



# IAS PARLIAMENT

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A Shankar IAS Academy Initiative

## SCIENCE MONTHLY

FEBRUARY 2018

**Shankar IAS Academy™**

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## SCIENCE AND TECHNOLOGY

FEBRUARY 2018

### 1. SPACE

#### 1.1 ISRO to launch another IRNSS satellite

##### Why in news?

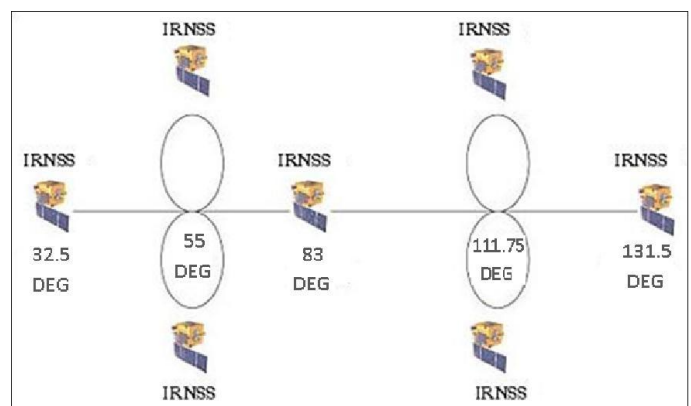
ISRO is going to launch another IRNSS satellite.

##### What is the need for another IRNSS satellite?

- ISRO failed to inject into the orbit the eighth of the navigation satellite, IRNSS-1H.
- IRNSS-1H was launched to replace the faulty IRNSS-1A in the Indian Navigation Satellite Constellation or NavIC in August last year.
- Therefore the ISRO is gearing up to launch another IRNSS satellite.

##### What is an IRNSS?

- The Indian Regional Navigation Satellite System (IRNSS) is a navigation system that is designed to provide geospatial positioning information within the Indian sub-continent.
- The operational name is NAVIC which stands for NAVigation with Indian Constellation.
- NAVIC enables users to map out their location (altitude, longitude and latitude).
- The objective of developing IRNSS was to cut down India's dependency on foreign navigation satellite systems.
- IRNSS is a constellation of seven satellites in space.
- Out of these, three are located in the geostationary orbit over the Indian Ocean and the other four in geosynchronous orbits, with the desired inclination and equatorial crossings in two different planes.
- These 7 satellites in IRNSS are: IRNSS-1A to 1G.
- IRNSS aims to provide the following services:
  1. Standard Positioning Service (SPS) for civilian, research & commercial use
  2. Restricted Service (RS) for authorized users.
- IRNSS is India's own GPS-like system, much like the American GPS system.
- The difference between both is that while the IRNSS is a regional satellite navigation system, the American GPS is a global satellite navigation system.
- IRNSS provides location information service to users in India and the region extending for up to 1,500 km from the Indian boundary.
- It is the primary service area of IRNSS.
- Four satellites are sufficient for navigation, but adding more satellites, however, will guarantee better accuracy.
- **Some of the 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



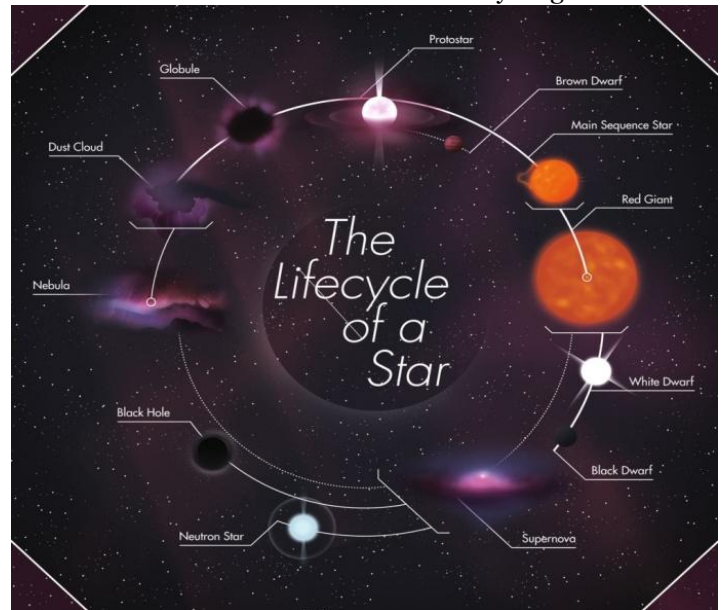
## 1.2 Aging brown dwarfs sweep the clouds away

### Why in news?

A team of astronomers measured for the first time the temperature at which atmospheric change takes place in young brown dwarfs.

