

Maty - size of India's digital economy is estimated to grow from \$200 bn (2017-18) to \$1tr (2025)

cloudscape - 700mn internet subscribers

77% data centres in OECD states

64% in NATO countries

mobile phones

growth in e-commerce & social media

e payments to digital kricchi

IT - India as global data centre hub

e gov.

Agri & FPI - hi tech services in PPP mode

edu - university

DESH e stack - online training

NDHM - health

75 DBUs - bank

100% PO under CBS

CLOUD COMPUTING

It works on 2 vital technologies- virtualisation (lets computer resources be shared through multiple virtual machines) and network (lets data requests flow to and from datacentre or Cloud through Internet).

Services provided-

- Software as a service- software user is charged on transactions a customer makes and volume of those transactions, eg Google photos, Zoho applications
- Infrastructure as a service- order hardware with minimal software, eg Microsoft Azure, Amazon Web services, Terraform
- Platform as a service- hardware with more than minimal software installed in it,
- Demand for cloud infrastructure is increasing due to 'digital first' approach by organisations
- Overall cloud spending to surpass \$1.3tr by 2025 acc to IDC

Advantages & uses-

- Sell products and services online
- With cloud computing, only required to subscribe to service provider to obtain the hardware and operating system that software needs
- Brings utility model for computer infrastructure just like electricity. We only pay how much we use the software. Pay as you go principle. Eg- Google photos.
- Almost 50% of all corporate data is stored in Cloud

Issues

1. Disruption and hampered access- eg Amazon Web services due to application programming interface
 2. Authentication problems, affecting customers services eg- Microsoft Azure active directory
 3. Outages- cripple productivity and communication
 4. Vulnerability of internet and concentration in hands of few firms representing feudal kingdoms than ecosystem of services such as Alibaba, AWS, Google, Microsoft.
 5. Increased centralisation than focusing on edges of internet that hold incredible distributed computing power
- Better operating models using blockchain tech, advancements in cryptography, clever consensus model for distributed decision making can decrease centralisation.
- Kubernetes to minimise risk as it isolates and compartmentalises network resources for better security and fault tolerance.
- Steps towards interoperability and spreading out risks to multiple cloud platforms can reduce outages.

Time tested decentralised peer-to-peer models at moving massive amount of data quickly ad efficiently

Edge and Cloud computing-

When software is built and run on "Cloud", depending on where the servers are located, response time differs.

To provide quick responses eps when customers are present in multiple geographies, then Cloud is hosted in multiple locations, known as edge computing, eg Google, Amazon or IRCTC

Cloud refers to same datacentre and network circuits that are used by multiple customers including possibly our business competitors. It is also known as 'public Cloud'.

✓ scalability
expand footprint

✓ physical security at data centres

✓ zero trust architecture

✓ encryption

✓ identity and access management

→ deploy of incompatible legacy IT system and third party data storage architecture

→ insecurity due to insecure APIs - risk

→ human errors

With growth of digital population, there comes a need of strong data centres.

secured centralised location share info on purpose

NASSCOM - Indian tech industry to reach \$227 bn in 2022.

'Private Cloud' is where geographically distributed hardware are cordoned off virtually such that computer resources are allotted only to one customer.

'Hybrid Cloud' where private info in private cloud while less critical data is stored in public cloud.

'Cloud Native Development' is developing software that runs on multiple parallel threads or can run automatically request for extra servers when demand is high and turn over servers when demand is low.

QUANTUM COMPUTING — quantum mechanics
— nature and behaviour of matter
— at atomic & subatomic level

APPLICATIONS — magnetometers in atomic systems
— atomic clocks — photon detectors
— meteorological apps.

- Solve problems that are too complex for classical computers to solve
- Important for quantum computing and quantum communication systems
- Quantum networks facilitate transmission of info in form of quantum bits

Quantum networks work in a similar way to classical networks- main difference is that quantum computing is better at solving certain problems such as modelling quantum systems.

- a quantum processor is a small quantum computer being able to perform quantum logic gates on certain number of qubits

ISSUES-

low patents
governance — loose research ecosystem — funding sustained
— skilled prof.
— indigenous dev of components
— industry academia gap
— difficult to achieve super position & entanglement

STEPS TAKEN-

— IIT Madras became first institute to join IBM Quantum network that aims to advance quantum computing skills and research in India.
— National Quantum Mission, NMQTA,
— QUEST, QSim Toolkit, Frontier mission

for India

— stay ahead in race
— tackle nat. security
— foster eco growth
— societal progress
— encourage entrepreneurship

* National Quantum Mission
₹6000 cr - (2023-2031) DoS
— immediate scale quan. comput
— satellite based communication
— QKD - 2000 km
— 4T - thematic hubs
— computing
— communication
— sensing & metrology
— material & devices

- Ind. govt boosted inv. in Digital India to \$477 mn in 2020 to boost AI, IoT, ML, cybersecurity and robotics
- Training to 10 mn youth in AI and big data
- National AI portal of India - (INDIAai) - AI future nation
- boost growth rate by 1.3% to → add \$1 tr by 2035 to Ind. eco

ARTIFICIAL INTELLIGENCE-

India is aiming to become the AI powerhouse of the world. AI/ML models and algorithms have supplemented the work of healthcare professionals, medical researchers, public health authorities and local administrations in monitoring and predicting the trends.

