied research institutions and CERN like multinational laboratory

#### **Concerns**

- No mechanism of funding. China subsidises AI firms and runs 5 year programmes for 500 teachers and 5000 students
- India hardly has any experience in AI . Only 4% of AI professionals are engaged in emerging technologies like deep learning
- Publications not very impactful, behind 18 countries
- Requires heavy investment with low chances of success
- Inadequate data, eg : agriculture and health for ML algorithms to work

NASSCOM sets up Centre of Excellence in AI in Bengaluru, MoU signed with NITI  
Google opening Launchpad Accelerator India to mentor AI startups in India

### **26 Spectrum Tech**

- Phone signals transmitted in the 800-2600 MHz band
- premium band is 700 MHz
- 5G Committee of DoT identifies 11 bands for providing 5G services: 700, 3.5 GHz, 24 GHz, 28 GHz. 6000 MHz of spectrum can be made available. Will be largest ever spectrum allocation if accepted.

### **27 National data centre**

- Set up by NIC and Meity
- 5 data centres currently. One more to be built in Bhopal- to be the largest with capacity to hold 5 lakh virtual servers
- Host govt websites, services and applications

### **28 Problems with Indian Pharma**

- Data falsification, inadequate documentation
- Issues with drug efficacy
- Environment issues. Major pharma factories in Guj declared critically polluted, facing CPCB action
- Pest infestations, dilapidated infra

- Cost of API production same in India and china. But China has larger capacities, strong tech capability and fermentation. Also, Drug Pricing Control to blame
- Limited research. Global companies invest 20% of profits in R&D, but Indian cos invest only 10%
- Regulatory problems: DPCO 2013 based on average price, allows margins of upto 2000 % in some drugs. Need to go back to cost plus pricing under DPCO 1995

### Positives

- Dominates world's generic drug market: exports \$17.3 billion in 2017-18
- Major markets : EU (15%), US, but china only 1%
- China easing regulatory approvals for Indian pharma in response to US tariffs

### Way Forward for dealing with spurious drugs

- Special courts
- Increase sample of testing drugs
- Ensure time-bound prosecution

### 29 Quantum Optics

- Development of laser made possible study of light governed by quantum theory
- LIGO
- Time Crystals:
- Mimic and speed up photosynthesis

### 30 Piezoelectricity

- Generation of electric charges in solid materials in response to applied mechanical stress- body's motion, wind, water or sound vibration

#### Applications

- Piezoelectric nanogenerator
- Power a pacemaker

### 31 Nipah transmission

- Pune's NIV has identified fruit bats as having Nipah virus
- Used RT-PCR
- Viral load in fruit bats in Assam and WB low. Unlikely to result in transmission

### 32 Issues with generic drugs

- **Clarity in definition:** There differences in definitions of branded drugs, generics and branded generics. This confuses doctors and patients alike.
- **Safe quality and standardised quality certifications:** How can doctors prescribe a certain generic if they don't know what the quality is, or under what conditions they are manufactured? Patients also reluctant to consume them, instead prefer branded drugs for better quality. Trust and goodwill built up over years with branded drugs
- **Qualifications of pharmacists:** Since it is the pharmacist who provides the generic medicine to patients, they should be properly trained to be able to identify quality of drugs

Generic drug: Drug that is comparable to a brand in dosage, strength, route of administration, quality and performance characteristics and intended use.

Branded generic: Those that are given a unique name by their marketers to enable doctors and patients to identify a product they can trust from the ocean of numerous alternatives.

### 33 Quantum computing

<https://singularityhub.com/2017/06/25/6-things-quantum-computers-will-be-incredibly-useful-for/#sm.0000rjy1lz45gf7cvuu1d41z2bdh0>


### 34 Brahmos

- Built by India and Russia
- World's fastest supersonic cruise missile with a strike range of 290 km
- Land-attack, anti-ship and from air.
- Army, navy already inducted. Air trials going on

### 35 Vikas engine

## Soaring high

The Vikas engine is aimed at improving the payload capability of PSLV, GSLV and GSLV Mk-III launch vehicles



- **Utility:** The engine is the workhorse liquid rocket engine powering the second stage of India's PSLV; second stage and the four strap-on stages of GSLV ; and twin engine core liquid stage (L110) of GSLV Mk-III
- **Performance:**  
Thrust 800 kN<sub>2</sub>  
Specific impulse: 290 seconds
- **Dimension**  
Length 3.70 m (12.1 feet)
- **Liquid-fuel engine:**  
Propellant: N<sub>2</sub>O<sub>4</sub>
- **Cycle:** Gas generator