### What is a Brown dwarf?

- Brown dwarfs are objects which have a size between that of a giant planet like Jupiter and that of a small star.
- Brown dwarfs usually have a mass less than 0.075 that of the Sun, or roughly 75 times that of Jupiter.
- Most astronomers would classify any object with between 15 times the mass of Jupiter and 75 times the mass of Jupiter to be a brown dwarf.
- Given that range of masses, the object would not have been able to sustain the fusion of hydrogen like a regular star.
- Thus, many scientists have dubbed brown dwarfs as "failed stars".
- The difference between brown dwarfs and stars is that, unlike stars, brown dwarfs do not reach stable luminosities by thermonuclear fusion of normal hydrogen.
- Both stars and brown dwarfs produce energy by fusion of deuterium (a rare isotope of hydrogen) in their first few million years.
- The cores of stars then continue to contract and get hotter until they fuse hydrogen.
- However, brown dwarfs prevent further contraction because their cores are dense enough to hold themselves up with electron degeneracy pressure.
- Brown dwarfs are not actually brown but appear from deep red to magenta depending on their temperature.



### What is the scope of the study?

- Brown dwarfs undergo atmospheric changes from cloudy to cloudless as they age and cool.
- Astronomers have measured the temperature at which the atmospheric change is happening in young brown dwarfs.
- This finding may help in understanding the process of evolution of gas giant planets like Jupiter.

## 1.3 Black Holes from Small Galaxies Might Emit Gamma Rays

### Why in news?

It has been widely believed that only massive galaxies contain enough energy to become blazars. But latest research might indicate that smaller galaxies can also do this, if the conditions are right.

### What is a galaxy?

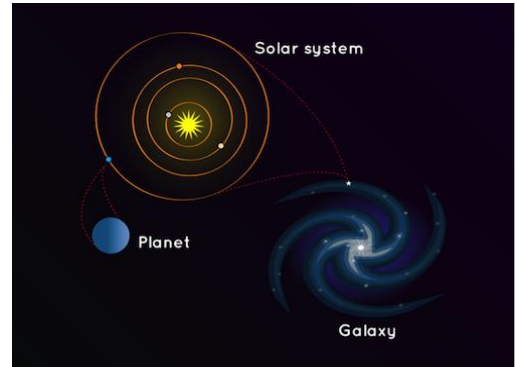
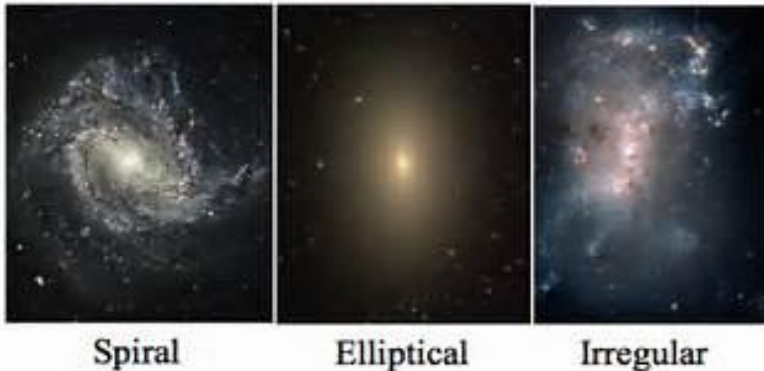
- A **galaxy** is a huge collection of gas, dust, and of stars and their planetary systems.
- Stars are collected together into galaxies.
- Galaxies are collected together into groups of galaxies and these groups are collected into clusters.
- The largest structures in the Universe are galaxy super clusters, which contain millions of galaxies and can measure hundreds of millions of light-years across.
- A galaxy is held together by gravity.
- Our galaxy, the Milky Way, also has a super massive black hole in the middle.

### What are the types of galaxies?

- There are three main types of galaxies: Elliptical, Spiral, and Irregular.
- Two of these three types are further divided and classified into a system that is now known the tuning fork diagram.

### Spiral galaxies

- Spiral galaxies are the most common type in the universe.
- Our Milky Way is a spiral, as is the rather close-by Andromeda Galaxy.
- Spirals are large rotating disks of stars and nebulae, surrounded by a shell of dark matter.
- The central bright region at the core of a galaxy is called the “galactic bulge”.
- Many spirals may also contain super massive black holes in their cores.



### Elliptical galaxies

- Elliptical galaxies are roughly egg-shaped (ellipsoidal or ovoid) found largely in galaxy clusters and smaller compact groups.
- Most elliptical galaxy contain older, low-mass stars, and lack a great deal of star-making gas and dust clouds.
- Therefore there is little new star formation occurring in them.
- Messier 87 is an example of an elliptical galaxy.