Acc to dept of telecom, internet consumption rose by 13% after lockdown. Higher consumption has generated goldmines of user data that online businesses harness.

NITI aayog 'AI for all' envisages inclusive growth and identifies healthcare, agr, edu, smart cities and infra, smart mobility and transportation as focus areas for AI led solutions on social impact.

- TL, KA, TN, MH govts have announced policies and strategies for adoption of AI.

- Tech companies have established AI centres of excellence to create solutions for global clients.

- India has thriving ecosystem of AI with cutting edge solutions being developed in areas such as cancer screening, smart farming, conversational AI for use of enterprises.

- Talent pool in AI/ML is increasing, with over 5 lakh people working on these techs at present.

- Meghraj cloud service

- A14 Bharat Nilekani centre- accelerate Bhashini mission, open source language AI for Indians.

✓ Digital India Bhashini mission- all services and info to citizens in their own language with 'collaborative AI'

- Reliable and consistent predictions of structures of proteins with great accuracy. The DeepMind company stunned the world by accurately predicting the structure of proteins, starting from the sequences of amino acids that constitute them.

1972 Nobel Prize in Chemistry- Christian B Anfinsen- protein could fold into structure based on info contained in sequence of amino acids.

X Ray crystallography- uses protein crystals and X rays to determine structures of myoglobin and haemoglobin.

NUCLEAR MAGNETIC RESONANCE
CRYPTO-ELECTRON MICROSCOPY

USES IN INDIA-

1. Debates on- training, deep learning models

2. Defence-

3. Ideas for innovation

4. FRAAS

5. RBI to use ML for strengthening real time tracking of eco activity to effectively deal with impact caused by pandemic - 7 day Weekly Activity Index and 15 indicator Weekly Diffusion Index

6. Fintech- detecting crime, fraud detection, quantifying risk (

7. Future of Finance is VUCA- volatile, uncertain, complex and ambiguous- Highlighted by FM- helps prevention of black swan event.

8. OTT, gaming

→ Ayushman Bharat -
fraud detection using
AI - (₹9.2 cr)

→ IAMA study - India's AI is expected to witness a growth of 20% over next 5 years,

with India among top 3 talent markets - producing 16% AI pool

→ Report "From Buzz to Reality" - AI market is expected to grow at second fastest rate of 20% among major economies, only behind China

STEPS TAKEN-

→ National Str. on AI

1. AI adoption Index- IT Industry trends in banking, fin services, consumer products & retail, health & automotive- 60% of AI potential to GDP.

2. "AI FOR HUMANITY"- 2nd edition of AI for All

Themes-

→ National Program on Resp. use of AI

- AI NOW- keynotes, panels, workshops, tech demonstrations
- AI NEXT- impact on people, business, govts
- AI NEVER- challenges and debates, ethics and responsible use

- Future Skills Prime for skills in AI

→ AI portal

→ RAISE 2020

→ Tech Inno. Hubs

CHALLENGES/ISSUES

privacy
society
accountability & transparency
ethical
IPR infringement

- ①-US-China trade war can hit supplies of advanced chips required by any major tech company running public clouds or advanced AI training modules in country. This can lead to global supply chain disruptions.

- ② Talent development- in 2019 AI workforce doubled from the 2018 demand in the sector continues.

- Policies around data usage, governance and security- without data there cannot be AI. Balanced approach is harnessing data and utilising data. Robust legal framework for ethical use of AI ✓

③ - Use of digital techs have gone up but level of digitisation continues to be low- challenge for organisations to find right amount of training data to run AI/ML algorithms, which affects accuracy.

④ - There is also a challenge of availability of clean datasets. Organisations need to invest in data management frameworks that will clean their data before they are analysed.

⑤ - Govt should introduce a sound data regulation framework to protect this national resource and ensure data privacy.

⑥ There is a need of transparency and accountability to protect against weaponisation of technology by non-state actors. Algorithm transparency is key to establish this trust.

- Even the smartest of AI cannot solve mankind's problems without blending with intellect & empathy.

- Intelligent data is "digital capital" and a vital national resource.

