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RAPID REVISION SERIES

700 High Probable Topics for UPSC Prelims 2021

(Current Affairs + Static Portion)

Part 1

ENVIRONMENT and S&T

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RAPID REVISION (RaRe) SERIES - UPSC 2021

RaRe Notes

DAY 5 - ENVIRONMENT and S&T

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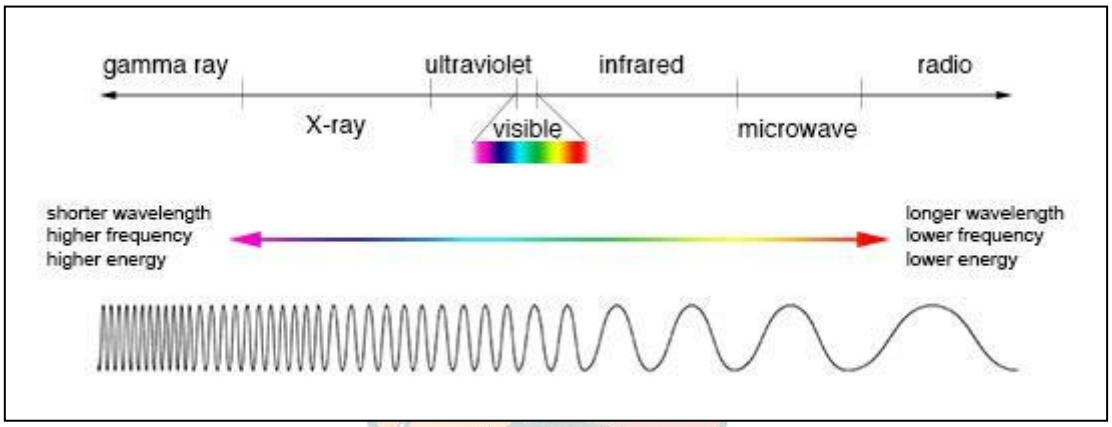
Topics Coverage:

41. Synthetic Aperture Radar (SAR)
42. Hyperspectral Imaging Satellite (HysIS)
43. Modern grand solar minimum
44. Sun spots
45. SHUKRAYAAN
46. LIGO-INDIA
47. Gaia Hypothesis
48. Ladakh's Tso Kar Wetland Complex
49. RAMSAR WETLANDS SITES in INDIA
50. National Marine Turtle Action Plan (2021-2026) and Marine Turtles

Topic 41: Synthetic Aperture Radar (SAR)

Key points:

1. Synthetic aperture radar is a way of creating an image using radio waves.
2. The radio waves used in SAR typically range from approximately 3 cm up to a few meters in wavelength, which is much longer than the wavelength of visible light, used in making optical images.
3. These wavelengths fall within the microwave part of the spectrum in the figure below.



In simple, SAR bounces a microwave radar signal off the Earth's surface to detect physical properties.

Application of SAR satellites

- They can exactly size farms, assess soil moisture, predict harvests, gauge terrain features and infrastructure, appraise water bodies, studying Antarctic icebergs, tracking the paths of oil spills and mapping wetlands.
- They can detect the movement of people on land or ships on sea (ideal for border and maritime surveillance)
- SAR data are also handy for authorities when it comes to deciding crop insurance, compensation, assessing the damage in areas hit by floods and other calamities.

Topic 42: Hyperspectral Imaging Satellite (HysIS) of ISRO

Key points:

1. HysIS is an earth observation satellite orbiting at 636 km above the surface of the earth.
2. It observes earth's surface in 3 different ranges including visible, near infrared and shortwave infrared ranges in 55 spectral or colour bands.
3. It is launched in the Sun-synchronous polar orbit
4. In short HysIS enables us to do a 'CATSCAN' equivalent of Earth from space.

Applications

- Monitoring agriculture, forestry
- Assessment of coastal zones, inland waters, soil
- Oil and minerals mapping
- Military surveillance

HYPERSPECTRAL IMAGING: BASICS

- Hyperspectral imaging combines digital imaging and spectroscopy.
- For this it uses a critical chip called as 'optical imaging detector array' which enables it to provide better defined images that more clearly than regular optical or remote sensing cameras.

Difference between Optical imaging based EO satellites and Synthetic aperture radar EO satellites:

- Optical imaging based EO satellites capture colour images of patches of earth from 500-600 km overhead and they can do so only when there is sunlight and no cloud or rain.
- A SAR satellite works 24/7, round-the-year in any weather. It bounces microwaves off the earth to sense in detail, the size, shape, height and changes in objects or terrains.
- Contrary to multispectral and hyperspectral satellites, Synthetic-aperture radar (SAR) satellites do not require sunlight to illuminate the scenes they capture.

Topic 43: Modern grand solar minimum

Key points:

According to recent findings and studies –

- Solar activity, which is measured by the number of Sun spots at any given time, was pretty low in 2019 and 2020.
- Scientists say the Sun may be going through a long period of decreased activity known as the Modern Grand Solar Minimum from **2020 to 2053**.

In simple words, the **period of decreased solar activity** is known as the Modern Grand Solar Minimum.

Note: The last time such an event occurred was during the **Maunder Minimum**, from 1645 CE to 1710 CE **–** which was part of what is now known as the Little Ice Age — when Earth went through a series of elongated cold periods during the medieval centuries.

Impacts:

- The surface temperatures on Earth may go down during the Modern Grand Solar Minimum due to a 70% reduction in solar magnetic activity. Variations in solar irradiance will lead to heating of the upper layer of the Earth's atmosphere and influences the transport of solar energy towards the planet's surface.
- Decreased solar activity has complex impacts on the abundance of ozone in the Earth's atmosphere

- It also affects the climatic cycles of Earth such as the North Atlantic Oscillation (NAO).

Topic 44: Sun spots

Key points:

- Sun spots are **areas of strong magnetic forces** on the surface of the Sun (photosphere) — sometimes as large as planets — that appear as darker spots because they are cooler.
- Sunspots are relatively cool because they form at areas where magnetic fields are particularly strong.
- They are caused by interactions with the Sun's magnetic field which are not fully understood.
- Sunspots occur over regions of intense magnetic activity, and when that energy is released, solar flares and big storms called coronal mass ejections erupt from sunspots.

Do you know?

- The number of sunspots is directly proportional to solar activity. More Sunspots mean more solar activity.

Topic 45: SHUKRAYAAN

Key points:

1. India to launch Shukrayaan Venus mission in 2024
2. It will be India's first mission to Venus
3. Plans to study the planet for more than four years

Scientific objectives of ISRO's Venus mission are –

- investigation of the surface processes and shallow subsurface stratigraphy;
- investigation of solar wind interaction with Venusian Ionosphere,
- to study the structure, composition and dynamics of the atmosphere.

Facts about Venus:

- Venus is often described as the "twin sister" of the Earth because of the similarities in size, mass, density, bulk composition and gravity.
- Venus is around 30 per cent closer to the Sun as compared to Earth resulting in much higher solar flux.
- Venus is one of just two planets that rotate from east to west. Only Venus and Uranus have this "backwards" rotation.

- Exploration of Venus began in the early 1960s. Venus has been explored by flyby, orbiter, a few lander missions and atmospheric probes.

Topic 46: LIGO-INDIA

Key points:

1. IndIGO (Indian Initiative in Gravitational-wave Observations) is a consortium of Indian gravitational wave physicists to set up advanced experimental gravitational-wave observatory facilities in India.
2. It is located near Aundha Nagnath, Hingoli District, Maharashtra.
3. It is piloted by Department of Atomic Energy (DAE) and Department of Science and Technology (DST).

Note: LIGO-India is planned as a collaborative project between a consortium of Indian research institutions and the LIGO Laboratory in the USA, along with its international partners Australia, Germany and the UK.

What is LIGO?

- It is a massive observatory for detecting cosmic gravitational waves and for carrying out experiments.
- The objective is to use gravitational-wave observations in astronomical studies.

Topic 47: Gaia Hypothesis

Key points:

1. Gaia hypothesis was proposed by James Lovelock
2. This hypothesis says that the biosphere and the physical components of the Earth (atmosphere, cryosphere, hydrosphere and lithosphere) are closely integrated to form a complex interacting system that maintains the climatic and biogeochemical conditions on Earth in a preferred homeostasis.
3. The hypothesis is frequently described as viewing the Earth as 'one great, living organism'.
4. James Lovelock's hypothesis could unlock a whole-systems approach to protecting the amazing life forms on Earth.
5. The Gaia hypothesis is named after the mythical Greek goddess Gaia who personifies the earth.

Topic 48: Ladakh's Tso Kar Wetland Complex

Key points:

1. Ladakh's Tso Kar Wetland Complex now a Wetland of International Importance.

2. India now has forty-two Ramsar sites.
3. Tso Kar Basin is a high-altitude wetland complex – with freshwater lake - Startsapuk Tso and hypersaline lake Tso Kar
4. Tso Kar → meaning white lake → because of the white salt efflorescence found on the margins due to the evaporation of highly saline water.
5. Tso Kar Basin is also an A1 Category Important Bird Area (IBA) as per Bird Life International and a key staging site in the Central Asian Flyway.

Important species –

- Black-necked Crane (Grus nigricollis)
- Great Crested Grebe (Podicepscristatus)
- Bar-headed Geese (Anserindicus)
- Ruddy Shelduck (Tadornaferruginea)
- Brown-headed Gull (Larusbrunnicephalus)
- Lesser Sand-Plover (Charadriusmongolus)

Topic 49: RAMSAR WETLANDS SITES in INDIA (as of 4th June, 2021)

S.No	Site name	Designation date	Area (ha)
1	Asan Conservation Reserve	2020-07-21	444.4
2	Ashtamudi Wetland	2002-08-19	6140
3	Beas Conservation Reserve	2019-09-26	6428.92
4	Bhitarkanika Mangroves	2002-08-19	65000
5	Bhoj Wetland	2002-08-19	3201
6	Chandertal Wetland	2005-11-08	49
7	Chilika Lake	1981-10-01	116500
8	Deepor Beel	2002-08-19	4000
9	East Calcutta Wetlands	2002-08-19	12500
10	Harike Lake	1990-03-23	4100
11	Hokera Wetland	2005-11-08	1375
12	Kabartal Wetland	2020-07-21	2620
13	Kanjli	2002-01-22	183
14	Keoladeo National Park	1981-10-01	2873
15	Keshopur-Miani Community Reserve	2019-09-26	343.9
16	Kolleru Lake	2002-08-19	90100
17	Loktak Lake	1990-03-23	26600
18	Lonar Lake	2020-07-22	427
19	Nalsarovar	2012-09-24	12000
20	Nandur Madhameshwar	2019-06-21	1437
21	Nangal Wildlife Sanctuary	2019-09-26	116
22	Nawabganj Bird Sanctuary	2019-09-19	224.6
23	Parvati Arga Bird Sanctuary	2019-12-02	722
24	Point Calimere Wildlife and Bird Sanctuary	2002-08-19	38500
25	Pong Dam Lake	2002-08-19	15662
26	Renuka Wetland	2005-11-08	20
27	Ropar	2002-01-22	1365
28	Rudrasagar Lake	2005-11-08	240
29	Saman Bird Sanctuary	2019-12-02	526.3
30	Samaspur Bird Sanctuary	2019-10-03	799.371
31	Sambhar Lake	1990-03-23	24000
32	Sandi Bird Sanctuary	2019-09-26	308.54
33	Sarsai Nawar Jheel	2019-09-19	161.27
34	Sasthamkotta Lake	2002-08-19	373
35	Sundarban Wetland	2019-01-30	423000
36	Sur Sarovar	2020-08-21	431
37	Surinsar-Mansar Lakes	2005-11-08	350
38	Tso Kar Wetland Complex	2020-11-17	9577
39	Tsomoriri	2002-08-19	12000
40	Upper Ganga River	2005-11-08	26590
41	Vembanad-Kol Wetland	2002-08-19	151250
42	Wular Lake	1990-03-23	18900

Topic 50: National Marine Turtle Action Plan (2021-2026)

Key points:

1. Ministry of Environment Forest and Climate Change (MoEF&CC) has recently released 'Marine Mega Fauna Stranding Guidelines' and 'National Marine Turtle Action Plan'.

2. National Marine Turtle Action Plan focuses on reducing threats, conserving critical habitat, exchanging scientifc data and increasing public awareness.

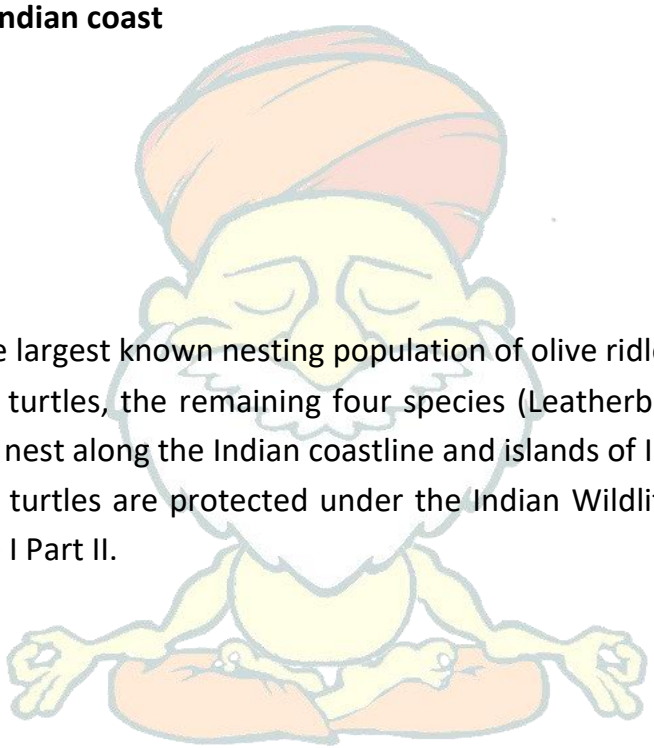
There are seven species of marine turtle –

1. Hawksbill
2. Leatherback
3. Kemp's ridley
4. Green turtle
5. Loggerhead
6. Olive ridley
7. Flatback turtle

However, the Indian coastal waters supports five species of sea turtles found worldwide.

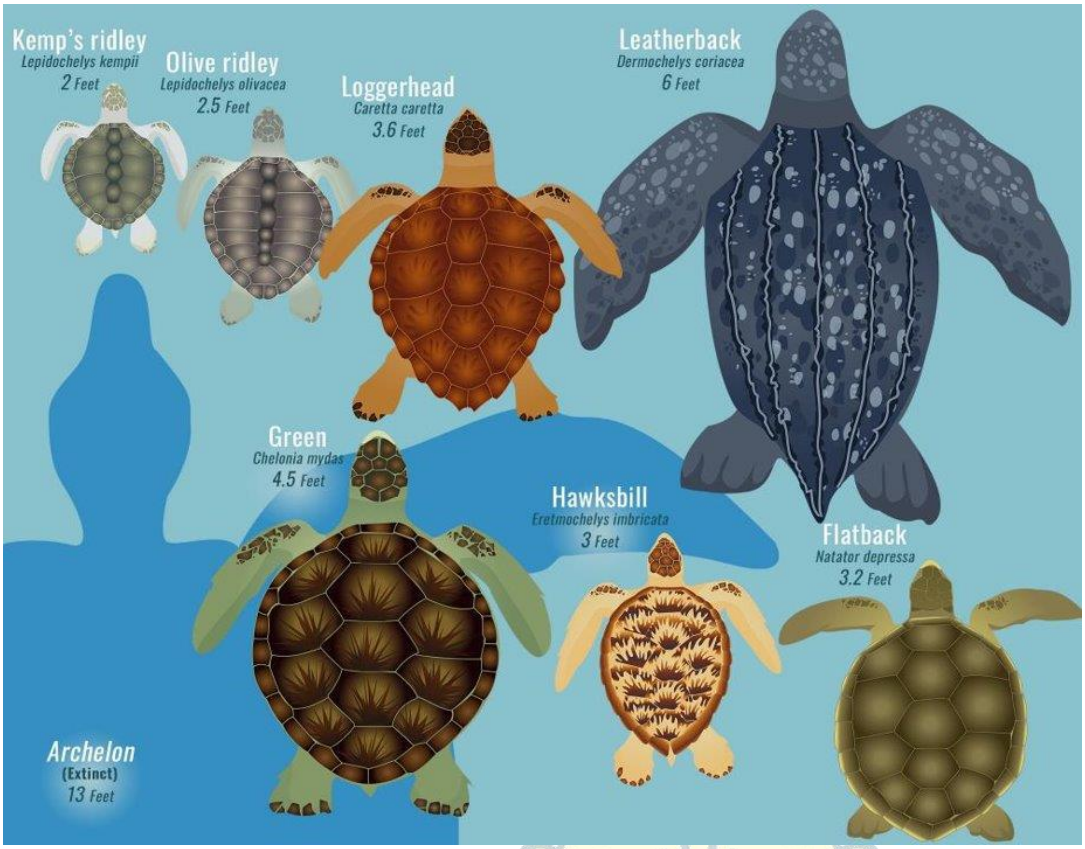
Marine turtles along the Indian coast

1. Olive Ridley
2. Green
3. Hawksbill
4. Loggerhead
5. Leatherback



Note:

- India is home to the largest known nesting population of olive ridley turtles.
- Except Loggerhead turtles, the remaining four species (Leatherback, Hawksbill, Green and Olive ridley turtles) nest along the Indian coastline and islands of India.
- In India, above sea turtles are protected under the Indian Wildlife Protection Act of 1972, under the Schedule I Part II.


Kemp's ridley
Lepidochelys kempii
2 Feet
Olive ridley
Lepidochelys olivacea
2.5 Feet
Loggerhead
Caretta caretta
3.6 Feet
Leatherback
Dermochelys coriacea
6 Feet
Green
Chelonia mydas
4.5 Feet
Hawksbill
Eretmochelys imbricata
3 Feet
Flatback
Natator depressa
3.2 Feet
Archelon
(Extinct)
13 Feet

Important Marine Turtle Habitats in India

State	Important Turtle Habitats (Catchment District)	Remarks / Clarification	Major Threats
Odisha	Rushikulya river (Kandhamal and Ganjam)	Mass nesting ground of Olive Ridley	Erosion, Nest predation, plastic pollution, light pollution and bycatch
Odisha	Gahirmatha river (Kandhamal and Ganjam)	Mass nesting ground of Olive Ridley	Erosion and Nest predation, bycatch
Odisha	Devi River (Jagatsinghpur, Puri)	Sporadic mass nesting ground of Olive ridley	Nest predation, plastic pollution, light pollution, plantation and bycatch
Andaman & Nicobar Islands	Galathea bay, Indira point, Hingloi, Alexandria, Dagmar, and Renhongbeaches (Great Nicobar Island)	Largest Leatherback turtle nesting ground in India	Nest predation
Andaman & Nicobar Islands	Bahua, Muhincohn and Kiyang beaches (Little Nicobar Island)	Leatherback, Green, Hawksbill and Olive ridley	Nest predation and bycatch
Andaman & Nicobar Islands	West Bay, Jackson Creek beaches (Little Andaman Island)	Leatherback nesting ground, currently largest in the Andaman group	Nest predation and bycatch
Andaman & Nicobar Islands	Cuthbert Bay, (Middle Andamans)	Leatherback, Green, hawksbill, and Olive ridley	Nest predation
Andaman & Nicobar Islands	South Reef Island, (Middle Andamans)	Best hawksbill turtle nesting ground in India	Nest predation
Lakshdweep Islands	Lagoons of Lakshdweep Islands (Agatti, Kadmat, Kavaratti and other islands)	Foraging ground of Green turtle	Erosion, over grazing, conflict with fishermen, nest predation and bycatch
Lakshdweep Islands	SuhelilIsland, (Lakshadweep)	Olive ridley / Hawksbill / Green turtle nesting ground (sympatric habitat for three species)	Erosion and bycatch
Andhra Pradesh	Godavari River Mouth (Sacramentoshoal, East Godavari)	Very high sporadic nesting of Olive ridleys (approx. 500 to 1000/year),	Nest predation, plastic pollution, light pollution, habitat degradation and bycatch
Andhra Pradesh	Kapasukuddi (Bahuda river mouth), Nagavali, Bamsadhara (Srikakulam)	High sporadic nesting of Olive ridleys	Nest predation, plastic pollution, light pollution, habitat degradation and bycatch
Andhra Pradesh	Beaches along Krishna River and Penneru river mouth (Nellore)	Moderate sporadic nesting of Olive Ridley	Nest predation, plastic pollution, light pollution, habitat degradation and bycatch

Important Marine Turtle Habitats in India

Puducherry	Nallavadu,Pannithittu, Narambi and Moorthikuppam villages (Puducherry) and beaches around Arasalar River (Karaikal)	High sporadic nesting of Olive Ridley	Nest predation, by-catch, erosion, habitat degradation, planta-tion, plastic and light pollution
Tamil Nadu	Gulf of Mannar Biosphere Reserve (Thoothukkudi and Ramanathapuram)	Foraging ground of green and Olive ridley, good seagrass beds	Nest predation, plastic pollution, habitat deg-radation, poaching, bycatch
Tamil Nadu	Chennai coast, (northern Tamil Nadu)	Sporadic nesting ground of Olive ridley turtles with conservation programmes from 1973	Nest predation, by-catch, plastic pollu-tion, light pollution, egg poaching, habitat degradation
Gujarat	Western Saurashtra coast, Gujarat (Junagadh, Jamnagar and Porbandar)	Green and -Olive ridley turtle nesting grounds	Nest predation, by-catch, plastic pollution, habitat degradation
Maharashtra	Sindhudurg Coasts (Raigad and Ratnagiri)	Sporadic nesting of Olive ridley and Green	Nest predation, bycatch, plastic pollution, habitat degradation
Goa	Galgibaga beach (South Goa)	Sporadic nesting of Olive Ridley	Nest predation, by-catch, plastic pollution, lighting, tourism, habi-tat degradation

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RaRe Notes

DAY 12 - ENVIRONMENT and S&T

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Topics Coverage:

91. Global Forest Resources Assessment (FRA) 2020
92. International Day of Forests
93. Banni grasslands
94. Net Present Value of Forests and Forest Advisory Committee
95. Dehing Patkai and Raimona National Parks
96. Advanced Chaff Technology
97. Counter Measure Dispensing System (CMDS)
98. Critical Near Isothermal Forging Technology
99. Naval Innovation and Indigenisation Organisation (NIIO)
100. Exercises in news

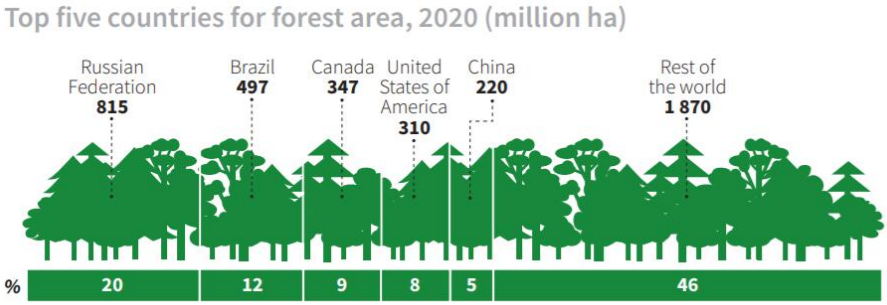
Topic 91: Global Forest Resources Assessment (FRA) 2020

About FRA

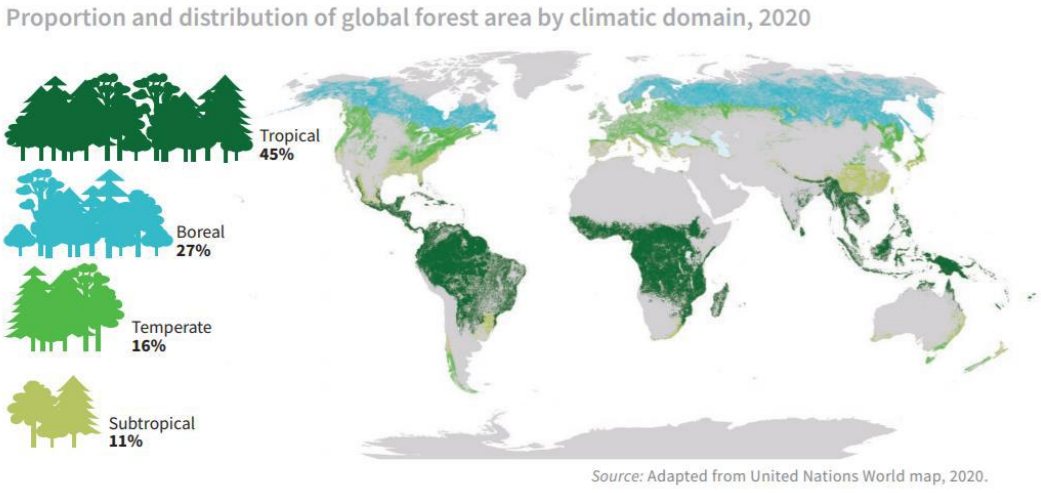
1. FRA 2020 examines the status of, and trends in, more than 60 forest-related variables in 236 countries and territories in the period 1990–2020.
2. Global Forest Resources Assessment 2020 has been released by the United Nations Food and Agriculture Organization (FAO).

