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Classroom Study Material

# **SCIENCE & TECHNOLOGY**

JULY 2015 – MAY 2016

**NOTE:** June 2016 current affairs for PT 365 will be updated on our website on second week of July 2016.

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# A. DEFENCE AND SPACE TECHNOLOGY



## A.1. AKASH AIR DEFENCE MISSILE SYSTEM

- The Akash **SAM** (surface to air missile) is a medium **range** (30-35 Km, 18 km altitude), **nuclear capable**, **all weather** system that can be launched both from both static and mobile platforms and employ **multiple air targets** while operating in fully autonomous mode.
- The Akash system can protect a moving procession of vehicles using an electronic counter countermeasures (**ECCM**) system.
- Developed under the integrated guided-missile development programme (**IGMDP**).
- Built by India's state-owned Defence Research and Development Organisation (DRDO).
- It uses high-energy solid propellant for the booster and ram-rocket propulsion for the sustainer phase.

## A.2. INDIA SUCCESSFULLY TESTED INTERCEPTOR MISSILE

### Why in news?

- DRDO has come up with a new indigenously produced **Advanced Air Defence (AAD) interceptor missile, Ashwin**.
- The missile was tested on the newly named Abdul Kalam Island located in the Balashore district off the Odisha coast. This was the 12th test in the series to develop interceptor missiles.
- The test involved the launch of the single-stage Ashvin Advanced Defense interceptor missile from a mobile launcher and the successful destruction of an incoming nuclear-capable Dhanush ballistic missile at endo-atmospheric altitudes of 20-40 kilometers.
- The 'kill' effect of the interceptor was ascertained by analyzing data from multiple tracking sources.

### Salient Features

- 7.5-metre-long, single stage solid rocket propelled, guided, supersonic missile.
- It is capable of destroying any incoming hostile ballistic missile.

<b>LAUNCH</b>	<b>ADVANCE AIR</b> Defence missile dubbed as Ashwin was fired at about 9.45 am from Abdul Kalam Island		
<b>INTERCEPTOR LAUNCHED</b> a few minutes after the electronic target was fired	<b>FIGURES</b>		
<b>THIS WAS</b> 11th test of the missile and second in eight months	<b>7.5</b> metres tall	<b>1.2</b> tonnes weight	<b>0.5</b> metre diameter
<b>SINGLE-STAGE</b> missile powered by solid propellants	<b>AIM</b>	India plans to deploy a two-tiered ballistic missile defence system to protect its important cities and vital installations from enemy attack	
<b>TARGET</b>	First phase to destroy enemy missiles outside the atmosphere and second phase to kill enemy missiles in more than 2,000 km range inside the atmosphere		



- The missile comes with an inbuilt navigator, an advanced computer and an electro-mechanical activator.
- The technology in the missile is encrypted using a secure data link independent tracking and homing capabilities and sophisticated radars.
- After the successful test, India became the fourth country in the world to have full-fledged multi-layer Ballistic Missile Defence system. Only United States, Russia and Israel are in the same league.
- The new supersonic missile interceptor will soon become a part of the Indian Army's arsenal.

#### About India's BMD

- India began developing a multi-tiered Ballistic Missile Defense (BMD) system in 1999, after the end of the Kargil War in reaction to Pakistan's growing missile arsenal.
- A consortium of 40 Indian companies were involved in the development of the missile defense shield.
- India's BMD shield is a two-tiered defense system
  - ✓ Prithvi Air Defense (PAD) / Pradyumna Ballistic Missile Interceptor destroying missiles at exo-atmospheric altitudes of 50–80 kilometers (31–50 miles),
  - ✓ Advanced Air Defense (AAD)/ Ashvin Advanced Defense interceptor missile endo-atmosphere at altitudes of 20-40 kilometers (12-24 miles).
- In addition to the indigenously developed BMD system, India has procured six regiments of Russian S-300 air defense systems and is negotiating for five regiments of more advanced S-400 systems with Russia.

### A.3. AMOGHA-I MISSILE

- Indigenously developed
- Second generation **anti-tank** guided missile.
- **Range** - 2.8 km
- Developed by Bharat Heavy Dynamics Limited (BDL)
- Other anti-tank missile: Nag

### A.4. BARAK 8

- **Indo-Israeli long range surface-to-air missile (MR-SAM)**
- Designed to defend against any type of airborne threat including aircraft, helicopters, anti-ship missiles, and UAVs as well as cruise missiles and combat jets.
- The radar system provides 360 degree coverage and the missiles can take down an incoming missile as close as 500 meters away from the ship.
- Maximum speed **Mach 2**

### A.5. NIRBHAY MISSILE

- It is Indigenous, surface-to-surface, nuclear capable **subsonic cruise** missile.
- Range of around 1,000 km.





## A.6. THE INDIAN NAVAL INDIGENISATION PLAN 2015-2030

- This plan aimed at enabling the development of equipment and systems through the Defence Research and Development Organisation (DRDO) and Indian industry over a 15-year period.
- According to the plan, Navy will achieve full indigenisation in all phases of warship construction, from ship-building to systems to weapons.
- **Aim : 200 ship navy by 2027.**
- The Navy wants to involve **private** industry in a big way in this initiative.
- **Current status:** A warship can be broadly divided into three segments — float, move and fight.
  - ✓ Float category- 90% Indigenisation,
  - ✓ Move (propulsion) - 60%
  - ✓ Flight (weapons) - 30%

## A.7. INS VIKRANT

- The maiden **indigenous** aircraft carrier INS Vikrant was undocked on completion of structural work.
- The successful completion puts India in the elite group of four nations - the US, Russia, the UK and France - in the world capable of designing and constructing aircraft carriers.

INS Vikrant FACTS & FIGURES		
<b>BASIC DATA</b>		
<b>LENGTH</b> 262 metres	<b>STOBAR*</b> aircraft launch and recovery system	<b>TIMELINE</b>
<b>MAXIMUM BREADTH</b> 62 metres	Capable of operating 24 MiG 29K and LCA (Navy) fighter aircraft, besides 6 assorted helicopters	
<b>DISPLACEMENT</b> 40,000 tonnes	Cabling About <b>2,700 km</b>	Designed by Directorate of Naval Design
<b>SPEED</b> In excess of 28 knots	Complement <b>1,600 personnel</b>	<b>Construction sanctioned</b> January 2003
<b>FLIGHT DECK</b> 2 runways for take-off	Compartments <b>2,300</b>	<b>Keel laid</b> February 28, 2009
<b>PROPULSION</b> 2 shafts, each coupled to 2 LM 2,500 gas turbines generating 80 MW	Decks <b>10</b> decks plus <b>5</b> levels in the island structure	<b>Launched</b> August 12, 2013
<ul style="list-style-type: none"> <li>• Early air warning radar and V/UHF tactical air navigational and direction finding systems, besides carrier control approach radar to aid air ops</li> <li>• State-of-the-art Integrated Platform Management System supplied by BHEL</li> </ul>	Weight at the time of undocking <b>26,000 tonnes</b>	<b>Undocking</b> June 10, 2015
	<b>TO BE ARMED WITH</b>	<b>Basin trials</b> 2017
	<ul style="list-style-type: none"> <li>• Long Range Surface to Air Missile with Multifunction Radar</li> <li>• Close-In Weapon System for terminal air defence (All weapons to be integrated using an indigenous Combat Management System)</li> </ul>	<b>Delivery</b> 2018 likely
	* Short Take-off But Arrested Recovery	



INS Vikrant, undocked on completion of structural work at Cochin Shipyard on Wednesday.



## A.8. INS ASTRADHARINI

**What it is:** India's first totally indigenously designed (95%) and built **torpedo launch and recovery vessel (TLRV)**.

### Features:

- Speed upto 15 knots.
- It can operate on high sea states and its stability makes it very suitable for carrying passengers.
- It is an advanced replacement for Astravahini.

### Project Seabird -1985

- A 25000 cr project to build a naval base at Karwar which is to be commissioned progressively from 2005 onwards.
- Phase I – INS Kadamba naval station
- Phase II- INS Vajrakosh naval station.

## A.9. KARWAR- WORLD'S LARGEST NAVAL BASE EAST OF THE SUEZ CANAL

- Together with **INS Vajrakosh** and **INS Kadamba** (another station 20 km away), the naval base at **Karwar** is spread out over 1000 acres making it - **the world's largest naval base east of the Suez Canal**.
- It will base two aircraft carriers, 40 submarines, amongst other ammunitions.
- **Repair Centre** - 6,500 ton ship lift capacity to move all our major warships - except the aircraft carriers - to the dry docks for repairs.
- **INS Vajrakosh** will be the biggest missiles, ammunition and spares dump on the Western Sea Board. It will be a station that will equip all warships and airplanes.

### Why Karwar was chosen

- The Bombay and Cochin Harbours - the two major Naval stations in the Western Sea Board - are over-crowded with commercial traffic.
- Conceived to be out of range of Pakistan's Airforce. (Not the case now)
- From Karwar, deployment can be done simultaneously in a very short time.

## A.10. INTEGRATED AIR COMMAND AND CONTROL SYSTEM (IACCS)

The government has cleared the proposal for a nearly Rs 8,000-crore project for IAF's Integrated Air Command and Control System (IACCS).

### Features

- IACCS is an automated command and control system for Air Defence (AD) planned by the Indian Air Force.
- It will detect and tackle enemy and terror aerial threats in real-time by putting in place a composite and enhanced surveillance capability.
- With the help of this the air headquarters will get a composite air situation picture since it will be integrating Air Force, Army, Naval and civilian radars.
- It enables the surveillance of national airspace for airspace safety and Air traffic operations.
- It helps in real time transportation of data, voice and images among stations and aircrafts.





## A.11. HERON - DRONE

- Government approves \$400-million plan to procure 10 missile armed Heron TP drones from Israel
- It is capable of reconnaissance, combat and support roles.
- It will enhance India's cross-border military strike capability

## A.12. MULTI-BILLION DOLLAR DEFENSE DEAL WITH BOEING

- The Cabinet Committee on Security (CCS) cleared a multi-billion dollar deal with American aviation giant Boeing.
- Items in the deal: **22 Apache attack helicopters and 15 Chinook heavy-lift choppers.**
- The deal for Apache is "**a hybrid one**", with one contract to be signed with Boeing for the helicopter and the other with the US government for its weapons, radars and electronic warfare suites.
- Earlier deals with USA in last decade includes aircraft like **P-8I maritime surveillance planes, C-130J 'Super Hercules'** and **C-17 Globemaster-III** in the transport category.

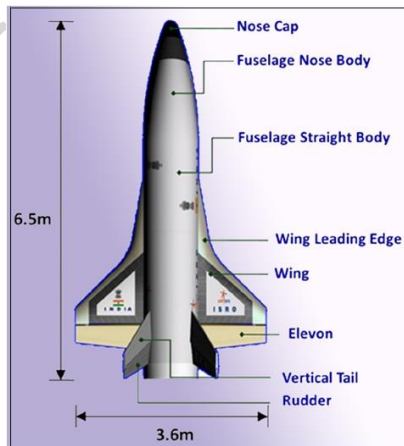
## A.13. REUSABLE LAUNCH VEHICLE-TECHNOLOGY DEMONSTRATOR

### Why in news?

- RLV-TD was successfully flight tested recently, validating the critical technologies such as autonomous navigation, guidance & control, reusable thermal protection system and re-entry mission management.

### Features and significance

- A reusable launch system (RLS, or reusable launch vehicle, RLV) is a system capable of launching a payload into space **more than once.**
- The model is 6.5 metres long and weighs about 1,750 kg and design is that of a delta-winged aircraft.
- The working RLV will be about 40 metres long and it will need a five km-long landing runway. It might be 2030 before it is fully operational.
- It demonstrated the success of hypersonic flight, re-entry aero thermodynamics, autonomous mission management and hot structures for thermal protection.



### About RLV-TD

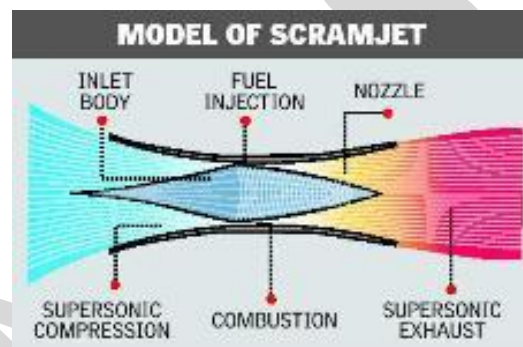
- The cost of access to space is the major deterrent in space exploration and space utilization. RLV is the solution to achieve low cost, reliable and on-demand space access.
- RLV-TD is part of a series of technology demonstration missions that have been considered as a first step towards realizing a Two Stage To Orbit (TSTO) fully reusable vehicle.



- The configuration of RLV-TD is similar to that of an aircraft and combines the complexity of both launch vehicles and aircraft.
- A Winged RLV-TD has been configured to act as a flying test bed to evaluate technologies like hypersonic flight, autonomous landing, powered cruise flight and hypersonic flight using air-breathing propulsion.
- These technologies will be developed in phases through a series of experimental flights. The first in the series of experimental flights is the hypersonic flight experiment (HEX) followed by the landing experiment (LEX), return flight experiment (REX) and scramjet propulsion experiment (SPEX).
- **Objectives of RLV-TD**
  - ✓ Hypersonic aero thermodynamic characterisation of wing body
  - ✓ Evaluation of autonomous Navigation, Guidance and Control (NGC) schemes
  - ✓ Integrated flight management
  - ✓ Thermal Protection System Evaluation

### About Hypersonic Technology & SCRAMJET Engine

- Hypersonic aviation technology involves speeds greater than 5 mach.
- To fly at hypersonic speed a different type of engine such as a supersonic-combustion ramjet, or **scramjet** is required.
- Unlike in a jet engine where the rotating compressor and turbine are used, in a scramjet engine air is compressed and expanded by complex systems of shockwaves under the front of the aircraft, inside the inlet and under the fuselage at the rear.
- It uses oxygen from the atmosphere for fuel.
- This makes it lighter and faster than fuel-carrying rockets, making it an alternative to rockets for putting satellites into space.
- It will also help making air travel in earth's atmosphere faster and cheaper.