■ Vikas is a family of liquid fuelled rocket engines

### 36 BCAS Counter-drone strategy

- Soft-kill approach to neutralise drones, as hard-kill/destroying a drone with payload of explosives or chemicals will result in a terrorist attack
- Banned drones within 5 km radius of airports, 50 km from international border
- Soft kill: Entrapping drones or jamming them

### 37 Formalin in fish: need for scientific study

- Fresh fish should not have preservatives. Presence of formalin suggests vendors selling stale fish as fresh. Trade malpractices
- Lack of evidence linking ingested formalin with cancer doesn't necessarily mean it is safe. Need for greater study
- When marine fish is improperly frozen, formalin develops. But this binds to muscle tissue. Need to ascertain if the detected formalin is bound to tissue or not.

### 38 New Meghalayan Age

- 4200 years ago: mega-drought and cooling around the globe
- Based on sediments in stalactite and stalagmites collected in Meghalaya caves
- 200 year event, affected civilizations in Indus, Mesopotamia, China
- Two other ages: Middle Holocene Northgrippian Age and Early Holocene Greenland Age
- 3 ages comprise the Holocene Epoch
- Units of Geologic Time Scale based on sedimentary strata containing isotopes, chemicals, fossils etc that record biological and geological events

### 39 Parker Solar Probe

- Corona gives rise to solar wind- a continuous flow of charged particles that permeates the solar system
- Unpredictable solar winds cause disturbances in earth's magnetic field and can play havoc with communication systems
- In extreme cases, can actually affect our power grids
- Corona is highly magnetised
- Parker probe will enter sun's corona within 3.8 million miles from sun's surface- under NASA's Living with a Star programme

### 40 TRAI's demonstration license

- Global companies import products and solutions for demo purposes and for customer trials. These are reqd to take demonstration license from govt.
- Usually runs into 5-6 weeks, but TRAI wants it done by 15 days for EODB

### 41 s-400 Triumf (SA-21 Growler by NATO)

- Most advanced Modern Long Range SAM (MLRSAM), ahead of US THAAD
- Can engage all types of aerial targets including UAVs, Ballistic, cruise missiles
- Range 400 km, altitude 30 km
- Can track 100 airborne targets, engage 6 of them simultaneously
- Can be deployed in 5 minutes
- Multifunctional radar, autonomous target detection systems, anti-aircraft systems
- China buying 6 battalions
- Used in Syria

### 42 e-cigarettes

#### Pros

- safer than combustible cigarettes as they heat a liquid to generate nicotine-containing aerosol, instead of burning tobacco that produces tar
- Can be used from a 'harm minimization' perspective, for addicts to reduce their chances of lung cancer

#### Cons

- At high temperatures, the liquid can turn into carcinogens especially formaldehyde.
- Can increase odds of lung disease and heart attacks
- Use precautionary principle: since new tech and its ill effects unknown, avoid its use
- e-cigarette users more likely to turn into regular smokers eventually.
- Difficult to regulate under COTPA as it doesn't contain tobacco
- As per ICMR research- e-cigarettes cause- DNA damage, immunological toxicity, resp, cardio and neuro disorders, adverse impact on foetus
- ENDS is a way to satisfy nicotine addiction

KN, MH banned its use. Delhi is planning too. Centre in favour of ban. **Update:** CDSCO approved to regulate them as drugs and prohibit sale under Drugs and Cosmetics Act 1940 Sec 26A, 10A

## Way Forward

- Create standards for aerosols
- Ban underage and public use
- Regulate its use, rather than banning

## 43 Evolutionary biology

### Uses

- Multi-drug resistance in microbes
- Nipah outbreak: How habitat loss of fruit bats played a role in transmission of virus
- Host-range expansion: how, due to climate change, pathogens move from one host to another
- DNA fingerprinting

### State in India

- No PG depts of evolutionary biology in any university
- Indian Society of Evolutionary Biologists (ISEB) set up recently to bring together researchers from the field and engage with public