Key findings:

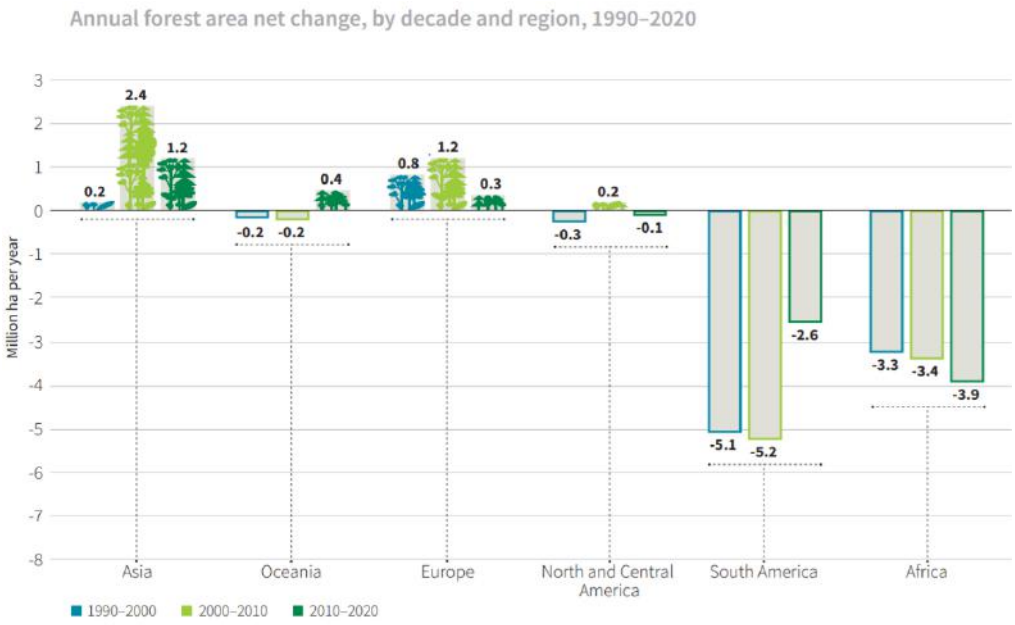
1. Forests cover nearly 1/3 of land globally (approx. 4.06 billion hectares)
2. More than half (54 percent) of the world's forests are in only five countries



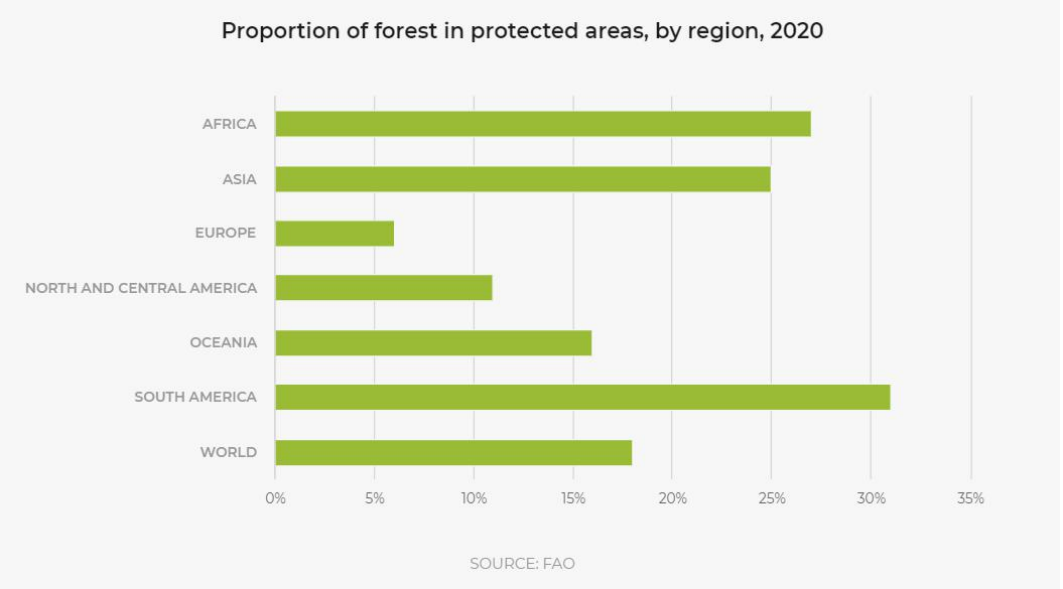
3. Of the major climatic regions, the tropical zone contains the highest percentage of forest at 45 percent.



4. Ninety-three percent of the forest area worldwide is composed of naturally regenerating forests and 7 percent is planted.
5. The area of naturally regenerating forests has decreased since 1990 but the area of planted forests has increased.
6. Africa had the largest annual rate of net forest loss in 2010–2020. Asia had the highest net gain of forest area in 2010–2020.



7. According to the state of forests worldwide, the rate of forest loss is slowing down. The world's forest area is decreasing, but the rate of loss has slowed.
8. Of the six major world regions, South America has the highest share of forests in protected areas, at 31 percent.
9. Seventy-three percent of the world's forests is under public ownership, 22 percent is privately owned.
10. Globally, the share of publicly owned forests has decreased since 1990 and the area of forest under private ownership has increased.



FRA on India:

India has ranked third among the top 10 countries that have gained in forest areas in the last decade, the latest Global Forest Resources Assessment (FRA) brought out by the Food and Agriculture Organization (FAO).

The top 10 countries that have recorded the maximum average annual net gains in forest area during 2010-2020 are China, Australia, India, Chile, Vietnam, Turkey, the United States, France, Italy and Romania, according to the FRA 2020. India accounts for two per cent of total global forest area.

Topic 92: International Day of Forests

Key points:

1. UN observes March 21 as the International Day of Forests.
2. The theme for 2021 is "Forest restoration: a path to recovery and well-being".
3. This year's theme aims to emphasise how restoration and sustainable management of forests can help address climate change and biodiversity crisis.
4. It can also help produce goods and services for sustainable development, fostering an economic activity that creates jobs and improves lives.
5. Themes of the International Day of Forests are aimed to fit into the UN Decade on Ecosystem Restoration (2021-2030), which calls for the protection and revival of ecosystems around the world.

Topic 93: Banni grasslands

Key points:

1. Banni is the largest grassland of Asia situated near the Great Rann of Kutch in Gujarat**.**
2. It accounts for almost 45% of the pastures in Gujarat.
3. Two ecosystems, wetlands and grasslands, are mixed side by side in Banni and Vegetation in Banni is sparse and highly dependent on rainfall.
4. Banni is dominated by low-growing plants, forbs and graminoids, many of which are halophiles (salt tolerant), as well as scattered tree cover and scrub.
5. They are known for rich wildlife and biodiversity and are currently legally protected under the status as a protected or reserve forest in India.
6. Banni grassland is peculiar to the Rann of Kutch, it has some forty Sindhi speaking Maldhari (cattle breeders) hamlets, home to the Halaypotra, Hingora, Hingorja, Jat and Mutwa tribes.

Note:

Prosopis juliflora, a non-native, thorny, shrubby species of mesquite locally known as ganda bawal, was planted in the area to help the Gujarat State forest department fight salinity ingress and barrenness in the Banni region of Kutch.

In dark nights an unexplained strange dancing light phenomenon known locally as Chir Batti (Ghost lights) is known to occur here in the banni grasslands, its seasonal marshy wetlands and in the adjoining desert of the marshy salt flats of Rann of Kutch.

Topic 94: Net Present Value of Forests

Key points:

- It is a mandatory one-time payment that a user has to make for diverting forestland for non-forest use, under the Forest (Conservation) Act, 1980.
- This is calculated on the basis of the services and ecological value of the forests.
- It depends on the location and nature of the forest and the type of industrial enterprise that will replace a particular parcel of forest.
- These payments go to the Compensatory Afforestation Fund (CAF) and are used for afforestation and reforestation.
- Decided by: The Forest Advisory Committee.

About Forest Advisory Committee

- The Committee is constituted by the Ministry of Environment, Forest and Climate Change (MoEF&CC) and decides on whether forests can be diverted for projects and the NPV to be charged.
- It is a statutory body constituted by the Forest (Conservation) Act 1980.

Know about Green Credit Scheme from previous RRS videos (Session 22) – CLICK HERE

Note:

- In the N. GodavarmanThirumulpad v. Union of India case, 2008, the Supreme Court mandated the payment of NPV.
- The Kanchan Gupta Committee developed the concept of NPV after this case.

Topic 95: Dehing Patkai and Raimona

Key points:

1. Both Dehing Patkai and Raimona reserve forest was upgraded to a national park on June 5, 2021.
2. Assam now is the state with the second highest number of national parks in the country, after Madhya Pradesh's 11.

Assam's National parks –

1. Kaziranga
2. Nameri
3. Orang
4. Manas
5. Dibru-Saikhowa
6. Dehing Patkai and
7. Raimona

About Dehing Patkai NP

1. Dehing Patkai wildlife sanctuary (notified in 2004) is located inside the larger Dehing Patkai Elephant Reserve.

2. It is rich in coal and oil — and is believed to be the last remaining contiguous patch of lowland rainforest area in Assam.
3. It also harbours highest concentration of the rare endangered White Winged Wood Duck.

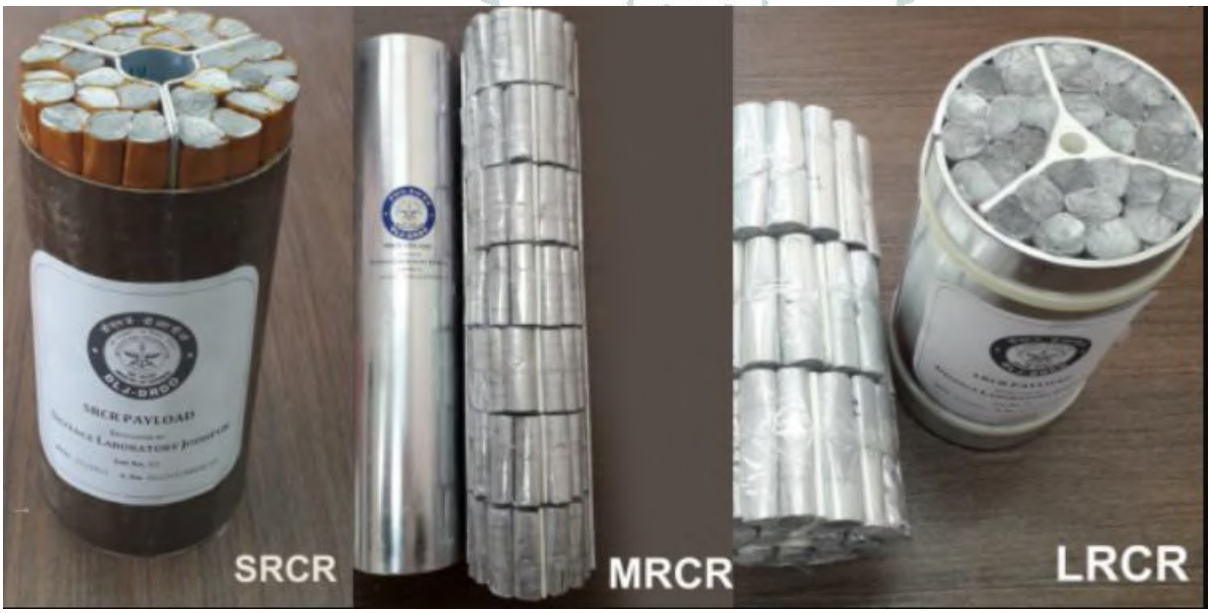
About Raimona NP

1. It is surrounded by the Phipsoo Wildlife Sanctuary in Bhutan to its north, the Buxa Tiger Reserve in West Bengal to its west and the Manas National Park to its east.
2. With eleven different forest types and subtypes, the area is home to the golden langurs, elephants, tiger, clouded leopard, several species of orchids and has more than 150 species of butterflies, 170 species of birds besides 380 species of plants.

Topic 96: Advanced Chaff Technology

Key points:

1. DRDO has developed an Advanced Chaff Technology to safeguard naval ships against missile attack.
2. It has indigenously developed three variants of this critical technology - Short Range Chaff Rocket (SRCR), Medium Range Chaff Rocket (MRCR) and Long Range Chaff Rocket (LRCR)
3. Chaff is a passive expendable electronic countermeasure technology used worldwide to protect naval ships from enemy's radar and Radio Frequency (RF) missile seekers.
4. The importance of this development lies in the fact that very less quantity of chaff material deployed in the air acts as decoy to deflect enemy's missiles for safety of the ships.



Topic 97: Counter Measure Dispensing System (CMDS)

Key points:

1. CMDS is a passive countermeasure system against incoming anti-aircraft missiles and it forms an important and effective part in aircraft's or warship's arsenal.
2. Counter Measure Dispensing System (CMDS) mainly comprises of two units viz. a Chaff system and Flares.
3. Usually, Chaff and Flares are launched from the onboard Counter Measure Dispensing System (CMDS).
4. Chaff and Flares degrade the performance characteristics of adversaries weapon system and help safeguard own platform.

About Chaff System

1. Chaff forms a volumetric radar reflecting material (composed of many small aluminium or zinc coated fibres) and is composed of distributed metalized radar reflector material.
2. This protects the host aircraft from a radar-guided missile by luring it to a better radar cross-section substitute, thus achieving a distraction towards the Chaff cloud.
3. This decoy is considered effective when it is able to lead the anti-aircraft missile away from the host aircraft such that it passes target aircraft safely.
4. The chaff are designed to operate in a frequency band of 2 to 18 GHz and can create an average Radar Cross Section (RCS) of about few square meter within a fraction of a second.
5. These systems are designed for extreme environmental conditions like minus 45 to plus 70 degrees Celsius etc.

Do you know?

- Indian Navy uses shipborne chaff naval decoy system to distract radar-guided anti-ship missiles in a self-defence role of the ship. The indigenized version is christened Kavach decoy system which releases Chaff made up of silver coated glass fibre.

About Flares

1. Flares are part of CMDS configuration and protect the platform from the Infrared (IR) seeking missiles.
2. Flares are useful in distracting the heat seeking missiles. Mostly magnesium pellets are ejected from the tubes.
3. Flares on being fired provide an alternate strong IR source to heat-seeking anti-air missiles so that they are lured away from the aircraft.
4. The IR radiation signature created by flare is larger than that of the aircraft and attracts the missile towards it.

Topic 98: Critical Near Isothermal Forging Technology

Key points:

1. DRDO has established the near isothermal forging technology to produce all the five stages of high-pressure compressors (HPC) discs out of difficult-to-deform titanium alloy using its unique 2000 MT isothermal forge press.
2. This is a crucial technology for establishing self-reliance in aeroengine technology. With this development, India has joined the league of limited global engine developers to have the manufacturing capabilities of such critical aero engine components.
3. This technological breakthrough, which involves developing complex titanium and nickel-based alloys that can withstand temperatures of more than 1,000 degrees Celsius, was achieved by the DRDO.
4. With this development, India has joined the league of limited global engine developers to have the manufacturing capabilities of such critical aero-engine components. (even resource-rich China is struggling to achieve)

Topic 99: Naval Innovation and Indigenisation Organisation (NIIO)

Key points:

1. Indian Navy has set up a Naval Innovation and Indigenisation Organisation (NIIO)
2. NIIO seeks to bridge the Navy's technological gap through innovation and the involvement of both the academia and the industry.

3. NIIO puts in place dedicated structures for the end users to interact with academia and industry towards fostering innovation and indigenisation for self-reliance in defence (Atmanirbhar Bharat).

The NIIO is a three-tiered organisation:

1. The **Naval Technology Acceleration Council (NTAC)** will bring together the twin aspects of innovation and indigenisation and provide apex level directives.
2. **Working group under the N-TAC** will implement the projects.
3. **Technology Development Acceleration Cell (TDAC)** has been created for induction of emerging disruptive technology in an accelerated time frame.

Topic 100: Exercises in news

Exercise	Associated Countries and description
JIMEX 20	• Japan Maritime bilateral exercise JIMEX • held in the North Arabian Sea
Passage Exercise (PASSEX)	• In 2020 → Between Royal Australian Navy and Indian Navy in East Indian Ocean Region
Indra Navy – 20	• Biennial bilateral maritime exercise between Indian Navy and Russian Navy (in Bay of Bengal)
Malabar 2020 Naval Exercise	• It was held in the Bay of Bengal and the Arabian Sea • Indian Navy-US Navy – Japan and – Australia
Security Belt 2021	• Iran-Russia Maritime (northern part of the Indian Ocean) • Indian Navy confirmed that it did not join the exercise
SLINEX-20	• Annual (Indian Navy – Sri Lanka Navy) Bilateral Maritime Exercise • Held in Trincomalee
SIMBEX-20	• India - Singapore Bilateral Maritime Exercise (in Andaman Sea) • being conducted annually since 1994
SITMEX-20	• India, Singapore and Thailand Trilateral Maritime Exercise • The first edition of SITMEX was conducted off Port Blair in September 2019. • The 2020 edition of the exercise is being hosted by Singapore Navy in Andaman Sea
CORPAT	• India-Thailand Coordinated Patrol between the Indian Navy and the Royal Thai Navy

Varuna-2021	• joint naval exercises between India and France (western Arabian Sea) • participation of the United Arab Emirates (UAE) Navy for the first time
Gulf Star 1	• India and the UAE started a new bilateral naval exercise
Quad Plus France	• India and three other Quad member nations- the US, Australia and Japan joined France (in eastern Indian Ocean)
TROPEX exercise	• Theatre Level Operational Readiness Exercise • participation of all operational units of Indian Navy including ships, submarines, aircraft as well as units of the Indian Army, Indian Air Force and Coast Guard
AMPHEX- 21	• Large-scale tri-service joint amphibious exercise

Exercise	**Associated Countries and description**
Khanjar Exercise	• Special forces of India and Kyrgyzstan (in Bishkek)
Exercise Desert Flag	• annual multi-national large force employment warfare exercise hosted by the United Arab Emirates Air Force. • Other than India and the UAE, Bahrain, France, Saudi Arabia, South Korea and the United States are also participating.
Ex Desert Knight-21 and Garuda	• Indian Air Force and French Air and Space Force
Exercise Kavach	• Joint Military exercise involving assets of Indian Army, Indian Navy, Indian Air Force and Indian Coast Guard
Pitch Black	• Australia and India (multilateral air combat training exercise) • 2020 edition was cancelled
Kavkaz 2020 Or Caucasus-2020	• India was supposed to take part in the Russian Kavkaz 2020 strategic command-post exercise. (but later India pulled out) • The invitees also include China and Pakistan, apart from other member-states of the Shanghai Cooperation Organisation.

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RaRe Notes

DAY 19 - ENVIRONMENT and S&T

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Topics Coverage:

141. National Biotechnology Development Strategy (2021-2025)
142. Atal Jai Anusandhan Biotech UNATI Mission
143. GARBH-ini
144. Ind-CEPI MISSION and CEPI
145. National Bio-Pharma Mission (NBM)
146. CAR-T cell therapy
147. Role of T-Cells and different types of white blood cells
148. Bioassay
149. Biofloc technology
150. Key terms in Biotechnology

Topic 141: National Biotechnology Development Strategy (2021-2025)

Key points:

1. Biotechnology → as a key driver for a "Knowledge and Innovation Driven Bio-economy"
2. Vision: To harness the potential of biotechnology as a premier precision tool for national development and well-being of society
3. Mission: To make India globally competitive in biotechnology research, innovation, translation, entrepreneurship and industrial growth and be a USD 150 billion Bioeconomy by 2025.
4. India is ranked amongst the top 12 biotech destinations in the world and ranks 3rd in Asia.
5. Current estimates value the industry at USD 63 billion in FY2019-20, which is expected to grow to USD 150 billion by FY25.

The biotech sector is primarily divided into five major segments:

1. bio-pharma,
2. bio-services,
3. bio-agri,
4. bio-industrial and
5. bio-informatics, which together contribute to the Bioeconomy.

Note: Biotechnology industry growth in India is primarily driven by vaccines and recombinant therapeutics at present.

Topic 142: Atal Jai Anusandhan Biotech UNATI (Undertaking Nationally relevant Technology Innovation) Mission

Key points:

1. It is implemented by Department of Biotechnology (DBT), Ministry of Science and Technology.
2. UNATI is expected to transform Health, Agriculture and Energy sectors during the next 5 years.

This mission includes five important areas –

1. GARBH-ini – A Mission to promote Maternal and Child Health and develop prediction tools for pre-term births
2. IndCEPI – A Mission to develop affordable vaccines for endemic diseases
3. Development of Biofortified and Protein Rich wheat – contributing to POSHAN Abhiyan
4. Mission on Antimicrobial Resistance for Affordable Diagnostics and Therapeutics
5. Clean Energy Mission – Innovative Technology interventions for Swachh Bharat.

Topic 143: GARBH-ini

Key points:

1. GARBH-ini → interdisciplinary Group for Advanced Research in Birth outcomes- DBT India Initiative
2. It was initiated by the Department of Biotechnology (DBT)
3. The study aims to discover molecular risk-markers and generate a risk-prediction algorithm for preterm birth which will facilitate timely referral and care for at-risk mothers, thus saving children's lives and reducing morbidity.

4. This programme has established a unique pregnancy cohort comprising more than 8000 women to study PreTerm Birth (PTB).
5. The GARBH-ini platform comprises a bio-repository (Rakshita) of well characterized clinical phenotypes which has now expanded to include 750,000 bio-specimens and 450,000 ultrasound images.

Topic 144: Ind-CEPI MISSION and CEPI

Key points:

1. It is an India centric collaborative mission of DBT aligned to the global initiatives of CEPI (Coalition of Epidemic Preparedness Innovations).
2. DBT is supporting the implementation of the Ind-CEPIs mission "Epidemic preparedness through rapid vaccine development: Support of Indian vaccine development is aligned with the global initiative of the Coalition for Epidemic Preparedness Innovations (CEPI)
3. Ind-CEPI Mission initiated the eCourse Series entitled "Strengthening Clinical Trial Research Capacity in Neighbouring Countries" primarily aimed towards skill development, capacity building and regional networking and coordination.
4. A total of 4-Program 10 sessions series were conducted via an online platform with total engagement of more than 750 participants from neighbouring countries like Afghanistan, Bangladesh, Bhutan, Maldives, Mauritius, Nepal and Srilanka.

About CEPI (Coalition of Epidemic Preparedness Innovations)

1. It is a global partnership launched in 2017 to develop vaccines to stop future epidemics
2. CEPI was conceived in 2015 and formally launched in 2017 at the World Economic Forum (WEF) in Davos, Switzerland.
3. CEPI focuses on WHO's "blueprint priority diseases" -- which include: the Middle East respiratory syndrome-related coronavirus (MERS-CoV), the Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the Nipah virus, the Lassa fever virus, and the Rift Valley fever virus, as well as the Chikungunya virus and the hypothetical, unknown pathogen "Disease X".

Topic 145: National Bio-Pharma Mission (NBM)

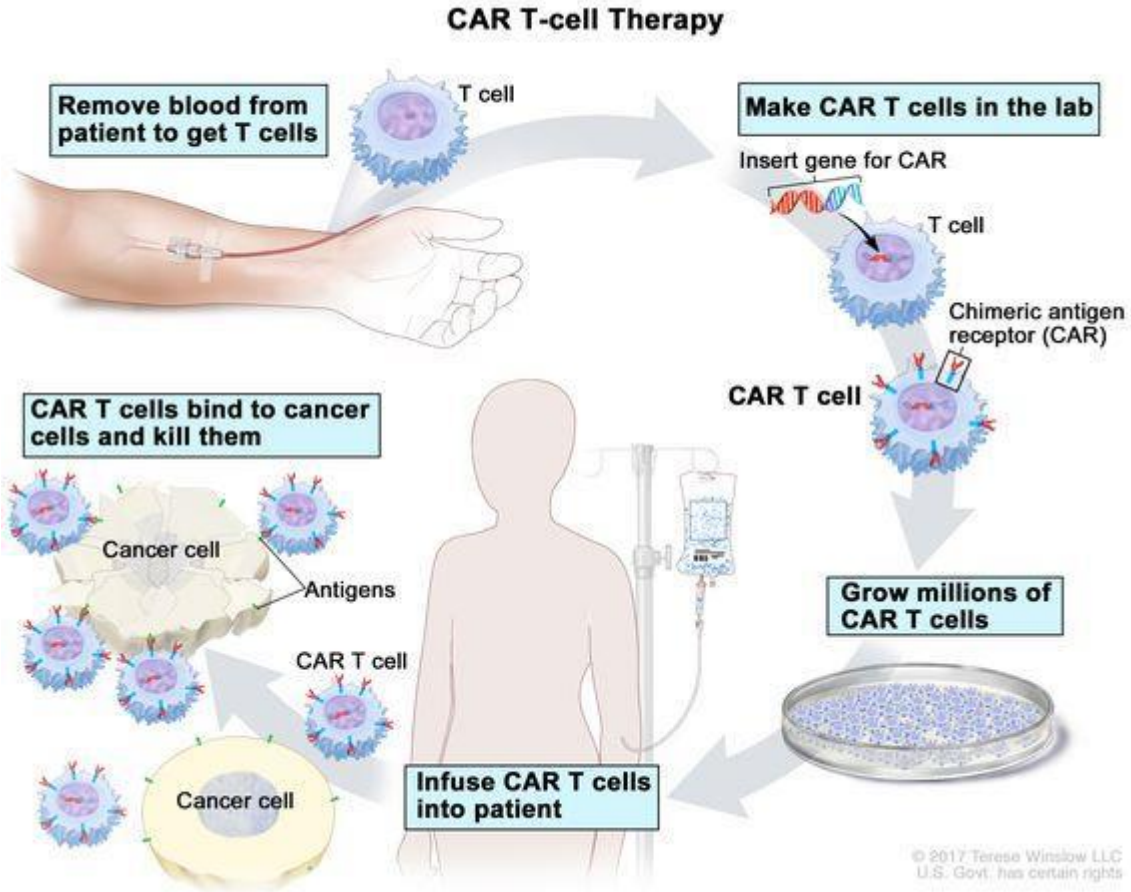
Key points:

1. NBM is an industry-academia collaborative mission for accelerating biopharmaceutical development in the country.
2. It was launched in 2017 at a total cost of Rs 1500 crore and is 50% co-funded by World Bank loan.
3. It is being implemented by the Biotechnology Industry Research Assistance Council (BIRAC) and we know that BIRAC is a Public Sector Enterprise, set up by the Department of Biotechnology (DBT).
4. The oversight to the mission activities is provided by the inter-ministerial Steering Committee chaired by the Secretary-DBT (Ministry of Science & Technology).
5. The Technical Advisory Group (TAG) chaired by an eminent scientist provides scientific leadership to the mission drawing upon global expertise.
6. Under this Mission, the Government has launched Innovate in India (i3) programme to create an enabling ecosystem to promote entrepreneurship and indigenous manufacturing in the biopharma sector.