### Irregular galaxies

- Irregular galaxies are as their name suggests: irregular in shape.
- The best example of an irregular that can be seen from Earth is the Small Magellanic Cloud.

### What is a blazar?

- A blazar is a galaxy which, like a quasar, has an intensely bright central nucleus containing a supermassive black hole.
- In a blazar, however, the emitted light sometimes includes extremely high energy gamma rays.
- Sometimes over a hundred million times more energetic than the highest energy X-rays that the Chandra X-ray Observatory can study.

### 1.4 Some black holes erase your past

#### Why in news?

A mathematician found some types of black holes that allow an observer inside the black hole to travel across a horizon into a place where the past is erased and there are an infinite number of possible futures for every initial state.

#### What is a black hole?

- A black hole is a place in space where gravity pulls so much that even light cannot escape.
- The gravity is so strong because matter has been squeezed into a tiny space.
- This can happen when a star is dying.
- Because no light can get out, people can't see black holes.

- They are invisible.
- Space telescopes with special tools can help find black holes.
- The special tools can see how stars that are very close to black holes act differently than other stars.

### How big are Black Holes?

- Black holes can be big or small.
- Scientists think the smallest black holes are as small as just one atom.
- These black holes are very tiny but have the mass of a large mountain.
- Another kind of black hole is called "stellar."
- Its mass can be up to 20 times more than the mass of the sun.
- There may be many, many stellar mass black holes in Earth's galaxy.
- The largest black holes are called "supermassive."
- These black holes have masses that are more than 1 million suns together.
- Scientists have found proof that every large galaxy contains a supermassive black hole at its center.
- The supermassive black hole at the center of the Milky Way galaxy is called Sagittarius A.
- It has a mass equal to about 4 million suns and would fit inside a very large ball that could hold a few million Earths.

### How do Black Holes form?

- Scientists think the smallest black holes formed when the universe began.
- Stellar black holes are made when the center of a very big star falls in upon itself, or collapses.
- When this happens, it causes a supernova.
- A supernova is an exploding star that blasts part of the star into space.
- Scientists think supermassive black holes were made at the same time as the galaxy they are in.

## 1.5 Universe Expanding Faster Than Expected

### Why in news?

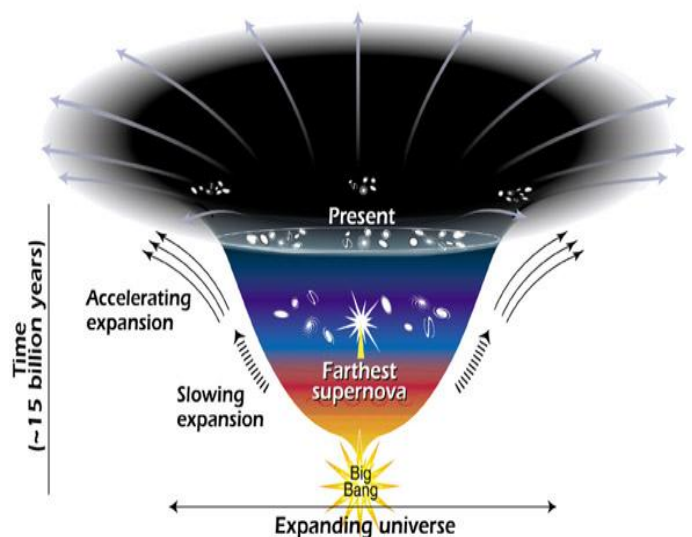
Astronomers have used NASA's Hubble Space Telescope to make the most precise measurements of the expansion rate of the universe.

### Why is it important?

- The latest Hubble finding confirms a discrepancy showing the universe to be expanding faster now than was expected from its trajectory seen shortly after the big bang.
- Researchers suggest that there may be new physics to explain the inconsistency.

### What is the current explanation for expanding universe?

- We know that our universe is expanding at an accelerating rate.
- The reason behind this growth remains a mystery.
- The most likely explanation is that a strange force dubbed "dark energy" is driving it.
- Now a new astronomical instrument, called the Physics of the Accelerating Universe Camera (PAUCam) was created.
- It will look for answers by mapping the universe in an innovative way.



This diagram reveals changes in the rate of expansion since the universe's birth 15 billion years ago. The more shallow the curve, the faster the rate of expansion. The curve changes noticeably about 7.5 billion years ago, when objects in the universe began flying apart at a faster rate. Astronomers theorize that the faster expansion rate is due to a mysterious, dark force that is pushing galaxies apart.