## 44 LIGO INDIA PROJECT

- Constructing a network of L-shaped arms, each 4 kms long, can detect even the faintest ripples from cosmic explosions millions of light years away
- Hosting such a detector in India will improve odds of detecting more such phenomena (like gravitational waves)- Hingoli district, MH
- There are only 3 of its kind in the world
- Requires extremely flat surface
- Is to check if land can be made perfectly level at a reasonable cost
- LIGO project operates 3 gravitational wave (GW) detectors, 2 at Hanford in Washington State and 1 at Livingstone, Louisiana.
- LIGO-India project aims to move one advanced LIGO detector from Hanford to India
- This project an international collaboration between LIGO Laboratory and 3 lead institutions in LIGO-India consortium: Institute of Plasma Research, Gandhinagar; IUCAA, Pune and Raja Ramanna Centre for Advanced Technology, Indore.
- LIGO Lab to provide complete design and all the key detector components
- Indian scientists would provide the infrastructure to install the detector
- It would be operated jointly by LIGO-India and the Ligo-Lab
- India making **ultra stable laser, quantum measurement techniques, ultra high vacuum technology**
- Piloted by DAE and DST
- To cost Rs.1200 crore
- Expected to be ready by 2025.

### Utility of gravitational waves

- New way to map the universe
- GW bouncing off celestial objects can help us detect them

## 45 MEDIOCRITY IN SCIENTIFIC ACHIEVEMENT:

Causes:

- Nature of school education
- State of science administration
- Our cultural response to the idea of excellence
- Excessive power invested in individuals in Indian science
- DST and other departments which disburse funds are not held accountable to the results of that funding
- Scientists know how best personal contacts and networks are still so important in securing funds, other incentives

- Its far more difficult for a person to stand out in terms of high quality work since the system has little support for excellence
- Great work in any domain is not produced in isolation
- For great work to be possible in science, the larger society has to produce great work in art, literature, humanities and so on

#### **46 PROBLEM WITH RAISING DEFENCE EXPENDITURE:**

- India's defence expenditure as % of GDP: **1.49%**, lowest ever, lowest than what it was before 1962
- This figure doesn't include defence pensions and MoD spending. If included it'd be 2.16% of GDP
- Defence expenditure currently 16.6% of central govt expenditure(CGE); has been stable in range of 16-18% over the past decade
- But DE as % of GDP has been falling becoz CGE as % of GDP has come down from 16% to 13% over the past decade
- GDP becomes a misleading metric
- Raising of DE to 3% of GDP will be 23% of CGE
- The increase would be on the capital side
- Defence Ministry's capital expenditure in 2018-19 is 33% of the govt's total capital expenditure
- Defence capital expenditure raising would increase the ratio to 85%
- This would leave the govt with very little money for capital spending, including for infrastructure and asset creation, outside the procurement for defence services
- Most defence equipment is procured from foreign countries, an increased capital budget would increase the defence import bill+ add to current account deficit
- If we want to increase to 3%, require either an increase in the current tax rates or a widening of the tax base. Both difficult in the short run.
- If revenue collection not increased, DE can go up if allocation to other heads is reduced
- There is very little for education, health, police and public infrastructure

#### Way Forward:

- Between 2011-12 & 2018-19, share of manpower costs-pay, allowances, pensions-in total DE has increased from 44% to 56%
- This increase has largely come at the cost of capital procurement(gone down from 26% to 18%)
- Challenge is to optimize the existing defence allocations

#### **47 Indian Space Vision 2025**



## INDIAN SPACE VISION 2025

The space vision 2025, a future roadmap for ISRO was unveiled at the Indian Science Congress Session in 2003, in Bangalore. The vision document spells out the steps to take our space programme to greater heights. As India has already achieved self-sufficiency in fabrication of satellites, thus now emphasis is on achieving self-reliance in launching capabilities. It includes:

1. Satellite based communication and navigation systems; for rural connectivity, security needs and mobile services;
2. Enhanced imaging capability for natural resource management, weather and climate change studies;
3. Space science missions for better understanding of solar system and universe;
4. Planetary exploration;
5. Development of Heavy lift launcher;
6. Reusable Launch Vehicles - Technology demonstrator missions leading to Two Stage To Orbit (TSTO); and
7. Human Space Flight

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## India's Space Programme

- **Satellite Communication:** Guided by Sat Com Policy 1997. For telecom, broadcasting and broadband infra- telecom, telemedicine, broadband infra
- **Earth Observation:** Guided by National Remote Sensing Data Policy 2001. For weather forecasting, DM, national resource mapping, agriculture, watershed, forestry- **RISAT, cartosat, resourcesat**
- **Satellite-aided navigation:** GAGAN- using AAI and ISRO, and **IRNSS (renamed NavIC)** - constellation of 7 satellites at GS or GTO
- **Space Science and exploration missions:** Chandrayan, Mangalyan