- It will boost India's eco growth in big way. NASSCOM believes that data and AI will contribute to \$450bn-\$500bn to India's GDP by 2025, which is around 10% of \$5tr economy target. ✓✓

- scale infra and sensitivity

⑦ Data quality

- It can generate over 20mn technical roles alone.

⑧ Failure to develop Minimum viable products due to lack of infra, tools and skills

⑨ Large enterprises have adopted AI at much faster rate - 45% small enterprises to buy inbuilt models due to high cost

⑩ Enterprises lack domain specific enterprise

SPACE

India is **6th largest space industry** having **3.6% of world's space tech companies**. Indian space industry valued at \$7bn in 2019 and **target of \$50bn by 2024**.

- **60 odd startups registered with ISRO** majority being in space debris management.
- **Funding in sector start ups tripled on y-o-y basis in 2021**.
- Global space economy is valued at \$360bn, **India accounts only 2% of global economy**.

SPACE SECTOR SIGNIFICANCE-

- o Satellites provide more accurate info on weather forecasts and assess long term trends of climate change. This can help in planning and action.
- o Real time monitoring and EWS against natural disasters and defence.
- o Satellite communications can reach remote areas. **WEF stated that satellite communication can connect 49% of world's unconnected population.**
- o Space sector is integration of aerospace, IT hardware and telecom sectors.

REGULATIONS-

1. INSPACE for promoting, authorising and registering and licensing private players
2. ISRO shares expertise in matters of quality & reliability through INSPACE 'interface mechanism'.
3. NSIL
4. ISpA

India's space programme is different from others in 3 ways-

1. Indigenous
2. Global leader in IT and ITes- spin in effect
3. Rapidly growing start up ecosystem with 44 unicorns in 2021

6key enablers-

- Access and non strategic satellite data by private entities and start ups for societal and commercial applications, **such as Bhuvan**
- Leveraging LEO latency mega constellations to **supplement terrestrial 5G infra**-reusable launch vehicles, miniaturisation of satellite tech, digital equity and inclusion
- Creation of **sustainable pipeline of projects across range of tech maturity** levels through appropriate models of PPP- UPI transactions on increase.
- Dedicated **incubation centres for space tech startups** to better support entrepreneurship and commercialisation of R&D
- **Space situational awareness** and management of **space debris** - increasing orbital density and deployment of mega satellites such as **Starlink**
- Growth of **shared and virtualised space economy** where infra as a Service, Ground as a Service, cloud services and SaaS are game changers.

AATMANIRBHARTA IN SPACE SECTOR-

Private sector participation-

- Reduced cost and turnaround time
- innovation & advanced technology
- cost competitive programs
- create jobs in space sector
- optimal utilisation of space technologies
- delivery of governance services and boost developmental efforts

*Limited to being vendors or suppliers to govt's space program

REFORMS PRINCIPLES-

- enable and promote private enterprises for independent space activities by ease of business and single window mechanisms with predictable timelines
- Open up ISRO infra and techs- testing, tracking, labs, launch pads, telemetry -to climb the value chain
- Inspire youngsters to take up careers under STEM
- Public sector focus on R&D work
- Transfer of tech mechanisms to private sector
- demand driven approach for space assets

IMPACT OF REFORMS=

1. Industries, start ups and academia welcomed space sector reforms and new INSPACE mechanism.
2. Proposals from start ups, MSME and industries for future consideration
3. National Indian Space Association to function as advisory and advocacy group
4. 6 space tech incubational centres
5. Private entities in space business- Digantara, Bellatrix, Agnikul, Tathya, Indigenously Dev Techs

enhance operations
eg - now just limited to sat. making
FDI in space

SSA.

- ✓ inv. and expertise
- ✓ ↑ share in global space sector
- ✓ better utilisation of space infra

- INSpace - 26 applications from Ind + foreign firms - to include proposals for ground stations

Benefits that India can provide -

- cost effective - eg - Mars mission
- exceptional success rate
↳ 6th largest space agency - ISRO - launch of EOS-04 etc
- innovative equipment -
eg - SSLV with pvt companies
- liberalised space sector -
MSME Boost, startup - 3rd largest ecosystem.