It has a focus on following four verticals:

1. Development of product leads for Vaccines, Biosimilars and Medical Devices that are relevant to the public health need by focussing on managed partnerships.
2. Upgradation of shared infrastructure facilities and establishing them as centres of product discovery/discovery validations and manufacturing.
3. Developing human capital by providing specific training.
4. Developing technology transfer offices to help enhance industry academia inter-linkages.

Topic 146: CAR-T cell therapy



Key points:

1. CAR-T therapy → Chimeric Antigen Receptor T-cell Chimeric Antigen Receptor T-cell
2. It is associated with cancer treatment (especially patients suffering from Acute Lymphocytic Leukemia)
3. Note: At present this technology is not available in India and each patient's CAR-T cell therapy costs 3-4 crore (INR)
4. The challenge therefore is to develop this technology in cost-effective manner and make it available for the patients.

In order to promote and support development of CAR-T cell technology against cancer and other diseases, BIRAC and DBT have taken initiatives and launched specialized calls to invite proposals in the last 2 years.

Why in news?

1. First CAR-T cell therapy (a type of gene therapy) was done recently at the Bone Marrow Transplant unit at ACTREC, Tata Memorial Center in Mumbai.
2. The CAR-T cells were designed and manufactured at Bioscience and Bioengineering (BSBE) department of IIT Bombay.
3. This project ("first in India" gene therapy clinical trials) was done through National Biopharma Mission.
4. If the trials are successful, it may save millions of lives by making the treatment available in India at an affordable cost.

Topic 147: Role of T-Cells and different types of white blood cells

Key points:

1. T cell, also called T lymphocyte, is a type of leukocyte (white blood cell) that is an essential part of the immune system.
2. There are two types of lymphocytes—B cells and T Cells.
3. Lymphocytes determine the specificity of immune response to antigens (foreign substances) in the body.
4. T-cells play a plethora of roles in immunity — as killer cells that can attack an infected cell and kill it along with the infecting agent, and as suppressor cells that modulate the level of functioning of other lymphocytes. They also have a starring role in the production of antibodies, a function performed by the other variant of lymphocytes called the B cells.

Types of white blood cells

The following are the types of WBCs and their common functions:

Granulocytes: Granulocytes are named after the peculiar granules noticed in their cytoplasm when seen under the microscope. These cells include:

- Neutrophils: Neutrophils are the first types of WBCs to reach an infection site. They eliminate the pathogen by either killing or eating it.
- Eosinophils: Eosinophils are mainly responsible for fighting parasites. Their numbers increase in case of allergic reactions and parasitic infections.
- Basophils: Basophils are the rarest type of WBCs and are involved in the inflammation process.

Agranulocytes: These WBCs do not have any granules present in them and are of the following types:

- Lymphocytes: Lymphocytes include B and T cells, which are involved in the acquired immunity (the one you generate after being exposed to an antigen) of the body.
- Monocytes: Monocytes enter tissues and turn into macrophages, which then eat away antigens and also interact with lymphocytes to eliminate the pathogen.

Topic 148: Bioassay

About Bioassay

1. A bioassay is the use of a living organism to test for the presence of a compound or to determine the amount of the compound that is present in a sample.

2. It is an analytical method to determine concentration or potency of a substance by its effect on living animals (in vivo) or tissue/cell culture systems (in vitro).
3. Depending on the test organism, soil, air, or liquid samples can be assayed.
4. Therefore, Bioassay is used to detect biological hazards or give a quality assessment of a mixture and they are often used to monitor water quality and also sewage discharge and its impact on surrounding.
5. It is also used to assess the environmental impact and safety of new technologies and facilities.

Topic 149: Biofloc technology

Key points:

1. It is a technique of enhancing water quality in aquaculture through balancing carbon and nitrogen in the system.
2. The technology has recently gained attention as a sustainable method to control water quality, with the added value of producing proteinaceous feed in situ.
3. Biofloc technology was developed in the 1990s as a way for fish and shrimp farmers to conserve feed inputs and utilise wastewater during production.
4. The main concept is that producers could carry off the nitrogen cycle and let beneficial bacterial colonies proliferate in culture water.
5. The biofloc model is an intensive aquaculture system and is considered to hold an advantage over conventional systems, as the normally harmful waste produced in conventional aquaculture can be turned into feed for fish.
6. It is considered the new "blue revolution" in aquaculture.

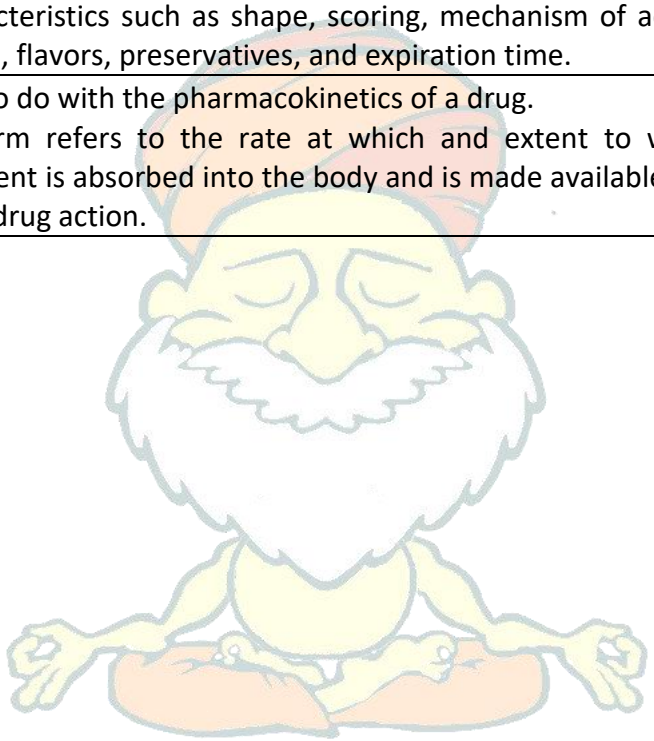
Do you know?

- Bottom-dwelling species like shrimp and tilapia are best suited to biofloc production.
- Andhra Pradesh is the largest producer of seafood in India, and contributes about 40% of total marine exports in the country.

Topic 150: Key terms in Biotechnology

Terms	Description
Biologics	• Biologics or biological products are medicines made from living organisms through highly complex manufacturing processes and must be handled and administered under carefully monitored conditions. • Biologics include a wide variety of products such as gene and cell therapies, therapeutic proteins, monoclonal antibodies, and vaccines. • Biologics are used to prevent, treat or cure a variety of diseases including cancer, chronic kidney disease, diabetes, cystic fibrosis, and autoimmune disorders. • Biologics are powerful medications that can be made of tiny components like sugars, proteins, or DNA or can be whole cells or tissues. • These drugs also come from all sorts of living sources — mammals, birds, insects, plants, and even bacteria.

Biosimilars	• A biosimilar is exactly what its name implies — it is a biologic that is "similar" to another biologic medicine. • Biosimilars are highly similar to the reference product in terms of safety, purity and potency, but may have minor differences in clinically inactive components.
Bioequivalent	• A bioequivalent drug is the pharmaceutical equivalent of another drug, with bioavailability comparable to that of the reference drug. • For drugs to be considered pharmaceutically equivalent, they must contain the same active ingredient or ingredients, the same amount (dose), the same route of administration, and the same strength or concentration. • Pharmaceutical equivalents may differ from the original approved drug in characteristics such as shape, scoring, mechanism of action, packaging, colors, flavors, preservatives, and expiration time.
Bioavailability	• It has to do with the pharmacokinetics of a drug. • The term refers to the rate at which and extent to which the active ingredient is absorbed into the body and is made available at the intended site of drug action.



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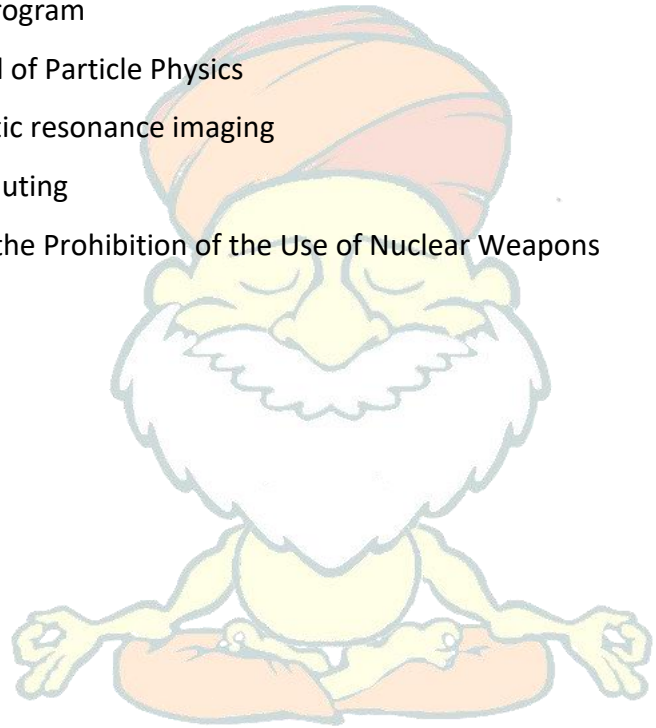


191. Miyawaki Method

In News: States like Telangana, Maharashtra and Delhi are adopting Japanese "Miyawaki" method of afforestation to grow forests and expand the green cover.

- Miyawaki is a technique pioneered by Japanese botanist Akira Miyawaki, that helps build **dense, native forests** in a **short time.**
- It includes planting trees (**only native species)** as close as possible in the same area which not only saves space, but the planted saplings also support each other in growth and block sunlight from reaching the ground, thereby preventing the growth of weed.
- Thus the saplings become maintenance-free (self-sustainable) after the first three years.
- The approach is supposed to ensure that **plant growth** is 10 times faster and the resulting plantation is **30 times denser** than usual.
- It helps to create a forest in just 20 to 30 years while through conventional methods it takes anywhere between 200 to 300 years.
- It is one of the novel methods of urban afforestation by turning backyards into mini-forests.

Miyawaki Process

- The native trees of the region are identified and divided into four layers — shrub, sub-tree, tree, and canopy.
- The quality of soil is analysed and biomass which would help enhance the perforation capacity, water retention capacity, and nutrients in it, is mixed with it.
- A mound is built with the soil and **the seeds are planted** at a very high density — three to five sapling per square meter.
- The ground is covered with a thick **layer of mulch.**

Concerns

- Such forests lack some qualities of natural forests, such as **medicinal properties** and the ability to **bring rain.**
- Even if they plant native species inside Miyawaki plots, it bears little resemblance to properly restored forests, especially in dry, deciduous forests which exist in most parts of this country.
- Several environmentalists have questioned the efficacy of the method that accelerates the growth of trees and claims to match a forest's complex ecosystem (as it is not a good idea to force plants to **photosynthesize fast**)

192. Platypus Sanctuary in Australia

In News: Australia will build the world's first refuge for the platypus, to promote breeding and rehabilitation as the duck-billed mammal faces extinction due to climate change.

- It is a semiaquatic, **egg-laying mammal** endemic to eastern Australia, including Tasmania.
- Extreme, prolonged drought conditions in Australia have dried up the waterways that make up the platypus's habitat putting them at the **risk of extinction.**
- **IUCN Status –** Near Threatened
- Unlike other famous Australian animals such as the koala or kangaroo, the beaver-like platypus is rarely seen in the wild due to its reclusive nature and highly specific habitat needs.
- **Platypuses Are Venomous Mammals:** A male platypus delivers venom through ankle spurs (females aren't venomous). The venom can severely hurt (but not kill) humans, although it can be lethal to smaller animals
- Together with the four species of echidna, it is one of the five extant species of **monotremes**, the only mammals that lay eggs instead of giving birth to live young; they are **all native to Australia.**
- Like other monotremes, it senses prey through electrolocation.
- When they dive underwater, platypuses are basically sightless and unable to smell anything. Their bills, however, have electroreceptors and mechanoreceptors that allow them to detect electrical fields and movement, respectively.

193. New Rules to Regulate Exotic Animal Trade

In News: Ministry of Environment Forests and Climate Change (MoEFCC) has issued an advisory to streamline the process of importing and possessing exotic live species in India

Exotic live species are both plants and animals that are moved from their source (original) habitat to a new one, mainly due to human intervention

New rules

- Owners and possessors of such animals and birds must also register their stock with Chief Wildlife Warden of their States.
    - Currently, Directorate-General of Foreign Trade oversees its trade.
- Wildlife Department will prepare an inventory of such species and have right to inspect facilities of such traders.
- Exotic live species will mean animals named under Appendices I, II and III of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). It will not include species from Schedules of the Wildlife (Protection) Act, 1972.

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

- CITES entered into force in July **1975.** Currently there are 183 Parties (include countries or regional economic integration organizations).

- Aim**:** Ensure that international trade in specimens of wild animals and plants does not threaten their survival.
- Secretariat is administered by UNEP (The United Nations Environment Programme) and is **located at Geneva, Switzerland.**
- The Conference of the Parties to CITES, is the supreme decision-making body of the Convention and comprises all its Parties.
- Although CITES is **legally binding on the Parties,** it does not take **the place of national laws.** Rather, it provides a framework to be respected by each Party, which has to adopt its own domestic legislation to ensure that CITES is implemented at the national level.
- The CITES works by subjecting international trade in specimens of selected species to certain controls.
- All import, export, re-export and introduction from the sea of species covered by the Convention has to be authorized through a licensing system**.**
- India, being a CITES Party, actively prohibits the international trade of endangered wild species and several measures are in place to control threats from invasive alien species (e.g. certificates for exports, permits for imports, etc.).
- **Appendices I, II and III to the Convention** are lists of species afforded different levels or types of protection from over-exploitation.

Appendix I - Species that are the most endangered among CITES-listed animals and plants.

Appendix II - Species that are not necessarily now threatened with extinction but that may become so unless trade is closely controlled.

Appendix III - Species included at the request of a Party that already regulates trade in the species and that needs the cooperation of other countries to prevent unsustainable or illegal exploitation.

194. Wildlife and Conservation

	Fishing Cat 	• **In News:** The Chilika Development Authority (CDA) designated the Fishing Cat as ambassador of Chilika Lake. • An adept swimmer, nocturnal • Found in mangroves and foothills of Himalayas • In 2012, the West Bengal government officially declared the Fishing Cat as the State Animal. Conservation status • IUCN status: Vulnerable • CITES list: Appendix II. • Schedule I of the Indian Wildlife (Protection) Act, 1972
	Asiatic Lion	• **In News:** Gujarat against transfer of lions to Kuna Wildlife sanctuary (Madhya Pradesh)

		• IUCN: Endangered • Wildlife (Protection) Act 1972: Listed in Schedule I • CITES: Appendix I
	Mandarin Duck 	• **In News:** It was spotted in Assam's Maguri Motapung Beel • Native to East Asia • Primary habitat is in eastern China and southern Japan • IUCN: Least concerned
	Lichens 	• **In News:** Uttarakhand forest department has developed the country's first lichen park in Munsiyari, Uttarakhand. • Lichen is a composite organism that emerges from algae or cyanobacteria living among the filaments of the fungi, living in a symbiotic relationship. • Lichens are slow growing and can live for centuries • Whereas algae normally grow only in aquatic or extremely moist environments, lichens can potentially be found on almost any surface (especially rocks) or as epiphytes (meaning that they grow on other plants). • More than 20,000 species of lichens are found in the world and India has around 2,714 of them. Uttarakhand is home to more than 600 species of lichens. **Some major uses of lichens:** • Separation of minerals by eroding rocks. • Key ingredient in many cuisines. • Used for preparing an indigenous perfume in Kannauj. • Used in sunscreen creams, dyes, and some medicines • Act as bioindicators: • Used as Filter: It absorbs and stores radioactive substances, such as cesium and strontium compounds, without apparent harm.

195. Experimental Advanced Superconducting Tokamak (EAST)

In News: EAST, which mimics the energy generation process of the sun, set a new record in April 2021 after it ran at 216 million degrees Fahrenheit (120 million degrees Celsius) for 101 seconds.

- For another 20 seconds, the "artificial sun" (referring to EAST) also achieved a peak temperature of 288 million degrees Fahrenheit (160 million degrees Celsius), which is over ten times hotter than the sun

About EAST

- EAST reactor is an advanced nuclear fusion experimental research device located at the Institute of Plasma Physics of the Chinese Academy of Sciences (ASIPP) in Hefei, China.
- The EAST Tokamak device is designed to replicate the nuclear fusion process carried out by the sun and stars.
- The EAST is one of three major domestic tokamaks that are presently being operated across the country. Apart from the EAST, China is currently operating the HL-2A reactor as well as J-TEXT.
- The EAST project is part of the International Thermonuclear Experimental Reactor (ITER) facility, which will become the world's largest nuclear fusion reactor when it becomes operational in 2035.

Tokamak

- The tokamak is an experimental magnetic fusion device designed to harness the energy of fusion.
- Inside a tokamak, the energy produced through the fusion is absorbed as heat in the walls of the vessel, which will be used by a fusion power plant to produce steam and then electricity by way of turbines and generators.
- The device uses magnetic fields to contain and control the hot plasma, which enables the fusion between deuterium and tritium nuclei to produce great amounts of energy.

	FISSION	FUSION
Definition	Fission is the splitting of a heavy, unstable nucleus into two lighter nuclei, which releases a tremendous amount of energy.	Fusion is the process where two light nuclei combine together releasing vast amounts of energy.
Source Materials	Uranium and plutonium are most commonly used for fission reactors	Atoms of Tritium and Deuterium (isotopes of hydrogen) are used in fusion reactors.
Nuclear Waste	Fission reactors produce highly radioactive fission products.	Fusion reactors produce no high activity/long-lived radioactive waste. The burnt fuel in a fusion reactor is helium, an inert gas
Sustenance	Additional neutrons released in the fission reaction can initiate a chain reaction which sustains fission reactions for longer durations.	Due to the tremendous amount of pressure and temperature needed to join the nuclei together, fusion reactions are difficult to sustain for long periods of time

Advantages of Nuclear Fusion

- Zero Carbon Emission: Major By-products is helium which is inert, non-toxic gas
- Abundance of source material: Fusion fuels are widely available and nearly inexhaustible

- It releases four million times more energy than a chemical reaction such as the burning of coal, oil or gas.
- No high activity long-lived radioactive waste.
- Limited risk of proliferation & No risk of meltdown

International Thermonuclear Experimental Reactor (ITER)

- Launched in 1985, ITER is an experimental fusion reactor facility currently under construction in Cadarache, south of **France**.
- Once complete, ITER will be the first fusion device to produce net energy.
- It aims to prove the feasibility of nuclear fusion as a future source of energy and build the world's largest tokamak through an international collaboration
- Signatories to the ITER Agreement include China, the European Union, India, Japan, Korea, Russia and the United States (35 nations).
- These countries share the cost of project construction, operation and decommissioning, and will also share in the experimental results and any intellectual property generated by the project.
- European Union being the host party contributes 45% while the rest of the parties contribute 9% each.
- **India's contribution:** India which formally joined the ITER project in 2005 and is contributing resources worth about $2.2 billion to this effort.
- India is responsible for delivery of cryostat, in-wall shielding, cooling water system, cryogenic system, heating systems, Diagnostic Neutral Beam System, power supplies and some diagnostics.

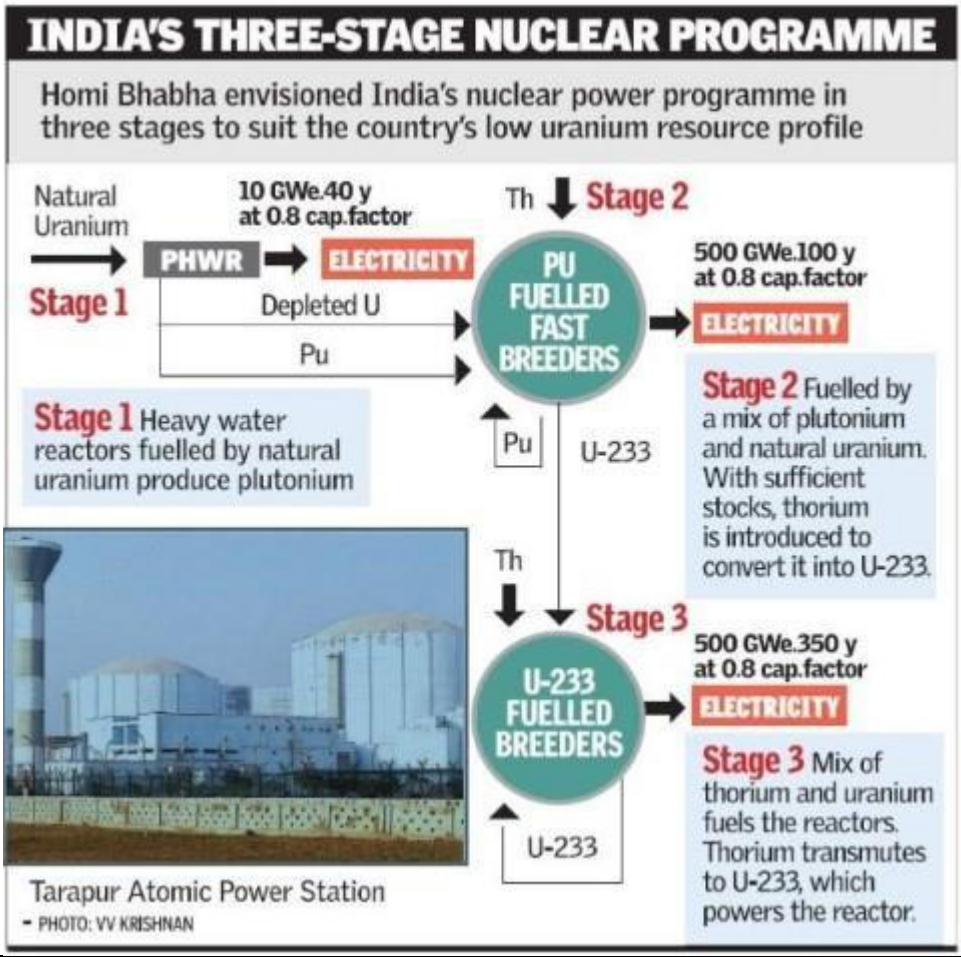
196. India Nuclear Program

In News: Third unit at Kakrapar Atomic Power Plant (KAPP-3) Achieves Criticality.

India's three-stage nuclear power programme was formulated by **Homi Bhabha** in the 1950s to secure the country's long term energy independence, through the use of **uranium** and **thorium** reserves found in the **monazite sands** of coastal regions of South India.

- The ultimate focus of the programme is on **enabling the thorium reserves of India to be utilized** in meeting the country's energy requirements.
- Thorium is particularly attractive for India, as it has only around 1–2% of the global uranium reserves, but one of the **largest shares of global thorium reserves**.
- However, at present thorium is not economically viable because global uranium prices are much lower.
- **Thorium itself is not a fissile material,** and thus cannot undergo fission to produce energy. Instead, it must be transmuted to uranium-233 in a reactor fueled by other fissile materials [plutonium-239 or uranium-235].
- The first two stages, natural **uranium-fueled heavy water reactors** and **plutonium-fueled fast breeder reactors**, are intended to generate sufficient fissile material from India's limited uranium

resources, so that all its vast thorium reserves can be fully utilized in the third stage of thermal breeder reactors.