## Steps taken by ISRO

- Mastering launch vehicle tech- SLV, ASLV, PSLV, GSLV
- Strong association with industry especially PSUs like HAL, and large private L&T
- Antrix Corporation- **private** company for commercial operations
- Village Resource Centres- but only 460 pilots have begun

## Newer areas

- AI to be used
- Startups, like INDUS
- Small satellite revolution

## Why recent renewed global interest in moon

- Scientific prestige and soft power for non- US and non- Russians
- Water resources- found by Chandrayan 1 using Moon Minerology Mapper
- Real estate
- Increasing international collaboration- even during the Cold War, US and USSR cooperated during space.
- Even private companies like Tesla, Amazon vying for the moon.
- Can be used as a base station for launch into interplanetary exploration
- Understanding origins of the moon (impact hypothesis) and solar system

## Way Forward

- Space industry globally makes up \$350 billion. India's share only 2%. Need to raise it to 10%
- ISRO should focus exclusively as a civilian organisation

## Likely problems with the Outer Space Treaty

- OST advocates non-interference in nation's space activities. So, those nations that set up stations in moon first will have effective property rights over that
- No provision for effective dispute resolution
- Who owns resources of moon. Mention 2015 US law

## 48 HySIS

- Technique that creates images with features that would not have been visible to the naked eye
- Works by dividing the EM spectrum into a large number of narrow bands, which help characterise objects in an image with great precision and detail
- Applications: remote sensing to agri, diagnostics and environmental monitoring
- ISRO's satellite to study earth's surface in visible, near infrared and shortwave infrared regions of EM spectrum

## 49 GSAT 11

- 6-tonne largest satellite launched by India from French Guyana- Big Bird



- Advanced communication satellite- high-speed internet services in rural, remote areas and to businesses down home over next 15 years
- Help Bharat Net programme
- Enable in-flight internet and village web series

## 50 5G

<https://www.thehindu.com/business/how-will-a-5g-network-power-the-future/article27698653.ece> (Must Read)

### Benefits

- Latest generation network equipment is 5G ready
- Data speeds 10 times faster than 4G networks
- Congestion relief: Seamlessly stream videos, data and pictures irrespective of the number of people using that service at any point of time
- Benefits to IoT: especially in mfg, energy and utilities

### Concerns

- High capital expenditures
- Businesses do not see immediate near-term gains

### What India needs to do to make the most of 5G

- Bring full benefits to the people at the lowest cost. It is in India's benefit to not exclude any players from the small set of 5G equipment vendors. It is to our advantage to keep competition high, telecom equipment pricing low, and access to the full range of technology options open. Can sign a **no-backdoor** agreement with India- so Huawei will not snoop
- minimise any security risks to critical telecom infrastructure. To do this, the nation should perform an integrated threat assessment that provides a "common threat perception picture" — this is best done by a multi-stakeholder and multidisciplinary (private-sector led) task force. Followed by a realistic risk mitigation programme through National Critical Information Infrastructure Protection Centre (NCIIPC).
- India can also consider forming a techno-diplomatic alliance with countries at risk from the same telecom products and create an information sharing and competency building agreement with them — Russia, Japan, France, and Germany are some of the potential partner countries
- India has limited intellectual property in 5G technologies and is largely going to be a buyer of this technology. Government should encourage capacity building in Indian companies for "5G deployment services" such that Indian talent can be used across the world. For vendors winning large 5G contracts in India, preferential agreements with Indian software companies could be considered. Additionally, setting up "use-case validation and development centres"
- Need to ensure that auction reserve prices are not too high- otherwise, high user charges, debt-trap and poor competition will result.

### Current progress

- Deliberations still on whether to give spectrum in 25 GHz and 28 GHz bands
- In Feb 2018, Airtel and Huawei conducted lab trials of 5G in which 3Gbps throughput achieved
- Telecom ministry cleared Idea, Voda, Jio and Airtel to conduct 5G trials from next month

## 51 Why landing on the far side of the moon by China (Chang'e-4) is important

- Landing on the far side is difficult because moon blocks the radio communications between its far side and the earth
- So, China used a relay satellite around a strategically selected point called L2
- Study of the craters will help understand: Composition, history of collisions between moon and earth, and early solar system

## 52 Rare disease

- A disease that affects less than 1 in 1000: WHO
- NHM not equipped to deal with it as tertiary care does not come under NHM
- Create a national rare disease cell, similar to blood cell

## 53 Plasma Environment of the moon

- Generated mainly by its interaction with the solar plasma wind flowing towards it from the Sun.
- This plasma wind consists of charged particles such as protons and is partly absorbed by the side of the Moon facing the sun.
- The rest of the solar plasma wind incident on the Moon flows around it, but leaves a wake (a void) on the side not facing the sun (the night-side of the Moon).
- Earlier, it was believed that this wake was devoid of any particles.
- Moon has no global magnetic field originating from a magnetized core. It has weak crustal fields that are too small to shield it globally from charged solar plasma particles incident on it.
- At some regions the crustal fields are quite strong and these are known as magnetic anomalies. The plasma particles scatter off these anomalous crustal fields.