- * Level playing field.
- * fair considerations of license by potential investors
- * CoI - DoSpace as sectoral regulator and service provider - overpowering ISRO
- * Lack of clarity over aspects related to procedures
- * Authorisation and clearances by diff agencies
- * Deals and intl arbitration - apprehensions
eg - Antrix Deal

PRIVATE SECTOR

- potential to capture 9% of global market share by 2030 ,
 - ✓ ISRO can concentrate on cutting edge R&D
 - ✓ shift to demand driven model
 - ✓ rising space industry - 48% CAGR over next 5 years to reach \$50bn
 - ✓ enhanced share in global space economy
 - ✓ innovation and indigenisation
 - ✓ promote Make in India
 - ✓ penetrate satellite based and ground based system segments
-
- approved participation in 2020
 - INSPACE
 - Agnikul designed first prt launch pad
 - UNNATI - training by ISRO
 - NSIL, ISPA
-
- * multiple regulations
 - * increased space debris
 - * security and strategic concern
 - * absence of independent regulator
 - * liability of prt entities
 - * IP protection concerns

MARS ORBITER MISSION - 2013 PSLV-C25

- 1st Asian, 4th in world to get to planet

Objectives

- scientific - features, morphology, atmosphere
- technological - develop tech required
- ✓ advanced tech capability
- ✓ space exploration
- ✓ empl. opportunities
- ✓ int'l partnerships
- Payloads
- 'Space Pioneer Award'

Achievements -

- I) Composition of several gases in Mar exosphere
- II) Discovery of 'suprathermal' Argon 40 in ↓
- III) 1st time photographed far side of Deimos
- IV) captured time variation of Martian polar ice caps
- x) classify extra terrestrial landslides using ML models.

NAVIC

- ISRO launched next-gen navigational satellites NVS-01 (1st 2nd gen satellite for NAVIC)
- independent standalone nav. satellite system
- [7 satellites, 1500 km
- ✓ terrestrial, aerial, marine
- ✓ disaster management
- ✓ vehicle traffic & fleet
- ✓ integration with mobiles & precise timing
- ✓ mapping & geodetic data capture
- ✓ visual and voice
- ✓ aid for hikers & travellers

ISAR satellite

LED observatory, map entire globe in 12 days,
- 2800 kg satellite - L and S bands (dual frequency)

NASA

ISRO

- launch in 2024 in near polar orbit

→ Applications -

- ✓ cryosphere tracking
- ✓ ecosystem and resource tracking
- ✓ disaster management

Features-

- can penetrate clouds and darkness
- accurate data at any weather
- high resolution images
- 2 bandwidths help measure changes in earth surface less than cm across
- observe sea characteristics over seas surrounding India's antarctic polar stations.

* band of radar is that it requires large antenna dish and large motor power

* S bands are not easy to attenuate

LIGO - INDIA

- to build an advanced gravitational wave detector as part of worldwide network
- consortium of labs around the world.
- Hingoli (MH) by 2030 - DAE & DST

Features

- indigenous components
- multidisciplinary benefits to India's astrophysics research
- high end tech deployment
- laser interferometers to detect waves

* sensitivity - can get easily influenced by events like earthquakes, landslides

* multiple observations for accuracy

CHANDRAYAAN-3

- GSLV MK III

Ch-2	Ch-3	
- similar landing site	- South pole at around 70° latitude	why dark - unlike earth, moon axis spins only 1.5°, permanently shadowed areas
	- larger site (2.5km)	world's first to soft land here
	- increased landing velocity	difficult different terrain
	- improved thrusters to maintain equilibrium	completely dark, -230°C temp
	- Rigorous tested instruments	✓ difficult to operate instruments
	- added solar panels, laser Doppler velocity metre	✓ deep craters (cms to kms)
- 48 days to moon	- 42 days to moon	✓ ice molecules indicators
		✓ speed
		✓ lunar dust

Space Tourism

- ISRO planning by 2030
- commercial activity related to cosmos that includes going to space as a tourist, watching rocket launch, stargazing, space centric destination
- global space tourism to \$.870 mn (2022) to \$1.3bn (2025)

→ Drivers

- rise in tech advancements
- declining cost of space tourism
- considerable eco impact
- info on universe, solar system

* high cost per seat

* env - carbon footprint from space

* lack of responsibility and regulation

* depleting ozone layer

* space debris

* ethical issues

- risks to tourists

- confront trade offs - health, poverty

- protect rights of those who go to space

- ~~wait~~ commercial interests and shift away from scientific research

- society - divide b/w rich & poor

Initiatives undertaken-

- Draft Space Activities Bill - in pursuance of UN - Committee on peaceful uses of outer space
- Pvt participation - IN space NSIL
- Access to ISRO facilities & expertise to support space activities

COMMERCIALISATION OF SPACE SECTOR- INDIA'S STAGE-

Govt has yielded its control over space industry bit by bit,

- starting from hiring of vendors
- active sourcing of rocket components
- Allowing external agencies to use ISRO facilities
- Shift from mandated focus on utilitarian projects to those focused on exploring space and planetary neighbours

India can see a collaboration as seen in case of SpaceX and NASA. The former director of ISRO notes that the collaboration between NASA & SpaceX is remarkable because it has in fact taken the American space programme to a level that had not been possible for NASA to achieve by itself. Having their own rockets to transport astronauts to the International Space Station and back has prevented Americans from spending hugely on mission, as they were doing earlier. The launch of 60 Starlink satellites with total no of such satellites sent up by the company equals 955. thousands more will join these and aim of this exercise is to provide Internet services that link any point on Earth to any other point. Aim is to cover the globe by 2021. this will be new telecom revolution in India by reaching out to rural areas as never before.