- The camera, which will record the positions of around 50,000 galaxies at once, could also shed light on what dark matter is and how the cosmos evolved.
- The rate at which the universe is expanding is known as Hubble's constant.
- Authors measure the rates using quasars.
- Scientists look for quasar reflection to figure out how fast they are moving away from earth.

## 1.6 Mysterious Origin of the Moon Finally Explained

### Why in news?

A new theory "First the Moon, Then Earth" reverses the current model of formation of earth and lunar system.

### What is the current model?

- Current models of lunar formation suggest that the Moon formed as a result of a glancing blow between the early Earth and a Mars-size body, commonly called Theia.
- According to the current model, the collision between Earth and Theia threw molten rock and metal into orbit that collided together to make the Moon.

### What is the newly proposed model?

- New theory, proposed by researchers, is a totally new model for how the Moon (and Earth) formed: a synestia.
- Earth's moon formed inside a cloud of molten rock, and may have done so before our planet itself formed, a new theory suggests.
- Scientists call such a cloud a synestia, a doughnut-shaped ring of debris full of molten rock that forms in the aftermath of a protoplanet collision.
- In this case, it would have been a massive collision early in our solar system's history.
- According to the new theory, the moon formed within a few dozen years after the crash, as the synestia shrank and cooled.
- The Earth subsequently emerged about 1,000 years after the moon.
- This is the first model that can match the pattern of the moon's composition.

### What is a synestia?

- A synestia is a hypothetical object.
- It is a huge, spinning, donut shaped mass of hot, vaporized rock, formed when planet-sized objects smash into each other.
- At one point early in its history, the Earth itself was likely a synestia.
- Synestias haven't been spotted in the sky yet because, the objects are relatively short-lived.
- After formation, they may persist for only a few hundred years.
- Synestias that formed gas-giant planets or stars, however, may last longer due to their larger size.
- A synestia forms following a high energy, high angular momentum, and giant impact.
- As the synestia cools droplets form in its outer layers and rain inward.
- Those that remain outside the roche limit of the inner region accrete to form moonlets and combine to form the moon.



## 1.7 Ideal lunar Landing Site in South Pole –Aitken basin

### Why in news?

Scientists have long wanted to retrieve rock samples from the **Moon's South Pole-Aitken basin**, and a new study could be helpful in locating an ideal landing site.

### What is South Pole–Aitken basin?

- The **South Pole–Aitken basin** is an impact crater on the far side of the Moon.
- It is roughly measured 2,500 km (1,600 mi) in diameter and 13 km (8.1 mi) deep.
- It is one of the largest known impact craters in the Solar System.
- It is the largest, oldest, and deepest basin recognized on the Moon.
- The outer rim of this basin can be seen from Earth as a huge chain of mountains located on the Moon's southern limb.
- Sometimes they are informally called "Leibnitz mountains".

### What is an impact crater?

- Impact craters are geologic structures formed when a large meteoroid, asteroid or comet smashes into a planet or a satellite.
- All the inner bodies in our solar system have been heavily bombarded by meteoroids throughout their history.
- The factors affecting the appearance of impact craters include the size and velocity of the impactor and the geology of the surface.
- The surfaces of the Moon, Mars and Mercury, where other geologic processes stopped millions of years ago, record this bombardment clearly.
- On the Earth, however, which has been even more heavily impacted than the Moon, craters are continually erased by erosion and re-deposition as well as by volcanic resurfacing and tectonic activity.

### How can craters be used to determine the age of a planet or moon?

- Scientists record the size and number of impact craters — and how eroded they are — to determine the ages and histories of different planetary surfaces.
- Early during the formation of our solar system there was lots of large debris striking the surfaces of the young planets and moons.
- These older impact basins are larger than the more recent craters.
- As a rule of thumb, older surfaces have been exposed to impacting bodies (meteoroids, asteroids, and comets) for a longer period of time than younger surfaces.
- Therefore, older surfaces have more impact craters.
- Mercury and the Moon are covered with impact craters; their surfaces are very old.
- Venus has fewer craters; its surface has been covered recently (in the last 500 million years!) by lava flows that obscured the older craters.

## 1.8 Dark Matter

### Why in news?

While attempting to detect the earliest stars in the universe through radio wave signals scientists accidentally made a discovery on dark matter.