## 54 Gaganyaan

<http://onesay.in/Current-affairs/Science-and-Technology/article1058-ISRO-cranks-up-Gaganyaan-project>

### India's Proposed Space Station

- **Why India not joining ISS instead:** ISS is winding up by 2024. In its heyday, India excluded from the project because of sanctions on ISRO and DRDO over its nuclear programme
- **What scientific benefits from microgravity experimentation?:** From astronomy to biology and medicine and materials. Breakthroughs in this field will have major commercial and strategic benefits
- **Why a small 20 tonne space station (ISS is 400 tonne):** GSLV not ready in time, and India needs to learn from past experiences of missions to moon and Mars
- **Economic viability:** India can involve the pvt sector. PPP mode.

## 55 Magnetic North Pole

- Currently located over Northern Canada
- Moving at 55 km per year, rather than 14-15 km earlier
- This has forced the updating of the World Magnetic Model (WMM) earlier than required.
- Caused supposedly by movement of liquid iron and other metals in the outer core

### Uses of the magnetic NP

- Aviation and shipping navigation charts
- Military- for firing missiles along designated paths
- Modern compasses highly precise, digital and sophisticated

## **56 How to deal with access of people's data by tech companies**

- As companies amass large amounts of data, they are able to produce targeted ads and keep people glued to them. Through this, they are able to concentrate their wealth and market share. 7 out of 8 of the most valuable firms in the world are tech companies
- But they are not generating enough jobs as compared to the ones they are eating up due to AI and automation

### **Way Forward**

- Educate people about the value of data they generate
- Make companies pay people for using their data. Use tech like blockchain to facilitate nano-payments based on degree of contribution, value creation etc

### **WHY countries want to regulate the flow of data**

- Where data is stored, sent, where it is processed- determines who has access to the data, who profits off it, who taxes the data and who owns it
- Raising values of national security
- Issues of privacy

### **Arguments against data localisation**

- Allows companies to store data in the most efficient place
- If all countries protect data, it will backfire on Indian companies seeking global growth
- Fears of state surveillance

## **57 Steps taken to promote innovation**

- Atal Innovation Mission and Atal Tinkering Labs
- IMPRINT
- GIAN, Uchhatar Avishkar Yojana
- Startup India
- Digital India- and the challenges
- Hackathon

### **Actual Innovations**

- e-NAM
- BHIM, UPI
- JAM
- ECOSAN- ecological sanitation- human excreta and waste water re-used in a hygienic manner
- Use of plastic waste in road construction
- **Social Innovations:** Stand-up India, MUDRA

### **India rises in Global Innovation Index by WIPO**

- Rises by 5 places to 52 rank
- Most innovative economy in central and South Asia
- Innovation drivers: ICT services exports, graduates in science and engineering, quality of universities, GCF- a measure of economy wise investments, creative goods exports
- World's top science and tech clusters- Delhi, Mumbai and Bengaluru