While there is room for curiosity driven science, there is also aspect of utility in the event of more humans travelling to space.

Space tourism--

- Becomes less expensive
- Companies such as Virgin Gigantic that will offer space flights, albeit for very high fee
- It may allow customers to experience only a few minutes of microgravity
- Space travellers can also be taken to Intl Space Station to spend more time
- Internet connections

Why space sector has not been able to progress?

→ Govt controlled sector - XFDI

i) Low participation from private industries

ii) Consolidation of space sector in hands of statutory bodies - eg - ISRO as operator & regulator - limited role as a vendor, supplier for ISRO

iii) Lengthy process to approve space FDIs.

→ 72nd Intl Astronautical Congress - 2021 - ISRO chairman emphasised on govt intention to create fav. env. for foreign investments in India.

NANOTECHNOLOGY

Nanotechnology is a process where molecular structures are conducted at nanoscale meters. Extremely small particles are brought together to create a layer of impregnation on any surface protecting it from bacteria, viruses and dust particles.

→ projected to reach \$33bn by 2030

- ✓ clinical inv.
- ✓ imaging tools
- ✓ drug del.
- ✓ gene sequencing
- ✓ diseases

HEALTH

- * unwanted allergic & reactions
- * free radicals → cell damage
- * particles toxicity
- * high cost, etc

1. Nanotech can help make cleaner and healthier India by bringing in nano-tech products for long term protection against bacteria.
2. The pandemic has created new opportunities as people are now more concerned about enhanced safety and protection, creating a much stronger need.

- Eg- Luxor Nano introduced 5 products in the category of 'All in One' disinfectants for hard and soft surfaces with long lasting protection and some products in 'Protection On the Go' category which are convenient sizes of hand sanitizers and disinfectants that can be carried by people of all ages at all times.

3. Nano particles can be used for efficient drug delivery. Similar to nanoshells and nanovesicles, nanomicelles are small structures noted as emerging platform in targeted therapy. Nanomicelle can be used to deliver a drug named docetaxel, which is commonly used to treat various cancers. They are less than 100nm in size and stable at room temp, easily escape circulation and enter solid tumours where blood vessels are found to be leaky, leaky blood vessels are absent in healthy organs.

→ India is among top 5 nations in terms of nanotech scientific publications

_ Syneria Biosciences made nanotech based intra-nasal platform of medicine for brain related disorders and acquired intl patent.

_ Nanobots can quickly do biopsies of cancerous tumours.

AGRICULTURE & FOOD INDUSTRY

_ Safe and better quality of food
_ Nano capsule can enable effective penetration of herbicides, chemical fertilisers, etc.

- Nano urea by IFFCO

→ **Nanocoating COVID19** - on N95, PPE -

N9 blue nanosilver - anti microbial agent - nanomaterial

Nano sensors and delivery systems can allow precision farming through natural resources like water, nutrients etc

_ Nano sensors can also detect plant viruses and soil nutrient levels

_ **Nano barcodes** and **nano processing** could also be used to monitor the quality of agr produce

_ **Anti microbial packaging** can kill bacteria

_ **nano enhanced barrier** can keep oxygen sensitive food fresh

_ **nano encapsulating** can improve solubility of vitamins, anti oxidants and healthy omega etc

_ Nano barcodes to tag individual products and trace outbreaks

- **Contamination sensor** can discover **e-coli**

_ **Decontamination of water** - eg IIT Madras arsenic water decontamination,

IIT Delhi water based **self cleaning tech** in textile industry

_ **Eco friendly** solutions

_ Greener and smarter **automobiles** to reduce GHG emissions

* new toxic products in env

* cytotoxic resp. & photo

* contamination

INDUSTRIAL & ELECTRONICS

_ **Nano computers**

_ Reduce size of equipments, improve display screens, reduce power consumption

_ **Energy efficiency** by solar panels improvement, cheaper and efficient

SECURITY & SPACE

_ **Nano satellites** to reduce weight of space ships and **increase strength**

STEPS TAKEN-

- **Nano Science and Technology Initiative** on nano-electronics in 2004
- **National Nano Mission** in 2007 - led to increased patent applications, rising number of papers - 23,000; 3rd in papers in 2018 - 9th FYP
- Major nano electronics Centres of intl standards set up at premier institutes
- Indian Nanoelectronics Users Programme by MeiT at IISC and IIT Bombay

• **Major Nanoelectronics Centres of intl standards** established at premier institutes - nanofabrication facilities

• **Indian Nanoelectronics User Programme** - Idea to Innovation (INUP-i2i) at centres of Ex. - R&D

• **Working group of Nanotech** - sensors, post Moore electronics, organic electronics, computational nanoelectronics, prototype & incubation facilities

• **ICONSAT** - nanoscience intl conferences - **AWSAR scheme** to tap potential of students

• **INSPIRE** - to attract talent

• **UNNATI** - nano Sat.