### What the discovery is?

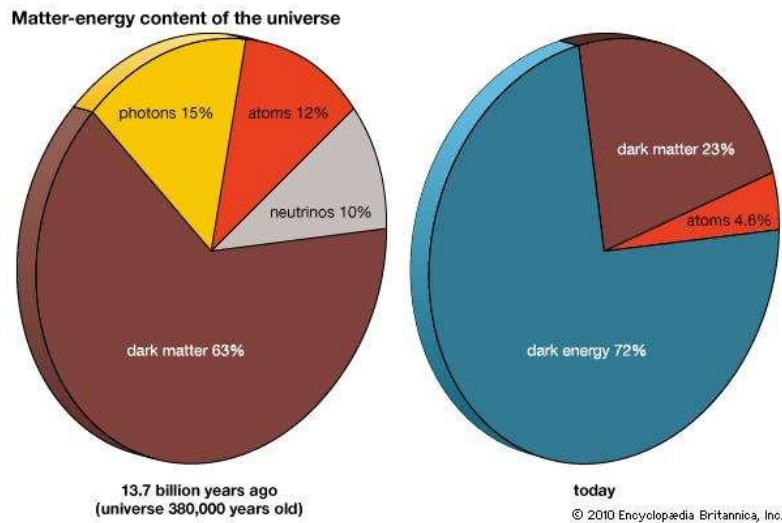
- Dark matter is the key to unlock the mystery of “what the universe is made of”.
- Most of the matter in the universe is invisible and known as 'dark matter.'
- The above mentioned discovery offers first direct proof that dark matter exists and that it is made up of low-mass particles.

### What is Dark matter/dark energy?

- Although the names seem to imply that they are similar, dark energy and dark matter are not directly related.



- Dark energy is the force responsible for the acceleration of the expansion of the universe at an ever-increasing rate since the Big Bang.



- Dark matter, on the other hand, consists of the unseen particles that bind our universe—and even our own bodies—together.
- Astronomers can't see dark matter through a telescope.
- They can locate dark matter by its gravitational effects on its surroundings and the detectable X-rays it emits.
- It is made of super-dense astronomical bodies called massive astrophysical compact halo objects (MACHOs) and weakly interacting massive particles (WIMPs).
- Dark matter is a type of matter which has not yet been directly observed.
- But it is thought to form a fundamental part of the universe.
- **Dark matter** produces an **attractive force** (gravity).
- **Dark energy** produces a **repulsive force** (antigravity).
- Together, they make up 96 percent of the universe—and we can't see either.
- Astronomers know dark matter exists because visible matter doesn't have enough gravitational muster to hold galaxies together.

### 1.9 So-2 star is single and ready for big Einstein test

#### Why in news?

A team of astronomers has found that So-2 does not have a significant companion.

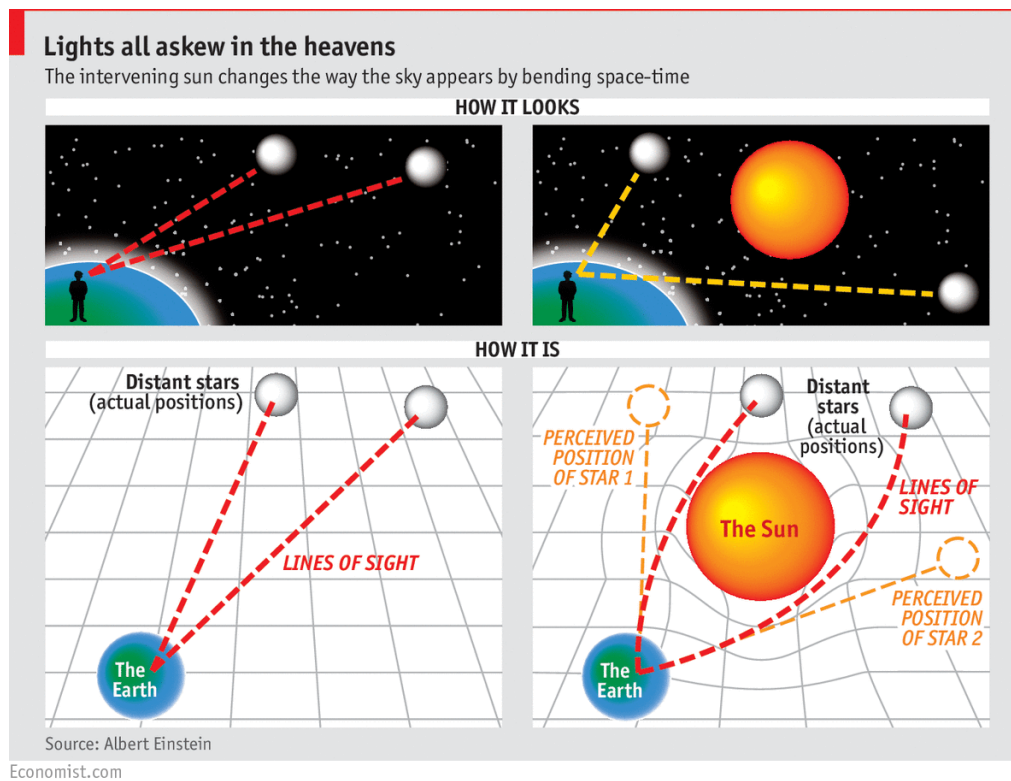
#### Why the discovery is important?