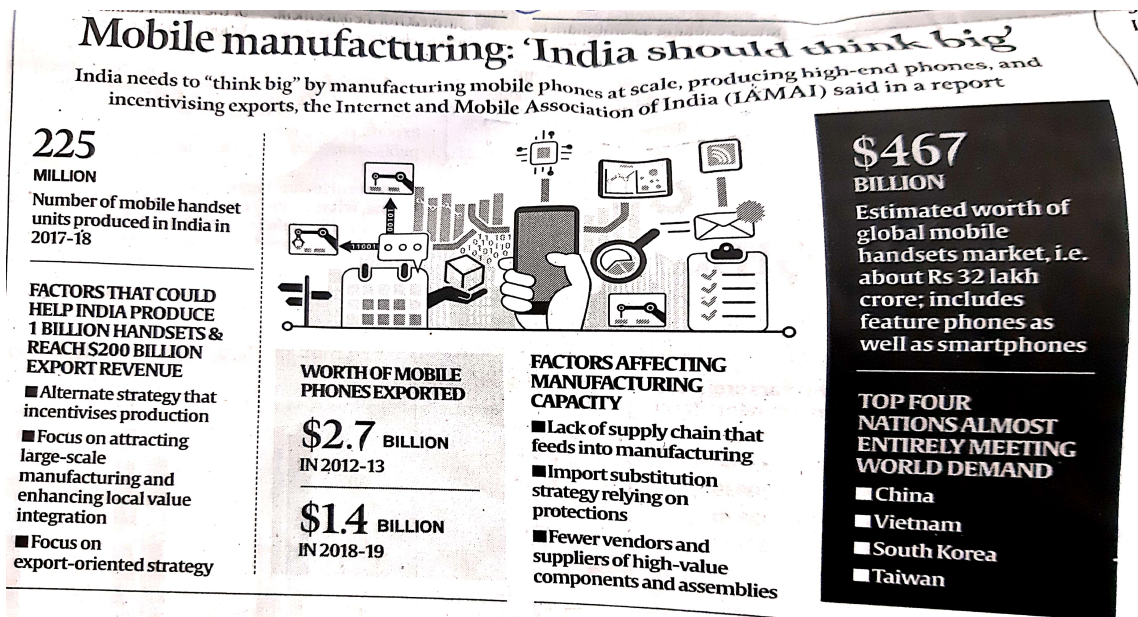
## **58 Steps taken to promote Digital India**

- AADHAAR
- Bharat Net
- National Knowledge Network: network to promote collaboration and exchange of ideas and knowledge among educational and research institutes
- GI Cloud - Meghraj
- eSign
- Digital India for **better governance**

1. JAM
2. BHIM-UPI
3. UMANG
4. Jeevan Praman
5. e-Hospital
6. Soil Health Card
7. eNAM
8. Digilocker
9. eCourts and National Judicial Data Grid
10. GeM

- PMGDISHA - digital literacy in rural areas
- Digital India for **Make in India**- promotion of electronics mfg
- **Cyber Security**

1. Cyber Swachhta Kendra
2. CERT-IN
3. NCIIPC
4. National Cyber Coordination Centre



### 59 The London patient

<https://indianexpress.com/article/explained/ccr5-delta-32-the-rare-mutation-that-could-help-stop-hiv-5612792/>


### 60 PSLV C45

- Place payloads at three different orbits
- The third stage will serve as an orbital platform for space-based experiments
- PSLV QL- 4 strap-on motors will be applied in the first stage itself
- Emisat- meant for EM spectrum measurements, gathering electronic intelligence from enemy radars, developed by DRDO

### 61 Chandrayaan 2

- India's first lander and rover mission- soft landing on Lunar South Pole- no country has ever done before
- Vikram- lander, Pragyan- rover
- 14 payloads, including NASA reflectometer for future missions
- Will use GSLV Mk III rocket

## Challenges of a Moon landing



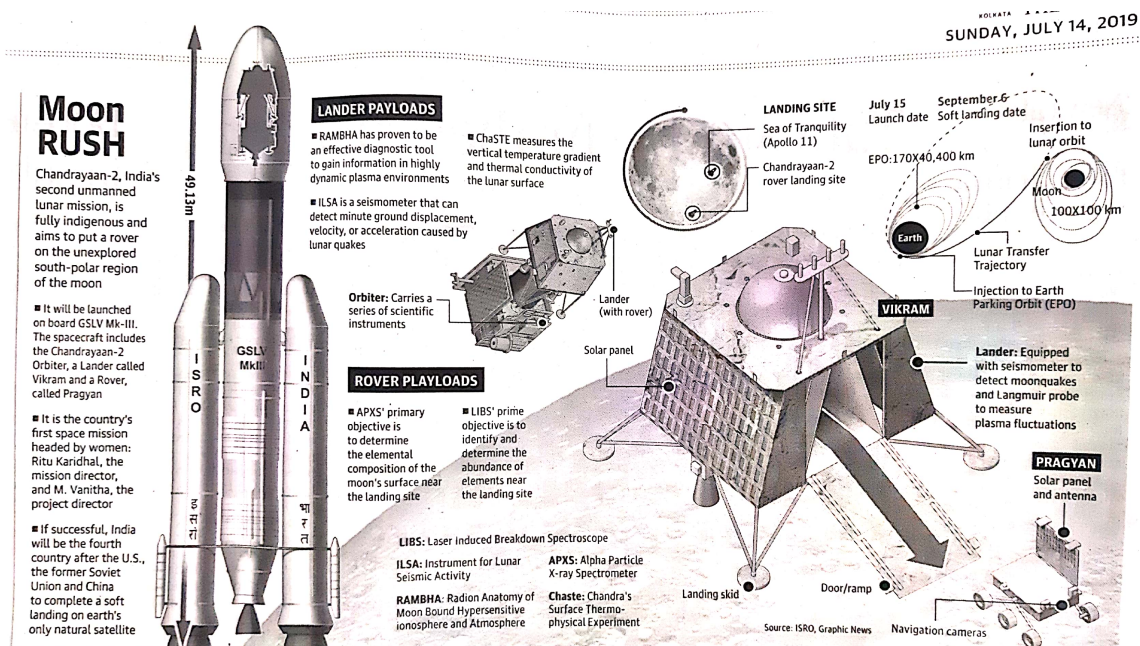
- **Trajectory accuracy:** Ensuring trajectory accuracy while covering a destination of 3.844 lakh km has its own challenges
- **Communication issues:** Owing to the large distance from earth, radio signals would be weak when Chandrayaan's handlers need to be in touch with the orbiter, monitor and control the lander and the rover later on Moon