✓ air & soil treat

✓ oil spill

ENVIRONMENT

✓ pollution prevention

✓ emissions

- promote nanotech

- infra

- R&D

- dev centre

- human dev

- Intl collabs



CHALLENGES- (failure of nano mission)

1. Amount spent on nanotech is low - than US, China, etc
2. Quality of research has shown little improvement - only 1% of Indian papers
3. Low number of students graduating from discipline and limited career prospects
4. Private sector contribution has been minimal
5. Bringing about habit change in end consumer was an uphill task.
6. Patents filed - only 0.2% in US patent office are from India

WAY FORWARD-

- * Increase funding and accommodate long term funding with research programs
- * Highly equipped central facility to plan and initiate research activities
- * Remuneration of people trained in field to increase, attract high calibre work force to join research
- * Outsourcing knowledge

BIOTECHNOLOGY=

Biotech industry is sunrise sector. Acc to India Bioeconomy report 2022, country's biotech sector reached \$80bn in 2021, 14.1% growth over 2020. It is estimated to reach \$150bn by 2025 and exceed \$300bn by 2030.

- among top 12 destinations globally.

Growth-

- Increasing population and need
- Rising public health infra
- Capacity building programmes such as National biopharma mission
- R&D
- Investment in sector tripled in 2021, reached \$1bn. FDI touched \$830mn in 2021.
- 49% of sector is pharma (diagnostics 52% and therapeutics 26%), 18% covid related techs, 13% agriculture.
- Number of startups in sector increased from 50 in 2010 to 5,365 in 2021. Highest % in MH (18%), then KA and DL. Reasons- use of ML and AI in drug discovery, increased investments, finding suitable alternatives, leveraging new modalities such as cell therapy and gene therapy, R&D manufacturing/

STEPS TAKEN BY GOVT-

- 100%
FDI

- Atal
Jai

Amisondhan
Mission

(DBT)

- Govt promoted BIRAC & IAN have launched an angel investor network called **BioAngels**, which is first sector focused angel investor group in world. It will fund high quality startups with money & mentoring.
- Govt has set up across **74 incubation centres** that specialise biotechnology.
- Biotech Ignition Grant for India's NE Region (**BIG-NER**)- facilitate financial startups from NE region.

- First repository for data - IBDC @ HR Faridabad
- higher budget allocation - 75 amit grants

CHALLENGES-

To create medical devices, we require engineers, connecting resource rich and resource poor regions to take it to last mile

Human concerns of gene-editing tech-

death of sole volunteer in a gene - editing technique died in USA

→ IPR regime [Sec 3(d) of Patents Act 2005
CL

- Lack of marketisation
- Lack of public awareness
- Quality of jobs
- Regulatory mechanism

* high skills
* long process
* capital

Health
Bipharmaeaceuticals

* supply chain
* quality & regulatory authority

- _ Reducing rate of infectious diseases
- _ Saving lives of million children
- _ Changing odds of serious, life threatening diseases
- _ Tailoring treatments to individuals to minimise health risk and side effects
- _ More precise tools for disease detection
- _ Combat serious illness and everyday threats of developing world

- Vaccines - RNA and DNA based for Covid
- Bio IT/ healthcare research
- COVID bioeconomy
- Diagnostics and medical devices
- Unicorns- pharameasy, innovaccer, pristyncare, Cure fit
- Bugworks- first class molecules in clinical trials for AMR
- Pandorum technologies- to develop functional human tissues such as bio engineered cornea and liver
- 1st vaccine for cervical cancer by SII

- curative therapies

Industry and fuel Bio-industrial	<ul style="list-style-type: none"> _ Streamline steps for chemical manufacturing processes by 80% or more _ Lowering temp for cleaning clothes and saving \$1.4bn _ Reducing reliance on petrochemicals _ Using biofuels to cut emissions by 52% or more _ Decreasing water usage and waste generation _ Biomass waste products 	<ul style="list-style-type: none"> • Biofuels
Agriculture Bio agriculture	<ul style="list-style-type: none"> _ Generating higher <u>crop yields</u> with fewer inputs _ Lowering volumes of <u>agricultural chemicals</u> required by crops- limiting the run off these products into <u>env</u> - _ Using biotech crops that <u>new fewer pesticides</u> and reduce <u>tilling farmland</u> _ Developing crops with <u>enhanced nutrition</u> and solve vitamin deficiencies _ Producing <u>allergen and toxin free foods</u> such as mycotoxin 	<ul style="list-style-type: none"> • Biofertilisers/Biopesticides • BT cotton • <u>Enzymes</u> • <u>Bamboo tissue culture plants</u>- Genewin Biotech