## A.14. SAARC SATELLITE

- **SAARC Satellite** is a proposed communication-cum-meteorology satellite by Indian Space Research Organisation (ISRO) for the SAARC region. It is planned to be launched in December, 2016.
- Even though all the countries had supported the idea during the 18th saarc summit in nepal, not all have given their approval. Countries like bangladesh, sri lanka have given their approval.
- Pakistan has raised a concern with respect to this project. Pakistan believes that this satellite could allow india to have access and secure key data on pakistan's sensitive information database infrastructure

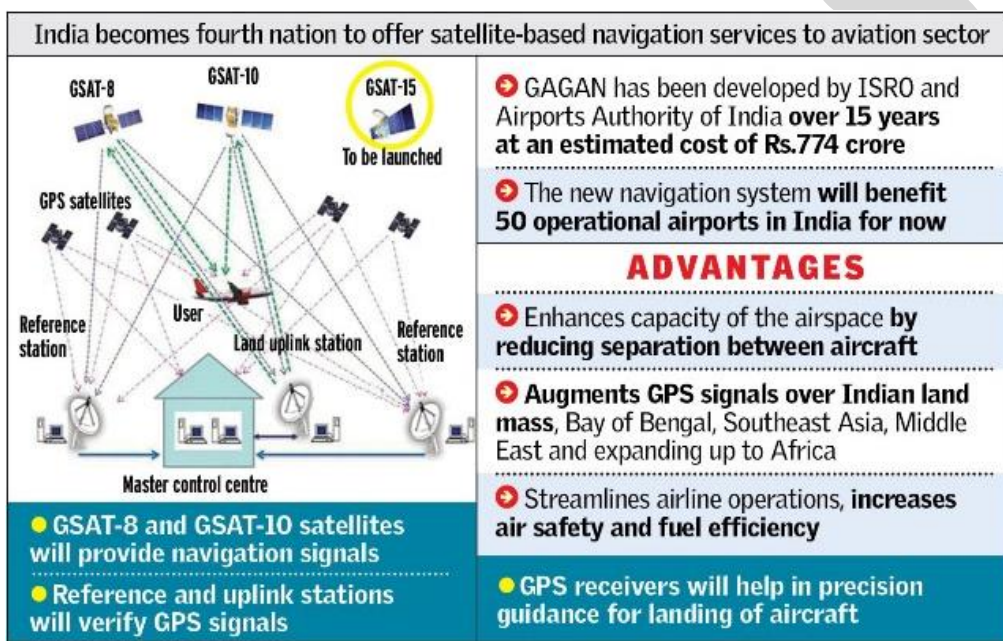
### Features

- Will have twelve 'Ku' transponders.
- It will have the capability to interconnect all these eight countries. Interconnection will be like
  - ✓ Hot contact for the political level
  - ✓ MEA interconnection
  - ✓ Disaster monitoring constellation
  - ✓ Meteorological data decimation



## A.15. GPS-AIDED GEO AUGMENTED NAVIGATION (GAGAN) SYSTEM

- The Indian Space Research Organization (ISRO) and Airports Authority of India (AAI) have implemented the GPS Aided Geo Augmented Navigation-GAGAN project as a Satellite Based Augmentation System (SBAS) for the Indian Airspace.
- It works by augmenting and relaying data from GPS satellites with the help of augmentation satellites and 15 earth-based reference stations.
- 3 Geostationary Satellites: GSAT-8, GSAT-10 and GSAT-15
- GAGAN system corrects any anomalies in the position data and gives accurate routes, landing guidance and time saving information to the pilots.
  - ✓ Improved efficiency, Direct routes, Increased fuel savings, all weather capabilities.
  - ✓ Accuracy – 3m and would be available to SAARC nations.



## A.16. INDIAN REGIONAL NAVIGATION SATELLITE SYSTEM (IRNSS): NAVIC

- The space segment consists of the IRNSS constellation of seven satellites, NavIC.
- Three satellites are located in suitable orbital slots in the geostationary orbit and the remaining four are located in geosynchronous orbits with the required inclination and equatorial crossings in two different planes.
- All the satellites of the constellation are configured identically.
- The satellites are configured with I-1K Bus to be compatible for launch on-board PSLV.
- IRNSS is an independent regional navigation satellite system being developed by India.

### Satellites Launched

PSLV-C22/IRNSS-1A Mission  
PSLV-C24/IRNSS-1B Mission  
PSLV-C26/IRNSS-1C Mission  
PSLV-C27/IRNSS-1D Mission  
PSLV-C31/IRNSS-1E  
PSLV-C32/IRNSS-1F  
PSLV-C33/IRNSS-1G



- It is designed to provide accurate position information service to users in India as well as the region extending up to 1500 km from its boundary, which is its primary service area.
- An Extended Service Area lies between primary service area and area enclosed by the rectangle from Latitude 30 deg South to 50 deg North, Longitude 30 deg East to 130 deg East.
- IRNSS will provide two types of services,
  - Standard Positioning Service (SPS) which is provided to all the users
  - Restricted Service (RS), which is an encrypted service provided only to the authorised users.
- The IRNSS System is expected to provide a position accuracy of better than 20 m in the primary service area.

#### Some applications of IRNSS are:

- Terrestrial, Aerial and Marine Navigation
- Disaster Management
- Vehicle tracking and fleet management
- Integration with mobile phones
- Precise Timing
- Mapping and Geodetic data capture
- Terrestrial navigation aid for hikers and travellers
- Visual and voice navigation for drivers

## A.17. GSLV D6 SUCCESSFULLY LAUNCHED

- The GSLV D-6 is the second successful consecutive launch (earlier launch GSLV D-5 in January) of the GSLV series with indigenous cryogenic upper stage.
- ISRO is planning to test **GSLV Mk III** capable of carrying payload up to **4 tonnes** by end of next year.

#### Difference between Cryogenic stage and other stages

- The cryogenic stage is technically a very complex system, as compared to solid liquid propellant stages, due to its use of propellants at extremely low temperature (cryo) and the associated thermal and structural challenges. A cryogenic rocket stage is more efficient and provides more thrust for every kilogram of propellant it burns.

**ISRO SUCCESS STORY SOARS TO NEW HEIGHTS**

ISRO proved beyond doubts its cryogenic expertise after launching the GSLV-D6 (left) placing GSAT-6 (below) in orbit

**CRYOGENIC CAPABILITY**

One of the advanced features of GSAT-6 is its S-Band Unfurlable Antenna of 6 m diameter. This is the largest satellite antenna realised by ISRO

The unfurlable antenna is utilised for five spot beams over the Indian mainland

**FACTOIDS**

POSITION: 83 Degree East Longitude

LAUNCH MASS: 2,117 kg

SATELLITE MASS: 985 kg

DIMENSION: 21 x 25 x 4.1 m

MISSION LIFE: NINE years

GENERATED POWER: 3,100 W

**EYE IN THE SKY**

GSAT-6 is the 25th geostationary communication satellite of India built by ISRO and 12th in the GSAT series

Five of GSAT-6's predecessors were launched by GSLV during 2001, 2003, 2004, 2007 and 2014 respectively

GSAT-6 provides communication through five spot beams in S-band and a national beam in C-band for strategic users

**THE TAKEOFF**

GSLV-D6 lifted off from Sriharikota at 4.52 pm. Seventeen minutes later, the rocket injected GSAT-6 into Geosynchronous Transfer Orbit

Another day & another phenomenal accomplishment by our scientists. Congratulations @isro for the successful launch of GSAT-6 - PM NARENDRA MODI ON TWITTER

Source: ISRO

GRAPHIC: KARTHICK S.T





### Significance

- GSLV will cost just one third of money spent on foreign agencies, which will reduce satellite launch cost as well as will save forex.
- It will enhance India's capability to be a competitive player in the multimillion dollar commercial launch market.
- The GSLV will help ISRO put heavier communication satellites of GSAT class into orbit.

### A.18. GSAT-6 (GEOSYNCHRONOUS SATELLITE)

- It is aimed at primarily benefiting the country's strategic users and other specific authorised users.
- It has life of nine years and 2 tonne launch mass.
- It will provide **S-band** communication services in the country.
- It includes a first-of-its-kind S-Band antenna with a diameter of six meter. This is the largest antenna ISRO has ever made for a satellite.
- It will offer a Satellite Digital Multimedia Broadcasting (S-band) service, via mobile phones and mobile video/audio receivers for vehicles.
- It can also be utilized for strategic and social applications.

### A.19. ISRO CONFERRED GANDHI PEACE PRIZE 2014

The ISRO has upheld its mission of bringing space to the service of the common man and in the service of the nation.

ISRO through space technology has immensely helped in:

- Improving the mapping of agricultural land and water-shed areas.
- Providing advisories to fishing communities.
- Creating data base of heritage sites.
- Improving disaster management support.
- Policy planning, monitoring and Implementation by gathering relevant data from remote sensing satellites.
- Communication and connectivity.

These contributions have led to social, economic and political transformation through non-violence.

### A.20. UN KALAM GLOBAL SAT

A global satellite for earth observation and disaster risk reduction — GlobalSat for DRR — proposed under the UN framework is to be dedicated to A.P.J. Abdul Kalam by naming it as **UN Kalam Global Sat**.

- Launched on third UN World Conference on Disaster Risk Reduction held at Sendai in Japan in March 2015.
- The GlobalSat was proposed in response to the need for a globally interconnected disaster and environmental management system since no single country can afford to develop a complete set of sensors and satellite systems needed for forecasting, monitoring and mitigating disasters like floods, drought, typhoons, earthquakes, wild fires, windstorms, or tidal events.

- It will provide a common platform that will allow sharing of space and data segments, with an ability to serve individual nation's disaster management and development needs.



## A.21. SEMI-CRYOGENIC LAUNCH VEHICLE

- ISRO signed MoU with Russian space agency to boost its plan for Semi-cryogenic launch vehicle.
- ISRO's third rocket development programme.
- Cost: Rs. 1,800-crore
- Fuel: space-grade kerosene and liquid oxygen
- Capacity: six to ten tonnes to heights of 36,000 km.
- Currently only the U.S. and Russia have this technology
- Future: According to ISRO it will be ready with the engine [SCE-200] in six to eight months.
- This would be double the lifting power of the GSLV and triple that of the PSLV.

## A.22. ASTROSAT

Astrosat is India's first dedicated astronomy observatory to study distant celestial object. ASTROSAT is seen as a smaller version of NASA's Hubble Space Telescope. The Space Observatory will be able to detect objects in **multiple wavelengths** such as X-rays and UV, but with far lower precision than Hubble.

### Launch Vehicle

- It was launched by PSLV-C30 along with six tiny satellites from foreign countries including US.
- This is the first time that an Indian rocket launched satellites from the US.
- 30<sup>th</sup> consecutive successful launch of PSLV.

### Main scientific focus on

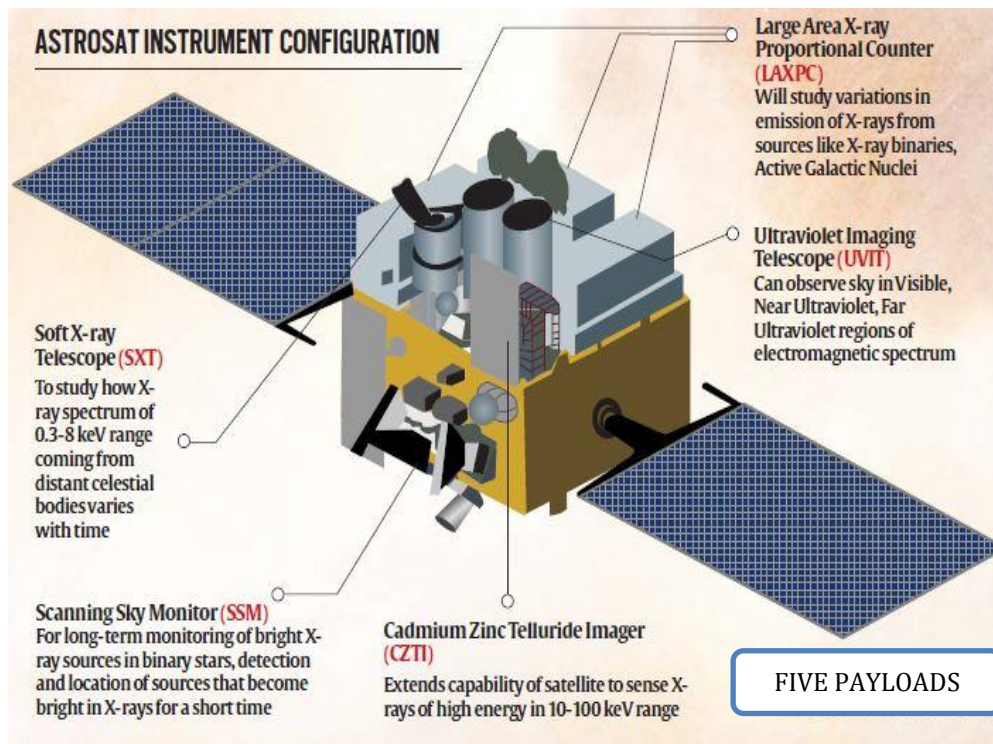
- Understand high energy processes in binary star systems containing neutron stars and black holes.
- Estimate magnetic fields of neutron stars.
- Study star birth regions and high energy processes in star systems lying beyond our galaxy.
- Detect new briefly bright X-ray sources in the sky.
- Perform a limited deep field survey of the Universe in the ultraviolet region.

### Significance

- An open observatory (after one year) with proposal driven research approach.
- Will provide useful data and big boost for the country's astronomy community with self-reliance of scientific data.
- It will put India in an elite orbit with the U.S., Europe, Russia and Japan.



## Components of ASTROSAT



## A.23. LAPAN A2/ ORARI

An Indonesian satellite launched by India, along with ASTROSAT onboard PSLV C30.

### Functions and Features

- Multi-Spectral remote sensing satellite
- To monitor land-use, natural resource and in disaster mitigation, ship movements, sea resources and fishing explorations.
- Successor to LAPAN A1 (also launched by India in 2007)

## A.24. NASA'S SERVIR-MEKONG PROJECT

- Launched by NASA and the US Agency for International Development (USAID)
- Countries that will be benefitted: Cambodia, Laos, Myanmar, Thailand and Vietnam.
- It will provide timely weather, climate and other Earth related data.
- It will enable to better address issues of natural resource and disaster management.
- It is intended to support climate resilience studies, providing early warning of dramatic changes in regional water, food security, weather and climate, and land use of the entire Mekong River Basin.



## A.25. MISSION ON MARS

- MOM was aimed to explore and observe Mars surface features, morphology, mineralogy and the Martian atmosphere.
- Further, a specific search for methane in the Martian atmosphere will provide information about the possibility or the past existence of life on the planet.