- **Trans-lunar injection:** On-board motors will be programmed to burn at the appointed time and spot, so that the spacecraft slips precisely into the pre-planned orbit
- **Lunar dust:** The lunar dust that may rise from craters can be deadly for the lander and rover. The dust can cling to the machines and damage their sensors and functions

Source: ISRO

### Significance

- Lander will study moon's atmosphere and seismic activity
- Orbiter will create high resolution 3D maps of the surface and study mineral composition of atmosphere
- Landing on South Pole for the first time. SP holds possibility of **presence of water**. Ancient rocks and craters can indicate the history of moon.



### 62 Issues with GM technology

- Can make it unsafe for consumption
- Adverse impact on plant and animal health
- Introduce problems in the soil or neighbouring crops



- Some traits of genes start expressing themselves after several generations
- For Bt Brinjal, many local brinjal varieties maybe wiped out. Many states, therefore, oppose its entry
- Massive rise in output will lead to fall in prices ultimately hurting farmers.
- No scientific consensus on efficacy. Pests have developed resistance to Bt Cotton forcing farmers to spray lethal pesticides
- Concerns over irregularities in the assessment of Bt Brinjal by GEAC

### **Why it is wanted by farmers**

- Makes it resistant to pink bollworm- Bt Cotton (through Cry1Ab and Cry2Bc genes from Bacillus Thuringiensis)
- Herbicide resistance enables farmers to spread glyphosate herbicide without losing crop. This saves de-weeding costs

**GEAC** has cleared Bt Brinjal and GM Mustard, but the Env't Minister has not yet given consent to their release.

### **Way Forward**

- Can look into alternative strategies like ZBNF, Organic Farming
- Need to label GM foods. FSSAI has recently started

### **63 Bihar's AES and low blood sugar**

<https://indianexpress.com/article/explained/acute-encephalitis-syndrome-low-blood-sugar-bihar-5785453/>

### **64 Superconductors**

- In superconductors, no resistance is offered to electric current. All electrons align themselves in a particular direction, and move without any obstruction in a coherent manner
- Can save huge amounts of energy and make highly efficient electrical appliances
- Problem: Superconductors only observed at very low temperatures close to 0 K

### **65 Improving IAF's combat capabilities and reducing accidents**

- Immediately replacing the Mig 21 and Mig 27 with LCA and MMRCA- expediting these developments. This includes accelerated Tejas production and no hiccups in Rafale purchase
- Augment training deficiencies. Currently, 40-year old Kiran is used. Need better aircraft like Pilatus and HTT 40
- Non-availability of Ground Proximity Warning systems in AN-32 and deficiencies in AN 32 led to crash. Need to equip those systems, and upgrade to Tata-Airbus C 295 which can fly at 19000 feet with a single engine
- Upgradation of simulators as force multipliers

### **66 NASA's Dragonfly drone mission to Titan**

- Titan has substantial atmosphere and considered equivalent to early earth
- Only celestial body other than earth to have lakes, rivers, seas of liquid hydrocarbons like methane and ethane, not water

### **PUNCH Mission**

- Understanding the transition of the particles from the sun's outer corona to the solar wind that fills the planetary space
- Will also study coronal mass ejections- huge masses of plasma thrown out of sun's atmosphere- can affect and drive weather systems on the earth
- Will consist of a constellation of satellites