* health concerns

* ecology -

transgenic cross pollinate, superweeds

* ethical concerns of GM
* yield -

- golden rice - health benefits

	_ Improve food crops for oil content and cardiovascular diseases	
Bio services		
Bio informatics		
Climate resilience	_ Turn production of agriculture crops- such as saffron production in J&K _ mapping of glaciers-	• String Bio- converts methane into proteins that reduces carbon footprint
Social empowerment		• Kiran Mazumdar- India's first biotech queen- Biocon Ltd
Wildlife and fauna	_ cross breeding	

WAY FORWARD-

1. Web 4.0 - Big data, AI and Augmented Reality- will support biotech. eg- biosensors in healthcare, Big data can reduce medical errors, AI can cut drug discovery time by 4 years and cost by 60%
- 1., Due to pandemic, the sector can get about 15-16% of angel funding deals from healthcare sector
- 2, Sustainability should be focus.
- 3, Focus on bringing greener alternatives can give competitive advantage.
- 4, Reducing and eliminating hazardous substances and chemicals.
- 5, Areas of priorities- reorganisation of supply chain and supply security, govt & policy makers revisit regulations, accelerated digital transformation and tech adoption.

GENOME SEQUENCING-

it is done by isolating RNA samples and then comparing the sequence in given sample to reference change.

RNA- nucleotide bases

approaches-

- Whole genome sequencing
- Next generation sequencing

uses-

- _ identify and understand the role of certain mutations in increasing virus infectivity.
- _ consequences for vaccines because some mutations have escape capability or to evade antibodies. eg- as seen in Omicron variant than alpha/delta variant hence need of booster doses.
- _ CRISPR CAS9 can be used to target root cause of sickle cell anaemia (Right to PwD 2017 recognised persons with blood disorders as PwD under act, those with 40% and above disability)
- _ Contact tracing and understanding transmission of virus across world

Issues-

- technically demanding where experts purify samples appropriately and get ready to use by sequencers.
- shortage of funds, insufficient reagents and tools to scale up. eg INSACOG could achieve only 1% of targeted 5% sequencing.
- equipment quality and manpower

IM Tech issues

- ✓ privacy - DNA
- ✓ legal - anonymity of data + questions

HUMAN GENOME PROJECT-

1990-2003

- ✓ more info to functional part of DNA
- ✓ identical genomes
- ✓ discovery of protein coding genes
- ✓ reduced cost of sequencing

INTELLECTUAL PROPERTY RIGHTS-

- ✓ boost FDI, R&D
- ✓ forbid fraud
- ✓ commercialisation
- ✓ adjudicatory mechanisms
- ✓ expand HR, capacities

India is party to TRIPS agreement, also other IPR related conventions such as Berne convention, Budapest Treaty, Paris convention for Industrial property, Patent cooperation treaty. Pharma patents were added in 2005 to comply with TRIPS.

- patentability requirement,
- patent enforcement,
- compulsory licensing,
- patent opposition,
- Regulatory data protection,
- transparency in reporting seizures,
- Singapore treaty of Law of TMs and Patent law treaty.
- online piracy
- sec 3D

INTERNATIONAL IP INDEX 2020-

Released by **US Chamber of Commerce's Global Innovation Policy Centre.**

Evaluates IP infra in each economy based on 45 unique indicators critical to its growth. 8 categories of IP protection.

PERFORMANCE OF ECONOMIES-

1. Top 5- US UK Sweden France Germany.
2. INDIA- 40/53 global economies, last year 36th, scored well in Systemic Efficiency Indicator with score ahead of 28 others

In 2022- India improved its score to 38.6% and ranked 43/55 countries.

2023 - 42/55

OBSERVATIONS ON INDIA (INTL IP INDEX 2020)-

- since 2016 GoI focused effort to support investments in innovation and creativity through increasingly robust IP protection and enforcement.
- Improved speed of processing for patent and trademark apps, increased awareness of IP rights.
- Progress in IP protections.
- 2019 DL HC used dynamic injunctions to disable access to copyright infringing content online and scores ahead of 24 countries in

-28,000 patents were granted in 2021 in contrast to 4,000 in 2013-14 that will have ripple effect on economy.

5 times increase in patent granted and 4times in trademark registration every year since 2014.

46% increase in domestic patent filing.