### Features

- It was launched by using a Polar Satellite Launch Vehicle (PSLV) rocket C25.
- It costs 450 crore, weighed 1350 kg, travelled for 300 days covered 65 crore km @ 7Rs/km
- It Carried 5 instruments
  - Lyman-Alpha Photometer (LAP),
  - Methane Sensor for Mars (MSM)),
  - Particle environment studies (Mars Exospheric Neutral Composition Analyser (MENCA)),
  - Surface imaging studies (Thermal Infrared Imaging Spectrometer (TIS),
  - Mars Colour Camera (MCC)

### Key Findings

The data filtering in from the payloads is yet to be fully analyzed and published by scientist involved. Initial outcomes include:

- Water on Mars
- Increasing possibility of life on Mars.
- High quality images published in Mars Atlas.

## A.26. NASA'S SPACE LAUNCH SYSTEM (SLS)

- The most powerful rocket ever built.
- The SLS launch vehicle is to be upgraded over time with more powerful versions. Its initial Block 1 has lift capacity of 70 metric tons to low Earth orbit (LEO). The next version Block 2 will be having lift capacity of 130 metric tons.
- The first SLS mission—Exploration Mission 1—in 2017 will launch an uncrewed Orion spacecraft to demonstrate the integrated system performance of rocket and spacecraft prior to a crewed flight.
- It will also be used for explorations on Mars.

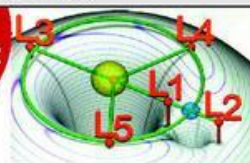
## A.27. ADITYA - INDIA'S SCIENTIFIC MISSION TO STUDY THE SUN

- A joint venture between ISRO and leading institutes of the country.
- The mission aims to put a heavy satellite into what is called a **halo orbit** around a point between the Sun and the Earth. This point is at a distance of about 1.5 million km from the earth.

### ALL ABOUT ADITYA-L1

Aditya will be India's third big extra-terrestrial outing after Moon and Mars

400-kg spacecraft to study Sun



• To orbit 1.5 million km from Earth  
• Likely launch in 2019-20 on the PSLV

• Its 7 instruments to focus on Sun's outer corona, magnetic field, solar winds

• Sanctioned in 2008 at a cost of Rs. 1275 crore.



### Importance of mission

- Help in understanding the origin of solar storms and also for constraining how the storms evolve and what path they take.
- Help us to understand the corona and solar wind's impact on environment.

ISRO's planning to add another spacecraft under Aditya to observe the sun from a different stable orbital position called L5.

- Adding another orientation viz L1 and L5 would provide more clarity.
- Older L1 sun missions by US and Japan could not yield much result/information.

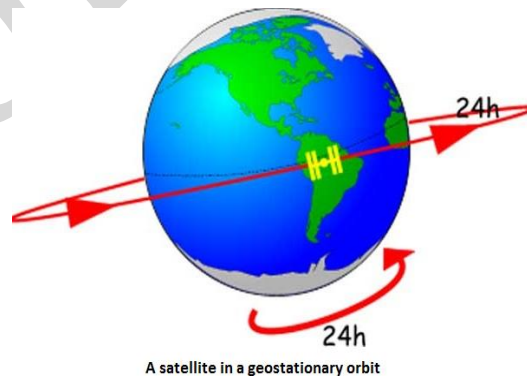
### What is L1, L5?

- Lagrange point is a position in space where the combined gravitational forces of two large bodies, such as Earth and the sun or Earth and the moon, equal the centrifugal force felt by a much smaller third body.
- The interaction of the forces creates a point of equilibrium where a spacecraft may be "parked" to make observation.
- These points are named after Joseph-Louis Lagrange, an 18th-century mathematician.
- There are 5 such points between the earth and the sun namely – L1, L2, L3, L4 and L5.

## A.28. GSAT-15 COMMUNICATION SATELLITE PLACED IN ORBIT

### What is GSAT

- A GSAT is a series of **geosynchronous satellite** placed in geosynchronous orbit, with an orbital period the same as the Earth's rotation period.
- A special case of geosynchronous satellite is the **geostationary satellite (36000 KM)**, which has a geostationary orbit – a circular orbit directly above the Earth's equator. Such satellites are often used for communication purposes.



### GSAT-15

- GSAT-15, India's latest communications satellite, was launched successfully from **Kourou in French Guiana** in South America.
- It will be controlled by ISRO's Master Control Facility (MCF) at Hassan in Karnataka.
- Design life of 12 years and carries a total of 24 communication transponders as well as a GPS-Aided GEO Augmented Navigation (**GAGAN**) payload.
- Its 24 transponders will mainly cater to public and private direct-to-home (DTH) broadcasters, VSAT operators and radio navigation services.



## A.29. SPACE PARKS: ISRO

- The Indian space agency will open a 100-acre Space Park in Bangalore where private industry players would be allowed to set up facilities to make subsystems and components for satellites.
- ISRO wants to groom and engage domestic industry in the launch vehicles area from integrating sub-systems up to assembling, and even launching the PSLV.
- On the spacecraft front, ISRO plans to increasingly support small and mid-sized industries at its 10-year-old second spacecraft complex, the 100-acre ISITE, at Marathahalli in Bengaluru.
- The Space Park will also contribute to the government's 'Make in India' initiative as the private industry and HAL (Hindustan Aeronautics Ltd) have been helping us in making rockets and satellites over the years.
- Also in the pipeline is allowing private players to make satellites and providing them facility at Sriharikota for launch.

## A.30. ASTROBIOLOGY MISSION

- A team of scientists from the NASA, the Mars Society Australia and the Birbal Sahni Institute of Palaeobotany, Lucknow, will mount an expedition to Ladakh this August.
- The aim is to study the similarities of certain parts of the region's topography and microbial life to Martian surroundings.
- This is the **first time** India is part of a Spaceward Bound Programme.

### What is a Space Bound Programme?

- Spaceward bound is an educational program developed at NASA Ames.
- The objective of this programme is for the participating scientific researchers, educators and students to visit the remote and extreme environments in different parts of the world and conduct the astrobiological experiments, make observations and learn about the origin, sustenance and adaptation of the living organism within such biospheres.
- Previous Spacebound experiments have been conducted in Mohave Desert, USA, Nambian Desert, Antarctica, etc.

## A.31. NISAR MISSION COLLABORATION OF ISRO AND NASA

- The NASA-ISRO Synthetic Aperture Radar (NISAR) mission will be the biggest collaboration between these two space organizations
- The mission is to build a 2,600 kg satellite for detailed view of Earth by using advanced radar imaging
- It is expected launched from Indian launch vehicle by 2020
- Payload
  - L-band (24-centimeter wavelength): To be produced by NASA
  - S-band (12-centimeter wavelength): To be produced by ISRO

### Functions of NISAR:

- Observe and take measurements of some of the planet's most complex processes, including ecosystem disturbances, ice-sheet collapse, and natural hazards such as earthquakes, tsunamis, volcanoes and landslides.
- To Predict changes in Earth's topography
- To create the world's largest freely available remote sensing data set

### Earlier collaborations between NASA and ISRO:

- 2005 Chandrayaan-I mission where Moon Mineralogy mapper from NASA accompanied the mission, resulting in “joint-discovery” of water on moon.
- 2014 Mars Orbiter Mission (Mangalyaan) where NASA’s navigational expertise in deep space trajectory and maneuverability aided the mission.



## A.32. SAKAAR

**Sakaar** is Indian Space Research Organisation's (ISRO) Augmented Reality (AR) application designed for Android devices.

- It consists of 3D models of MOM, RISAT, rockets (PSLV, GSLV Mk-III); videos of INSAT 3D-predicting cyclones, GSLV D5/Cryo, Mars Orbiter Mission (MOM) orbit insertion, launch video of MOM, 360 degree animated view of MOM; Anaglyph of Mars surface.

## A.33. NASA DETECTS ANOTHER POWERFUL GAMMA RAY EXPLOSION

### Background

NASA's swift spacecraft has detected its 1,000th **gamma-ray burst (GRB)**.

### What is GRB?

- GRBs are believed to consist of a narrow beam of intense radiation released during a supernova or hypernova as a rapidly rotating, high-mass star collapses to form a neutron star, quark star, or black hole.
- They are the brightest electromagnetic events known to occur in the universe. Bursts can last from ten milliseconds to several hours.
- The initial burst is usually followed by a longer-lived "afterglow" emitted at longer wavelengths (X-ray, ultraviolet, optical, infrared, microwave and radio).

### Significance of GRB

- Gamma-ray bursts can be an observational tool for cosmologists as it could help us to understand the form and evolution of the Universe.

## A.34. PHILAE-ROSETTA

- **What is Philae:** It is a robotic European Space Agency **lander** that accompanied **Rosetta** spacecraft until it landed on comet **67P/Churyumov–Gerasimenko**, more than ten years after departing Earth.
- The probe achieved the first-ever soft landing on a comet nucleus.
- **What is Rosetta: Mothership** (spacecraft) orbiting Comet 67P. Philae communicates with Rosetta, which sends the received data to the earth.

### Goals of the mission

- To focus on **elemental, isotopic, molecular and mineralogical composition** of the comet





- The characterization of physical properties of the surface and subsurface material
- The large-scale structure and **the magnetic and plasma environment** of the nucleus
- The mission seeks to unlock the long-held secrets of comets — **primordial clusters of ice and dust** that scientists believe may reveal how the Solar System was formed.

### Rosetta Findings

- Ingredients regarded as crucial for the origin of life on Earth have been discovered at the comet that ESA's Rosetta spacecraft has been probing for almost two years.
- The Rosetta spacecraft sent a probe, which discovered some basic building blocks of life on comet 67P, including phosphorus and the amino acid glycine.
- Glycine is commonly found in proteins and phosphorus is a key ingredient of DNA.
- The important point is that comets have not changed in 4.5 billion years, so they have the same ingredients that can be formed without our Sun or planets. This means that amino acids are kind of universal.
- Crucially the finding suggests that if comets transported the ingredients of life to Earth, they may have transported them elsewhere, raising the prospect of life on other planets.
- The comet probably contains all necessary ingredients for life, except one thing, and that's energy.

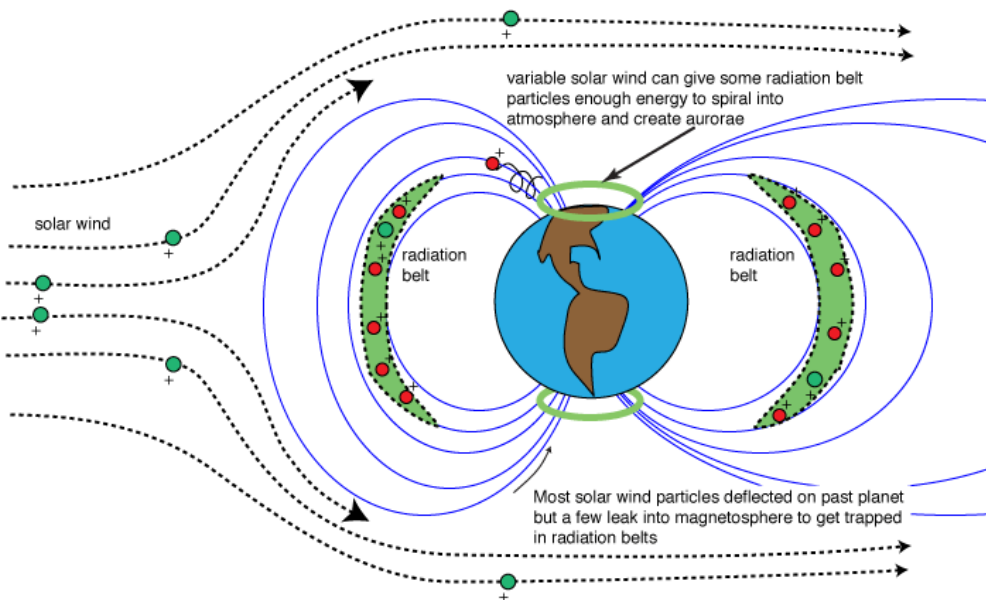
## A.35. STRONG SOLAR WINDS STRIPPED MARS' ATMOSPHERE: NASA

- According to NASA strong solar winds likely played a key role in the transition of the Martian climate from an early, warm and wet environment that might have supported life to the cold, arid planet Mars.
- NASA's Mars Atmosphere and Volatile Evolution (**MAVEN**) mission data has enabled researchers to determine the rate at which the Martian atmosphere currently is losing gas to space via stripping by the solar wind.
- Ancient regions on Mars bear signs of abundant water - such as features resembling valleys carved by rivers and mineral deposits that only form in the presence of liquid water.

### What is a solar wind?

- The solar wind is a stream of energized, charged particles, primarily electrons and protons, flowing outward from the Sun, through the solar system at speeds as high as 900 km/s and at a temperature of 1 million degrees (Celsius).
- It is made of plasma, 4<sup>th</sup> state of matter. Its particles can escape the Sun's gravity because of their high energy.





### How does it affect earth?

- They collide with the magnetic field of the Earth and cause it to change its shape. The particles then leak through the magnetic field of the Earth, particularly near the north and south poles.
- The effects of solar winds on the earth that are visible to naked eye are **the Aurora Borealis (the Northern lights)** at the North Pole and the **Aurora Australis (the Southern Lights)** at the South Pole.
- Astronauts and cosmonauts suffer serious radiation related health conditions if they are caught in the path of solar winds.
- Radiation from solar winds is known to cause chromosome damage and cancer, and these conditions may be fatal for humans in outer space.
- Disrupt radio and television communication and satellite based internet services and destabilize or power grids.

### A.36. HELIUM MICROSCOPE

- This device would enable scientists to study human, animal and plant samples, as well as computer chips and pharmaceutical drugs, without damaging or changing them.
- This would be able to see much smaller objects with a much higher resolution.
- It may be helpful in clean up of toxic or radioactive spills, without harming the surrounding flora or fauna.
- It could lead to the development of stealth technology and new explosives.

### A.37. KEPLER -62F

- It is a planet which is about 1,200 light-years away from Earth and, in all probability, has surface liquid water is a good prospect for a habitable world.
- Kepler-62f, which is in the direction of the constellation Lyra, is in the **Goldilock zone**.

- It is the outermost of five planets orbiting a star that is smaller and cooler than the sun.
- There are multiple atmospheric compositions that allow it to be warm enough to have surface liquid water.
- Further research is being done with simulations varying the amounts of carbon dioxide required to keep the planet warm enough for liquid and life to exist on its surface.