## Other Missions to Sun

- India's Aditya
- NASA's Parker Solar Probe
- ESA-NASA Solar Orbiter

**Hayabusa2** probe touches down on Ryugu asteroid to understand origins of solar system

## 67 Registry for phones

- As per National Telecom Policy 2012, under C-DoT, an autonomous body under DoT
- Central Equipment Identity Register- Every mobile network provider has an EIR or a database of phones connected to its network. The CEIR will integrate all the EIRs of the network providers
- CEIR will also have IMEIs- the unique device identification number of 15 digits
- Also know why a phone has been blacklisted

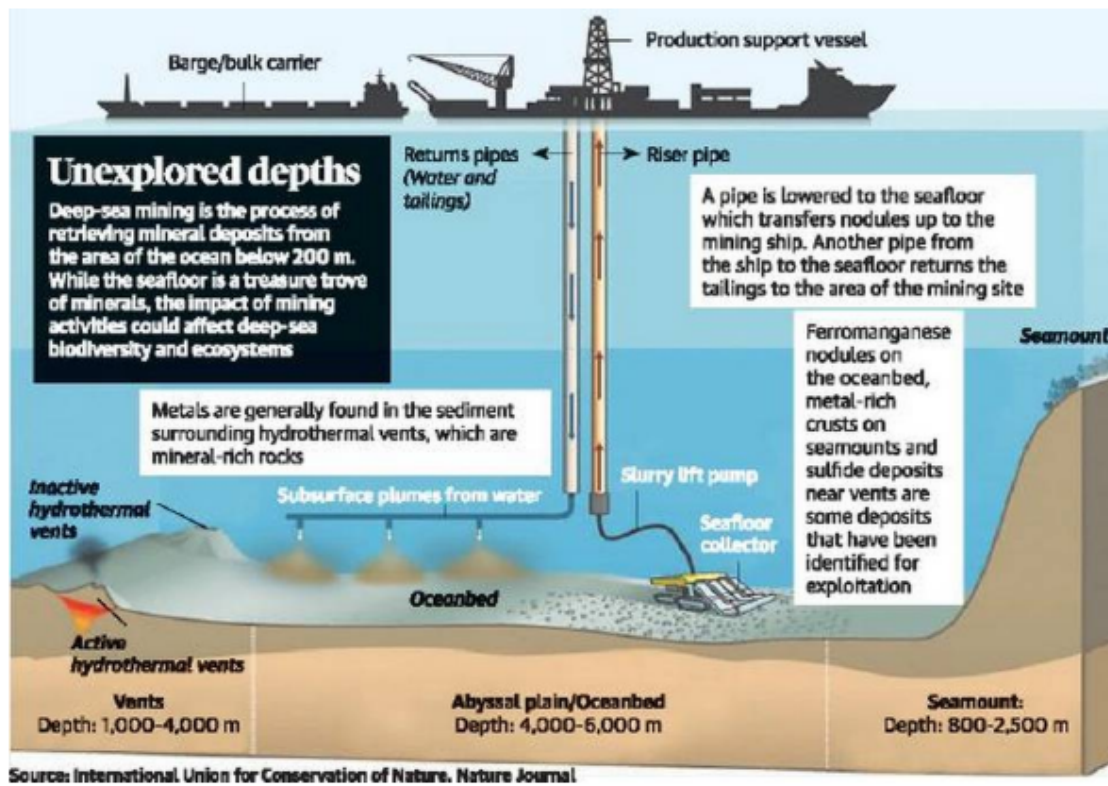
## Rationale

- Identify and block stolen or illegal phones
- Once a network provider blocks a phone in its EIR, using a different SIM again makes the phone usable. A central database will prevent this as other service providers will also know about it
- Will check if phone is authentic or using duplicate IMEI number

## Issues

- Who should be the custodian of such a high value database- ideally an independent body
- Cloning or reprogramming stolen phones with genuine IMEI numbers

## 68 Deep Ocean Mission



## Potential problems

- Unique species have adapted themselves to poor sunlight, oxygen, low temp and high pressure. Such expeditions can make them go extinct even before they are known to science
- Sediment plumes harming the filter feeders in the upper ocean layers

- Noise and light pollution and oil spills

## **69 CSIR's IndiGen Project for whole genome sequencing**

<https://www.thehindu.com/sci-tech/sequencing-indian-genes/article29865310.ece>

Exomes and whole genomes