-Increased ranking in WIPO Global Innovation Index to 46th in 2021.

- **50% increase in patent filing (2014-15 to 2021-22)**
- reduced time of patent examination to 5-23 months

- IPR plays an important role in development of country, along with growing startups, there has been need of giving up restrictions on IPR.
- National IP Rights Policy- Scheme for IPR protection started in 2016 as pilot scheme, till 2023- provides cost of facilitators for challenges in courts. guiding principle- "Creative India Innovative India".
- India's global pharma hub is supported by IPR regime - pharma companies contracting R&D to national labs in India- growth in generic medicines
- Initiatives been taken to take IP to grassroot levels and ensure innovations there
- DPIIT taken initiatives- modernisation of IP offices, manpower augmentation, use of IT and tech in e filing of applications, acceptance of email in all Indian Patent offices transactions, use of videoconferencing for hearing appeals, SMS alert for updates.
- Patent Prosecution Highway- WIPO pilot project with Japan in 2019
- Dialogues with Israel, EU
- Centre to impart training to 10 lakh youth on IPR matters awareness under AkAM.

*Creates solutions for growing global challenges such as cultural dev, public health, env sustainability, eco disparities.

*IP policies can spur innovators and creators.

*IP and youth

WIPO theme "IP and Youth Innovating better future".

*Key to success of Make in India and Design in India and Start up India

eg-

- two slit design tetrapack startup to resolve issue of food wastage
- toilet with automatic cleaning and flush
- weed removal machine from paddy field
- innovative easy brush
- air puro
- solar powered charger cum anti sweat easy breather mask
- TRITI
- SAATHI-no child left behind

IMPACTS-

- 1-New trademark applications period reduced to less than 30 days.
- 2-Trademark registered in less than 7 months if no objections filed
- 3-Increased trademark registrations and patents filed
- 4-Patent examinations increased with reduced time to around 36 months in 2019
- 5-grant of patents increased

Measures taken

- IPR policy 2016
- CIPAM - DPIIT - for impl of IPR policy
- India Patents Act 2001, 1970, Rules 2003
- NIP Awareness Mission

- enforcement of copyright act is weak
 - traditional knowledge kept out
 - lack roots in remote areas
 - monopoly by product patent
 - TRIPS flexibilities
- delays in granting patents
 - IPR policies fluctuation

ROADBLOCKS-

1, Challenges in intl cooperation- eg Israel while progressed on contributing know how to Make in India, also expressed concerns as Israeli companies raised serious complaints against IP problems in India.

2, USTR reported India as one of 'most challenging economies' as far as IP protection and enforcement is concerned- raised issues of what can be patented, waiting time for obtaining patents, reporting requirements and data safety.

Art 3(d) of Indian patents act is a major contention- related to evergreening of patents- acc to Parliamentary committee section acts as a safeguard against frivolous inventions in accordance with TRIPS agreement,

Novartis vs Uol judgement upheld the validity of section.

3, Tribunal Reforms act (amendment) 2021- abolished IPAB and assigned its functions to Commercial courts and HC- already stressed judiciary- delays in appellate process

IMPROVEMENTS NEEDED-

- NITI Aayog CEO Amitabh Kant said that unprecedented reforms undertaken on both governance and eco fronts by govt will usher in new era of growth and prosperity. He stressed on need to increased expenditure on R&D and strengthen IPR laws
- On judicial step, CJI recommended need to strengthen the High courts to deal with such issues- fill existing vacancies, increase no of judges, judicial infra improvement
- Need to improve GI tags - with keeping parity among states

NUCLEAR ENERGY

- 22 reactors, 6780 MW installed capacity
- 1.6% of total installed capacity
- 5th largest source of electricity

- * safety
- * land requirement
- * import dep. on fuel - uranium
- * manufacturing capability - eng. components
- * manpower needs
 - nuclear scientists & engineers

- PRAGATI project monitoring
- fuel supply contracts under IAEA
- Issues related to civil liability for nuclear damage
- AE Act and for TX of PSUs
- Global Centre for training & partnership

⇒ Nuclear fusion

- ✓ more energy than fission
- ✓ sustainable dev. & tri
- ✓ zero CO₂
- ✓ limited risk of ~~non~~ proliferation
- ✓ no meltdown risk
- ✓ no long lived radioactive waste

Why fusion by India?

- lack of fossil fuels
- long term - net zero 2070
- Rising energy demand

- * time taking
- * sustain high temp
- * deactivating fusion based nuc. weapon
- * huge energy to create conditions for fusion

3 Staged Nuclear Energy Program

- Stages
 - I - PHWRs - (2013)
 - II - $P-239 \rightarrow U-238$
 - III - Utilisation of thorium

- currently on second stage