	Stage I- Pressurized Heavy Water Reactor [PHWR]	• Natural **uranium** fuelled pressurized heavy water reactors (PHWR) produce electricity while generating **plutonium-239 as by-product.** • U-238 → Plutonium-239 + Heat • In PWHR, enrichment of Uranium to improve concentration of U-235 is not required. U-238 can be directly fed into the reactor core • Natural uranium contains only 0.7% of the fissile isotope uranium-235. Most of the remaining 99.3% is uranium-238 which is not fissile but can be converted in a reactor to the fissile isotope plutonium-239 • Heavy water (deuterium oxide, D 2O) is used as moderator and coolant in PHWR
	Stage II – Fast Breeder Reactor	• Fast breeder reactors (FBRs)[**moderators not required**] would use plutonium-239, recovered by reprocessing spent fuel from the first stage, and natural uranium. • In FBRs, plutonium-239 undergoes fission to produce energy, while the uranium-238 present in the fuel transmutes to additional plutonium-239.

		• Uranium-235 and Plutonium-239 can sustain a chain reaction. But Uranium-238 cannot sustain a chain reaction. So it is transmuted to Plutonium-239.
	Stage III – Thorium Based Reactors	• A Stage III reactor or an Advanced nuclear power system involves a self-sustaining series of **thorium-232-uranium-233** fuelled reactors. • This would be a thermal breeder reactor, which in principle can be refueled – after its initial fuel charge – using only naturally occurring thorium • Large scale thorium deployment is only to be expected 3 – 4 decades after the commercial operation of fast breeder reactors. [2040-2070] • As there is a long delay before direct thorium utilisation in the three-stage programme, the country is now looking at reactor designs that allow more direct use of thorium in parallel with the sequential three-stage programme • Three options under consideration are the Accelerator Driven Systems (ADS), Advanced Heavy Water Reactor (AHWR) and Compact High Temperature Reactor

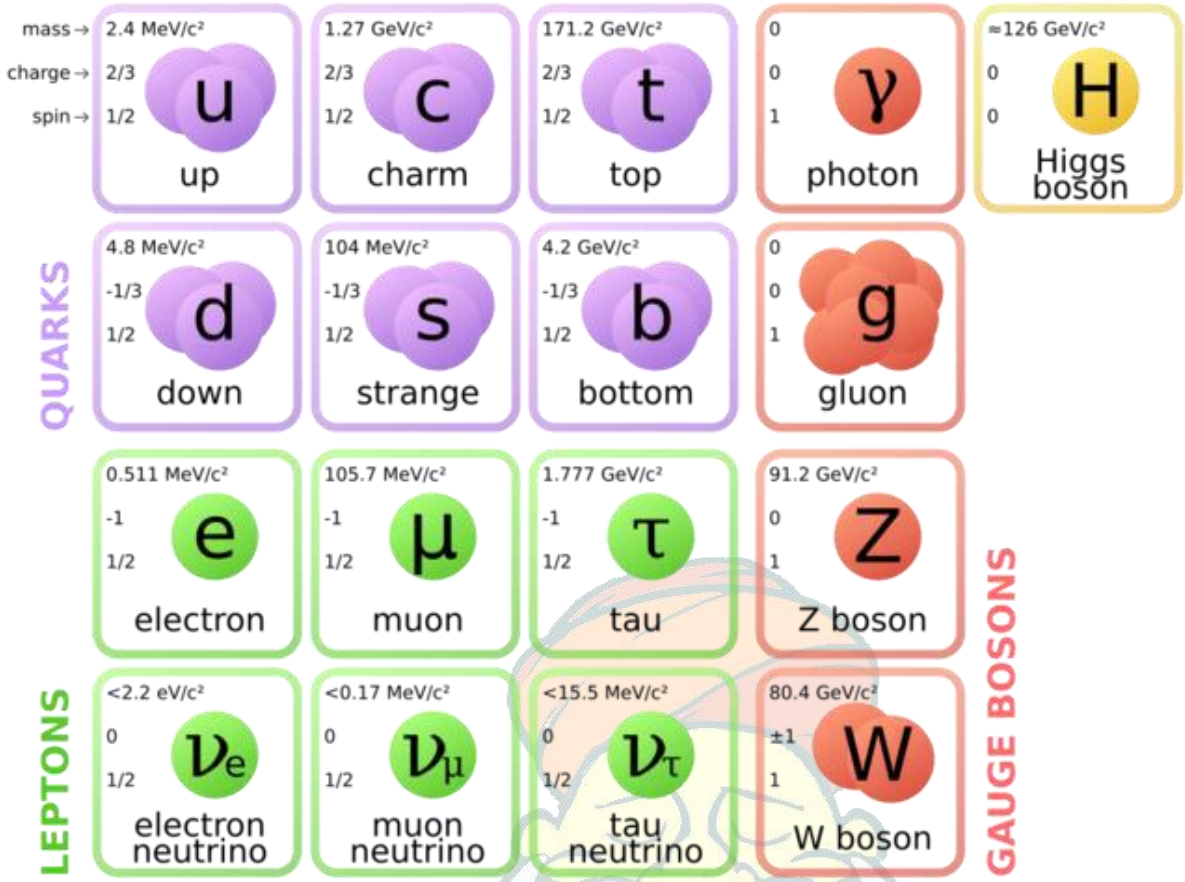
197. Standard Model of Particle Physics

In News: International Muon g2 Experiment again proves the standard model of physics wrong.

- The Standard Model is the name given in the 1970s to a theory of fundamental particles and how they interact. It incorporated all that was known about subatomic particles at the time and predicted the existence of additional particles as well.

- There are seventeen named particles in the Standard Model, organized into the chart shown below.

- The last particles discovered were the W and Z bosons in 1983, the top quark in 1995, the tau neutrino in 2000, and the Higgs boson in 2012.



- Fundamental particles are either the **building blocks of matter, called *fermions*** or the **mediators of interactions, called *bosons*.**
- There are twelve named fermions *(Quarks & Leptons shown above)*, and five named bosons (photon, gluon, Z boson, W boson, Higgs Boson) in the Standard Model.

	Fermions	• Fermions cannot occupy the same place at the same time. (More formally, no two fermions may be described by the same quantum numbers.) • Fermions have half integral spin quantum numbers (½, 1½, 2½, etc.) • Leptons and quarks are fermions, but so are things made from them like protons, neutrons, atoms, molecules, people, and walls. • This agrees with our macroscopic observations of matter in everyday life. People cannot walk through walls unless the wall gets out of the way.
	Bosons	• Bosons, in contrast, are have no problem occupying the same place at the same time. (More formally, two or more bosons may be described by the same quantum numbers.) • Bosons have integral spin quantum numbers (0, 1, 2, etc.)

		• The statistical rules that bosons obey were first described by Satyendra Bose (1894–1974) of India and Albert Einstein (1879–1955) of Germany. • Gluons, photons, and the W, Z and Higgs are all bosons. • As the particles that make up light and other forms of electromagnetic radiation, photons are the bosons we have the most direct experience with. • In our everyday experience, we never see beams of light crash into one another. Photons are like phantoms. They pass through one another with no effect.

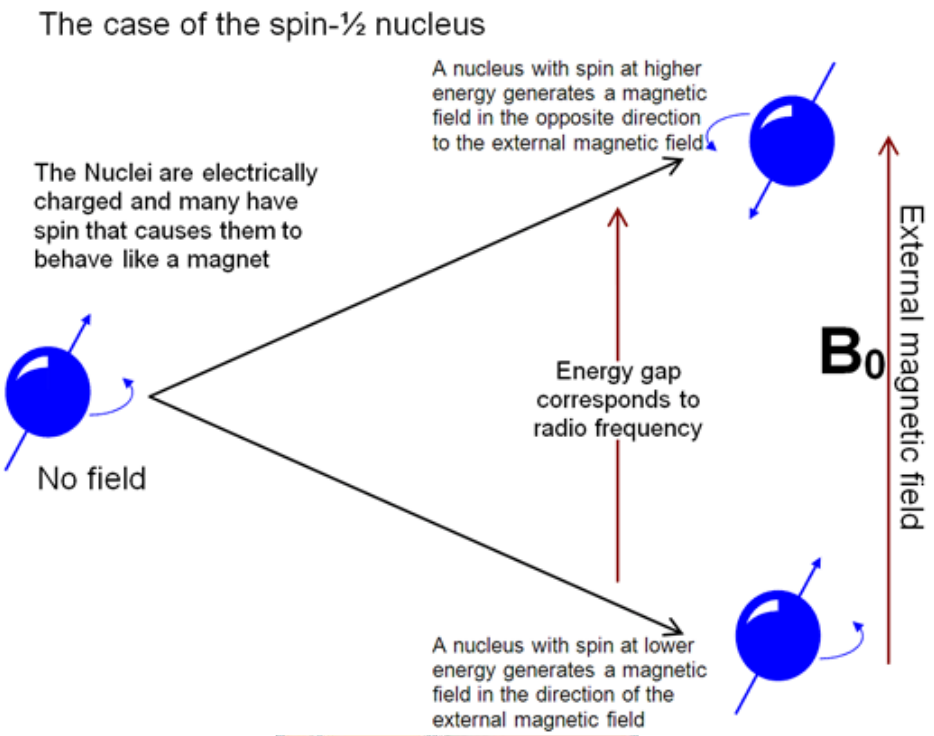
198. Nuclear Magnetic Resonance Spectroscopy

In News: As per an investigation carried out by the Centre for Science and Environment (CSE), honey sold by several major brands in India has been found adulterated with sugar syrup. Samples of 10 out of 13 brands, which were examined, failed to clear the **Nuclear Magnetic Resonance (NMR) test.**

- Indian companies in the business of honey are importing **synthetic sugar syrups** from China for adulterating with honey.
- Adulteration also destroyed the livelihoods of bee-keepers who found it unprofitable to make pure honey because sugar-syrup honey was often available at half the price.
- The **NMR test is not required by Indian law for honey** that is being marketed locally but is needed for export.

Nuclear Magnetic Resonance (NMR) Test

- It is **an analytical chemistry technique** used in quality control and research for determining the content and purity of a sample as well as its molecular structure.
- The principle behind NMR is that many nuclei have spin and all nuclei are electrically charged.
- If an external magnetic field is applied, an energy transfer is possible between the base energy to a higher energy level (generally a single energy gap).
- The energy transfer takes place at a wavelength that corresponds to radio frequencies and when the spin returns to its base level, energy is emitted at the same frequency (resonance)
- The signal that matches this transfer is measured in many ways and processed in order to yield an NMR spectrum for the nucleus concerned.



The above figure relates to spin-½ nuclei that include the most commonly used NMR nucleus, proton (^{1}H or hydrogen-1) as well as many other nuclei such as ^{13}C, ^{15}N and ^{31}P.

Chemical Shift, NMR & Analysis

- The precise resonant frequency of the energy transition is dependent on the effective magnetic field at the nucleus. This field is affected by electron shielding which is in turn dependent on the chemical environment.
- As a result, information about the nucleus' **chemical environment can be derived from its resonant frequency**. In general, the more electronegative the nucleus is, the higher the resonant frequency

Working

- The sample is placed in a magnetic field and the NMR signal is produced by excitation of the nuclei sample with radio waves into nuclear magnetic resonance, which is detected with sensitive radio receivers.
- The intramolecular magnetic field around an atom in a molecule changes the resonance frequency, thus giving access to details of the electronic structure of a molecule and its individual functional groups

199. Quantum Technology/Computing

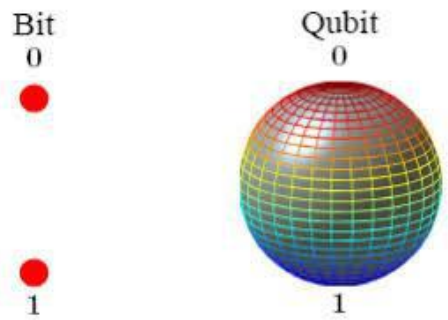
In News: Union Budget 2020-21 proposed to spend Rs 8,000 crore on the newly launched National Mission on Quantum Technology and Applications (NMQTA).

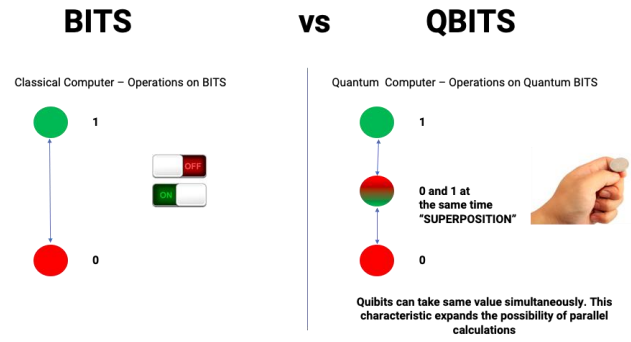
- In 2018, the Department of Science & Technology unveiled a programme called Quantum-Enabled Science & Technology (QuEST) and committed to investing Rs. 80 crore over the next three years to accelerate research.

- The mission seeks to develop quantum computing linked technologies amidst the second quantum revolution and make India the world's third-biggest nation in the sector after the US and China.

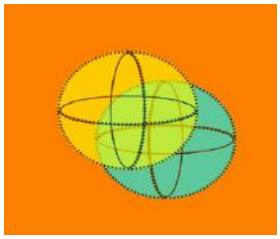
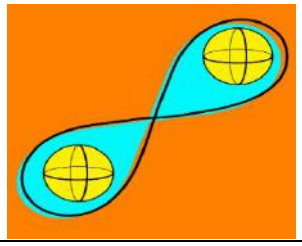
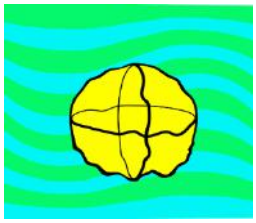
About Quantum Technology/Computing:

- Quantum Technology is based on the principles of Quantum mechanics that was developed in the early 20th century to describe nature at the scale of atoms and elementary particles.
- **Conventional computers** process information in **'bits' or 1s and 0s,** following classical physics under which our computers can process a '1' or a '0' at a time.
- **Quantum computers** compute in **'qubits' (or quantum bits).** They exploit the properties of quantum mechanics, the science that governs how matter behaves on the atomic scale.
    - In this scheme of things, processors can be a 1 and a 0 simultaneously, a state called quantum superposition.
    - Because of quantum superposition, a quantum computer — if it works to plan — can **mimic several classical computers working in parallel.**





- The basic properties of quantum computing are s**uperposition, entanglement, and interference**

	Superposition 	• It is the ability of a quantum system to be in **multiple states simultaneously.** • The example of superposition is the flip of a coin, which consistently lands as heads or tails—a very binary concept. However, when that coin is in mid-air, it is both heads and tails and until it lands, heads and tails simultaneously. Before measurement, the electron exists in quantum superposition.
	Entanglement 	• It means the two members of a pair (Qubits) exist in a single quantum state. Changing the state of one of the qubits will instantaneously change the state of the other one in a predictable way. This happens even if they are separated by very long distances. • Einstein called spooky **'action at a distance'.**
	Interference:	• Quantum interference states that elementary particles(Qubits) can not only be in more than one place at any given time (through superposition), but that an individual particle, such as a photon (light particles) can cross its own trajectory and interfere with the direction of its path.
	Decoherence 	• The interaction of qubits with their environment in ways that cause their quantum behavior to decay and ultimately disappear is called decoherence. • The slightest vibration or change in temperature—disturbances known as "noise" in quantum-speak—can cause them to tumble out of superposition before their job has been properly done.

Application of Quantum Technology/Computing

	Secure Communication	• China has demonstrated secure quantum communication links between terrestrial stations and satellites. • This area is significant to satellites, military and cyber security among others as it promises unimaginably fast computing and safe, unhackable satellite communication to its users.

	Basic Sciences Research	• It can help in solving some of the fundamental questions in physics related to gravity, black hole etc. • Similarly, the quantum initiative could give a big boost to the Genome India project, a collaborative effort of 20 institutions to enable new efficiencies in life sciences, agriculture and medicine.
	Climate Predictions	• Tsunamis, drought, earthquakes and floods may become more predictable with quantum applications. • The collection of data regarding climate change can be streamlined in a better way through quantum technology.
	Drug Discovery & Pharmaceuticals	• Quantum computing **could reduce the time frame of the discovery of new molecules and related processes** to a few days from the present 10-year slog that scientists put in.
	Augmenting Industrial revolution 4.0:	• Quantum computing is an integral part of Industrial revolution 4.0. • Success in it will help in Strategic initiatives aimed at leveraging other Industrial revolution 4.0 technologies like the Internet-of-Things, machine learning, robotics, and artificial intelligence across sectors will further help in laying the foundation of the Knowledge economy.

200. Convention on the Prohibition of the Use of Nuclear Weapons and Reducing Nuclear Danger

News: In Nov 2020, resolutions tabled by India in the UN General Assembly on measures to prevent terrorists from acquiring weapons of mass destruction was co-sponsored by more than 75 countries and adopted by consensus.

About

- The first committee of the United Nations General Assembly has adopted two India-sponsored resolutions on nuclear disarmament which aim to reduce risk of nuclear accidents and call for a prohibition on the use of nuclear weapons.
- The two resolutions adopted are–

	Convention on the Prohibition of the Use of Nuclear Weapons	• It was backed by a majority of UN Members and was tabled by India since 1982. • It calls for Conference on Disarmament to start negotiations on an international convention prohibiting the use or threat of use of nuclear weapons under any circumstances.

		• The aim is that a universal and legally binding agreement would generate the necessary global "political will" that can lead to the total elimination of nuclear weapons
	Resolution on "Reducing Nuclear Danger"	• This was tabled since 1998 puts focus on "unintentional or accidental use" of nuclear weapons and underscore the need for a review of nuclear doctrines • The resolution asks for "concrete steps" to reduce such risks, including through "de-alerting and de-targeting of nuclear weapons."

Significance

- The adoption of resolutions shows "India's commitment towards the goal of nuclear disarmament.
- The resolution, which is supported by a majority of UN members, reflects India's conviction that such a multilateral, universal and legally binding agreement would generate necessary political will among States possessing nuclear weapons to engage in negotiations leading to the total elimination of nuclear weapons.

Nuclear Technology in preventing Nuclear Terrorism

- **Nuclear terrorism** could be intercepted by neutron-gamma detector (NGET) that pinpoints source. It detects the intersection of neutron and Gama rays.
- The so-called **Neutron-Gamma Emission Tomography (NGET)** system goes beyond the capabilities of existing radiation portal monitors, by measuring the time and energy correlations between particles emitted in nuclear fission, and **using machine learning** algorithms to visualize where they're coming from.
- The system looks for coincidences of neutron and gamma ray emissions -- which when mapped together in real-time allow pinpointing their origin.
- A form of tomography, the system enables quick 3D imaging of the source of neutron and gamma ray emissions from weapons-grade plutonium and other special nuclear materials.
- NGET isn't only for nuclear weapons and radiation-dispersing "dirty bombs" -- it can be used to detect environmental radiation too, such as leaks from nuclear facilities or even natural sources.

Other applications:

- Detecting rare earth minerals.
- Detecting nuclear leakages.
- Detecting illegal enrichments.

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241. Elephant Corridors

In News: In October 2020, SC had upheld the Tamil Nadu government's authority to notify an 'elephant corridor' and protect the migratory path of the animals through the Nilgiri biosphere reserve

Brief background of the Judgement

- In 2011, the Madras HC upheld the validity of the Tamil Nadu government's notification (of 2010) declaring an 'Elephant Corridor' in the Sigur Plateau of Nilgiris District.
- It said that the government is fully empowered under the 'Project Elephant' of the Union government as well as Article 51 A(g) of the Constitution to notify the elephant corridor in the state's Nilgiris district.
- Further, it upheld directions to the resort owners and other private landowners to vacate lands falling within the notified Nilgiri elephant corridor.
- This decision by High Court was appealed by resort owner & other private landowners in Supreme Court, the judgement of which was delivered in October 2020.
- SC upheld Madras High Court Judgement and said it was the State's duty to protect a **"keystone species"** such as elephants, immensely important to the environment.

Nilgiris Elephant Corridor:

- The corridor is situated in the **ecologically fragile Sigur plateau,** which connects the Western and the Eastern Ghats and sustains elephant populations and their genetic diversity.
- It is situated **near the Mudumalai National Park** in the Nilgiris district.
- It has the Nilgiri hills on its southwestern side and the **Moyar river valley** on its northeastern side. The elephants cross the plateau in search of food and water.
- There are about 100 elephant corridors in India of which almost 70% are used regularly
- There are an estimated 6,500 elephants in just the Brahmagiri-Nilgiris-Eastern Ghats ranges.
- Challenges for elephant corridors include
    - Narrowing Passage Width due to Human encroachment
    - Interception of corridors by connectivity projects like roads & railways.

Nilgiri Biosphere Reserve

- The name **'Nilgiris' with literary meaning 'blue mountains'** has originated from the blue flower clad mountains of the Nilgiris plateau within the State of Tamil Nadu.
- It was the **first biosphere reserve in India** established in the year 1986.
- It is **located in the Western Ghats** and encompasses parts of **Tamil Nadu, Kerala and Karnataka.**
- It exemplifies the **tropical forest biome** which portrays the confluence of Afro-tropical and Indo-Malayan biotic zones of the world.
- Biogeographically, Western Ghats is the most important region and one of the noted **Biodiversity Hotspots** (biogeographic regions having highest density of endemic species) for speciation in the tropics.
- Vegetation
    - Major parts of the core areas spread over Kerala and Tamil Nadu States, include evergreen, semi evergreen, moist deciduous montane sholas and grassland types of vegetation.

  - Whereas the core area spread over the State of Karnataka contains mostly dry deciduous forests and a few patches of moist deciduous, semi evergreen and scrub jungles
- Many of the major tributaries of the river Cauvery like the Bhavani, Moyar, Kabini and other rivers like Chaliyar, Punampuzha, etc., have their source and catchment areas within the reserve boundary
- The Mudumalai Wildlife Sanctuary, Wayanad Wildlife Sanctuary, Bandipur National Park, Nagarhole National Park, Mukurthi National Park and Silent Valley are the protected areas present within this reserve.

Conservation Status of Elephants

- IUCN status: Endangered
- Wildlife Protection Act 1972: Schedule I

Elephant Conservation Efforts

- Project Elephant launched by the Government of India in the year 1992 as a Centrally Sponsored Scheme.
- 'Gaj Yatra' a nationwide awareness campaign to celebrate elephants and highlight the necessity of securing elephant corridors.
- Establishment of elephant reserves and adoption of the "World Elephant Day" (August 12) to help conserve and protect elephants in India and improve their welfare.
- The Wildlife Trust of India (WTI), had come out with a publication on the right of passage in 101 elephant corridors of the country in 2017, stressed on the need for greater surveillance and protection of elephant corridors.
- **The Monitoring the Killing of Elephants (MIKE**) programme launched in 2003 is an international collaboration that tracks trends in information related to the illegal killing of elephants from across Africa and Asia, to monitor effectiveness of field conservation efforts.

242. Xenobots

In News: Scientists in the United States have created the world's first "living robots" named "xenobots"

While humans have been manipulating organisms for their benefit since at least the dawn of agriculture, and genetic editing has created a few artificial organisms in recent years, the latest research is a breakthrough because it designs, for the first time ever, "completely biological machines from scratch".

About Xenobots

- Now a team of scientists has repurposed living cells -- scraped from frog embryos -- and assembled them into entirely new life-forms.
- These millimeter-wide "xenobots" can move toward a target, perhaps pick up a payload (like a medicine that needs to be carried to a specific place inside a patient) -- and heal themselves after being cut.
- They're neither a traditional robot nor a known species of animal. It's a new class of artifact: a living, programmable organism.

- Many useful applications of these living robots include searching out nasty compounds or radioactive contamination, gathering microplastic in the oceans, travelling in arteries to scrape out plaque, etc.

How they were prepared?

1. First they gathered stem cells, harvested from the embryos of African frogs, the species *Xenopus laevis*. (Hence the name "xenobots.")
    - **Stem cells** are the body's raw materials — cells from which all other cells with specialized functions are generated (ex Muscle cells, brain cells)
    - In other words, Stem cells are undifferentiated cells that can turn into specific cells, as the body needs them.
    - Stem cells originate from two main sources: adult body tissues and embryos.
2. These were separated into single cells and left to incubate.
3. Then, using tiny forceps and an even tinier electrode, the cells were cut and joined under a microscope into a close approximation of the designs specified by the computer.
4. Assembled into body forms never seen in nature, the cells began to work together.
5. The skin cells formed a more passive architecture, while the once-random contractions of heart muscle cells were put to work creating ordered forward motion as guided by the computer's design, and aided by spontaneous self-organizing patterns -- allowing the robots to move on their own

Advantages of Xenobot

- **Environment Friendly:** These xenobots are fully biodegradable - when they stop working (death) they usually fall apart harmlessly.
- **Regeneration capability**: Scientists sliced the robot almost in half and it stitches itself back up and keeps going

Challenges

- Unintended consequences
- Living robots are weak and it degrades quickly

Why Xenopus Laevis?