#### What is Kuiper Belt?

- It is flat ring of icy bodies that revolve round the Sun beyond the orbit of Neptune.
- It is home to three officially recognized dwarf planets: Pluto, Haumea, and Makemake.



## A.38. PLANET X

- Researchers at the California Institute of Technology have found evidence in the outer solar system of an object that could be a real ninth planet.
- Nicknamed Planet Nine, it has a mass about 10 times that of Earth and orbits about 20 times farther from the sun than Neptune.

#### How was the inference made?

- Its presence has been inferred from the peculiar **clustering** of six previously known objects that orbit beyond Neptune (Kuiper belt).
- It is said that there's only a 0.007% chance, that the clustering could be a coincidence. Instead, a planet with the mass of 10 Earths has shepherded the six objects into their strange elliptical orbits, tilted out of the plane of the solar system.

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# B. POLICIES / PROGRAMMES / INITIATIVES



## B.1. DRAFT GUIDELINES ON UAV'S

### Why in news?

Last month, the draft guidelines for civil UAV (Unmanned Aerial Vehicle) operations were announced by the DGCA (Directorate General Of Civil Aviation).

### Need of guidelines

- UAVs or Drones have the potential for use in a large number of civil applications. Its use, besides being a safety issue, also poses a security threat, and has the potential for invading privacy.
- The airspace over Indian cities already has a high density of aircraft traffic and unregulated use of drones poses a grave threat for air collisions and accidents.
- Further, in view of technological advancements in UAS (Unmanned Aircraft system), it has become necessary to develop guidance material to regulate its activity.

### Regulations

- All unmanned aircraft intended to be operated in India will require a Unique Identification Number (UIN) issued from DGCA.
- All civil UAVs have to obtain operator permit (UAOP) from DGCA.
- UIN to be granted to an Indian citizen or a company whose chairperson and two-thirds of its directors are Indian citizens.
- UAVs with an UIN shall not be sold or disposed to any other person or firm without permission from DGCA.
- The policy also lists out guidelines for training remote pilots who should have completed 18 years of age as well as the regulations on controlled airspace.
- Import of drones will require prior approval from DGCA based on which DGFT shall provide license for import.
- UA operations at or above 200 feet AGL (above ground level) in uncontrolled airspace will require permit from DGCA. Operations below 200 ft AGL in uncontrolled airspace will not require a UAOP.
- International operations of civil UAS (flying across territory) and/or over water shall be strictly prohibited.

#### Case Study: UAVs used by Karnataka Police:

Karnataka Police Department is the first to own and operate drone fleet. About 20 policemen have been trained and given the exclusive task of operating the drones. The UAVs have already helped the police identify sand mining along the border of Karnataka and Andhra Pradesh due to its night visibility.

### Uses and benefits of UAVs

- Damage assessment of property and life in areas affected with natural calamities, surveys, critical infrastructure monitoring.
- The benefits are immense - for government, security agencies, companies, researchers, retailers and aviation enthusiasts.
- Other commercial and recreational uses.



### Issues and Suggestions

- The operational limits of micro as well as the mini UAVs range is 500m which is a limiting factor for purpose of mapping and monitoring of large infrastructure projects such as power lines, highways, river basin, etc.
- The DGCA regulations must provide for a level playing field for the private sector so that innovation, growth and adopting of UAV technologies by end users can become commonplace.
- It must initiate multi stakeholder engagement process to develop a framework for privacy, accountability, and transparency issues of commercial and private UAV use in line with the policy of ease of doing business.
- Visual line of sight (VLOS) restrictions should go - it restricts the utility of a UAV fitted with camera and product delivery capability.
- Issues of security, enforcement and penalty have not been adequately dealt with. For e.g. without adequate monetary fines, the penalty provisions in the guidelines will lack the bite to be taken seriously.

### Conclusion

UAVs of today are a precursor to next generation aerospace technologies. Unless we bring in the right set of regulations, the investors would be reluctant to take a leap of faith in the development of the UAV industry.

## B.2. RASHTRIYA AVISHKAR ABHIYAN

**Aim:** to inculcate a spirit of inquiry, creativity and love for Science and Mathematics in school children.

- Developed by the Ministry of Human Resource Development
- It seeks to Develop Scientific Temper Among School Children,
- To encourage students to learn sciences beyond the classrooms.
- Under Rashtriya Avishkar Abhiyan, government schools will be mentored by Institutes like IITs/ IIMs/ IISERs and other Central Universities and reputed organisations through innovative programmes, student exchanges, demonstrations, student visits, etc. to develop a natural sense of passion towards learning of Science and Maths.

### Major interventions

- Sensitization of Parents and Community
- Organised visits to Science Museums, Innovation hubs and Science fairs and Mathematics Melas
- Participation of Students in Inter-school, State/ National Science and Mathematics competitions/ Olympiads etc.
- Expand outreach of programmes of Ministry of Science and Technology to promote science learning
- Science, Mathematics and Technology Clubs for Children
- Promotion of Science & Mathematics Teacher Circles
- School Mentoring
- Strengthening teacher support institutions through use of technology
- Use of Technology in Science and Mathematics teaching



### B.3. ATAL INNOVATION MISSION (AIM) AND SETU

- AIM is an Innovation Promotion Platform in the NITI Aayog, involving academics, entrepreneurs and researchers and draws upon national and international experiences to foster a culture of innovation, R&D and scientific research in India.
- It has an initial fund of **150 crore for R&D** .
- It will provide funds to a network of institutions to conduct research on innovations that can improve economic growth and job creation.
- It has replaced the **National Innovation Council**, a significant difference between the two will be the powers to disburse funds.
- Self-Employment and Talent Utilisation under NITI Aayog. SETU will be a Techno-Financial, Incubation and Facilitation Programme to support all aspects of start-up businesses, and other self-employment activities, particularly in technology-driven areas.

### B.4. IMPRINT INDIA PROGRAM

- A joint initiative of Indian Institutes of Technology (IITs) and Indian Institute of Science (IISc).
- Imprint India seeks to develop a road map for research to solve major engineering and technology challenges in 10 technology domains relevant for the country.
- The move will motivate technical institutions to conduct research in advanced area of SnT.
- The **objectives** of the initiative
  - Identifying areas of relevance to society that require innovation.
  - Ensuring higher funding support for research into these areas.
  - Measuring the research's impact on people's standard of living.

### B.5. DISHA (DIGITAL SAKSHARTA ABHIYAN)

- Central Government launched a programme to invest **Rs 500 crore** on providing **basic computer education to about 50 lakh people** over next **3 years** with the help of private companies.
- The programme offers two-hour, 10-hour and 20-hour courses in local languages.
- The scheme targets to train Anganwadi and ASHA workers and authorized ration dealers in all the States/UTs across the country apart from one person from every eligible household
- Government would deliver various services such as e-education, e-health and e-governance through a national broadband network which is expected to be in place by 2017.
- **Disha Mobile App** will help people learn about computers and Internet through self-learning.
- In order to offer digital literacy to tribal and Dalit women in Bihar, govt. awarded tablet computers to women who received training from common service centres in the state.



## B.6. KISAN (CROP INSURANCE USING SPACE TECHNOLOGY AND GEO-INFORMATICS)

- Under this programme govt. will use satellite and unmanned aerial vehicles to collect crop yield data and to assess damage from natural calamities.
- The scientific data collected by drones and collated with satellites imagery will be matched with traditional crop cutting experiments to arrive at a fool proof data.
- In earlier system, there has always been a problem in getting timely and accurate data, due to which payment of claims to farmers were getting delayed.
- Initially, KISAN programme will be tried out as a pilot study in identified districts in Haryana, Karnataka, Maharashtra and Madhya Pradesh.
- **Mobile application to help farmers:** Govt. launched an Android mobile phone application (developed by ISRO) to assess large-scale damage to crops from hail.
- Using this application, farmers can immediately send photos of their crop damage to officials concerned for immediate relief. This will cut the red tape in reaching assistance to farmers.
- **Need of such mobile application:** Hailstorms cause large-scale damage to standing crops. However, there was no comprehensive approach to collect hailstorm data.

## B.7. 103RD INDIAN SCIENCE CONGRESS AND TECHNOLOGY VISION DOCUMENT 2035

### Why in news?

- 103rd Indian Science congress in **Mysuru** was organized with the focal theme '**Science and Technology for Indigenous Development in India**'.
- It has been prepared by Technology Information, Forecasting and Assessment Council, (TIFAC)

### Aim of Technology Vision Document 2035:

Focus of 'Technology Vision Document 2035':

1. **Technology Leadership** – ex: Nuclear Energy, Space Science.
2. **Technology Independence** – ex: Defence sector.
3. **Technology Innovation** – ex: solar cells patterned on chlorophyll based synthetic pathway are a potent future source of renewable energy.
4. **Technology Adoption** – ex: foreign collaboration in the sectors of rainwater harvesting, agri-biotech, desalination, energy efficient buildings.
5. **Technology Constraints** –eg: Genetically Modified (GM) Crops.

### The Vision Document gives a 'Call to Action' to all the key stakeholders

- **Technical Education Institutions** .
- **Government** enhances financial support from current 1% to long-envisaged 2% of the GDP.
- **Academia-Intelligentsia-Industry connect** is established via idea exchange, innovative curricula design, based on the needs of the industry, industry-sponsored student internships and research fellowships inter alia.
- **Creation of a Research Ecosystem** to achieve translation of research to technology product/process by integrating students, researchers and entrepreneurs.





## B.8. 23RD NATIONAL CHILDREN SCIENCE CONGRESS (NCSC)

- 23rd NCSC (started in 1993) was based on **the theme of 'Understanding Weather and Climate'**
- Nearly 1,400 students in age group 10 to 17 years, from various schools presented projects under various categories depicting the problems faced by world due to climate change or possible solutions.
- More than 300 scientists and researchers from Department of Science and Technology also participated.

### Objectives of NCSC:

- Forum for young scientists to pursue their natural curiosity and to quench their thirst for creativity by experimenting on open-ended problems.
- To make children feel that science is all around and you can gain knowledge as well as solve many problems.
- To encourage children to visualize future of the nation and help build generation of sensitive, responsible citizens.

## B.9. REGULATION OF EXPLOSIVES IN INDIA

### Regulating Acts/Rules

- Explosives Act, 1884
- Inflammable Substances Act, 1952
- Explosives Rules, 2008

### Issues related to regulation

- The sale and transport of explosive materials is regulated by the Petroleum and Explosives Safety Organization (PESO), under the Union Commerce and Industry Ministry.
- This centralized regulation raises question about the ability of a Central agency to monitor all explosive substances everywhere in the country.
- The agency is still to computerize its operation which is very crucial for efficient regulation
- A system is yet to be worked out for a real-time tracing and tracking programme enabling police and district collector to monitor sale and purchase of explosive in their area.

### Why in News?

Recently, illegally stored gelatin sticks exploded in Madhya Pradesh, claiming about hundreds of lives and raising questions about regulation of the sale, purchase and subsequent monitoring of explosive materials across the country.

### What is Gelatin Stick?

It is a blasting material invented by Alfred Nobel (who also invented Dynamite). It cannot explode without detonator and thus, it can be stored safely.

## PESO - Petroleum and Explosives Safety Organization

### Objectives

- To administer the responsibilities delegated under the Explosives Act 1884 and Petroleum Act 1934 and the rules made thereunder related to manufacture, import, export, transport, possession, sale and use of Explosives, Petroleum products and Compressed gases.
- Providing operational and technical Advice and Assistance to the Central Government, States, Local Bodies, Law Enforcement Agencies, Industry, Trade and end users of these products.
- Ensure public safety in the areas of manufacture, transport, storage, etc. of Explosives, Petroleum, Carbide of Calcium, Inflammable substances etc.
- Framing National Standards concerning public safety in collaboration with BIS, OISD & other apex bodies and harmonizing Indian standards with international standards.



“You are as strong as your foundation”

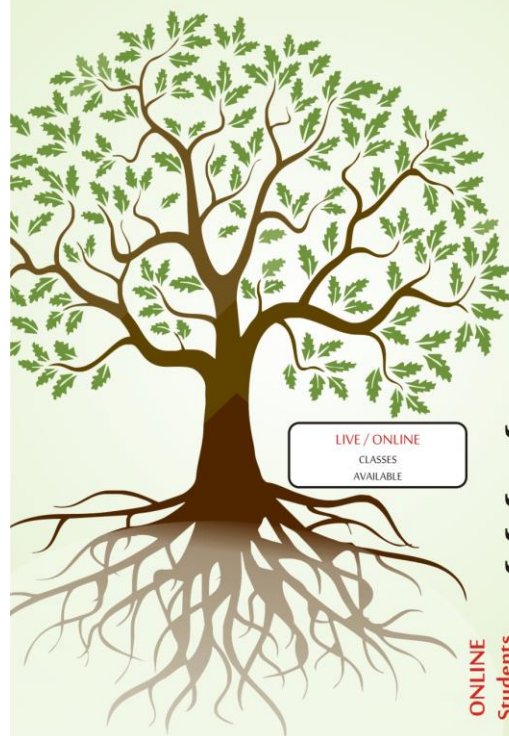
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# C. TECHNOLOGIES/NEW DICOVERIES

## C.1. GRAVITAIONAL WAVES



### Why in news?

- Gravitational waves have been discovered by the U.S.-based LIGO (Laser Interferometer Gravitational Wave Observatory).
- India is an important partner in the LIGO project and the announcement was simultaneously made at the **Inter-University Centre for Astronomy and Astrophysics (IUCAA) in Pune.**

### What are 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.
- Albert Einstein predicted the existence of gravitational waves in 1916 in his general theory of relativity.

### How it is detected in the lab?

- The basic principle for detection is **interference** – when two waves combine, they produce a pattern based on relative positions of peaks and troughs in those waves.
- In LIGO, a high powered laser beam is split and sent down two L-shaped vacuum tunnels, each 4 Km. long. They get reflected from two high precision mirrors and reach back at the base. They come back in such a way that they completely cancel out each other. No light is detected at the photo-detector.
- But when a gravity wave passes-by, it distorts space and changes the distance that the beams have to travel. No longer are the peaks and troughs of the two reflected waves perfectly aligned. As they do not cancel out each other now, some pattern is detected at the photo-detector.