- Up until now, it was thought that So-2 may be a binary system.
- Binary system is a system where two stars circle around each other.
- Having such a partner would have complicated the upcoming gravity test.
- Einstein's Theory of General Relativity predicts that light coming from a strong gravitational field gets stretched out, or "redshifted."
- Researchers expect to directly measure this phenomenon as So-2 makes its closest approach to the supermassive black hole at the center of our Milky Way galaxy.

#### What is Einstein's Theory of General Relativity?

- It is also known as the general theory of relativity.
- It is the geometric theory of gravitation and the current description of gravitation in modern physics.

- General relativity generalizes special relativity and Newton's law of universal gravitation, providing a unified description of gravity as a geometric property of space and time, or spacetime.



- In particular, the curvature of spacetime is directly related to the energy and momentum of whatever matter and radiation are present.
- Some predictions of general relativity differ significantly from those of classical physics.
- Especially concerning the passage of time, the geometry of space, the motion of bodies in free fall, and the propagation of light.
- Matter does not simply pull on other matter across empty space, as Newton had imagined.
- Rather matter distorts space-time and it is this distorted space-time that in turn affects other matter.
- Objects fly freely under their own inertia through warped space-time, following curved paths, because this is the shortest possible path (or geodesic) in warped space-time.
- Theory's central premise is that the curvature of space-time is directly determined by the distribution of matter and energy contained within it.

### 1.10 Habitability of Proxima

#### Why in news?

Astronomers have detected a massive stellar flare from Proxima Centauri.

#### Why the observation is important?

- At peak luminosity it was 10 times brighter than our Sun's largest flares when observed at similar wavelengths.
- This finding raises questions about the habitability of our Solar System's nearest exoplanetary neighbor, Proxima b, which orbits Proxima Centauri.
- Over the billions of years since Proxima b formed, flares like this one could have evaporated any atmosphere or ocean and sterilized the surface.
- This suggests that habitability may involve more than just being the right distance from the host star to have liquid water.

#### What is a stellar flare?

- A stellar flare is a sudden flash of increased star's brightness, usually observed near its surface.
- Flares are often, but not always, accompanied by a coronal mass ejection.
- Stellar flares fall on a very broad spectrum of emissions, an energy release of typically 10<sup>20</sup> joules of energy is considered to be the median for a well-observed event.
- The flare ejects clouds of electrons, ions, and atoms along with the electromagnetic waves through the Sun's corona into outer space.
- The phenomenon therefore provides an early example of multi-messenger astronomy.
- The term is also used to refer to similar phenomena in sun, where the term solar flare applies.
- In case if sun's ejection is in the direction of the Earth the particles hitting the upper atmosphere can cause bright auroras.
- This may even disrupt long range radio communication.
- It usually takes a day or two for these clouds to reach Earth.

### What is proxima centauri?

- At 4.2 light years away Proxima Centauri is the nearest star to the sun.
- It is so small and dim that it cannot be viewed with the naked eye.
- The star can be found in the Centaurus constellation.
- The red dwarf Proxima Centauri is part of the three star Alpha Centauri system, the other two stars, Alpha Centauri A and B, are similar to our own sun.
- Proxima Centauri is extremely distant from its two companions, orbiting them at a distance of around 1.2 trillion miles (1.9 trillion km).
- Stars like our sun exist for a few billion years, red dwarfs like Proxima Centauri burn their fuel at a much lower rate and can therefore exist far longer.
- In 2016 it was announced that an Earth sized planet had been discovered orbiting the habitable zone around Proxima Centauri.
- The planet named Proxima b could possibly have liquid water on its surface.
- Proxima b is the closest known planet outside our solar system.

### 1.12 SpaceX Falcon Heavy

- SpaceX's big new rocket Falcon Heavy, carrying a red sports car was launched successfully on its first test flight.
- Falcon Heavy is the most powerful operational rocket in the world.

| LAUNCHVEHICLE                    | FALCON HEAVY            | SPACE SHUTTLE          | PROTON M               | DELTA IV HEAVY         | TITAN IV-B             | ARIANE 5 ES            | ATLAS V 551            | JAPAN H2B              | CHINA LM3B             |
|----------------------------------|-------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
| PAYLOAD TO LOW EARTH ORBIT (LEO) | 63,800 kg<br>140,660 lb | 24,000 kg<br>53,790 lb | 23,000 kg<br>50,710 lb | 22,560 kg<br>49,740 lb | 21,680 kg<br>47,800 lb | 20,000 kg<br>44,090 lb | 18,510 kg<br>40,810 lb | 16,500 kg<br>36,380 lb | 11,200 kg<br>24,690 lb |

- It can lift about twice the payload at one third of the cost by Delta 4 rocket which was the most powerful rocket till now.
- In addition ,SpaceX is also involved in making of Dragon capsule which is a suborbital reusable launch vehicle (RLV), intended for low-altitude flight testing.