- This species of aquatic frogs is found across sub-Saharan Africa from Nigeria and Sudan to South Africa.
- Xenopus is a valuable tool because they are:
    - They are easy to maintain in captivity.
    - Hardy, fully aquatic.
    - **Genetically similar to humans** thus a good model for human disease
    - Produce eggs year-round.
    - Eggs are a reliable and flexible material for research,
    - Embryos are a **good model for vertebrate development.**

243. Gold nanoparticles (GNPS)

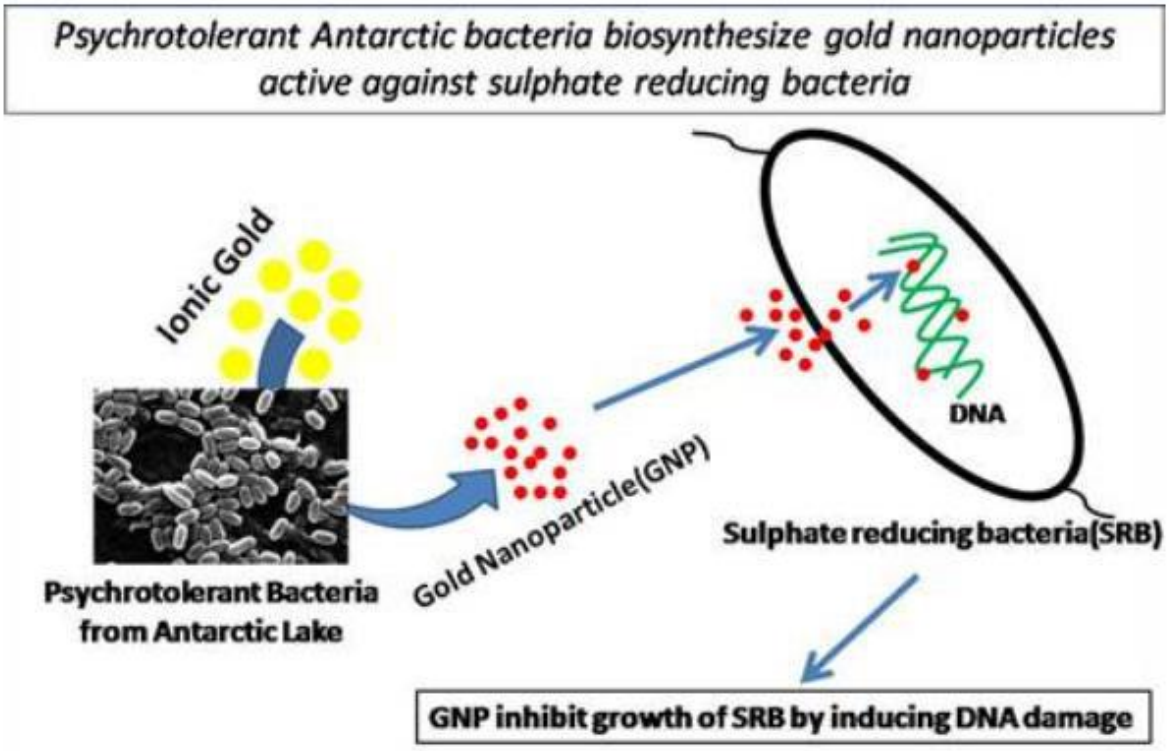
In News: Eco-friendly Synthesis of Gold Nanoparticles from Antarctic Bacteria for Therapeutic Use

What is nanotechnology and nanoparticle (NP)?

- Nanotechnology is a technology that creates new and novel materials through controlled manipulation at a size range of 1 nm (nanometer) to 100 nm (1 nm equals to 10^{-9} m).
- And NPs are those materials that are at least one dimension smaller than 100 nanometres.
- NPs have a high surface-to-volume ratio and they can provide tremendous driving force for diffusion, especially at elevated temperatures.

Gold Nano Particles

- Scientists at National Centre for Polar and Ocean Research (NCPOR) and the Goa University (GU) have resorted to environmentally acceptable green chemistry procedures to reduce gold ion to GNPs using psychrotolerant Antarctic bacteria.
- Moreover, they did not have to use synthetic chemical additives as stabilizing or reducing agents. The process resulted in 20-30-nm-sized spherical-shaped GNPs
- Use of psychrotolerant Antarctic bacteria is found to have special advantages like mild reaction condition to reduce gold ion to Gold Nanoparticles (GNPs) with a good dispersion capability.



Application of Gold Nano Particles (GNP)

- GNPs are found to have greater solar radiation absorbing ability than the conventional bulk gold, which makes them a better candidate for use in the **photovoltaic cell manufacturing industry.**

- GNPs have unique optical properties too. For example, particles above 100 nm show blue or violet colour in water, while the colour becomes wine red in 100 nm gold colloidal particles. They can thus be used of **therapeutic imaging.**
- GNPs also have unique physicochemical properties. Their biocompatibility, high surface area, stability, and nontoxicity make them suitable for various applications in therapeutic use including **detection and diagnosis of diseases**
- GNPs can also be used in **targeted drug delivery**. As nano-carriers, GNPs are capable of transferring various drugs made out of peptides, proteins, plasmid DNAs, small interfering RNAs, and chemotherapeutic agents to target diseased cells of the human body.
- GNPs are also found to be useful in the **electronics industry.** Scientists have constructed a transistor known as NOMFET (Nanoparticle Organic Memory Field-Effect Transistor) by embedding GNPs in a porous manganese oxide. NOMFETs can mimic the feature of the human synapse known as plasticity, or the variation of the speed and strength of the signal going from neuron to neuron.

244. Robotic Surgery

In News: Recently, Insurance Regulatory and Development Authority of India (IRDAI) has standardised health policies across all health insurers to even cover robotic and bariatric surgeries.

- Bariatric surgery is an operation that helps lose weight by making changes to the digestive system.
- Also, India became the first country to perform a telerobotic coronary surgery on humans.

Robotic Surgery

- Robotic or Robot-assisted surgery integrates advanced computer technology with the experience of the skilled surgeons.
- This technology provides the surgeon with a 10x magnified, high-definition, 3D-image of the body's intricate anatomy.
- The surgeon uses controls in the console to manipulate special surgical instruments that are smaller, as well as more flexible and manoeuvrable than the human hand.
- The robot replicates the surgeon's hand movements, while minimizing hand tremors.

Merits of Robotic Surgery

- They allow doctors to perform different types of complex procedures with more precision, flexibility, and control than possible with conventional techniques.
- Robotic surgeries reduce the trauma caused to the patient by allowing surgery to be performed through small ports or 'keyholes' rather than via large incisions.
- The instruments can access hard-to-reach areas of a patient's body more easily through smaller incisions compared with traditional open and laparoscopic surgeries.
- This helps in shorter recovery times, with fewer complications and a shorter hospital stay. They are minimally invasive, painless and have a bigger cosmetic advantage.

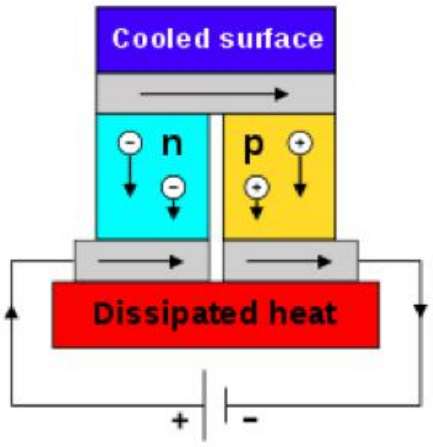
245. Silver Antimony Telluride

In News: Bengaluru-based scientists have developed a new material that can help in tapping waste heat produced by all kinds of domestic and industrial appliances, and use it to accomplish other useful work.

Background of Research

- Industrial processes and power plants produce ample amount of waste heat that can be utilised to do significant amounts of work.
- The key is to find an energy **conversion process that can convert heat into the more convenient electrical energy** which can then be deployed to drive other machines or processes.
- Scientists have found a new material, **Silver Antimony Telluride**, that can facilitate this energy conversion.
- Energy conversion, in general, is not a very efficient process. Only a small fraction of energy that is used is actually productive. The rest of it becomes waste, often getting released as heat.
    - For example, when we burn fuel in the automobile engines, only about 30 per cent of the total energy content is used to drive the vehicle.
- This waste heat can be tapped, and further converted into electrical energy, but this process too is highly inefficient. Typically, not more than 15 to 20 per cent of the waste heat can be utilised.

Thermo-electric effect - Underlying Principle of Waste Energy Conversion



- The underlying physical phenomenon, known as the thermo-electric effect, is rather simple and known to scientists for more than 200 years.
- If two ends of an electrically-conducting material, like a metal, are maintained at different temperatures, current flows from the hot end towards the cold one.
- This phenomenon makes it possible, for example, to generate an electric current in a metallic attachment that is connected to the exhaust pipe of an automobile engine, or a generator, or any other source of waste heat.
- The end connected to the heat source would be hotter than the other end, a current would be induced, which can be tapped by connecting the cooler end to a battery or some other device
- The problem in facilitating this transfer of energy, however, is the fact that **most materials that conduct electricity, also happen to be good conductors of heat**. That means that there would not be any significant temperature difference between the two ends of the material for very long.
- The quest has been to find a material that is a good conductor of electricity but a bad conductor of heat.

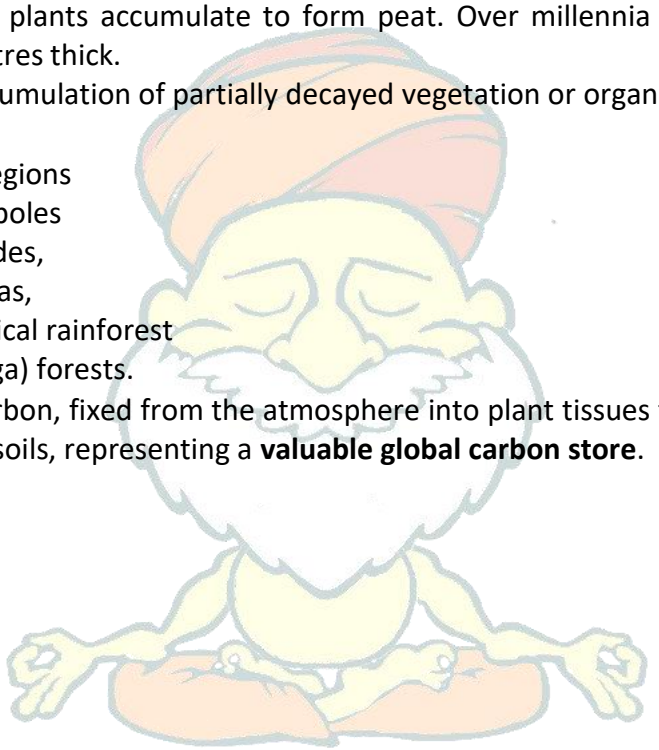
About Silver Antimony Telluride:

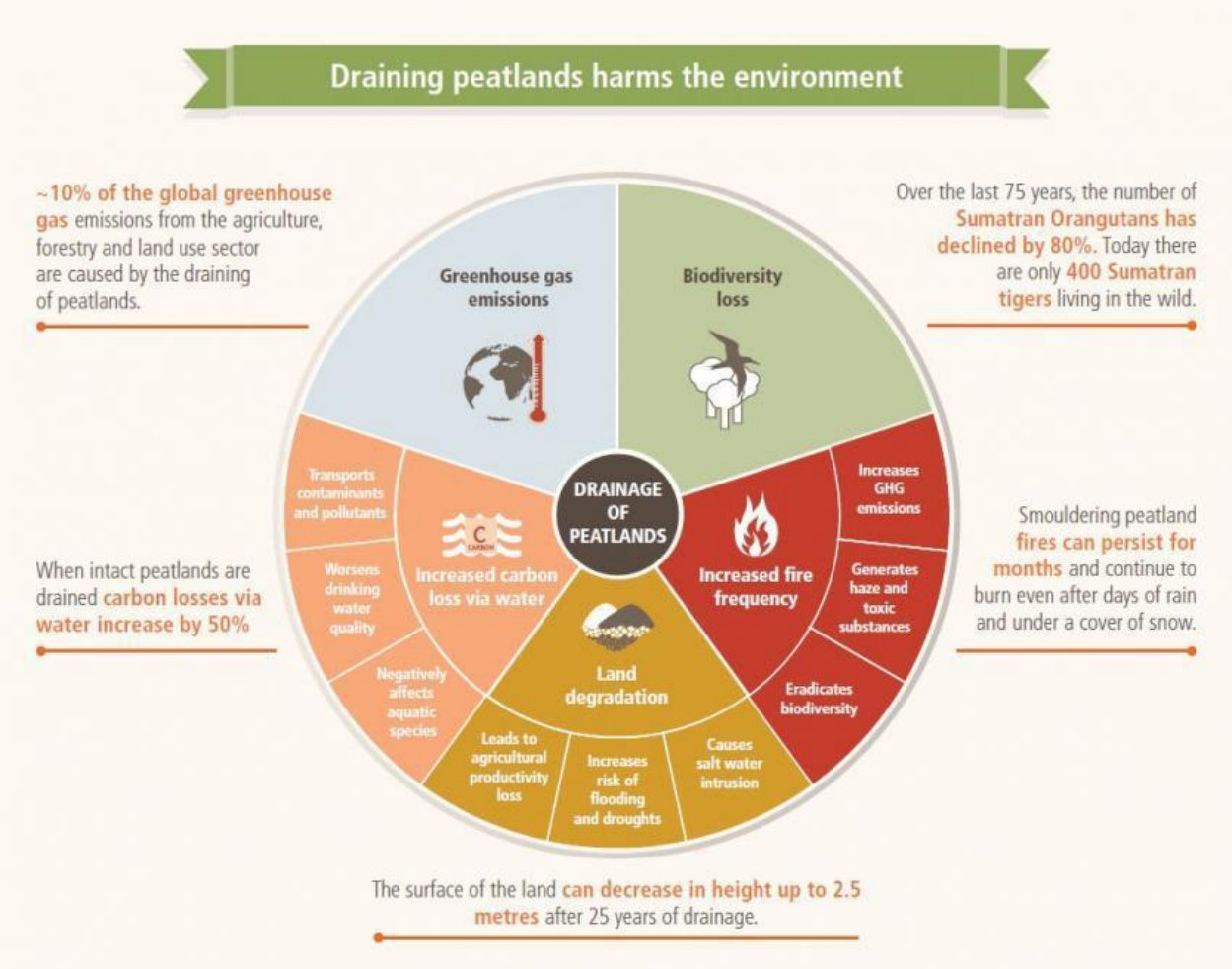
- It is a nanomaterial compound synthesised from Silver, Antimony and Tellurium.
- A crystalline solid, it has free electrons that help in conduction of electricity but its lattices (arrangement of atoms) are rather inflexible, and vibrate quite slowly thereby inhibiting the propagation of heat.

- The material has been found to have an efficiency of 14 per cent, though a prototype device has so far been able to achieve 10 per cent efficiency
- Tata Steel has already shown interest in the material and is collaborating with scientiests to develop this material for deployment in its steel manufacturing units where a huge amount of waste heat is generated.
- There is also a possibility of tapping the heat from traditional cooking chulhas to run some electrical appliances in rural households

246. Peatlands

- Peatlands are a type of wetlands that occur in almost every country on Earth, currently covering 3% of the global land surface.
- The term 'peatland' refers to the peat soil and the wetland habitat growing on its surface.
- In these areas, year-round waterlogged conditions slow the process of plant decomposition to such an extent that dead plants accumulate to form peat. Over millennia this material builds up and becomes several metres thick.
    - Peat is an accumulation of partially decayed vegetation or organic matter
- **They are found in**
    - Permafrost regions
    - Towards the poles
    - At high altitudes,
    - In coastal areas,
    - Beneath tropical rainforest
    - In boreal (taiga) forests.
- Large amounts of carbon, fixed from the atmosphere into plant tissues through photosynthesis, are locked away in peat soils, representing a **valuable global carbon store**.





Importance of Peatlands

- **Damaged peatlands** contribute about 10% of greenhouse gas emissions from the land use sector.
  - CO_2 emissions from drained peatlands are estimated at 1.3 gigatonnes of CO_2 annually. This is equivalent to 5.6% of global anthropogenic CO_2 emissions.
  - Fires in Indonesian peat swamp forests in 2015, for example, emitted nearly 16 million tonnes of CO_2 a day. This is more than the daily emissions from the entire US economy.
- Peatlands are the largest **natural terrestrial carbon store**.
  - Worldwide, the remaining area of near natural peatland (>3 million km^2) contains more than 550 gigatonnes of carbon, representing 42% of all soil carbon and exceeds the carbon stored in all other vegetation types, including the world's forests.
  - This area sequesters 0.37 gigatonnes of CO_2 a year.
- By regulating water flows, they help **minimise the risk of flooding** and drought and prevent seawater intrusion.
- In many parts of the world, peatlands **supply food**, fibre and other local products that sustain local economies.
- They also preserve important ecological and **archaeological information** such as pollen records and human artefacts.
- They also act as Natural firebreaks between sections of forest
- Damage to peatlands also results in **biodiversity** loss.

  - For example, the decline of the Bornean Orangutan population by 60% within a sixty-year period is largely attributed to the loss of its peat swamp habitat. The species is now listed as Critically Endangered on The IUCN Red List of Threatened Species
- A **lack of awareness** of the benefits of peatlands means that they have been severely overexploited and damaged as a result of actions including drainage, agricultural conversion, burning and mining for fuel, among others.

247. Nano Urea Liquid: IFFCO

In News: Recently, the Indian Farmers Fertiliser Cooperative Limited (IFFCO) introduced the world's first Nano Urea Liquid for farmers across the world.

About

- It has been indigenously developed at Nano Biotechnology Research Centre, Kalol, Gujrat in line with Atmanirbhar Bharat and Atmanirbhar Krishi.
- It is a nutrient (liquid) to provide nitrogen to plants as an alternative to the conventional urea.
- It is developed to replace conventional urea and it can curtail the requirement of the same by at least 50%.
- Conventional urea is effective 30-40% in delivering nitrogen to plants, while the effectiveness of the Nano Urea Liquid is over 80%.
- It will boost a balanced nutrition program by reducing the excess use of Urea application in the soil and will make the crops stronger, healthier and protect them from lodging effect.
  - Lodging is the bending over of the stems near ground level of grain crops, which makes them very difficult to harvest, and can dramatically reduce yield.
- An average 8% increase in yield has been witnessed.
- It will also have a huge positive impact on the quality of underground water.
- It is easy on the pocket of farmers and will be effective in **increasing farmers' income.** It will also significantly **bring down the cost of logistics and warehousing.**

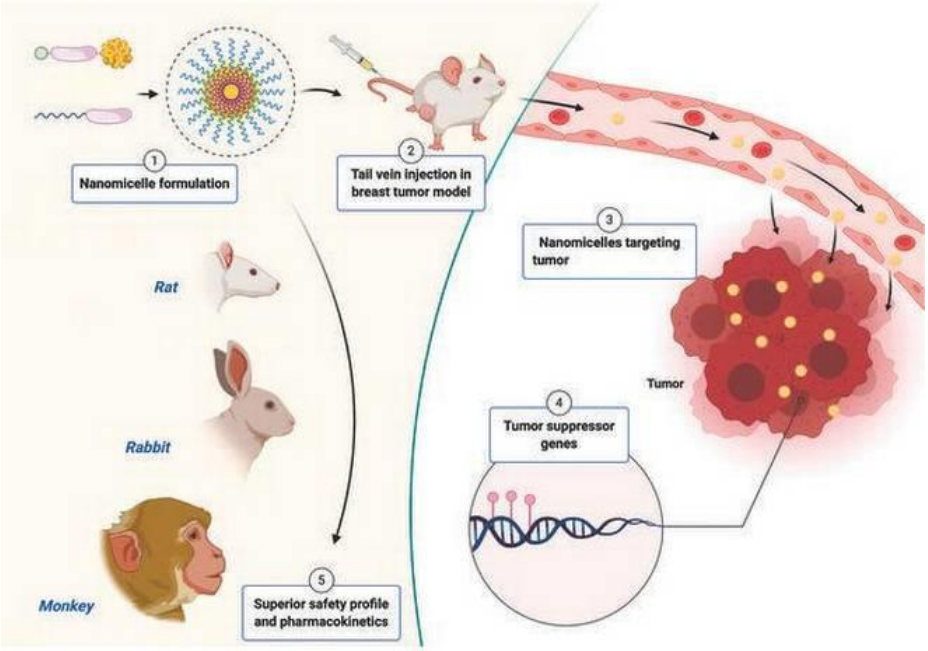
Indian Farmers Fertiliser Cooperative Limited (IFFCO)

- It is one of India's biggest cooperative societies which is wholly owned by Indian Cooperatives.
- Founded in 1967 with just 57 cooperatives, today it is an amalgamation of over 36,000 Indian Cooperatives with diversified business interests ranging from General Insurance to Rural Telecom apart from its core business of manufacturing and selling fertilisers.
- Objective is to enable Indian farmers to prosper through timely supply of reliable, high quality agricultural inputs and services in an environmentally sustainable manner and to undertake other activities to improve their welfare

248. Nano micelles

In News: A team of scientists has created a nano micelle that can be used for effective drug delivery to treat various cancers including breast, colon and lung cancer.

- Nanotechnology involves the manipulation of matter on atomic, molecular, and supramolecular scales. This includes particles of a scale of 1 to 100 nanometers.



About

- Nanomicelles are globe-like structures with a hydrophilic outer shell and a hydrophobic interior. This dual property makes them a perfect carrier for delivering drug molecules.
    - The **hydrophilic shell** makes the **micelle water soluble** that allows for intravenous delivery while the hydrophobic core carries a payload of drug for therapy
- Different agents are used to create nanomicelles, however, they are usually made through surfactant molecules that may be **non-ionic, ionic, and cationic detergents.** Some nanomicelles may also be developed from a mixture of **lipids and detergents.**

How it nanomicelles useful in Cancer Therapy?

- Scientists have created a nanomicelle that can be used to deliver a drug named docetaxel, which is commonly used to treat various cancers including breast, colon and lung cancer
- The ideal goal for cancer therapy is destroying the cancer cells without harming healthy cells of the body, and chemotherapeutics approved for treatment of cancer are highly toxic.
- The currently used docetaxel is a highly hydrophobic drug, and is dissolved in a chemical mixture. This aggravates its toxic effects on liver, blood cells, and lungs.
- So, there was an urgent and unmet need to develop effective drug delivery vehicles for docetaxel without these side effect
- The nanomicelles developed are less than 100nm in size and are stable at room temperature.

- Once injected intravenously these nanomicelles can easily escape the circulation and enter the solid tumours where the blood vessels are found to be leaky. These leaky blood vessels are **absent in the healthy organs**, thus minimising side effects.
- Once nanomicelles enters the cancer cells, the enzymes will cleave the bond to activate the drug, and kill the cancer cells.

249. Nanobodies

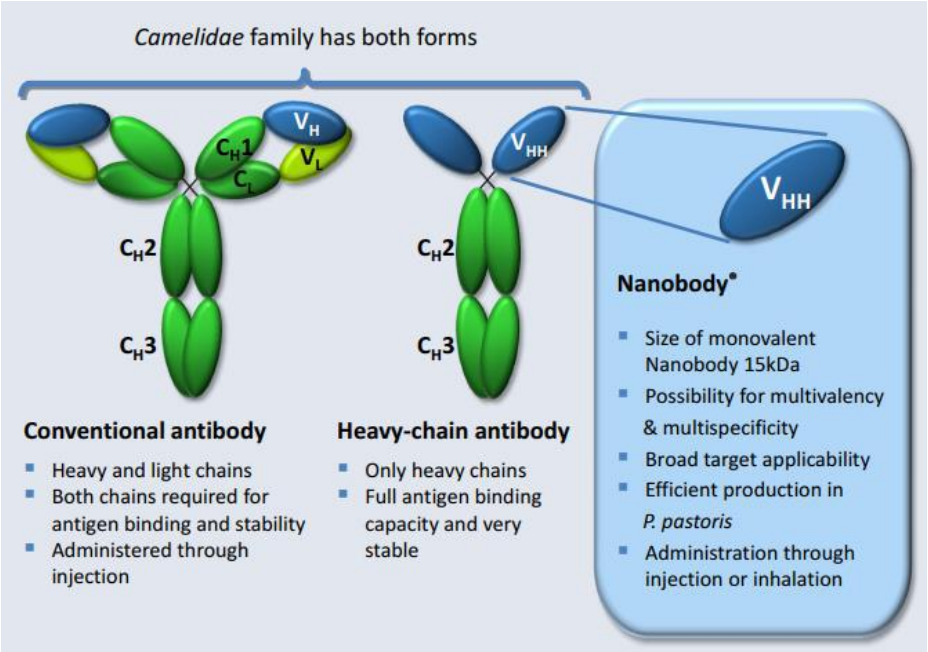
In News: An international research team led by the University of Bonn (Germany) has identified and further developed novel antibody fragments (nanobodies) against SARS-CoV-2, the virus that causes Covid-19.