### Gravitational wave detector in India: INDIGO

- India-LIGO project will be a replica of the two LIGO detectors and would be stationed at a perpendicular direction to the detectors in USA.
- LIGO-India project is piloted by Department of Atomic Energy (DAE) and Department of Science and Technology (DST).
- The LIGO-India project will be jointly coordinated and executed by three Indian research institutions: the Inter-University Centre for Astronomy and Astrophysics (**IUCAA**), Pune and Department of Atomic Energy organisations: Institute for Plasma Research (**IPR**), Gandhinagar and the Raja Ramanna Centre for Advanced Technology (**RRCAT**), Indore.
- It will enrich technological areas like precision metrology, photonics and control systems.

## HOW WILL THE DISCOVERY CHANGE **SCIENCE & OUR WORLD?**



### WE WILL BE ABLE TO...

- ▶ For the first time **receive cosmic signals** that were previously **entirely hidden** from us, revealing an entirely new layer of reality
  - ▶ **Track supernovas** hours before they're visible to any telescope because the waves arrive at Earth long before any light does, giving astronomers time to point telescopes like Hubble in that direction
  - ▶ **Measure the frequency of major cosmic phenomena** such as supernovas or merger of black holes – events that shape star systems and galaxies
- ▶ **Hear the noises produced by gravitation of celestial bodies** on the fabric of space-time. Since the star or black hole does not stop these waves, which move at the speed of light, they come right to us and we can therefore make models... to distinguish and detect their signatures



## C.2. SMART GRID

### About the Smart Grid project:

- The project is a part of the smart city initiative.
- The project has been divided into three phases
  - Replacing old equipment and cables
  - Installing smart meters in households
  - Developing software to improve the efficiency of electricity distribution.
- A major highlight of the NDMC's Smart City proposal is its plan to upgrade its electricity network into a smart grid system.
- A smart grid network will facilitate two-way communication between the consumers and the power utilities.
- It will bring synergy between generation, transmission, distribution systems, consumers and also renewable sources by integrating all into one seamless system.
- An important aspect of the system is to have 100 per cent Advance Metering Infrastructure (AMI), which will give the consumers real-time data about power consumption thereby allowing them to make informed choices about their usage.
- A basic example of how it will help the consumers is that they will be able to give commands right in their energy meters including troubleshooting.

The NDMC is coming up with a Rs 500-crore "Smart Grid" project aimed at reducing losses through better power distribution and checking thefts and faults in transmission.

## C.3. HVDC TECHNOLOGY

### What is HVDC?

- High-voltage direct current (HVDC) is a technology developed to increase the efficiency of power transmission over long distances by using Direct current transmission at high voltage.



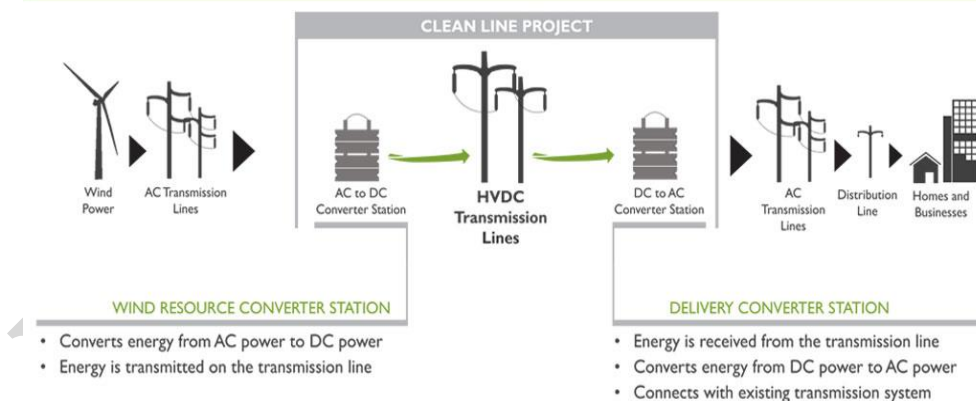
## Background and Technology:

- Power stations generate alternating current (AC) and most power lines carry AC that oscillates with 50 or 60 cycles per second, whether for the high, medium or low-voltage distribution grid.
- Power also reaches consumers in homes, industries and offices as AC.
- Direct current doesn't oscillate, so less energy is lost during transmission using DC.
- The current is changed in a converter station and transmitted to the receiving point by an overhead line or cable.
- It is then restored to AC in another converter station and injected into the receiving AC network.
- A 2,000-km long DC transmission line at 800 kV loses about 5 percent of its power, while the power losses in an AC line of similar voltage are about twice as high.

## Why HVDC demand is increasing?

- rising energy needs
- less electricity is lost in transmission than with conventional AC technology
- requires fewer transmission lines, meaning that less land has to be cleared
- Why HVDC only for longer transmission?
- Because special equipment is needed to convert electricity from alternating current to direct current, HVDC is cheaper only over long distances, typically more than 600 kilometers for overhead lines and more than 50 km for underwater cables

## DELIVERING RENEWABLE ENERGY WITH HVDC



## India's first HVDC transmission line

- India's first high-voltage, direct-current (HVDC) transmission line was built by the state-owned PowerGrid connecting the northern states with the north-eastern ones.
- The HVDC corridor would facilitate transfer of 24,000 Mw from future power generation projects in the northeastern region and Bhutan.
- The corridor would help resolve the issue of congestion in the north and northeast regions.

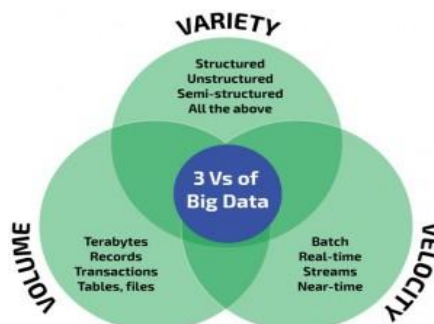


## C.4. CLOUD COMPUTING AND BIG DATA

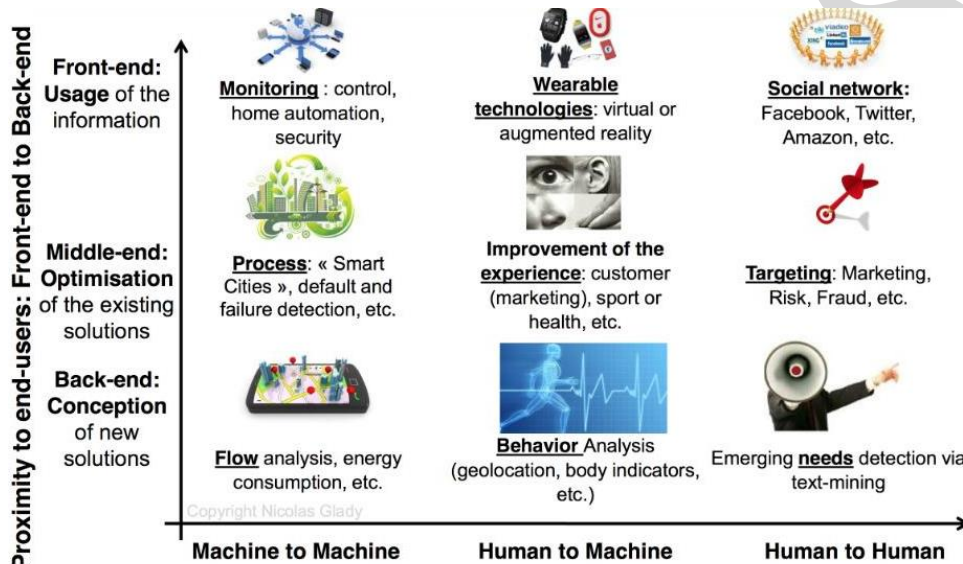
- At the 103rd Indian Science Congress, experts said that Cloud computing can be the solution to Big data problem.

### What is Big Data?

- Big data is a term that describes the large volume of data – both structured and unstructured beyond the ability of commonly used software tools to capture, curate, manage, and process data within a tolerable elapsed time.
- Big data is characterized by 3Vs



### Applications of Big Data



### How is cloud computing related to Big data?

- Cloud computing is very important in BIG data analytics due to its application sharing and cost effective properties.
- Large centralised servers and processing power would be crucial to harness the full potential of big data.

## C.5. BIO-GLASS

### Why in news?

- Scientists from Imperial College London in the UK and University of Milano-Bicocca in Italy have developed a bio-glass material that mimics the shock-absorbing and load bearing qualities of real cartilage.
- The material can also **mimic cartilage** and encourage it to re-grow, which will be helpful in damaged cartilage replacements between discs in vertebrae.
- The bio-glass consists of silica and a plastic or polymer called polycaprolactone.

Cartilage is the flexible connective tissue found in the joints and between vertebrae in the spine. Compared to other types of connective tissues, it is not easy to heal when damaged.





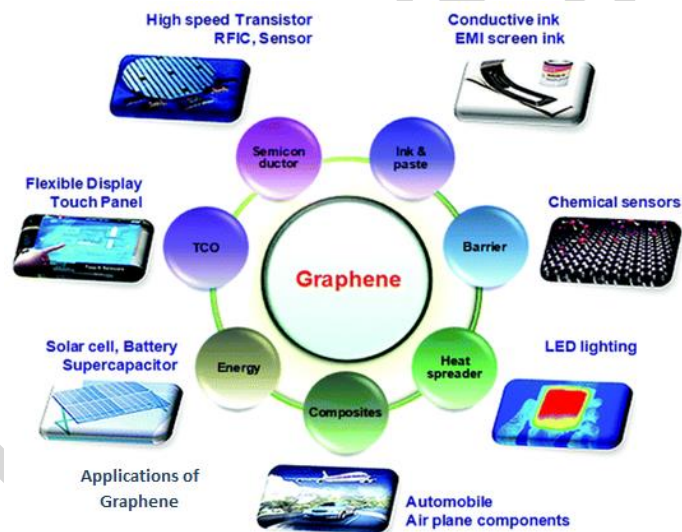
## Features

- It can be made in a biodegradable ink form, enabling the researchers to 3D print it into structures that are tiny, biodegradable scaffolds.
- It also displays self-healing properties when it gets damaged, which could make it a more resilient and reliable implant. When implanted, the combination of the structure, stiffness and chemistry of the bio-glass would encourage cartilage cells to grow through microscopic pores.
- Thus it has the potential to encourage cartilage cells to grow in the knees, which was not possible till now.
- Over time the scaffold would degrade safely in the body, leaving new cartilage in its place that has similar mechanical properties to the original cartilage.
- Bioglass also finds application in drug delivery, as antibacterial agent, as remineralization element and in bone tissue engineering.

## C.6. NANOTECHNOLOGY TO RECREATE BONES

Scientists at the Indian Institute of Science (IISc), Bengaluru suggests that '3D Blocks' of **graphene** composites can be used for bone tissue regeneration as they mimic the environment of the bone.

- Graphene will be used for strengthening Polycaprolactone (PCL) - a biodegradable polymer which will be used for bone support
- The purpose of the PCL is to provide only a temporary home for the regenerating cells & allowing for healthy tissue to eventually replace the scaffold.
- Nanotechnology will be used to create 3D structure of Graphene



### What is Graphene?

Graphene form of carbon consisting of planar sheets (2D structure) which are one atom thick, with the atoms arranged in a honeycomb-shaped lattice.

## C.7. 'LI-FI'

- Until now, wireless data was facilitated by Bluetooth (for low-speed, short distance wireless communication,) cellular signals (wide range 3G, and soon 4G etc.) or WiFi (broadband wireless within rooms, buildings and open areas).
- Recent developments are pointing to a new-generation technology that uses LED light to transmit data known as **Li-Fi (loosely expanding to Light-Fidelity)**.

- Using precisely controlled light modulation, data can be transmitted using regular, visible light.
- Its speeds will be between 10 and 100 times faster than current-generation WiFi.
- Transmission range of this technology is limited compared to a radio frequency based technologies like Wi-Fi.
- Range is inversely proportional to frequency



### Current applications

- Used in enabling of household appliances and devices communication
- Used in high-speed point-to-point networking devices that deliver backbone network support.
- Data-laden lights can continue to function for regular illumination.

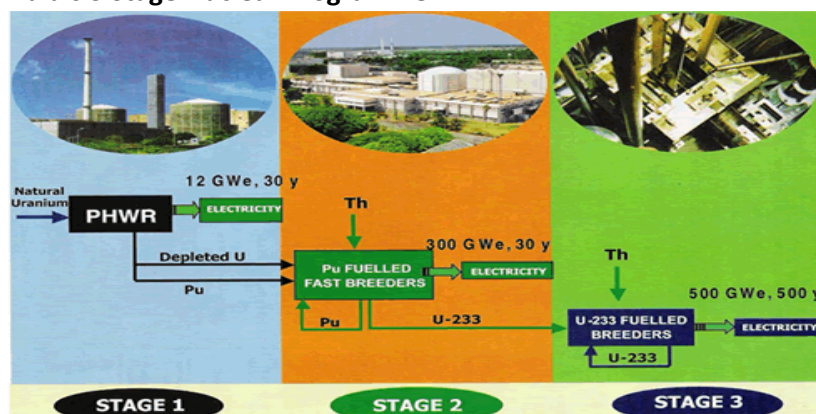
## C.8. AUGMENTED REALITY TECHNOLOGY

- Augmented Reality is a live direct view of a physical, real-world environment whose elements are augmented (or supplemented) by computer-generated 3D models, animations, videos etc.
- It enhances user's current perception of reality.
- The AR requires three elements - Android device with back camera, AR application and AR markers.

## C.9. KALPAKKAM FAST BREEDER REACTOR

- The 500-MWe Prototype Fast Breeder Reactor (PFBR) at Kalpakkam is getting ready to be commissioned in September.
- It will signal India's entry into the second stage of its three-stage nuclear power programme.
- **Fuel:** plutonium-uranium oxide ; **Coolant:** liquid sodium
- **What is FBR:** A reactor, which produce more fuel than it consumes.
- **Current status:** The PFBR construction had been completed and equipment energised. The agency is awaiting clearance from the Atomic Energy Regulatory Board (AERB) for sodium charging, fuel loading, reactor criticality and then stepping up power generation.
- **Who build reactors:** Bharatiya Nabikhiya Vidyut Nigam Limited (**BHAVINI**), a public sector undertaking of the Department of Atomic Energy.

### India's 3 Stage Nuclear Programme





- **India's three-stage nuclear power programme** was formulated by Dr. 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.
- Motivation behind this programme: India has 25% of world thorium reserves but only 1-2% global uranium reserve. So it will enable the thorium reserves of India to be utilised in meeting the country's long term energy requirements.
- The recent Indo-US Nuclear Deal and the NSG waiver, which ended more than three decades of international isolation of the Indian civil nuclear programme, have created many hitherto unexplored alternatives for the success of the three-stage nuclear power programme.