- ISRO in 2016 tested Reusable Launch Vehicle - Technology Demonstrator (RLV-TD) successfully.

### 1.13 Solar Cycles and Sun spots

- The amount of magnetic flux that rises up to the Sun's surface varies with time in a cycle called the solar cycle, which lasts 11 years on average.
- This cycle is sometimes referred to as the sunspot cycle.
- Sunspots are regions where the solar magnetic field is very strong.
- In visible light, sunspots appear darker than their surroundings because they are a few thousand degrees cooler than their surroundings.
- They are usually concentrated in two bands, about 15 - 20 degrees wide in latitude, that go around the Sun on either side of the solar equator.

### 1.14 National Large Solar Telescope

- National Large Solar Telescope (NLST) is a proposed ground based 2-m class optical and near infra-red (IR) observational facility in the country.
- It is designed to address the scientific issues related to origin and dynamics of solar magnetic fields.
- The instrument has a broad scope to support and substantiate the solar atmospheric observations from space-based ADITYA mission and ground based MAST telescope (Udaipur).

### 1.15 Hubble Space Telescope

- Hubble Telescope has tracked the Neptune's Mysterious Shrinking Storm.
- It is the world's first large, space-based optical telescope, named in honor of astronomer Edwin Hubble.
- The Hubble is a joint project between NASA and the European Space Agency.
- Sun is the energy source of this space based telescope.
- Some of the interesting Hubble Discoveries are
  1. Creating a 3-D map of mysterious dark matter.
  2. Discovering Nix and Hydra, two moons of Pluto.
  3. Helping determine the rate of the universe's expansion.
  4. Discovering that nearly every major galaxy is anchored by a black hole.
  5. Helping refine the age of the universe.

### 1.16 Chandrayan 2 Mission

- ISRO planning to launch Chandrayaan-2 mission around April, 2018.
- It is the first time India attempts to land a rover on the moon's South Pole.
- Only USA Russia and China were able to soft land successfully on the lunar surface and these landings were near the lunar equator.
- The components of the mission are – Orbiter, Lander and Rover.
- The purpose of the mission is to collect data on the lunar topography, mineralogy, elemental abundance, lunar exposure and signatures of water-ice.
- India's Chandrayaan-1 mission was its first mission to moon where India was the captain and carrying the payloads built in UK, USA, Bulgaria Germany and Sweden.
- The mission comprised an orbiter and an impactor launched by ISRO's workhorse PSLV.
- Chandrayaan-1's greatest discovery was the widespread presence of water molecules in the lunar soil.

## 2. DEFENCE

### 2.1 Prithvi-II

- India successfully test-fired the indigenously developed nuclear capable Prithvi-II missile from a test range in Odisha.
- The surface to surface missile has strike range of 350 km.
- It is capable of carrying 500-1,000 kilogram of warheads and is thrusted by liquid propulsion twin engines.
- The state-of-the-art missile uses advanced inertial guidance system with manoeuvring trajectory to hit its target.

## 2.2 INS Chakra

- Russian authorities have demanded over \$20 million for rectifying the damage suffered by nuclear submarine INS Chakra.
- INS Chakra is a Russia-made, nuclear-propelled, hunter-killer akula class submarine.
- INS Chakra is one of the quietest nuclear submarines around, with noise levels next to zero.
- INS Chakra has been taken on lease from Russia for 10 years and would provide the Navy the opportunity to train personnel and operate such nuclear-powered vessels.
- The INS Chakra joined the Eastern Naval Command at Visakhapatnam in 2012.

## 2.3 Dakota DC3 Aircraft

- Air Chief Marshal (ACM) B.S. Dhanoa received a restored World War-II DC3 Dakota aircraft from an IAF veteran.
- The gift deed was signed between ACM Dhanoa and Air Cdre (Retd) Chandrasekhar at a handover ceremony.
- The DC3 Dakota aircraft Parashurama bearing the Tail Number VP-905 will be part of the IAF's vintage fleet.
- DC-3 transport aircraft, the world's first successful commercial airliner, readily adapted to military use during World War II.