Antibodies:

- Antibodies are an important weapon in the immune system's defense against infections.
- They bind to the surface structures of bacteria or viruses and prevent their replication.
- One strategy in the fight against disease is therefore to produce effective antibodies in large quantities and inject them into patients.
- However, producing antibodies is difficult and time-consuming

Nanobodies

- Nanobodies are derived from a special type of antibodies naturally produced by the immune systems of camelids, i.e. camels, llamas, and alpacas.
- Most antibodies are made from 4 proteins bound together: two heavy chains and two light chains.
- Camelids make special antibodies that are made from just 2 proteins: 2 heavy chains.
- Nanobodies are created in the laboratory by isolating just the tips of the heavy chains, where the binding occurs. On average, these nanobody proteins are about a tenth the weight of a typical human antibody.
- These nanobodies have a **hydrophilic** (having a tendency to dissolve in a water) side.
    - Hydrophilic side means they do not have issues with solubility and aggregation otherwise associated with conventional antibodies.
- Nanobody production follows many of the same protocols as used in traditional antibody production. However, it also has distinct advantages not available with traditional antibodies, such as **improved screening, improved isolation techniques, and no animal sacrifice.**



Advantages of Nanobodies

- One advantage of nanobodies is their small size, which enables them to penetrate tissues and recognize epitopes (the region of an antigen to which an antibody binds) that are normally inaccessible to conventional antibodies.
- Nanobodies are more stable, less expensive to produce, and easier to engineer than typical antibodies
- Nanobodies can be aerosolized and inhaled to coat the lungs and airways. This does not usually work well for typical antibodies.
- Nanobodies are also compatible with genetic engineering methods, which allow alteration of amino acids to improve binding.

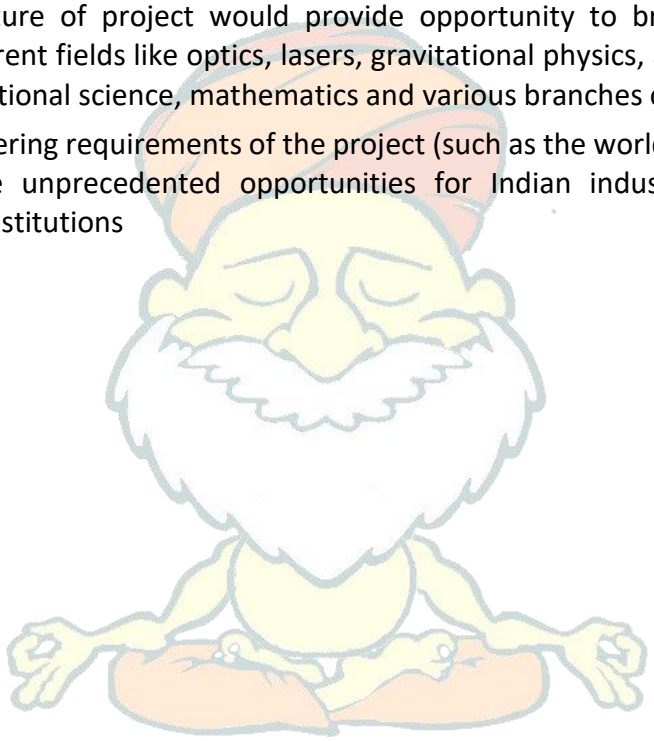
250. Gravitational Waves

- Gravitational waves are distortions or 'ripples' in the fabric of space-time caused by some of the most violent and energetic processes in the Universe.
- They transport energy as gravitational radiation and pass through matter without interacting with it.
- Gravitational waves were first predicted in 1916 by Albert Einstein on the basis of his Theory of General Relativity.
- Strongest sources of gravitational waves are among enigmatic objects in our universe like black holes, supernova, neutron stars and Big Bang
    - **Black Holes**- A black hole is a place in space where gravity pulls so much that even light can not get out. The gravity is so strong because matter has been squeezed into a tiny space. This can happen when a star is dying.
    - **Supernova-** A supernova is the explosion of a star. It is the largest explosion that takes place in space. A supernova happens where there is a change in the core, or center, of a star.

- **Neutron stars** are ancient remnants of stars that have reached the end of their evolutionary journey through space and time.

Laser Interferometer Gravitational Wave Observatory (LIGO) project.

- The project involves constructing a network of L-shaped arms, each four kilometres long, which can detect even the faintest ripples from cosmic explosions millions of light years away.
- LIGO India is a planned advanced gravitational-wave observatory to be located in Maharashtra, India as part of the worldwide network.
- The LIGO project operates three gravitational-wave (GW) detectors. Two are at Hanford in the State of Washington, north-western USA, and one is at Livingston in Louisiana, south-eastern USA.
- Information extracted by these transmitted waves will help to address unsolved questions and mysteries of physics and astronomy.
- Multidisciplinary nature of project would provide opportunity to bring together scientists and engineers from different fields like optics, lasers, gravitational physics, astronomy and astrophysics, cosmology, computational science, mathematics and various branches of engineering.
- The high-end engineering requirements of the project (such as the world's largest ultra-high vacuum facility) will provide unprecedented opportunities for Indian industries in collaboration with academic research institutions



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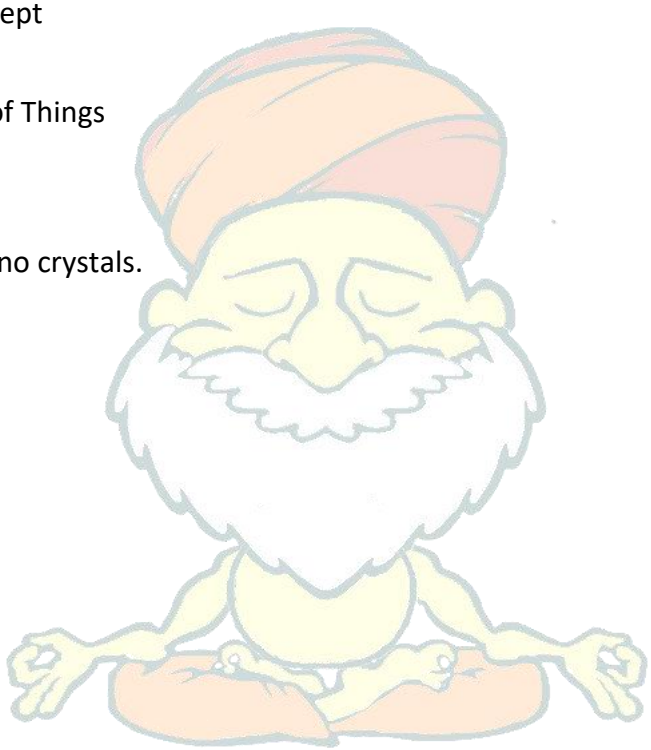
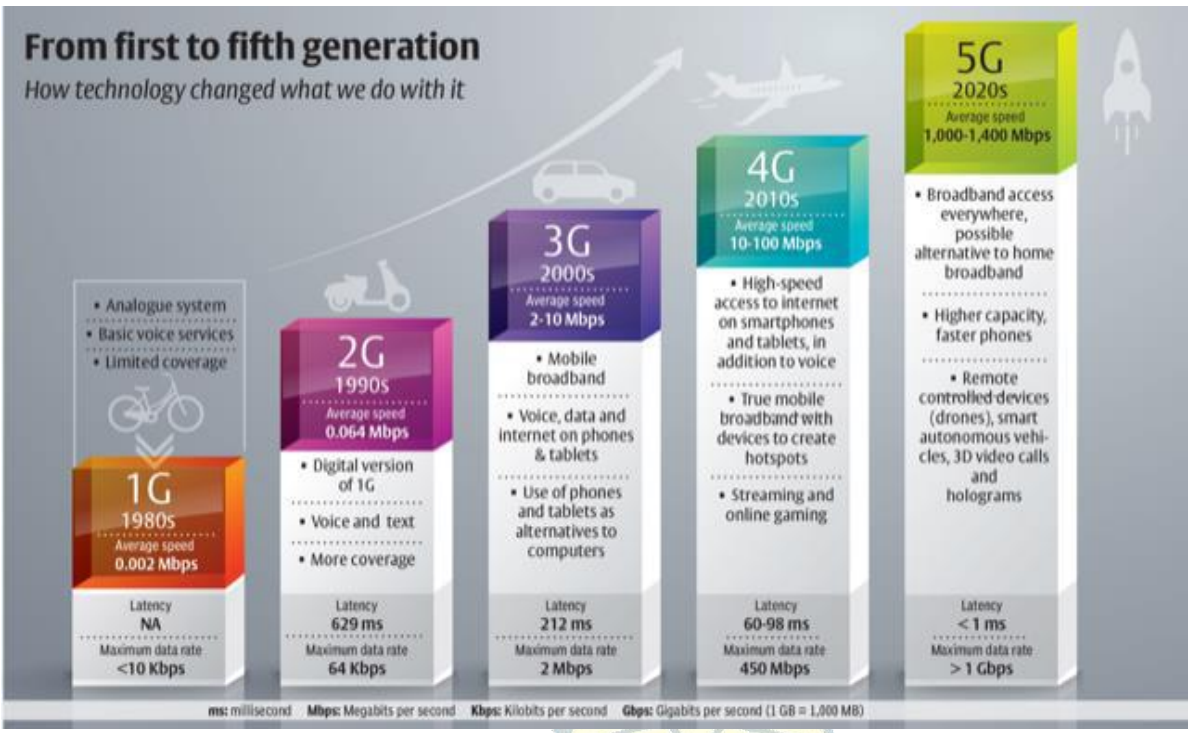


291. 5G

In News: Chinese telecom vendors **Huawei and ZTE** have not found a place in governments 5G trials.



About 5G

- 5G, fifth generation cellular technology, is the latest upgrade in the long-term evolution (LTE) mobile broadband networks.
- **Speed**: In the high-band spectrum of 5G, internet speeds have been tested to be as high as **20 Gbps** (gigabits per second) as compared to the maximum internet data speed in 4G recorded at 1 Gbps.
- 5G also reduces the **latency** i.e. the time taken by a network to respond. The latency in 4G networks is about 50ms, but in 5G networks, it is virtually zero or about 1ms only**.**
- It also increases **energy efficiency** (consumption of power is less than that of 4G) and offers more **stable** network connections.
- 5G will have a wider area in the **frequency spectrum** (range of frequencies) that will ensure no network congestion. 5G mainly works in 3 bands, namely low, mid and high-frequency spectrum — all of which have their uses and limitations.
    - While **the low band spectrum** has shown great promise in terms of coverage but the maximum speed is limited to 100 Mbps.
    - **The mid-band spectrum**, on the other hand, offers higher speeds compared to the low band, but has limitations in terms of coverage area and penetration of signals. This band may be used by industries and specialised factory units for building captive networks.
    - **The high-band spectrum offers** the highest speed of all the three bands, but has extremely limited coverage and signal penetration strength. Internet speeds in the high-band spectrum of 5G has been tested to be as high as 20 Gbps (giga bits per second), while, in most cases, the maximum internet data speed in 4G has been recorded at 1 Gbps.

- 5G is capable of **Machine to Machine communication** that is needed by the IOT applications and others.
- 5G can take benefit of cloud-based or virtual **Radio Access Network (RAN),** while 4G technologies are not capable of working with RAN.
- 5G can identify the fixed devices and mobile devices. It identifies each device with the help of **cognitive radio techniques** and hence provides the **most suitable delivery channel.**
- 5G will help facilitate the ecosystem for the **Internet of Things (IoT)** and to incorporate **Artificial Intelligence (AI)** in our daily lives and
- To get the benefits of 5G, users will have to buy new phones, while carriers will need to install new transmission equipment to offer the faster service.

292. Air Fiber

In News: In Aug 2020, Bharat Air Fibre Services, by BSNL, have been inaugurated at Akola in Maharashtra providing the residents wireless internet connections on demand

About Air Fibre

- It provides wireless broadband connectivity up to a range of 20 km from the BSNL points of presence (Towers).
    - Typical broadband connectivity involves laying optical fibre to your building.
- A vast network of Optical Fibre has been laid by BSNL up to nearest Telephone Exchange or Mobile Tower and from there the **connectivity is provided to subscribers over wireless**.
- It uses **unlicensed spectrum** (which are not been licensed to any entity) that has less interference and line-of-sight **radio waves** to deploy the service
    - Radio waves have the longest wavelengths in the electromagnetic spectrum with wavelengths ranging from approximately 1mm to several hundred meters.
- BSNL is providing **unlimited free voice calling** and connectivity speed is 100 Mbps through this Air Fibre services
- The service is becoming popular due to Work from Home (WFH), e-learning, online shopping, gaming and entertainment, etc. amidst lockdowns.

Benefits

- This technology helps bridge the gap of last-mile connectivity in rural areas as private service providers might find it unprofitable to lay cables to each building in rural areas.
- BSNL can effectively tap into its existing network in rural areas and thus revive its business revenues amidst intense competition from private players.
- Also in rural places, there is less usage of WiFi routers and appliance-like microwave ovens thus there is very **less interference in these airwaves.**
- BSNL is tying up with local entrepreneurs/unemployed youth on revenue sharing basis thereby **generating employment** in rural areas
- This service could be a game-changer for rural areas as with a little integration of **Internet of Things (IoT**) and sensors, the moisture content of soil can be known on a real-time basis, so that irrigation can be planned, resulting in saving of water and thereby increasing productivity.

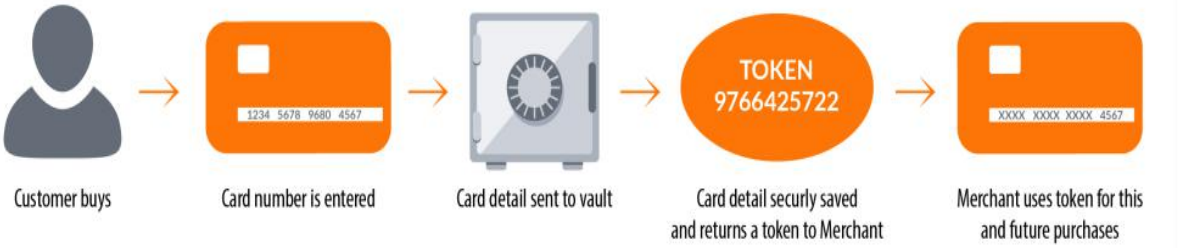
- Sensors can be tied to the neck of dairy cattle, enabling continuous recording of body temperature so as to know the exact time when milk output is best.

293. Card Tokenization

In News: RBI has allowed **tokenization of debit, credit and prepaid card transactions** to enhance the safety of the digital payments ecosystem in the country

What is Tokenization?

- Tokenization will replace card details with a code, called a "token," which will be specifically for the card, the token requestor and the device being used to pay.
- Instead of the card's details, the token is used to perform transactions in contactless mode at point of sale(POS) terminals, quick response(QR) code payments.
- The goal of the process is to improve the safety and security of payments.
- With tokenisation in place, digital payments are likely to grow by 20-25 per cent It is considered a global best practice.



Example:

- If you have to make payments on an online shopping portal, you have to enter the 16-digit card number. For instance: 1234 5678 9012 3456
- As soon as you enter your card number a token number will be created for your card number. For instance: A$VF6748#&1##+7.
- The merchant system stores only a token number, not your card number.
- This token will be sent to the Payment Processor of card networks and it is the only readable link in the whole system.
- Once it is sent to the Payment Processor, it will be de-tokenized and the payment will be made to the merchant.
- These tokens have high-security features. Once the token is issued, nobody can reverse the token to find the original card number other than the cardholder himself.

RBI guidelines

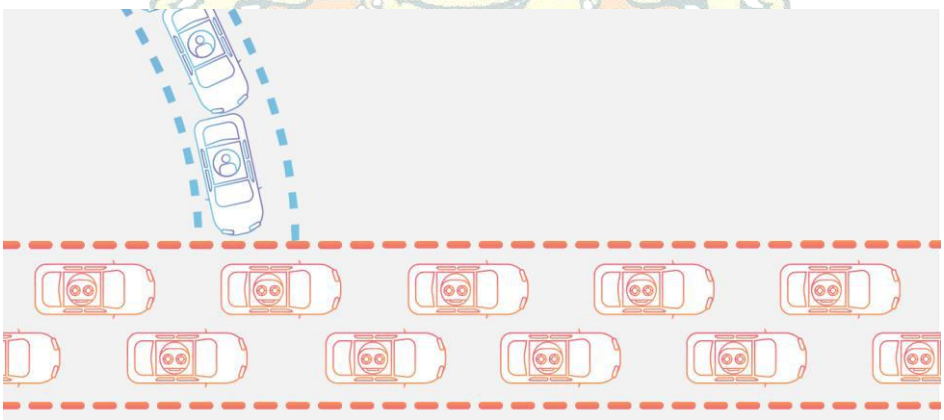
- **No charges should be recovered from the customer** for availing this service.

- The RBI has allowed card payment networks to offer card tokenization services to any token requestor, that is, a third-party app provider. It extends to all use cases/channels [e.g., Near-Field Communication (NFC) / Magnetic Secure Transmission (MST)-based contact-less transactions, in-app payments, QR code-based payments etc.] or token storage mechanisms (cloud, secure element, trusted execution environment etc.).
- All parties involved in the "payment transaction chain**" will have to be registered with the central bank.**
- A cardholder can avail of these services by registering the card on the token requestor's app and after giving 'explicit consent'.

294. DDOS Attack & ShadowPad

Distributed denial-of-service (DDoS) attack

- It is a malicious attempt to disrupt the normal traffic of a targeted server, service or network by overwhelming the target with a flood of Internet traffic
- DDoS attacks achieve effectiveness by utilizing multiple compromised computer systems as sources of attack traffic.
    - Exploited machines can include computers and other networked resources such as IoT devices.
- The goal of these attacks is to exhaust the target's resources to create a denial-of-service.
- From a high level, a DDoS attack is like an **unexpected traffic jam** clogging up the highway, preventing regular traffic from arriving at its destination.
- In a DDoS attack, the traffic can come from **hundreds or thousands of sources**, which makes it near-impossible to stop the attack simply by blocking a single IP address.
- Sites also **struggle to differentiate between a legitimate user and attack traffic.**
- The most obvious symptom of a DDoS attack is a site or service suddenly becoming slow or unavailable. But since a number of causes — such a legitimate spike in traffic — can create similar performance issues, further investigation is usually required.
- A DDoS attack differs from a **Denial of Service (DoS) attack, which typically uses a single computer** and connection to flood a system or site.



Shadowpad

- There has been a steep rise in the use of resources like **malware** by a Chinese group called **Red Echo** to target "a large swathe" of India's power sector.

- Red Echo used malware called **ShadowPad,** which involves the use of a backdoor to access servers.

What is it:

- ShadowPad is a backdoor **Trojan malware**, it opens a secret path from its target system to its command-and-control servers.
- Information can be **extracted or more malicious code delivered** via this path.
- ShadowPad was discovered in 2017. The malware had been injected into software updates provided by a legitimate software provider, NetSarang, that is headquartered in the US and South Korea.
- The ShadowPad malware steals data from a 'victim' computer and is able to automatically communicate with the computer servers at the hacker's end. Once every eight hours, ShadowPad sends back information like user name, domain name, host name to the hacker's computer system.
- When an "interesting" target is found, the hacker's computer server can seek more information from the victim system via the malware and even deploy more malicious code.
- Presently, we are aware of at least 5 Chinese threat activity groups using ShadowPad, including APT41, Tonto Team, groups using the Icefog malware, KeyBoy, and Tick

295. Wireless Charging Concept

What is Wireless Charging?

- Basically remote charging (a.k.a wireless power exchange or induction charging) **utilizes electromagnetic fields** to securely transfer power from a transmitting source to the gadget for remotely charging (or reviving) the battery.
- As the name recommends, it does as such **without the utilization of a physical wire**.
- Wireless charging works on the principle of electromagnetic induction.
    - Coils of wire in the base station (the charging plate) create an oscillating magnetic field as the current passes through.
    - This field can induce an **electrical current in an adjacent coil of wire** (that is inside the gadget) without actually touching it.
    - The generated current is used to charge batteries of gadgets.
    - Physics Principle used in this technology is: **A time-varying magnetic field induces a current in a closed loop of wire.**
    - Coil size also affects the distance of power transfer. The bigger the coil, or the more coils there are, the greater the distance a charge can travel.
        - In the case of smartphone wireless charging pads, for example, the copper coils are only a few inches in diameter, severely limiting the distance over which power can travel efficiently

Radio Frequency Wireless Charging

- RF wireless charging is a type of uncoupled wireless charging in which an antenna embedded in an electronic device can pick up low level radio frequency waves from external sources and convert the waves' energy to direct current (DC) voltage.

- The voltage the antenna harvests over the air is then used to power an electronic device or recharge its batteries**.**

Did You Know?

- The concept of wireless power transmission was originally proposed by Nikola Tesla, a Serbian-American electrical engineer.
- Tesla envisioned a world in which towers scattered across the globe used electromagnetism to transmit electricity and information wirelessly.

Body Coupled Powering

- Researchers from National University of Singapore have come up with a way to use one single device - such as a mobile phone or smart watch - to wirelessly power up to 10 wearables on a user.
- This novel method uses the human body as a medium for transmitting power.
- Here we can use one single device - such as a mobile phone or smart watch - to wirelessly power up to **10 wearables on a user.**
- **Body-coupled powering** - the human body is able to harvest the electromagnetic energy emitted from various gadgets like **laptop** to power the wearable devices, regardless of their locations around the body.

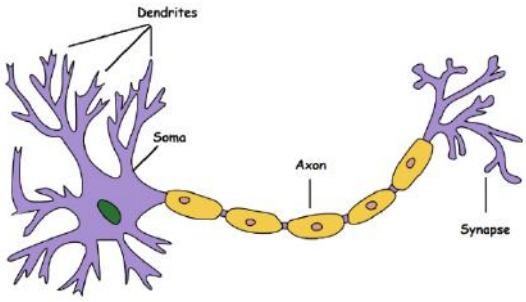
296. Artificial neurons

In News: Researchers from University of Zurich have developed a compact, energy-efficient device made from artificial neurons that is capable of decoding brainwaves.

- The chip uses data recorded from the brainwaves of epilepsy patients to identify which regions of the brain cause epileptic seizures.

Biological Neuron

- **Dendrite**: Receives signals from other neurons
- **Soma**: Processes the information
- **Axon**: Transmits the output of this neuron
- **Synapse**: Point of connection to other neurons



What are artificial neurons?

- Artificial Neurons has multiple inputs and one output. This is analogous to the axon of the biological neuron.
- The output can be both the **last in the network architecture and the input of the next neuron.**
- In conventional electronic systems, transistors process information at regular intervals and in precise amounts — either 1 or 0 bits.
- But neuromorphic devices can accumulate small amounts of information from multiple sources, alter it to produce a different type of signal and fire a burst of electricity only when needed — just as biological neurons do.

297. Narrow Band Internet of Things

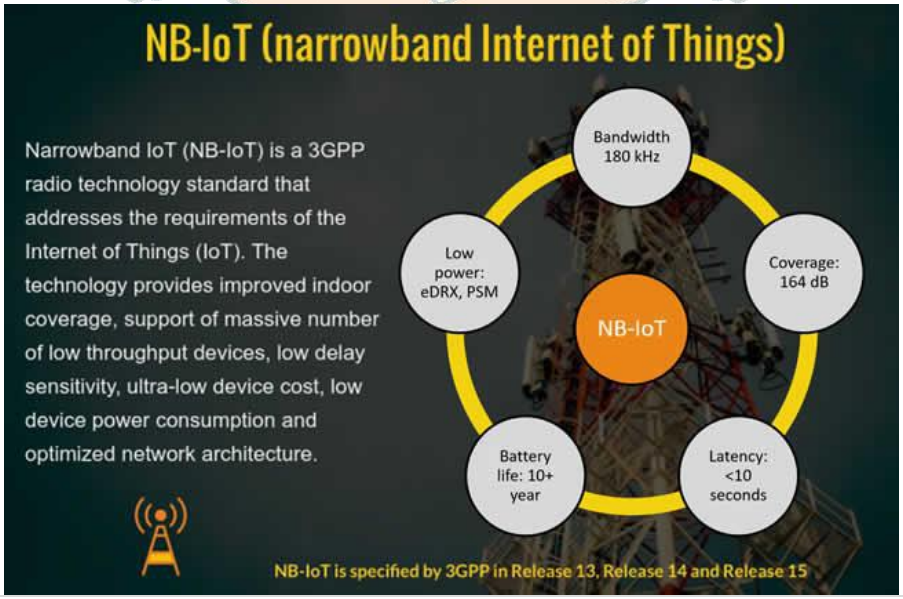
In News: On December 10, 2020, BSNL in partnership with the Skylo announced the world's first satellite based Narrow Band Internet of Things network in India

What is Narrow Band Internet of Things (NB-IoT)?

- It is a **wireless communication standard** designed for Internet of Things (IoT) devices.
  - IoT describes the network of physical objects—"things"—that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the Internet
- It belongs to a category of Low Power Wide Area (LPWA) that enables devices to connect devices that need small amount of data, low bandwidth and long battery life.
- NB-IoT uses a subset of the LTE standard, but limits the bandwidth to a single narrow-band of 200kHz.
- IoT applications which require more frequent communications will be better served by NB-IoT, which has no duty cycle limitations operating on the licensed spectrum.
- NB-IoT focuses specifically on indoor coverage, low cost, long battery life, and high connection density.
- Since it operates in licensed spectrum, it is secure and reliable providing guaranteed quality of service.
- It connects devices more simply and efficiently on already established mobile networks.