## C.10. CLOUD SEEDING

Cloud seeding, a form of weather modification, is an attempt to change the amount or type of precipitation that falls from clouds, by dispersing substances into the air that serve as cloud condensation or ice nuclei.

- **Chemicals used:** Silver iodide, potassium iodide and dry ice (solid carbon dioxide). Liquid propane

### Uses:

- To increase rainfall in a particular area.
- To prevent hail and fog



## C.11. AERIAL SEEDING

### What it is:

Aerial seeding is a technique of sowing seeds using helicopters and aeroplanes to scatter them.

### Why in News:

Andhra Pradesh govt. launched aerial seeding of nearly 1,500 hectares of degraded forest on hill slopes in Guntur and Krishna districts that are not suitable for traditional methods of sowing.

### Significance

- In the aftermath of a wildfire – reforestation.
- Can be used where terrain is extremely rocky or at high elevations or otherwise inaccessible
- Efficient coverage of a large area in the least amount of time



## C.12. POWERWALL

- Powerwall is rechargeable lithium-ion battery product manufactured by Tesla Motors for home use.
- It charges home appliances using electricity generated from solar panels when sun goes down.
- Automated, compact and simple to install, Powerwall offers independence from the utility grid and the security of an emergency backup.
- **Powerpack** is a bigger variant available for industrial consumers with a storage capacity of 100 kWh.

## C.13. PROJECT LOON

Project Loon is a network of balloons traveling on the edge of space, designed to connect people in rural and remote areas, help fill coverage gaps, and bring people back online after disasters.

- The initiative has already been tried out in Brazil, New Zealand and Australia.
- Around 1,000 Internet balloons have already been deployed worldwide, and had flown nearly 20 million km while some of them had circled the world 20 times.

### Significance:

- The system aims to bring Internet access to remote and rural areas poorly served by existing provisions.
- It will improve communication during natural disasters to affected regions.
- A recent UN study claimed that a 10 percent rise in internet penetration would mean a 1.4 per cent annual increase in a country's GDP.

## C.14. HYBRID VACUUM TOILETS

- It is combination of vacuum toilets and bio-digester in which the discharge of the vacuum toilets is transferred into biodigester.
- The biodigester tank is fitted underneath the coach and contains anaerobic bacteria that convert human fecal matter into water and small amount of gases before discharging the same on the ground/track.
- This concept of hybrid vacuum toilet is developed by Indian railways.
- Water uses: Appx. 500 ml of water for flushing while conventional toilets consume 10-15 lt water/flush.

## C.15. DARK MATTER AND DARK ENERGY

- Roughly 80 percent of the mass of the universe is made up of material that scientists cannot directly observe known as dark matter.

### Background

- Studies of other galaxies in the 1950s first indicated that the universe contained more matter than seen by the naked eye.
- The familiar material of the universe, known as baryonic matter, is composed of protons, neutrons and electrons. Dark matter may be made of baryonic or non-baryonic matter.



- To hold the elements of the universe together, dark matter must make up approximately 80 percent of its matter.
- The missing matter could simply be more challenging to detect, made up of regular, baryonic matter.
- Most scientists think that dark matter is composed of non-baryonic matter.

### Proof

- Scientists calculate the mass of large objects in space by studying their motion.
- Astronomers examining spiral galaxies in the 1950s expected to see material in the center moving faster than on the outer edges.
- Instead, they found the stars in both locations traveled at the same velocity, indicating the galaxies contained more mass than could be seen.
- Studies of the gas within elliptical galaxies also indicated a need for more mass than found in visible objects.
- Clusters of galaxies would fly apart if the only mass they contained were visible to conventional astronomical measurements.
- All of these methods provide a strong indication that the most of the matter in the universe is something yet unseen.

### Dark matter versus dark energy

- Although dark matter makes up most of the matter of the universe, it only makes up about a quarter of the composition. The universe is dominated by dark energy.
- After the Big Bang, the universe began expanding outward. Scientists once thought that it would eventually run out of the energy, slowing down as gravity pulled the objects inside it together.
- But studies of distant supernovae revealed that the universe today is expanding faster than it was in the past, not slower, indicating that the expansion is accelerating.
- This would only be possible if the universe contained enough energy to overcome gravity - dark energy.

## C.16. 15 YEARS OF HUMAN PRESENCE ON ISS

- The International Space Station (ISS) has completed 15 years of continuous human presence.
- Expedition 1, the first station crew, docked inside the Soyuz TM-31 spacecraft on 2<sup>nd</sup> November 2000.
- Its first component launched into orbit in 1998 but the first Expedition arrived on 2 November 2000. Five different space agencies representing 15 countries built the \$100-billion International Space Station and continue to operate it today. NASA, Russia's Federal Space Agency (Roscosmos), the European Space Agency, the Canadian Space Agency and the Japan Aerospace Exploration Agency are the primary space agency partners on the project.
- The International Space Station (ISS) is a space station, or a habitable artificial satellite, in low Earth orbit.
- Moon is the largest body orbiting the earth. ISS is the largest artificial body in orbit and can often be seen with the naked eye from Earth.



## C.17. MULTI-APPLICATION SOLAR TELESCOPE (MAST)



### Purpose and significance

- Detailed study of the Solar activity including its magnetic field. This study of solar activities would facilitate space weather predictions in the future.
- Capable of capturing three-dimensional aspects of the solar magnetic fields further enabling the scientists to get a better understanding of the solar flares and eruptions taking place in such twisted magnetic fields.
- USO is a part of Physical Research Laboratory (PRL), which is an autonomous unit of the Department of Space.
- The observatory is situated on an island in the middle of Fatehsagar lake.

### Features of MAST

- 50 cm aperture
- Off-axis Gregorian-Coude telescope

### Other Telescopes in India

Name/Observatory	Aperture	Year	Location
National Large Solar Telescope	200 cm	Proposed	Merak Village, Ladakh,
ARIES Observatory	15 cm	1961–	Nainital,
Solar Tunnel Telescope, Kodaikanal Solar Observatory	61 cm (24 in)	1958–	Kodaikanal,



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# D. HEALTH AND BIOTECHNOLOGY



## D.1. SUPERBUG IN USA

### Why in news?

Recently, a woman in the U.S. was detected with E.coli bacteria, bearing a new gene, **MCR-1, resistant** to a last-resort antibiotic like colistin.

### Why is it being called as Superbug?

- Though resistance to colistin had been detected in several countries in the past, it was overlooked as such resistance was brought about by gene mutations that cannot spread easily between bacteria.
- But **MCR-1** poses a threat of an entirely different order; in this case a small piece of DNA (plasmid) found outside the chromosome carries a gene responsible for antibiotic resistance. Since the gene is found outside the chromosome, it can spread easily among different types of bacteria, as well as among patients.
- If this gene spreads to bugs treatable by only last-resort antibiotics, it could create the superbug.
- It could well lead to an era without effective drugs to treat bacterial infections — the post-antibiotic age.
- The unchecked use of antibiotics in livestock is a major reason for the development of drug resistance.

## D.2. INDIA'S RED LINE CAMPAIGN ON ANTIBIOTICS

### Why in news?

The Global Review on Antimicrobial Resistance, commissioned by U.K. Prime Minister in 2014 in its report, has praised this campaign of India.

### What is the Red Line Campaign?

- Consumption of antibiotics in India increased sharply, while the effectiveness of these to treat bacterial infections has been steadily declining. India consumed 13 billion units of antibiotics, the highest in the world.
- A much-needed public awareness campaign called '**Medicines with the Red Line**' to highlight the dangers of misuse and irrational use of antibiotics was launched by the Ministry of Health and Family Welfare.
- Now, packs of certain medicines carry a '**red line**' differentiating them from other drugs.

### Way forward

- Drug companies manufacturing irrational fixed-dose combination drugs should be checked.
- The government should also regulate drug companies discharging antimicrobial waste into the environment and use of antibiotics in animal feed.

### D.3. GENE DATABASE PROJECT



#### Why in news?

- Bangalore-based Medgenome has teamed up with a Southeast Asian consortium to sequence 100,000 Asian genomes which could include at least 30,000 Indian genomes and could help understand the wide genetic variety in India's various ethnic groups.
- This would be the largest database of Indian genomes.
- **Need:** Indian populations are neglected in databases like 1000 Genomes Project, Asia genome Projects etc.

#### Some details about the project

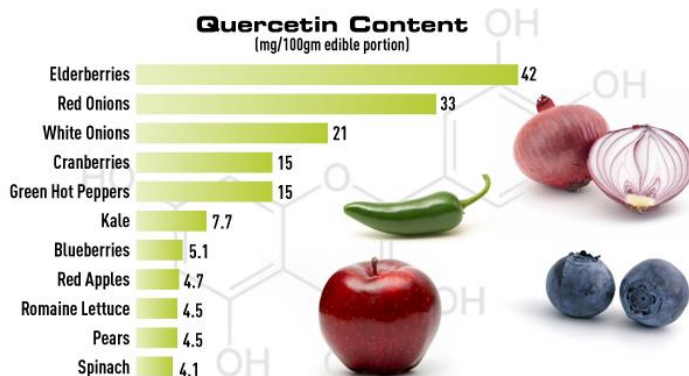
- The project will develop in phases with initial 1000 genomes, consisting of India and East Asian populations, sequenced within this year and the entire database to be ready by 2020.
- Nearly 60 petabytes of data - equivalent to 30 trillion pages of text - are expected to be churned out.
- By utilizing big-data parsing tools and artificial intelligence, researchers can apply precision medicine to multiple goals, including cancer prevention.
- These projects can help in innovative clinical drug trials for cancers, reduction in drug resistance, understanding direct ties between diet and genetics.
- The genome database can help to compare known healthy DNA to the DNA of diseased tissue to identify minute differences in case of such complex diseases.

### D.4. QUERCETIN

#### Why in news?

- IISc Bangalore concluded study on quercetin recently and found it to be extremely useful for cancer patients.

- Quercetin is a flavonoid (plant pigment) commonly found in fruits and vegetables, especially onions, citrus, and apples.
- The primary benefit of quercetin is that it possesses potent antioxidants. Antioxidants fight against free radicals - chemically reactive compounds that damage cell membranes and DNA and also cause cell death.



#### Why is it called a Green Way to cancer treatment?

- Quercetin, known to cause anti-cancer and anti-inflammatory activity, reportedly induces 'apoptosis,' a process by which cells commit suicide in a controlled manner.
- The compound may also prevent multiplication of cancerous cells by blocking the process of cell division.
- It can even kill the highly aggressive leukaemia cell line K562, which is resistant to most anti-cancer drugs.

- It is an originally purified compound, which is now also commercially purified and sold.
- It was found to have no adverse effects on the non-cancerous cells even while killing the cancerous ones, including in the experimental animals.



## D.5. HYPOXIA AND FROSTBITES

### Consequence of High Altitude on human health:

- **Hypoxia:** It is a condition in which the body or a region of the body is deprived of adequate oxygen supply.
- **Frostbites:** It is an injury that is caused by exposure of parts of your body to temperatures below freezing point. The cold causes freezing of your skin and underlying tissues. The fingers, toes and feet are most commonly affected but other extremities including the nose, ears, and the cheeks can also develop frostbite.
- **Hypothermia:** It is a potentially dangerous drop in body temperature, usually caused by prolonged exposure to cold temperatures.
- **High-altitude pulmonary edema:** It is a medical condition in which excess fluid develops in the lungs, either in the lung tissue itself or in the space normally used for gas exchange.

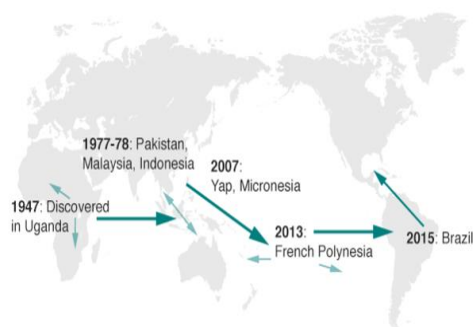
**High-altitude cerebral edema:** It is a medical condition in which the brain swells with fluid because of the physiological effects of traveling to a high altitude.

## D.6. ZIKA VIRUS

### Origin

- It was first identified in monkeys in Uganda in 1947.
- The first human case was detected in Nigeria in 1954 and there have been further outbreaks in Africa, South East Asia and the Pacific Islands.

How Zika virus spread from Africa



### Countries Affected

- In May 2015, it was reported in Brazil and has spread rapidly.

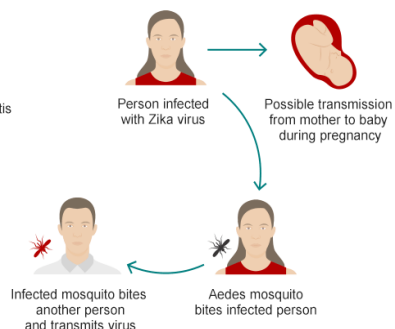
### Cycle of Spread

- It is spread by **Aedes mosquitoes**.
- They are found throughout the Americas **except for Canada and Chile where it is too cold for them to survive**.
- If mosquitoes drink the blood of an infected person they can then infect subsequent people they bite.

Zika virus transmission cycle

#### Symptoms

- Fever
- Rash
- Joint pain
- Conjunctivitis (red eyes)



Zika can be transmitted through blood, but this is an infrequent mechanism. The virus has also been isolated in semen, but person-to-person sexual transmission is unconfirmed.

- Unlike the mosquitoes that spread malaria, they are mostly active during the day, so bed nets offer limited protection.



### Affected People

- Most virus carriers are symptomless.
- It is a silent infection in a group of **highly vulnerable individuals – pregnant women** which in turn is associated with a horrible outcome for their babies.
- The virus causes microcephaly, a condition that causes babies to be born with an abnormally small head.

## D.7. EXPERIMENTAL MEDICINES UNDER THE EXCEPTIONAL CIRCUMSTANCES

### Why in news?

- World Health Organization (WHO) in August 2014 declared that it was not unethical to use experimental medicines (Zmap and convalescent plasma therapy) under the exceptional circumstances as witnessed in West Africa during Ebola outbreak.
- West Africa has been defined as including the 18 countries Benin, Burkina Faso, the island of Cape Verde, Gambia, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Liberia, Mauritania, Niger, Nigeria, the island of Saint Helena, Senegal, Sierra Leone, Sao Tome and Principe and Togo.