GPRS and GSM

- GPRS is General Packet Radio Service. GSM is Global System for Mobile communication.
- The GSM was developed to describe the protocols of 2G digital cellular networks. It was first implemented in Finland in 1991. In 2010s, it became a global standard for mobile communications achieving more than 90% market share.
- The GPRS is mobile data standard launched for 2G and 3G cellular networks. Both GSM and GPRS were established by European Telecommunications Standards Institute.
- The NB-IoT can coexist with 2G, 3G and 4G mobile networks



298. Dark Net

In News: Recently, records of 20 million Bigbasket users were made available on the dark net

What is Dark Net?

- Also known as Dark Web, it is that **part of the Internet which is neither accessible through traditional search engines** like Google nor is it accessible by normal browsers like Chrome or Safari.
- It **generally uses non-standard communication protocols** which make it inaccessible to internet service providers (ISPs) or government authorities.
- **The content on Dark Net is encrypted and requires specific browser such as TOR** (The Onion Ring) browser to access those pages.
- **Dark Net itself is only a part of the Deep Web** that is a broader concept, which includes sites that are protected by passwords.
    - **For e.g.**- A person's bank statements which are available online but will not be pulled up in generalised Internet searches. Only difference is that while the **Deep Web is accessible, the Dark Net is deliberately hidden.**
- The **part of internet that is readily available to general public** and searchable on standard search engines **is called as Surface Web.**
- Dark net is generally used by law enforcement agencies, journalists and citizen- activists working in oppressive regimes (to communicate without any government vigilance), researchers and students to do research on sensitive topics, etc.
- However, there are concerns with Dark Net being misused like- haven for illicit activity, privacy and ethical concerns, use of crypto currencies, drug dealing, arms trafficking, communication by terrorists etc

299. Deep Learning

In News: Deep machine learning system completes inferring information about the bioactivity of **one million molecules.**

About Deep Learning

- Machine learning is a part of artificial intelligence that enables machines to **learn from past data** and perform a given task.
- **Deep Learning is the subset of machine learning** – also called Deep Neural Learning.
- It is inspired by the functionality of **human brain cells**, which are called neurons, and leads to the concept of artificial neural networks.
    - Deep learning mimics the workings of the human brain in processing data for use in detecting objects, recognizing speech, translating languages, and making decisions.
- In deep learning, models **use different layers to learn** and discover insights from the data.
- Deep learning AI is able to learn without human supervision, drawing from data that is both unstructured and unlabeled.
- **Some applications** of deep learning are self-driving cars, language translation, natural language processing, etc.

300. Thermal imaging via nano crystals.

In News: Scientists have developed technology that is able to transform infrared light, normally invisible to the human eye, and turn this into images people can clearly see -- even at distance.

- They have developed a very thin film, consisting of nanometre-scale crystals, hundreds of times thinner than a human hair, that can be directly applied to glasses and acts as a filter, allowing you to see in the darkness of the night
- The technology is extremely **lightweight, cheap and easy to mass produce.**
- Currently, high-end infrared imaging tech requires **cryogenic freezing** to work and are costly to produce.
- This new tech works at room temperatures.
- **Uses:** In defense, safe drives at night, walking home after dark

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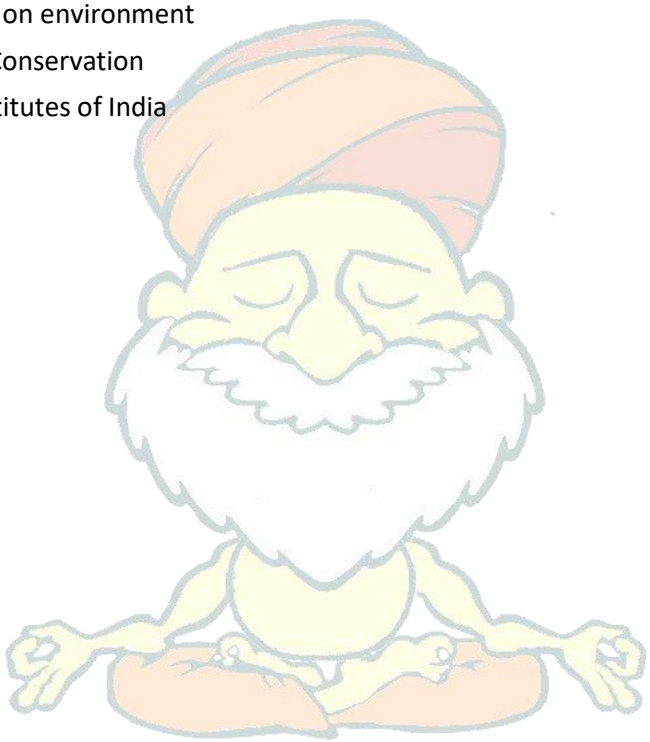


341. Darwin's Nightmare

Context: Lake Victoria had come under the spotlight in 2004 by the documentary 'Darwin's nightmare'.

- Located in East Africa, just south of the Equator, Lake Victoria is the source of the Nile and is the largest tropical lake in the world
- With a surface area of 68,800 km² (twice the size of Belgium), it is considered to be one of the largest water and fishery resources in East Africa.
- It water supports more than 47 million people in the three neighbor countries (Uganda, Tanzania and Kenya).

Issue highlighted in Darwin's Nightmare Documentary

- Darwin's Nightmare, focused on the environmental and social effects of the **Nile perch fishing industry.**
- Nile perch is the largest freshwater fish and voracious predator that can grow up to two metres long and weigh 200kg,
- Its introduction into Lake Victoria in the 1950s and its population explosion in the 1960s gradually **wiped out the native fish species** living in the lake, causing a major ecological disaster.
- Today, the Nile perch population remains ubiquitous but has declined slightly due to overfishing, allowing some species to partially recover.

Issue of Eutrophication

- The general water quality of lake also declined sharply between the 1960s and the 1990s due to **eutrophication**, which is caused by increased **inputs of nutrients** (nitrogen and phosphorus) into the water bodies as a result of **increased human activities** in the catchment area (intensive agriculture with fertilisers or domestic wastewater)
- This eutrophication leads to a **significant development of micro-algae** (phytoplankton).
- The excess phytoplankton biomass (the organic matter from these algae) cannot generally be transformed by the rest of the food web.
- This excess remains unused and stagnant at the bottom of the lakes, creating a **phenomenon of anoxia,** the absence of oxygen in the bottom waters of the lakes. This leads to the degradation of the ecosystem.

Recent research shows improvement in water quality in Lake Victoria

- New Study shows that the phytoplankton biomass has decreased by about seven times compared to the 1990s.
- Paradoxically, the quantity of nutrients remained comparable to that of the 1990s.
- This paradox can be explained,
    - In addition to nutrients, phytoplankton (like all plants) also need light to grow.
    - In lakes, the amount of light for phytoplankton obviously **depends on the solar radiation at the surface** of the lake, but also on the depth of the water on which the phytoplankton cells reside.
    - This depth, known as the mixing layer, depends mainly on the **intensity of the wind.**
    - If the wind is intense, the depth of the mixing layer is greater, and the phytoplankton cells spend less time near the surface where the light is more intense, and do not develop as well.
    - Research shows that the current weather conditions are windier than in the 1990s, so the **depth of the mixed layer is greater and phytoplankton growth less** intense than in the 1990s.
    - The weaker winds of the 1990s were related to the prevailing conditions of **El Niño**
- This rather complex story shows that the established climate regime in the Pacific Ocean (El Niño) affects the ecology of a lake in Africa, on the other side of the planet.

- More specifically, it shows that the growth of phytoplankton in large tropical lakes responds to eutrophication in a complex way and is **strongly modulated by climate**.
- Therefore, the current improvement in water quality in Lake Victoria **may only be temporary**, and that conditions could deteriorate again in the future if vertical mixing in the lake decreases due to reduced wind intensity (a new period of prevailing El Niño conditions) or due to continued climate warming.

342. International Treaties in Disaster Management

1989	• International Decade for Natural Disaster Reduction- 1990-99 by UNGA
1994	• First World Conference on Disaster Reduction (1995-2005) • The **Yokohama Strategy** for a Safer World: Prevention, Preparedness and Mitigation and its Plan of Action
1999	• International Strategy for Disaster Reduction (UNISDR) • Launched by UN Economic and Social Council together with the Inter-Agency Task Force on Disaster Reduction (IATF).
2002	• The World Summit on Sustainable Development (WSSD) in Johannesburg • The Johannesburg Plan of Action provided UNISDR and the IATF a set of objectives for integrating risk reduction into development policies.
2005	• Second World Conference on Disaster Reduction • "**Hyogo Framework** for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters"
2007	• First session of the Global Platform on Disaster Reduction • Global Platform on disaster risk reduction set up by UNGA to support Hyogo Framework
2011	• The Istanbul Program of Action (IPoA) • Program of Action for the Least Developed Countries for the Decade 2011-2020
2012	• United Nations Conference on Sustainable Development - Rio+20
2014	• Third International Conference on Small Island Developing States • SIDS Accelerated Modalities Of Action (S.A.M.O.A.) Pathway
2015	• **Sendai Framework** for Disaster Risk Reduction 2015-2030

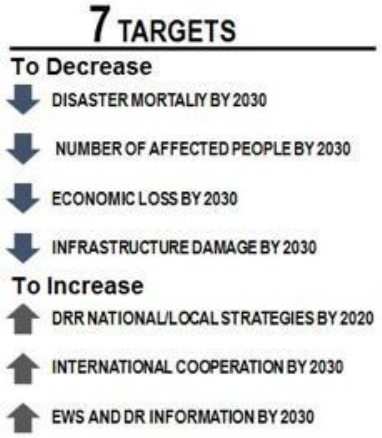
343. Sendai Framework

- Sendai Framework for Disaster Risk Reduction (SFDRR) was approved at the 3rd World Conference on Disaster Risk Reduction in March 2015, held in Sendai, located in Japan.
- It is the successor to the Hyogo Framework (2005-15)
- This **treaty is voluntary** and not binding upon the member states.
- Under the framework, the primary role of the Member States is to reduce the identified disaster risks.
- The framework has a time frame of 15 years, i.e., 2015-2030.

- SFDRR aims at achieving a substantial reduction of disaster risk and disaster losses in lives, livelihoods and health; in the environmental, cultural, social, physical-economic assets of people, communities, businesses
- United Nations International Strategy for Disaster Reduction (**UNISDR**) is tasked with the implementation, follow-up, support and review of the Sendai Framework.
- The framework comprises of a **set of standards** and an all-encompassing framework containing achievable targets
- Sendai framework recognises that the State has the primary role to reduce disaster risk but that responsibility should be shared with other stakeholders including local government, the private sector and other stakeholders
- It highlights the concerns on human health and well-being that are common to disaster risk reduction, climate change and sustainable development.

The Sendai Framework **sets four priorities for action** to be implemented at national & local levels and at global & regional levels-

- Understanding the disaster risk.
- Strengthening the governance of disaster risks for managing disaster risks.
- Investments in disaster risk reduction for resilience
- Improving disaster preparedness to ensure effective response, recovery, reconstruction, and rehabilitation.



Major departures regarding Sendai Framework

- For the first time the goals are defined in terms of **outcome-based targets** instead of focusing on sets of activities and actions.
- It places **governments at the center of disaster risk reduction** with the framework emphasizing the need to strengthen the disaster risk governance.
- There is significant shift from earlier emphasis on disaster management to addressing disaster risk management itself by **focusing on the underlying drivers of risk**.
- It places almost equal importance on **all kinds of disasters** and not only on those arising from natural hazards.
- In addition to **social vulnerability**, it pays considerable attention to **environmental aspects** through a strong recognition that the implementation of integrated environmental and natural resource management approaches is needed for disaster reduction
- Disaster risk reduction, more than before, is seen as a **policy concern that cuts across many sectors**, including health and education.

344. Carbon Credits

- It is a market-oriented mechanism to reduce greenhouse gas emissions
- A carbon credit is a permit that allows the company that holds it to emit a certain amount of carbon dioxide or other greenhouse gases.
- One credit permits the emission of a mass equal to **one ton of carbon dioxide.**
- The carbon credit is one half of a so-called "**cap-and-trade" program**.

- Companies that pollute are awarded credits that allow them to continue to pollute up to a certain limit. That limit is reduced periodically.
- Meanwhile, the company may sell any unneeded credits to another company that needs them.
- Private companies are thus doubly incentivized to reduce greenhouse emissions.
    - First, they will be fined if they exceed the cap.
    - Second, they can make money by saving and reselling some of their emissions allowances.
- The underlying theory is simple. If one party can't stop emitting CO2, it can ask another to emit less so that, even as the first carries on producing CO2, the total amount of carbon in the atmosphere is reduced.
- Companies can meet their climate targets by purchasing credits for their current emissions
- The intention is to reduce the number of credits over time, thus incentivizing companies to find innovative ways to reduce greenhouse gas emissions.

345. UN Organizations related to environment

United Nations Environment Programme (UNEP)

- The rising pollution levels of the 1960s and 1970s prompted the international leadership to think about having laws and regulations in place for environmental concerns, along the likes of the International Labour Organisation (ILO), WHO etc.

- These concerns were addressed at the 1972 United Nations Conference on Human Environment (also known as the **Stockholm Conference).** The Conference led to the adoption of the **Stockholm Declaration (Declaration on the Human Environment).**

- The Conference also resulted in the formation of a management body for these concerns, which was later called the **United Nations Environment Programme**.

- The UNEP is an international environmental authority engaged in establishing a global environmental agenda and promoting the efficient implementation of the environmental dimension of the United Nations Sustainable Development Programme.

- UNEP was established on 5th june 1972 and Headquartered at Nairobi, Kenya.

- The UNEP's stated mission is to offer leadership and promote partnership in caring for the environment through informing, inspiring and enabling countries and peoples to enhance their quality of life without compromising that of future generations.

- The UNEP engages in developing global conventions on the environment and related issues. It hosts the secretariats of various conventions such as:
    - Minamata Convention on Mercury
    - United Nations Convention on Biological Diversity
    - Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
    - Basel Convention- Control of Transboundary Movements of Hazardous Wastes
    - Stockholm Convention - on Persistent Organic Pollutants
    - Rotterdam Convention – on Hazardous Chemicals and Pesticides in International Trade
    - Vienna Convention - Protection of the Ozone Layer
    - Montreal Protocol – on reducing substances that Deplete the Ozone Layer
    - Convention on Migratory Species

- The UNEP's governing body is called the **United Nations Environment Assembly**, which is said to be the world's highest decision making body on the environment.
    - It meets once in two years to establish priorities for international environmental policies and develop international environmental law.
    - Formed in 2012, it is headed by a Bureau and its President.
    - The Bureau comprises ten environment ministers of various countries who all hold two-year terms, based on geographical rotation.
    - Currently, it has 193 member states (all UN member countries).

- UNEP engages with national governments, NGOs, etc. in relation to environmental policy and implementation.

- The UNEP also formulates treaties and guidelines in the domain of international trade in harmful chemicals, international waterways pollution & transboundary pollution of air.

- It also awards and honours individuals as well as institutions that do stellar work in this field.

- Major Reports of UNEP: Emission Gap Report, Global Environment Outlook, Frontiers, Invest into Healthy Planet.

- Major Campaigns: Beat Pollution, UN75, World Environment Day, Wild for Life.

Intergovernmental Panel on Climate Change (IPCC)

- The IPCC is a scientific government body under the United Nations set up at the request of the member governments, dedicated to providing the world with an objective, scientific view of climate change and its political and economic impacts on the nations.
- It was established in 1988 by two UN organizations, the World Meteorological Organization and the UNEP and later endorsed by UN General Assembly.
- Membership of the IPCC is open to all members of the WMO and the UNEP.
- The IPCC produces reports that support the United Nations Framework Convention on climate change, which is the main international treaty on climate change.
    - IPCC reports cover the scientific, technical and socio-economic information relevant to understanding the scientific basis of risk of human-induced climate change, its potential impacts and options for adaptation and mitigation.
- The main objective of UNFCCC is to stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system
- The IPCC has three working groups:
    - Working Group I, dealing with the physical science basis of climate change.
    - Working Group II, dealing with impacts, adaptation and vulnerability.
    - Working Group III, dealing with the mitigation of climate change.

346. International conventions on environment

Year	Convention	Area of Focus
1971	Ramsar Convention	Ramsar Wetlands Montreux record
1973	CITES	Trade in engendered species
1979	Bonn Convention	Conservation of Migratory species
1985	Vienna Convention	Conservation of Ozone Layer
1987	Montreal Protocol	Protocol on the substances that deplete ozone layer.
1989	Basel Convention	Transboundary Movements of **Hazardous Wastes** and their Disposal.
1992	Convention on Biological Diversity	Conservation, sustainable use and sharing of biodiversity.
1998	Rotterdam Convention	Prior Informed Consent for international trade **Hazardous Chemicals and Pesticides.**
2000	Cartagena Protocol on Biosafety	Transport and use of **Living Modified Organisms.**
2001	Stockholm Convention	Persistent Organic Pollutants (DDT, Endrin, Heptachlor, Hepta-Chloro Benzene)
2008	UN-REDD UN-REDD+	Reducing Emissions from Deforestation and Forest Degradation.
2010	Nagoya Protocol	Fair access **to genetic resources**
2013	Minamata Convention	Adverse Effects of **mercury**
2016	Kigali Amendment	An amendment to **Montreal Protocol**

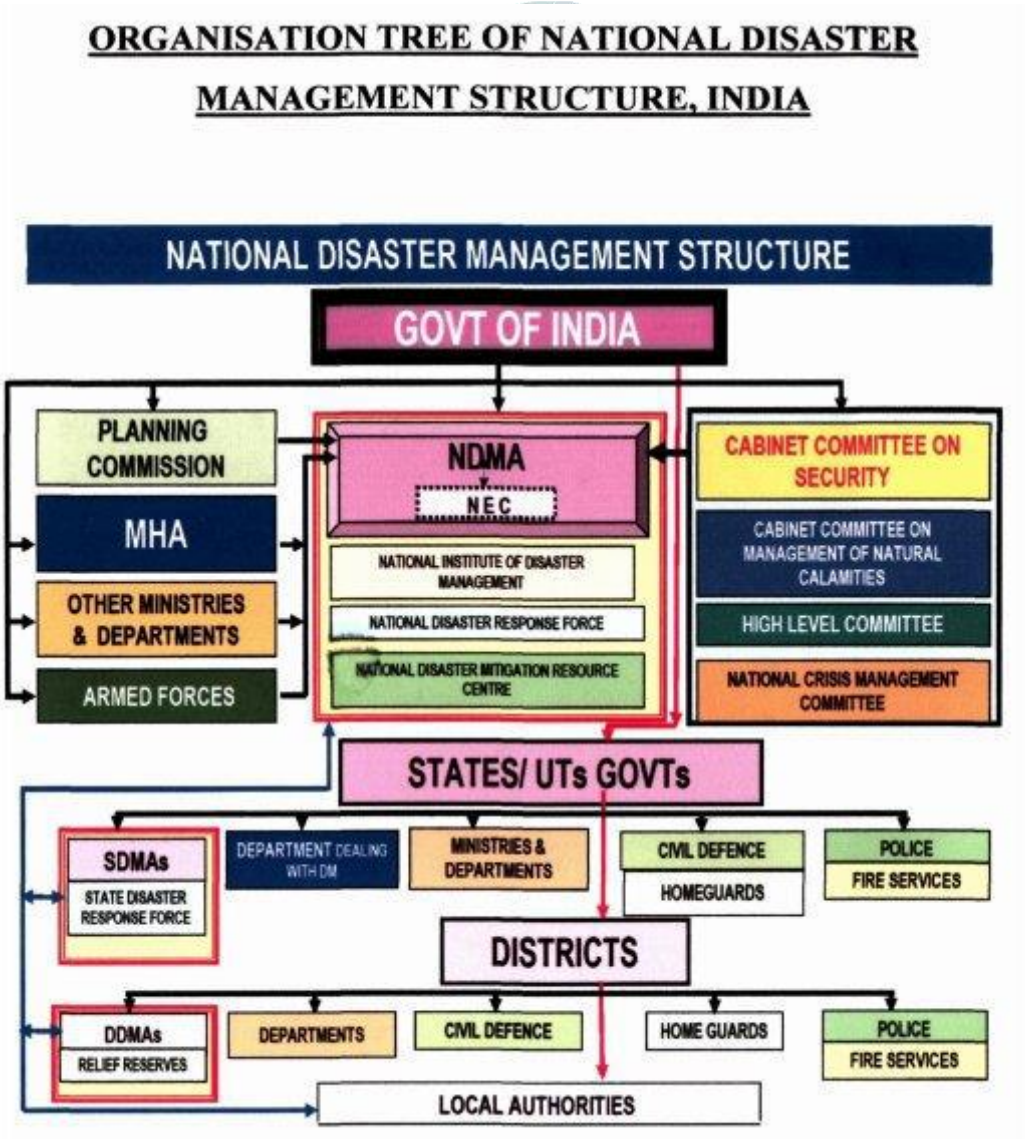
347. NGOs for Environmental Conservation

The International Union for Conservation of Nature (IUCN)	• The world's oldest and largest global environmental organization. • Produces Red list which provides the protection status of fauna & flora
The Global Environment Facility	• Was established as a $1 billion pilot program. • Under the Aegis of World Bank
Global Green Growth Institute	• GGGI was first launched as a think tank. • Later converted into an international treaty-based organization in 2012 at the Rio+20 Summit.
International Whaling Organization	• Set up under the International Convention for the Regulation of Whaling
German Watch	• Caters to environmental relation between industrialized and non industrialized countries. • Releases Global Climate Risk Index and Climate Change Performance Index

World wildlife Fund	• Living Planet index and Living planet report • Earth Hour
Global Footprint Network	• Earth Overshoot Day
World Life Trust of India	• Conservation of wildlife in **6 priority areas:** northeast India, western Himalayas, terai, southern Ghats system, central India and marine.
Bombay Natural History Society	• National Dragon Fly Festival • Asian Water Bird Census

348. Disaster Management Institutes of India

A disaster is defined as a disruption on a massive scale, either natural or man-made, occurring in short or long periods. Disasters can lead to human, material, economic or environmental hardships, which can be beyond the bearable capacity of the affected society.



The Disaster Management Act of 2005 defines Disaster Management as an integrated process of planning, organizing, coordinating and implementing measures which are necessary for-

1. Prevention of threat of any disaster
2. Reduction of risk of any disaster or its consequences
3. Readiness to deal with any disaster
4. Promptness in dealing with a disaster
5. Assessing the severity of the effects of any disaster
6. Rescue and relief
7. Rehabilitation and Reconstruction

Agencies involved in Disaster Management

- **National Disaster Management Authority (NDMA):**
  - Established in 2005, it is an apex body for disaster management, headed by the **Prime Minister of India.**
  - It has a vice chairman with the status of Cabinet Minister and eight members with the status of Ministers of State.
  - It is responsible for the supervision, direction, and control of the National Disaster Response Force (NDRF).
- **National Executive Committee (NEC):-**
  - The NEC is composed of high profile ministerial members from the government of India that include the Union Home Secretary as Chairperson, and the Secretaries to the Government of India (GoI)like Ministries/Departments of Agriculture, Atomic Energy, Defence, Drinking Water Supply, Environment and Forests, etc.
  - The NEC prepares the National Plan for Disaster Management as per the National Policy on Disaster Management.
- **State Disaster Management Authority (SDMA):-**
  - The Chief Minister of the respective state is the head of the SDMA.
  - The State Government has a State Executive Committee (SEC) which assists the State Disaster Management Authority (SDMA) on Disaster Management.
- **District Disaster Management Authority (DDMA):-**
  - The DDMA is headed by the District Collector, Deputy Commissioner or District Magistrate depending on the situation, with the elected representatives of the local authority as the Co-Chairperson.
  - The DDMA ensures that the guidelines framed by the NDMA and the SDMA are followed by all the departments of the State Government at the District level and the local authorities in the District.

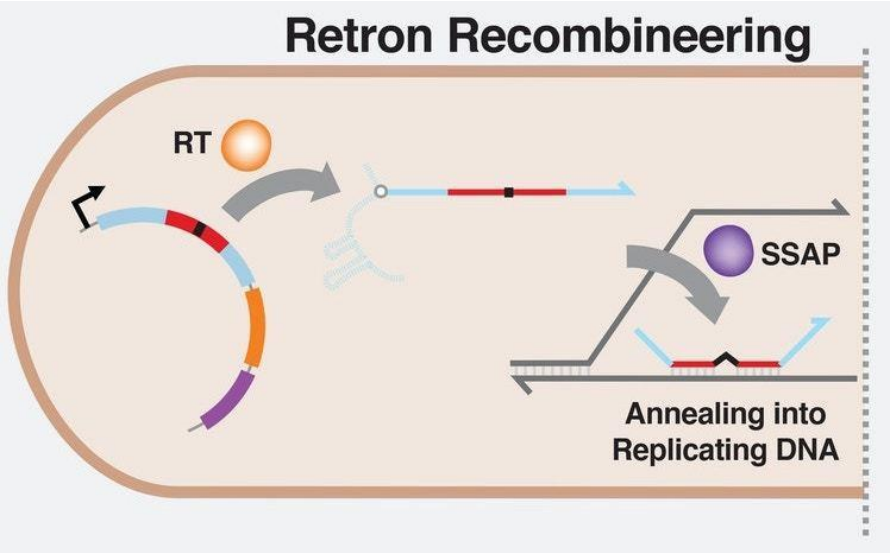
349. Retrons

Context: Retron Library Recombineering (RLR) is evolving as alternative genetic engineering system to CRISPR

About CRISPR

- CRISPR is an acronym for **clustered regularly interspaced short palindromic repeats**. CRISPR is a family of DNA sequences found in the genomes of prokaryotic organisms such as bacteria and archaea
- CRISPR technology is a simple yet powerful tool for editing genomes
- CRISPR works like a pair of genetic scissors, able to make precise cut-and-paste edits to the genome of living cells.