### What is convalescent plasma technique and how does it work?

- The rationale of techniques is that the plasma taken from survivors will have antibodies (against the virus) that would fight the virus. It is similar to passive immunity (which results when a person is given someone else's antibodies) technique.
- However, its potential depends on amount of antibodies introduced. There is a direct correlation between antibody level and its effectiveness.
- It had once been used successfully to treat measles, mumps, pneumonia, influenza and diphtheria.

## D.8. GENE EDITING (CRISPR/CAS9)

Recently, scientists from the United Kingdom's Francis Crick Institute got approval to start research on human embryos using a new genome editing technology called CRISPR/Cas9.

### What is Genome editing?

- It is a type of genetic engineering in which DNA is inserted, deleted or replaced in the genome of an organism using engineered nucleases, or "molecular scissors".
- These nucleases or enzymes create site-specific double-strand breaks (DSBs) at desired locations.

There are currently four families of engineered nucleases being used:

1. Meganucleases.
2. Zinc finger nucleases (ZFNs).
3. Transcription Activator-Like Effector-based Nucleases TALENs).
4. CRISPR- Cas system.

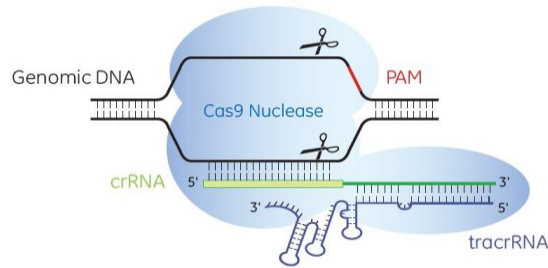


- The induced double-strand breaks are repaired through end joining or recombination, resulting in targeted mutation.



### What is CRISPR/Cas9?

- It is a revolutionary gene editing technique that scientists have borrowed from nature.
- CRISPRs (clustered regularly interspaced short palindromic repeats) are sections of DNA, while CAS-9 (CRISPR-associated protein 9) is an enzyme.
- Bacteria use them to disable attacks from viruses.



### How it works?

- Cas9 scans the genome looking for the right location and then uses the Cas9 protein as molecular scissors to snip through the DNA.
- Cas9 endonuclease - guide RNAs direct it to a particular sequence to be edited.
- When Cas9 cuts the target sequence, the cell repairs the damage by replacing the original sequence with an altered version.
- Unlike other gene-editing methods, it is cheap, quick, easy, safer and more accurate to use because it relies on RNA–DNA base pairing, rather than the engineering of proteins that bind particular DNA sequences.

### Germline Editing

- “Germ line” refers to the egg and sperm, which combine to form an embryo.
- Germline editing is a genome- editing technology that can, in principle, be developed to make specific and targeted genetic alterations in embryos, which will be carried by all the cells of a resulting child and passed on to his/her offspring, a part of the human gene pool.
- All other techniques of genome editing currently in various stages of clinical development focus on modifying the genetic material of somatic cells, such as T cells (a type of white blood cell).
- These are not designed to affect sperm or eggs.

## D.9. CLONE BUFFALO

- ICAR-Central Institute for Research on Buffaloes (CIRB) has produced cloned calf called ‘HISAR GOURAV’.
- This cloned buffalo calf is distinct from the earlier clones produced in India, as this is produced from cells of ventral side of tail of superior buffalo bull.
- This part is least exposed to sunlight and may have less mutation rate, and can be good choice for isolation of donor cells to produce healthy clones.
- With this achievement CIRB becomes world’s third and India’s second institute to produce cloned buffalo. National Dairy Research Institute in Karnal was the first in India.



## D.10. UNIVERSAL IMMUNISATION PROGRAMME FOR CERVICAL CANCER

The health ministry is going to introduce Human Papilloma Virus (HPV) vaccine in the universal immunisation programme .

- The virus is believed to be responsible for most cervical cancer cases
- After breast cancer, cervical cancer is the second most common cancer among women in India.
- National cancer registry data has registered around 90,000 cases for year 2013.

### What is HPV?

HPV is a group of 150 viruses, known to cause warts or papillomas. Some can cause cancer, particularly cervical cancer. HPV vaccine should be administered at 11-12 years of age.

## D.11. DEVELOPMENT OF ARTIFICIAL LIVER TISSUE BY 3-D PRINTING

- Recently, Pandorum Technologies Pvt. Ltd, a biotechnology start-up focused on tissue engineering, has made India's first artificial human liver tissue with the help of 3D printing technology.
- The tissue performs critical functions of a human liver tissue including detoxification, metabolism and secretion of biochemicals such as albumin and cholesterol. The tissue can grow and survive up to eight weeks

### What is 3D printing?

3D printing, also known as additive manufacturing (AM), refers to various processes used to synthesize a three-dimensional object.

In 3D printing, successive layers of material are formed under computer control to create an object.

These objects can be of almost any shape or geometry, and are produced from a 3D model or other electronic data source. A 3D printer is a type of industrial robot.

## D.12. NEW INFLUENZA VIRUSES LIKELY TO INFECT INDIANS

- India should be prepared for the invasion of new influenza viruses H9N2 and H7N9, which is currently very active in poultry markets in Bangladesh and China
- Earlier Indians were infected by H5N1 virus in 2006 that came from china.

### What does H and N stands for in Inflenza virus

- Influenza viruses are divided into subtypes based on two proteins on the surface of the virus:
  - the hemagglutinin (H) and
  - the neuraminidase (N).

There are 18 different hemagglutinin subtypes and 11 different neuraminidase subtypes.

India will introduce injectable or inactivated polio vaccine (IPV) in its universal immunisation programme (UIP) in a phased manner from November, 2016.

## D.13. PARTHENOGENESIS/ VIRGIN BIRTH

It is the first time this phenomenon has been seen in a vertebrate (**Smalltooth Sawfish**) in the wild. There have been a number of cases in reptiles, birds and sharks of 'virgin birth' in captivity. It is reproduction without mating.



### Process

- In this a female's egg cell can develop into a baby without being fertilized by a male's sperm cell.
- In making an egg cell, a precursor cell divides into four cells.
- The one that eventually becomes the egg cell retains key cellular structures and the gel-like cytoplasm.
- The other three hold extra genetic material. One of these cells essentially acts as a sperm cell and fuses with the egg.
- This "fertilized" egg possesses about half the mother's genetic diversity, a trait allowing parthenogenesis to be detected through genetic testing.

## D.14. INJECTABLE POLIO VACCINE (IPV)

Difference between Oral Polio Vaccine (OPV) and IPV:

OPV is made up of attenuated or weakened poliovirus and there is a risk of vaccine derived polio. IPV is made up of inactivated (killed) polio virus and will provide immunity from all three strains of polio.

### Advantages

- As IPV is not a 'live' vaccine, it carries no risk of vaccine-associated polio paralysis.
- IPV triggers an excellent protective immune response in most people.

### Disadvantages

- IPV induces very low levels of immunity in the intestine. As a result, when a person immunized with IPV is infected with wild poliovirus, the virus can still multiply inside the intestines and be shed in the faeces, risking continued circulation.
- IPV is over five times more expensive than oral polio vaccine.
- Administering the vaccine requires trained health workers and sterile injection equipment and procedures.

### Indian Scenario

From April, 2016 the trivalent polio vaccine was replaced by the bivalent variety. It will reduce incidence of vaccine-derived polio virus.

- Suggestions to enhance immunization: Drawing up comprehensive micro-plans for routine immunization.
- Intensively training frontline health workers who will carry out vaccinations.
- Putting in place monitoring systems so that corrective measures can be taken when needed.



## D.15. BRUCELLA

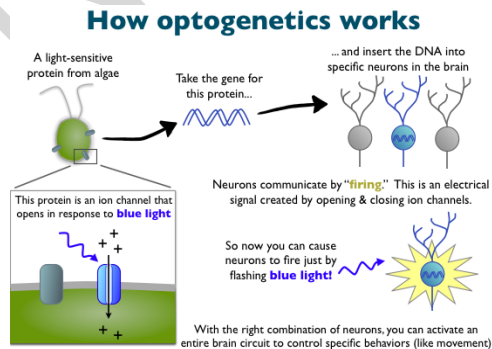
- It is a bacteria
- It is potential bioweapon of low intensity
- It is a causal agent for Malta fever.
- Recently in the Gulf of Mexico, dolphins were found to be infected with these bacteria.

## D.16. MTDNA

- Mitochondrial DNA (mtDNA) is the DNA located in organelles called mitochondria. Most other DNA present in eukaryotic organisms is found in the cell nucleus.
- In humans, mitochondrial DNA (having 16569 base pairs) is solely inherited from mother.
- Scientists in the Anthropological Survey of India (AnSI) have been studying mitochondrial DNA of various tribal communities in India under National Project “DNA Polymorphism of the Contemporary Indian Populations Phylogeny Studies” to construct the maternal phylogeny and prehistoric population movements of human beings in the Indian sub-continent.

## D.17. OPOGENETICS AND CLARITY

- Prof. Deisseroth (Professor of Bioengineering and of Psychiatry and Behavioural Sciences at Stanford University) was recently awarded prestigious Life Sciences Breakthrough Prize for 2016.
- He has devised two path-breaking techniques that are changing understanding and control of the brain.



### What is Optogenetics?

- It is combining genetics and optics.
- It is a neuromodulation method employed in neuroscience that uses a combination of techniques from optics and genetics to control and monitor the activities of individual neurons in living tissue—even within freely-moving animals—and to precisely measure the effects of those manipulations in real-time
- Use of optogenetics
- It has potential to treat disease like Parkinson’s disease.
- It can also be used to cure blindness.

### What is CLARITY?

- CLARITY (Clear Lipid-exchanged Acrylamide-hybridized Rigid Imaging / Immunostaining / in situ-hybridization-compatible Tissue hydrogel) is a method of making brain tissue transparent using acrylamide-based hydrogels built from within, and linked to, the tissue.

## D.18. CSIR SUCCEEDS IN WHOLE GENOME SEQUENCING OF HOLY BASIL (TULSI)

CSIR-Central Institute of Medicinal & Aromatic Plants (CSIR-CIMAP), has published whole genome sequence of Tulsi.

**Other names:** Ocimum sanctum, the wonder plant 'Holy basil'

### Significance of Tulsi

#### Medical benefits

- It is used in several systems of traditional medicine, including Ayurveda, Greek, Roman, Siddha, and Unani.
- It is used in the preparations to cure various diseases like bronchitis, bronchial asthma, malaria, diarrhea, dysentery, skin diseases, arthritis, painful eye diseases, chronic fever, insect bite.
- It has also been described to possess anti-fertility, anti-cancer, anti-diabetic, anti-fungal, anti-microbial, hepatoprotective, cardioprotective, anti-emetic, anti-spasmodic, analgesic, adaptogenic and diaphoretic actions.

## D.19. ACUTE FLACCID PARALYSIS (AFP)

A Case of Vaccine Derived Polio Virus (VDPV) was reported from New Delhi recently. The polio virus causes paralysis — medically known as an acute flaccid paralysis (AFP) — which is characterised by sudden muscle weakness, and fever in one or more limbs.

AFP can occur due to many reasons, one of which is **vaccine-linked**.

### Why increase in the AFP cases?

- Oral polio vaccine (OPV) contains an attenuated vaccine-virus. This weak form of the virus is used to activate an immune response in the body, which protects the child when challenged by WPV.
- But when the child is immunised with OPV, the virus replicates in the intestine and during this time, the virus is excreted.
- In areas of inadequate sanitation, the excreted vaccine-virus can quickly spread in the community and infect children with low immunity.
- This excreted vaccine undergoes genetic changes as it circulates in the community and causes VDPV.



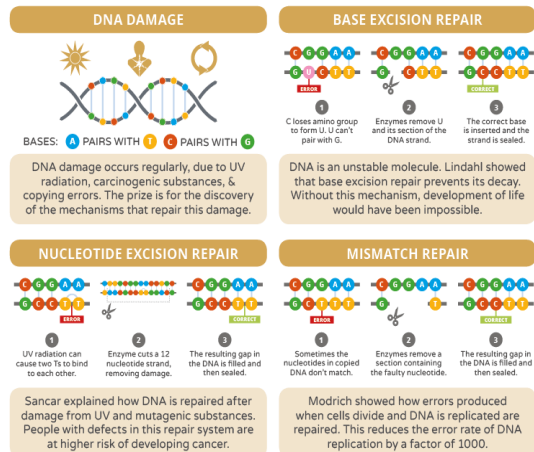




# E. MISCELLANEOUS

## E.1. NOBEL PRIZE IN CHEMISTRY FOR 2015

- The Nobel Prize in Chemistry 2015 is awarded to Tomas Lindahl, Paul Modrich and Aziz Sancar for having mapped, how cells repair damaged DNA and safeguard the genetic information.
- They found that a host of molecular systems continuously monitor and repair DNA.
- Aziz Sancar mapped nucleotide excision repair, the mechanism that cells use to repair UV damage to DNA. People born with defects in this system will develop skin cancer if exposed to sunlight.
- Paul Modrich has demonstrated how the cell corrects errors that occur when DNA is replicated during cell division. Congenital defects in this process causes a hereditary variant of colon cancer.

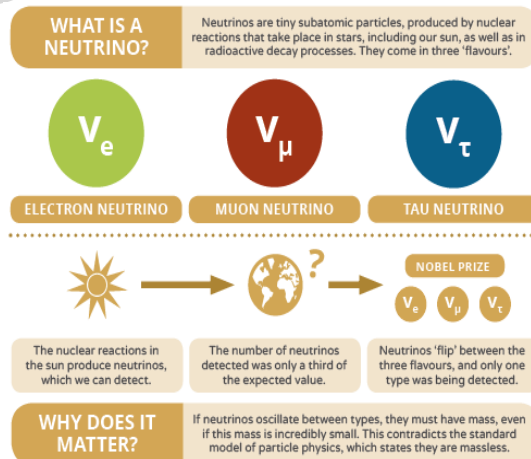


### Significance

- Their work has provided fundamental knowledge of how a living cell functions. This work can be used for the development of new cancer treatments.

## E.2. NOBEL PRIZE IN PHYSICS FOR 2015

- It was awarded jointly to Takaaki Kajita (Japan) and Arthur B. McDonald (Canada) for the discovery of **neutrino oscillations**, which shows that neutrinos have mass.