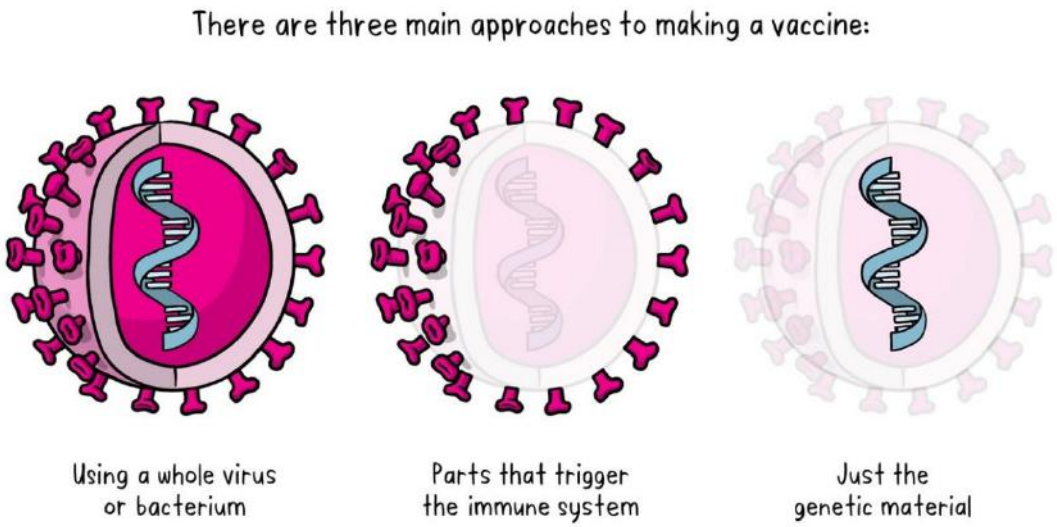
- The system can seek out a particular DNA sequence, then uses an enzyme, most commonly Cas9, to make a cut there.
- As the cell performs its DNA repair procedures, **CRISPR instructs it to use a different sequence instead of the original one**, thereby editing the genome.
- This system is already proving invaluable in a range of applications, from treating diseases like cancer, HIV and muscular dystrophy, to pest control, improving crops, and building biological computers out of bacteria.
- There are, however, potential problems with CRISPR Technology
    - Cutting DNA could cause some unintended side effects, and concerns have been raised that CRISPR can make edits in the wrong section of the genome.
    - It can also be a little tricky to scale up to make larger amounts of edits at once, and to track which mutants are having which effect in lab tests.



Retron Library Recombineering (RLR)

- RLR's main point of difference is that it doesn't cut the DNA at all – instead, it introduces the new DNA segment while a cell is replicating its genome before dividing.
- It does so using **retrons, which are segments of bacterial DNA that produce pieces of single-stranded DNA (ssDNA**).
    - This was originally a self-defense mechanism that bacteria use to check if they've been infected with a virus
- By adding both the desired DNA segment along with a single-stranded annealing protein (SSAP), the RLR system makes sure that the intended DNA segment ends up in the genome of the daughter cell, after the original cell divides.
- Retrons give the ability to produce ssDNA within the cells that needs to be edited rather than trying to force them into the cell from the outside, and without damaging the native DNA.
- The retron sequence can also be tracked like a "barcode," allowing scientists to easily check which cells received which edit, when trying to study the effects.

350. mRNA Vaccine or Types of Vaccines for COVID-19



The whole-microbe approach

The subunit approach

- A subunit vaccine is one that only uses the very specific parts (the subunits) of a virus or bacterium that the immune system needs to recognize. It doesn't contain the whole microbe or use a safe virus as a vector. The subunits may be proteins or sugars.
- Ex: whooping cough, tetanus, diphtheria and meningococcal meningitis.

The genetic approach (nucleic acid vaccine)

- A nucleic acid vaccine just uses a section of genetic material that provides the instructions for specific proteins, not the whole microbe.
- DNA and RNA are the instructions our cells use to make proteins.
- In our cells, DNA is first turned into mRNA (messenger RNA), which is then used as the blueprint to make specific proteins.
- A nucleic acid **vaccine delivers a specific set of instructions to our cells, either as DNA or mRNA,** for them to make the specific protein that we want our immune system to recognize and respond to
- The nucleic acid approach **is a new way of developing vaccines.**
- Before the COVID-19 pandemic, none had yet been through the full approvals process for use in humans, though some DNA vaccines, including for particular cancers, were undergoing human trials.

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RaRe Notes

DAY 54 - ENVIRONMENT and S&T

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391. Persistent Organic Pollutants

- The Union Cabinet has approved the ratification of seven chemicals listed under Stockholm Convention on Persistent Organic Pollutants (POPs).

About Persistent Organic Pollutants (POPs)

- POPs are defined as chemical substances that **persist** in the environment, **bioaccumulate** through the food web, less soluble in water & pose a risk of causing **adverse effects** to human health & the environment.
- The property of **long-range environmental transport (LRET)** makes them spread widely in the atmosphere.
- Exposure to POPs can lead to cancer, damage to central & peripheral nervous systems, diseases of the immune system, developmental and **carcinogenic** effects, reproductive disorders and interference with normal infant and child development.

The Stockholm Convention:

- It is a **global treaty** to protect **human health and the environment from POPs.**
- It was opened for signature in 2001 in Stockholm,Sweden and became effective in **2004.**
- POPs are listed in various Annexes to the Stockholm Convention after thorough scientific research, deliberations and negotiations among member countries.
- **Objectives:**
    - Support the transition to safer alternatives.
    - Target additional POPs for action.
    - Cleanup old stockpiles and equipment containing POPs.
    - Work together for a POPs-free future.
- **India ratified the Stockholm Convention in 2006** as per **Article 25(4),** which enabled it to keep itself in a default "opt-out" position such that amendments in various Annexes of the convention cannot be enforced on it unless an instrument of ratification/ acceptance/ approval or accession is explicitly deposited with UN depositary.
- Initially, twelve POPs have been recognized as causing adverse effects on humans and the ecosystem and these can be placed in 3 categories:
    - **Pesticides**: aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, hexachlorobenzene, mirex, toxaphene;
    - **Industrial chemicals**: hexachlorobenzene, polychlorinated biphenyls (PCBs); and
    - **By-products**: hexachlorobenzene; polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans (PCDD/PCDF), and PCBs.
    - 16 newly chemicals have been added later to the Stockholm Convention
- The **Global Environmental Facility (GEF**) is the designated interim financial mechanism.
- The United Nations Industrial Development Organization (UNIDO) takes the responsibility for developing nations to help them implement the measures
- **Annex A** – Chemicals listed under this annexure are to be **eliminated** by the member states (Some exceptions are given.)
- **Annex B** – Chemicals listed under this annexure are to be **restricted** for their use. (Some exceptions are given.)
- **Annex C** – Unintentionally produced chemicals are to be **reduced** with measures for ultimate elimination under this annexure.

Global Environment Facility

- GEF was established with the **Rio Earth Summit of 1992.**
- Headquarter: Washington, D.C., USA.
- The GEF is jointly managed by the United Nations Development Programme (**UNDP**), the **World Bank,** and the United Nations Environment Programme (**UNEP**).

- The **financial mechanism** was established to help tackle our planet's most pressing environmental problems.
- It provides **funds** to the developing countries and transition economies for projects related to climate change, biodiversity, the ozone layer, etc.
- It is a financial mechanism for 5 major international environmental conventions:
  - ✓ The United Nations Framework Convention on Climate Change (UNFCCC),
  - ✓ The United Nations Convention on Biological Diversity (UNCBD),
  - ✓ The Stockholm Convention on Persistent Organic Pollutants (POPs),
  - ✓ The United Nations Convention to Combat Desertification (UNCCD), and
  - ✓ The Minamata Convention on Mercury.

392. DDT & Endosulfan

- **In News:** Recently, HIL (India) Limited has supplied 20.60 Metric tonne of **Dichlorodiphenyltrichloroethane (DDT),** a fertilizer to South Africa for their malaria control program.
  - HIL is a PSU under the Ministry of Chemicals and Fertilizers.
  - It was incorporated in 1954 to manufacture and supply DDT to the Ministry of Health and Family Welfare for malaria control programmes.

About Dichlorodiphenyltrichloroethane (DDT)

- It is a colorless, tasteless, and almost odorless crystalline chemical compound.
- It was first synthesized in 1874 by the Austrian chemist Othmar Zeidler.
- Its insecticidal action was discovered by the **Swiss chemist Paul Hermann Muller** in 1939.
  - He was awarded the **Nobel Prize** in Physiology or Medicine in 1948 "for his discovery of the high efficiency of DDT as a **contact poison against several arthropods.**
- **D.D.T.** is a highly persistent chemical called an **organophosphate.**
- It is readily absorbed by the soil and is **hydrophobic.**
- Originally developed as an **insecticide**, it became infamous for its environmental impacts.
- It enters food chains and results in **bioaccumulation.**
- It can cause **weakening of eggshells** reproductive failures among birds and fishes
  - The **bald eagle** had almost gone extinct but their population began to rebound once D.D.T. was banned
- D.D.T. is **carcinogenic** and is also an **endocrine disrupter** (hormone imbalance). It can cause reproductive and developmental problems in humans and other species.
- By 1972, the use of this pesticide **was banned in the United States.**
- A worldwide ban on agricultural use was formalized under Stockholm Convention on POPs
- However, its limited use in disease vector control continues, because of its e**ffectiveness in reducing malarial infections.**
- WHO recommends DDT as one of the efficient Indoor Residual Spraying chemicals to curb mosquito menace and it is widely used by Southern African countries like South Africa, Zimbabwe, Zambia, Namibia, Mozambique and India.
  - Malaria is caused by Plasmodium parasites. The parasites are spread to people through the bites of infected female Anopheles mosquitoes.

Endosulfan

- Endosulfan is an **organochlorine insecticide** which was first introduced in the 1950s and is commonly known by its **trade name Thiodan.**
- Endosulfan can be utilized as a **pesticides and wood preservative** as well.
- Sprayed on crops like **cotton, cashew, fruits, tea, paddy, tobacco etc.** for control of pests such as whiteflies, aphids, beetles, worms etc.

- Endosulfan in the environment **gets accumulated in food chains** leading to higher doses causing problems.
- If Endosulfan is **released to water**, it is expected to absorb to the sediment and may **bioconcentrate in aquatic organisms.**
- The endosulfan ingestion results in diseases ranging from physical deformities, cancer, birth disorders and damage to the brain and nervous system
    - The health effects of the chemical include neurotoxicity, late sexual maturity, physical deformities, poisoning, among others.
    - People, especially newborns, have suffered deformaties, health complications and loss of family members due to exposure to the agrochemical.

Ban on Endosulfan

- The Supreme Court in India has banned the manufacture, sale, use, and export of endosulfan throughout the country, citing its harmful health effects in 2015.
- Endosulfan is listed under both Rotterdam Convention on the Prior Informed Consent and the Stockholm Convention on Persistent Organic Pollutants

Rotterdam convention 1998

- The convention aims to promote cooperation and responsibility sharing measures amongst different countries dealing with trade in **hazardous chemicals and pesticides**.
- PIC, Prior Informed Consent is the main feature of the convention and is **legally binding on the party members.**
- PIC facilitates information exchange about nature and trade-related information amongst the party members.
- The Convention creates obligations for the implementation of the Prior Informed Consent (PIC) procedure.

393. Diclofenac & Neo-nicotinoides

About Diclofenac

- Diclofenac is an NSAID or Nonsteroidal Anti-Inflammatory Drug used to **decrease inflammation** and also as an **analgesic (pain killer)** in certain conditions. It is delivered as such or supplied in medications under different trade names.
- Diclofenac is a name derived from the drug's chemical name which is 2-(2,6-dichloroaniline) phenylacetic acid
- This medicine was synthesised for the first time by Rudolf Pfister and Alfred Sallman and sold in 1973.
- Diclofenac is sold as eye drops to treat non-bacterial inflammation on the anterior part of the eyes. They are also used to handle the pain from corneal abrasion
- Diclofenac is often used to treat chronic pain associated with cancer, especially if inflammation is present.
- In India, UK, USA and Brazil, the drug is supplied either as the potassium salt or as the sodium salt. It is mostly sold as a sodium salt in China. In some countries, just the potassium salt is supplied.
- **Side effects:** Studies have shown that there is a link with Diclofenac and increased coronary risk. Many gastrointestinal complications were found to be reported.
    - They work by reducing hormones that cause inflammation and pain in the body. This also at times have to lead to hormonal imbalance at times.

Why is Diclofenac banned in India?

- The government had prohibited the use of **diclofenac for veterinary operations** in 2006 after it was found that the once-thriving vulture population in the country was brought to near extinction after consuming the carcasses of animals that were illegally treated with human formulations of the drug.
- The drug was commonly administered to cattle **to treat inflammation**
- **Bioaccumulation** (the gradual accumulation of substances, such as pesticides, or other chemicals in an organism) of Diclofenac caused **kidney failure** in Vultures, leading to death.
- Diclofenac is dangerously fatal for Vultures. Even 1% of it in carcass would kill the Vulture in a short time after it feeds such carcass.
- After the ban on Diclofenac, efforts on searching for an alternative drug finally manifested **'Meloxicam'.**

Neonicotinoids

- Neonicotinoids are a new class of insecticides chemically related to **nicotin**. The name literally means "new nicotine-like insecticides".
- Like nicotine, the neonicotinoids act on certain kinds of receptors in the **nerve synapse.**
- They are much **more toxic to invertebrates, like insects,** than they are to mammals, birds and other higher organisms.
- One thing that has made neonicotinoid insecticides popular in pest control is their **water solubility,** which allows them to be applied to soil and be taken up by plants.
    - Soil insecticide applications reduce the risks for insecticide drift from the target site, and for at least some beneficial insects on plants.
- Neonicotinoids are typically applied as seed treatments by seed producers, before sale to farmers.
- In addition to being effective against sap-feeding pests, neonicotinoids provide good control against certain beetles (like white grub larvae in lawns), fleas (Advantage flea control products, and nitenpyram pills for pets), certain wood boring pests, flies (fly baits), cockroaches and others.

Environmental Concerns

- Its negative affects including **honey-bee colony collapse disorder (CCD)** and loss of birds due to a reduction in insect populations.
- Some sources have proposed that neonicotinoids reduce a bee **colony's ability to survive the winter.**
- The neonicotinoids act on certain kinds of receptors in the **bees' nerve synapse.**
- They do not normally kill bees directly, they may impact some bees' ability to foraging for nectar, learn and remember where flowers are located, and possibly impair their ability to find their way home to the nest or hive.

394. Coronavirus Mutants

- All viruses – including SARS-CoV-2, the virus that causes COVID-19 – evolve over time.
- When a virus replicates or makes copies of itself, it sometimes changes a little bit, which is normal for a virus. These changes are called "mutations".
- A virus with one or more new mutations is referred to as a "**variant" of the original virus.**
- Most viral mutations have little to no impact on the virus's ability to cause infections and disease. But depending on where the changes are located in the virus's genetic material, they may affect a virus's properties, such as transmission (for example, it may spread more or less easily) or severity (for example, it may cause more or less severe disease).

Variants of Concern

These variants have the following properties:

1. Increase in transmissibility or **detrimental change** in COVID19 epidemiology.
2. Increase in **virulence** or change in clinical disease presentation.
3. Decrease in effectiveness of the public health and social measures or available diagnostic techniques

Name of Variant	Lineage	Earliest Sample	First Outbreak	Designated
Alpha	B.1.1.7	September 2020	**United Kingdom**	18 December 2020
Beta	B.1.351	May 2020	**South Africa**	18 December 2020
Gamma	P.1	November 2020	**Brazil**	11 January 2021
Delta	B.1.617.2	October 2020	**India**	11 May 2021

Variant of Interest

The SARS-CoV- 2 variant which is phenotypically changed. It is either

1. Identified to cause community transmission in multiple countries.
2. Is assessed to be a VOI by WHO in consultation with the Virus Evolution working group.

Name of Variant	Lineage	Earliest Sample	First Outbreak	Designated
Epsilon	B.1.429, B.1.427	March 2020	United States	5 March 2021
Eta	B.1.525	December 2020	Multiple Countries	17 March 2021
Kappa	B.1.617.1	December 2020	India	4 April 2021
Lambda	C.37	August 2020	Peru	14 June 2021
Lota	B.1.526	November 2020	United States	24 March 2021
Theta	P.3	January 2021	Philippines	24 March 2021
Zeta	P.2	April 2020	Brazil	17 March 2021

395. Thrombosis

- Thrombosis is the **formation of a blood clot**, known as a thrombus, within a blood vessel. It prevents blood from flowing normally through the circulatory system.
- Blood clotting, also known as coagulation, is the body's first line of **defense against bleeding.**
- When we hurt ourselves, our clotting system forms a "plug" or "seal" to protect us from losing too much blood.
    - When a blood vessel is injured, the body uses **platelets (thrombocytes) and fibrin** to form a blood clot to prevent blood loss.
- Our bodies often **break down the clot after we've healed** but sometimes, clots form inappropriately or fail to dissolve after an injury.
- There are two main types of thrombosis:

- **Arterial thrombosis** refers to a blood clot that blocks an artery. Arteries carry blood away from the heart to other parts of the body. Arterial blood clots can block blood flow to the heart and brain, often resulting in a heart attack or stroke.
- **Venous thrombosis**, also known as venous thromboembolism or VTE, refers to a blood clot in a vein. Veins carry blood to the heart from other parts of the body. VTE is a condition that includes deep vein thrombosis (DVT) and pulmonary embolism (PE).

- ***Embolus or Embolism:*** A clot that detaches and travels through blood vessels to another part of the body
  - **Pulmonary embolism (PE)** occurs when a clot elsewhere in the body travels through the bloodstream to the lungs. PEs block blood flow to the lungs, decrease the amount of oxygen in the blood, and affect a person's ability to breathe. PEs can be life-threatening.

396. Parosmia & Mucormycosis

- Parosmia is a medical term used to describe a condition in which affected individuals experience "distortions of the sense of smell".
- A person with parosmia is able to detect certain odours, but they might experience the smell of certain things as different and often unpleasant. For instance, to someone with parosmia, coffee may smell like burnt toast.
- This abnormality is typically experienced by those people who are recovering their sense of smell following loss from a virus or an injury.
- Parosmia is a temporary condition and is not harmful in itself
- It is likely that parosmia manifests itself due to the damage caused to the olfactory neurons when "the delicate and complex structure in the nose is attacked by a virus."
- It can also be due to damage to olfactory lobe.
- It is one of the first symptoms of **Alzheimer's disease and Parkinson's disease**.
- Dementia and Huntington's disease also bring on difficulty in sensing smells properly.

Mucormycosis

- **Mucormycosis**, also known as black fungus, is a **serious fungal infection.**
- It caused by a group of molds called mucormycetes, which is abundant in the environment.
- It mainly affects people who have **health problems** or **take medicines** that lower the body's ability to fight germs and sickness.
- It most commonly infects the nose, sinuses, eye and brain resulting in a runny nose**, one sided facial swelling**, blurred vision, bulging eye, and **tissue death**
- The **types of Mucormycosis** are:
  - Rhinocerebral (Sinus and Brain)
  - Pulmonary (Lung)
  - Gastrointestinal
  - Cutaneous (Skin)
  - disseminated Mucormycosis.
- It **occurs through** inhalation, inoculation, or ingestion of spores from the environment.
- Mucormycosis **does not spread between people or between people and animals.**
- Symptoms include pain and redness around eyes and/or nose, fever, headache, coughing, shortness of breath, bloody vomits, and altered mental status.
- **Prevention:** Avoiding areas with a lot of dust like construction or excavation sites, avoiding direct contact with water-damaged buildings and flood water after hurricanes and natural disasters and avoiding activities that involve close contact to soil.
- **Treatment:**

- Mucormycosis needs to be treated with **prescription antifungal medicine.**
- In some cases, it can **require surgery.**

397. Neuro-prosthesis

- **News**: Researchers have successfully developed a 'speech neuroprosthesis' that has enabled a man with severe paralysis to communicate in sentences, translating signals from his brain to the vocal tract directly into words that appear as text on a screen.
  - It shows strong promise to restore communication by tapping into the brain's natural speech machinery

About Neuro-prosthesis:

- Neural prostheses are a series of devices that can substitute a motor, sensory or cognitive modality that might have been damaged as a result of an injury or a disease.
- Communication neuroprosthetics technology that allows people with **paralysis to communicate** even if they are unable to speak on their own.
- Previously, work in the field of communication neuroprosthetics has focused on restoring communication through spelling-based approaches to type out letters one-by-one in text.
- The latest research by University of California San Francisco is the first successful demonstration of direct **decoding of full words** from the brain activity
- Researchers used custom neural network models, which are forms of artificial intelligence. When the participant attempted to speak, the networks **distinguished subtle patterns in brain activity to detect speech attempts** and identify which words he was trying to say.
- The team found that the system was able to decode words from brain activity at rate of up to 18 words per minute with up to 93 percent accuracy

398. Neural disorders

Disease	Causes	Symptoms
Parkinson's disease	Genetic disorder, Pollution	Long-term degenerative disorder, mainly affects the motor system.
Alzheimer's disease	Genetic mutation Shrinking of Hippocampus.	Dementia, mood swings, self-neglect.
Epilepsy	Genetic disorder Pre-natal injuries Infectious diseases.	Staring blankly for a few seconds during a seizure. Repeatedly twitching the arms or legs.
Huntington's disease	Stress, emotional problems	Loss of multitasking. Tremors. Chorea
Guillain-Barre syndrome	Cause by immune system damaging the peripheral nervous system.	Back pain Weak muscles Breathing and blood pressure.
Cerebral palsy	Genetic disorders Preterm birth	A group of permanent movement disorders that appear in early childhood. Stiff muscle, speech and hearing impairment

399. Omega-3 fats & Trans fats

- **In News:** An omega-3 that's poison for tumors

About

- Omega-3s are a family of essential fatty acids that play important roles in your body and may provide a number of health benefits
- As your body cannot produce them on its own, you must get them from your diet.
- The three most important types are
  - ALA (alpha-linolenic acid)
  - DHA (docosahexaenoic acid)
  - EPA (eicosapentaenoic acid).
- ALA is mainly found in plants, while DHA and EPA occur mostly in animal foods and algae
- Among the Omega-3 fatty acids, DHA or docosahexaenoic acid is crucial to brain function, vision and the regulation of inflammatory phenomena. DHA is also associated with a reduction in the incidence of cancer.
- Common foods that are high in omega-3 fatty acids include fatty fish, fish oils, flax seeds, chia seeds, flaxseed oil, and walnuts.
- For people who do not eat much of these foods, an omega-3 supplement such as fish oil or algal oil, is often recommended.

Recent Research Findings

- Certain fatty acids stimulated the tumour cells while others killed them,
- In the presence of a large amount of DHA, the tumour cell is overwhelmed and cannot store the DHA, which oxidises and leads to cell death
- In the presence of DHA, spheroids first grow and then implode. The research team administered a DHA-enriched diet to mice with tumours. The result: tumour development was significantly slowed compared to that in mice on a conventional diet.

400. Monoclonal Antibody

- One way the body's immune system attacks foreign substances is by making large numbers of antibodies.
- An antibody is a protein that sticks to a specific protein called an *antigen*.
- Antibodies circulate throughout the body until they find and attach to the antigen. Once attached, they can force other parts of the immune system to destroy the cells containing the antigen.
- Researchers can design antibodies that specifically target a certain antigen, such as one found on cancer cells. They can then make many copies of that antibody in the lab. These are known as **monoclonal antibodies (mAbs or Moabs).**
- Monoclonal antibodies are used to treat many diseases, including some types of cancer. To make a monoclonal antibody, researchers first have to identify the right antigen to attack.

What mAbs are made of?

Monoclonal antibodies are man-made proteins that act like human antibodies in the immune system. There are 4 different ways they can be made and are named based on what they are made of.

- **Murine:** These are made from mouse proteins and the names of the treatments end in -omab.
- **Chimeric:** These proteins are a combination of part mouse and part human and the names of the treatments end in -ximab.
- **Humanized:** These are made from small parts of mouse proteins attached to human proteins and the names of the treatments end in -zumab

- **Human:** These are fully human proteins and the names of the treatments end in -umab.

Possible side effects of monoclonal antibodies

- Monoclonal antibodies are given intravenously (injected into a vein).
- The antibodies themselves are proteins, so giving them can sometimes cause something like an allergic reaction. This is more common while the drug is first being given.
- Possible side effects can include:fever, chills, weakness, headache, nausea, vomiting, diarrhea, low blood pressure and rashes.
- Compared with chemotherapy drugs, naked mAbs tend to have fewer serious side effects. But they can still cause problems in some people.