### Neutrino

- Neutrinos are subatomic particles produced by the decay of radioactive elements and are elementary particles that lack an electric charge.
- Neutrinos are of 3 types - electron neutrino, muon neutrino and tau neutrino.
- Neutrinos can be created in several ways - radioactive decay, in the Sun, in nuclear reactors.



### E.3. NOBEL PRIZE IN PHYSIOLOGY

- To: Satoshi Ōmura, William C. Campbell and Youyou Tu
- For: Exceptional effective treatment against parasitic disease: malaria and Elephantitis.
- Campbell and Ōmura won for their discoveries concerning a novel therapy against infections caused by roundworm parasites.
- Youyou Tu for her work on a therapy against malaria. Tu discovered one of the most effective treatments for malaria while working on a secret military project during China's Cultural Revolution.
- Tu Youyou who turned to traditional herbal medicine to develop novel malaria therapies, should inspire India to focus on scientifically validating and promoting its rich heritage of folk medicine.

### E.4. MAGGI ROW

What Is The Controversy Around Maggi?

- A Gorakhpur lab tested maggi for **monosodium glutamate (MSG)** to check Nestle's claim that Maggi had none. The test found MSG in Maggi and a complaint was lodged in Barabanki court.
- In addition, the Kolkata lab found "very high quantities" of **lead** — 17.2 parts per million.

What Rules Govern "Instant Noodles" (Such As Maggi) Under FSSAI?

- According to Food Safety and Standards Rules, 2011, MSG, a "flavour enhancer", should not be added to food for *infants below 12 months*.
- MSG is not permitted in over 50 items, including Pastas and noodles (only dried products) but is allowed in the seasoning used for noodles and pastas.

Why Do Noodles Have MSG And Lead?

- MSG *stimulates the nervous system and makes food appear tastier*. It is widely used in "Indian Chinese" food.
- The US FDA says MSG is "generally recognized as safe", same as salt, pepper, vinegar and baking powder. Glutamate is present in many natural foods including tomato, mushroom, and cheese.

#### MSG

- MSG, is a glutamate, or salt of glutamic acid, a "**non-essential amino acid**, which means it is produced by the body, and thus not required in our diet.
- In its pure form, MSG is a white crystalline powder. Among different varieties of glutamate, sodium glutamate is the most soluble and the easiest to crystallize.
- MSG is naturally occurring salt in tomatoes, potatoes, seaweed, etc. But today, instead of extracting it from seaweed or other natural foods, MSG is produced by fermentation of starch, sugar cane etc.
- MSG is a **neurotransmitter** — transporting messages from one nerve cell to another. Because it is said to enhance flavours, some scientists believe it "excites nerve endings". In cases of excessive stimulation, this can result in killing or damaging of nerve cells, inducing headaches at best and Alzheimers at worst.
- It is a major factor in causing obesity.



## E.5. MUKHOTA

- Fishing crews mainly from Porbandar, Verawal and other parts of Gujarat being arrested for accidentally crossing international maritime boundaries.
- To help these fishermen, a Mumbai-based NGO 'Work in India' and a digital firm Kinetic India and have come up with a device called Mukhota.
- It is GPS-enabled and coded in such a way that once it comes near the coastal border, it sends out an alert.
- For now, each device costs Rs 5,000 but after receiving grants from state governments, the cost will be reduced to make it more easily affordable.

## E.6. GEO-TARGETING IN ADVERTISEMENTS

- With the trend of geo-targeted advertising catching on, more companies are making use of technology to beam adverts to only areas where their products have strong presence.
- Airing of region-specific content on websites is determined by triggers like the user's GPS location or the mobile tower location of the user.
- In case of television, the trigger for the geo-targeted ad comes from a unique watermark inserted on the video, which gives the cue to the smart box to run the local ad.
- Watermark is an invisible and inaudible identifier, like a product barcode.
- The technology for geo-targeted advertising has helped small advertisers get access to the national channels.

## E.7. LOHAFEX PROJECT

### Why in news?

- Recently, Indian scientists discovered 3 new clusters of bacteria not related to any other bacteria.
- The discovery happened during LOHAFEX experiment in the Southern Ocean, Antarctica, which was aimed at increasing CO sequestration through ocean iron fertilisation as part of studies on global warming mitigation.
- Among the three new LOHAFEX clusters that were discovered, the first was related to class of Bacteroidetes while the second and third belonged to Firmicutes.
- A unique feature of the three clusters was their differentiated response to the presence of iron in the ocean.

### What is LOHAFEX all about?

- The Indo-German project (Loha means iron in Hindi while Fex is an acronym for fertilization) in the Antarctic assumed that the algal bloom (algae need iron to grow) induced by iron fertilization would suck up a lot of carbon dioxide from the environment and sink it.
- Experiments in oceans near Antarctica have indicated that seeding the oceans with iron might not help to suck up carbon dioxide from the environment in sufficient quantities as to check global warming.
- Also, Environmentalists have opposed it as the effects on marine ecosystems are unknown and they violate the norms of CBD (Convention on Biological Diversity).

## E.8. FACEBOOK'S FREE BASICS TUSSELS WITH TRAI



### What is Free Basics?

- Internet.org was rechristened Free Basics.
- According to Facebook, it is an open platform that gives Indian developers the opportunity to make their services and websites available free of cost to those who cannot afford internet access.
- However, this free access is limited to partner websites and applications.
- It was launched two years ago globally in partnership with Samsung, Ericsson, MediaTek, Opera Software, Nokia and Qualcomm.

### TRAI'S Consultation paper:

The consultation paper on differential pricing of data services raises concerns over zero-rating tariff models — a practice wherein service providers offer free data to users for select applications and websites. According to Internet activists, this model violates the principle of net neutrality as it restricts access to free, open Internet for users, making the paper key to the ongoing debate on **net neutrality**.

### What's the problem with Free Basics?

- It doesn't offer equal and unbiased access to all services.
- Facebook is partnering with ISPs to provide preferential and selective access to a set of app developers and services.
- Critics argue that the internet should be free and equal for all users. This is also the cornerstone of net neutrality.

## E.9. CALL DROP ISSUE

### Reasons:

- The root of the problem is inadequate spectrum — a telco in India has 12 MHz of spectrum compared to the global average of 40 MHz which reduces the capacity.
- Hoarding of spectrum by the government .
- Though the Centre recently approved a spectrum-sharing policy, the rules are too constrictive to bring change.
- Civic authorities have forced about 10,000 towers to shut down across major cities due to various reasons.

### Govt. steps and Solutions:

- To address the scarcity of cell phone towers — there are about 5,50,000 towers in India at present and approximately 1,00,000 more are needed.
- Govt. has agreed to allow them to be set up on top of government buildings dispel some of the misinformation on radiation from them.
- TRAI raised the penalty on telecom operators to up to Rs. 2 lakh for poor mobile service quality, including call drops.

## E.10. MINAMATA CONVENTION ON MERCURY

The Convention **obliges** government Parties to take a range of actions, including addressing mercury emissions to air and to phasing-out certain mercury-containing products.

### Mercury pollution

#### Sources

- Burning coal for power and heat a major source of mercury.
- Products like: batteries, measuring devices, such as thermometers and barometers, etc

#### Impact

- Exposure to mercury – even small amounts – may cause serious health problems, and is a threat to the development of the child in utero and early in life.
- Mercury may have toxic effects on the nervous, digestive and immune systems, and on lungs, kidneys, skin and eyes.
- Skin rashes and dermatitis; mood swings; memory loss; mental disturbances; and muscle weakness.

## E.11. SILAGE

### What it is?

Silage, a green fodder compacted in air tight conditions to be used as substitute for green fodder during the lean period for livestock.

- It can be used as fodder for livestock living in the rain shadow areas or during dry period
- It has potential to increase the milk yield.

### Method of Silage Preparation

- Green grass mass is stored in large sacks made from polythene.
- Once the bag is filled, the material is pressed to remove the air and thereby preventing decomposition.
- After that it is fermented by adding diluted molasses and preserved for 60 days at appropriate moisture levels.

## E.12. TSUNAMI EARLY WARNING SYSTEM

The Indian Tsunami Early Warning System (**ITEWS**) has the responsibility to provide tsunami advisories to Indian Mainland and the Island regions. ITEWS also provide tsunami advisories to the Indian Ocean rim countries along with Australia & Indonesia.

- Managed by the Indian National Centre for Ocean Information Services (INCOIS), an autonomous organisation under the Ministry of Earth & Sciences (MoES), Government of India.







#### Features:

- The Warning Centre is capable of issuing Tsunami bulletins in less than 10 minutes after any major earthquake in the Indian Ocean.
- Near-real time determination of earthquake parameters
- 24 X 7 operational warning centre to detect tsunami genic earthquakes, to monitor tsunamis and provide timely advisories following the Standard Operating Procedure (SOP)

### E.13. WHITEFLY PROBLEM

- There is large-scale crop damage from whitefly infestation this year, especially in northern India.
- There are over 250 Bt cotton hybrids on the shelf in North India. More than 90 per cent of these are susceptible to whitefly and leaf-curl.

#### What is Whitefly?

- It is a small (1-2 mm) white coloured insect affecting cotton, and also occurring on vegetables and other crops in tropical and sub-tropical regions.
- The whitefly sucks sap from the phloem or living tissue carrying organic nutrients, causes yellowing and upward curling of the leaves.

#### Control measures:

- Beneficial insects that can control the whitefly naturally.
- Therefore, broad-spectrum insecticides such as synthetic pyrethroids and mixtures should be strictly avoided.
- It is better to rely initially on water sprays, followed by soap sprays, sprays with preparations of neem oil, castor oil, fish oil and rosin soap.

### E.14. HYDROGEN BOMB

- Hydrogen bombs are thermonuclear weapons.
- A **thermonuclear weapon** is a nuclear weapon that uses the energy from a **primary nuclear fission** reaction to compress and ignite a **secondary nuclear fusion** reaction.
- The result is greatly increased explosive power when compared to single-stage fission weapons.
- It is colloquially referred to as a **hydrogen bomb** or **H-bomb** because it employs fusion of isotopes of hydrogen.

#### NUCLEAR VS. THERMONUCLEAR WEAPONS

##### NUCLEAR (ATOMIC BOMBS)

Atomic bombs use fission — the splitting of a large atom into two smaller ones.



##### THERMONUCLEAR (HYDROGEN BOMBS)

More powerful hydrogen bombs use fusion — the fusing of two or more atoms into a larger one.



### E.15. ROAD ASSETS MANAGEMENT SYSTEM

- NHA is developing a road assets management system (RAMS) for the entire national highways network. This project is funded by World Bank.
- GAGAN and BHUVAN satellite systems, drones (for difficult terrains) will be used to prepare a 360-degree mapping of all national highways by 2017.
- Accurate and scientific planning and finalising of road projects

## E.16. WORLD'S HIGHEST TERRESTRIAL RESEARCH CENTRE

**Height:** 17,600 feet, **Location:** Changla near Pengong lake in Ladakh.

### Purpose:

- The Centre will serve as a natural cold storage for preserving rare and endangered medical plants for generations to come.
- A large number of scientific activities are proposed to be undertaken in the Centre including designing, testing, validation and demonstration of mobile and portable greenhouses, soil-less micro-farming technologies for fresh food in remote landlocked posts.



## E.17. CONTRIBUTIONS OF SIR CHANDRASEKHARA VENKATA RAMAN

### Notable works

- **Raman Effect:** Explained the scattering of light passing through a transparent material. He won the 1930 Nobel Prize in Physics for this discovery.
- Experimental and theoretical studies on the diffraction of light by waves of ultrasonic and hypersonic frequencies.

### Raman Effect: Applications

#### What is Raman Effect?

A change of wavelength exhibited by some of the radiation scattered in a medium. The effect is specific to the molecules which cause it, and so can be used in spectroscopic analysis.

February 28 marks the National Science Day that celebrates physicist CV Raman's discovery of the Raman effect.

#### Some of the Applications:

##### Chemical Industry

1. To study catalysts
2. To monitor chemical purity in petro chemical industry
3. Control of polymerisation reaction

##### NanoTechnology and material science

1. To study nonparticles
2. To develop microelectronics devices and novel photovoltaic cells.

##### Biomedical Application

1. In vivo studies of the skin
2. Transdermal drug transfer
3. Cancer identification
4. Bone studies

##### Detection of Narcotics and explosives

1. Hand held Raman scanners to detect narcotics
2. Handhelp Raman scanners to detect explosives such as TNT, RDX, HMX



## E.18. KHOYA-PAYA WEB PORTAL

'Khoaya-Paya', is a web portal for citizens to report children sighted as abandoned, lost or with suspicious person. It has been developed by the Ministry of Women and Child Development and the Department of Electronics and Information Technology (DeitY).

### Features

- Any parent whose child is missing can update information on this portal which will be shared with the cops and authorities in real time.
- Anyone in the country can also update information on any missing children they are aware of.
- The reporting can be done through text, photographs, videos and other means of transmitting and uploading information
- The website is not a substitute for registering First Information Report (FIR) or police action.

## E.19. NEEM COATED UREA (NCU)

- The Union government's recent decision making it mandatory for domestic manufacturers to produce 100 per cent NCU.
- Urea from now on will be coated with neem oil. The move will not only benefit the environment and improve farmers' lives, but curb illegal urea diversion for industrial use.
- The normal urea is a highly soluble and volatile material and is up to 40 per cent less efficient than NCU. NCU, on the other hand, acts as a physical barrier, slowing down the process of solubility and volatility.
- NCU also reduces the amount of nitrogen released from the soil. It destroys the Roundworm parasite found in the soil and kills the bacteria which de-nitrifies and produces nitrogen in the atmosphere.
- Indian Agricultural Research Institute study reveals the use of NCU will reduce consumption by 10-15%. Less usage will reduce the levels of nitrous oxide and other harmful gases during the production of urea.
- Industries use urea to prepare formaldehyde, which is used in vaccines, furniture, flooring, automobile industries and packaging materials etc.

## E.20. MELDONIUM DRUG

- Russian tennis star Maria Sharapova recently failed a drug test for meldonium at the Australian Open this year.
- Meldonium is most commonly used in Eastern European and ex-Soviet countries as a drug for people with heart conditions. Meldonium is used to treat ischaemia: a lack of blood flow to parts of the body, particularly in cases of angina or heart failure.
- Meldonium was banned because it aids oxygen uptake and endurance by virtue of carrying more oxygen to muscle tissue
- There are also signs that a sizable minority of athletes were using before it was banned. The World Anti-Doping Agency monitored the effects and use of meldonium before announcing in September that it would be declared a banned substance from January 2016.

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