## 2.4 ICGS Vajra

- The Indian Coast Guard ship 'Vajra', was decommissioned in Paradip.
- The Indian Coast Guard ship rendered three decades of service in maritime security along the northeast coastal waters.
- The ship monitored the coastal activities along with Odisha and West Bengal.
- It was built by Mazagon Dock, named 'Vajra', after the weapon of Lord Indra, and commissioned on 1988.

## 2.5 Rustom-2

- DRDO successfully flew its Medium Altitude Long Endurance (MALE) RUSTOM-2, unmanned aerial vehicle (UAV) at its Aeronautical Test Range (ATR) at Chitradurga.
- Rustom 2 is developed on the lines of predator drones of the US to carry out surveillance and reconnaissance (ISR) roles for the armed forces.
- The significance of this flight is that this is the first flight in user configuration with higher power engine.
- Rustom 2 is capable of carrying different combinations of payloads like synthetic aperture radar, electronic intelligence systems and situational awareness payloads
- The UAV is designed and developed by Aeronautical Development Establishment (ADE) of the DRDO, and aerospace major Hindustan Aeronautics Ltd and Bharat Electronics Ltd are its production partners.

## 3. ENVIRONMENT

### 3.1 Climate change threatens King penguins

#### Why in news?

Climate change is likely to have a devastating impact on King penguins if global warming continues at its present rate, scientists warn.

#### **Why Polar bears never, ever eat penguins?**

- Because they are found at opposite ends of the Earth.
- Polar bears roam within the Arctic Circle—including the North Pole.
- Penguins are found only in the Southern Hemisphere, mostly near Earth's South Pole, in Antarctica.

#### **Where do penguins live?**

- Not all penguins live in super cold climates.
- Within the penguin family, there are several species.
- All penguins reside in the Southern Hemisphere.
- But most do not live in Antarctica.
- In fact, only two species actually live on the Antarctic coastline.

#### **Why do penguins only live in the Southern Hemisphere?**

- Although penguins are able to swim long distances, they are predominately shore birds and thus do not venture far into the ocean.
- They have easy access to prey, while nearby predators prevent them venturing too far from their habitat.
- In the North Pole, predators such as polar bears and arctic foxes would limit their survival.
- In addition, migrating through warmer waters to reach the northern hemisphere is almost impossible for penguins and could prove fatal.
- As they are flightless, the penguins' range is small unlike many other species of birds.
- As such they have remained in roughly the same area, mostly around the South Pole, for 40 million years.
- Some have been found as far north as the equator, but for most part they have no need to leave their home at South Pole.

### **3.2 Beware of LED lights, cautions expert**

#### **Why in news?**

Experts caution that LED lighting if not installed in moderation, could cause serious damage to the health of human beings.

#### **What is a diode?**

- A diode is a specialized electronic component with two electrodes called the anode and the cathode.
- Most diodes are made with semiconductor materials such as silicon, germanium, or selenium.
- Some diodes are comprised of metal electrodes in a chamber evacuated or filled with a pure elemental gas at low pressure.
- Diodes can be used as rectifiers, signal limiters, voltage regulators, switches, signal modulators, signal mixers, signal demodulators, and oscillators.
- The fundamental property of a diode is its tendency to conduct electric current in only one direction.

#### **What is an LED?**

- A light-emitting diode (LED) is a semiconductor device that emits visible light when an electric current passes through it.
- The light is not particularly bright, but in most LEDs it is monochromatic, occurring at a single wavelength.
- The output from an LED can range from red (at a wavelength of approximately 700 nanometers) to blue-violet (about 400 nanometers).
- Some LEDs emit infrared (IR) energy (830 nanometers or longer).
- Such a device is known as an *infrared-emitting diode* (IRED).

#### **How LEDs differ from Diodes?**

- An LED or IRED consists of two elements of processed material called *P-type semiconductors* and *N-type semiconductors*.
- These two elements are placed in direct contact, forming a region called the *P-N junction*.
- In this respect, the LED or IRED resembles most other diode types, but there are important differences.
- The LED or IRED has a transparent package, allowing visible or IR energy to pass through.

#### What are the benefits of LEDs and IREDS?

Compared with incandescent and fluorescent illuminating devices, the benefit includes:

- **Low power requirement:** Most types can be operated with battery power supplies.
- **High efficiency:** Most of the power supplied to an LED or IRED is converted into radiation in the desired form, with minimal heat production.
- **Long life:** When properly installed, an LED or IRED can function for decades.

### 3.3 Plant Named After Kalam

#### Why in news?

New plant species from West Bengal named after former President Abdul Kalam.

#### What is the new plant found?

- Scientists from the Botanical Survey of India have identified a new plant species from two protected National Parks in West Bengal.
- Named *Drypetes kalamii*, it is a small shrub found to be shorter version of its close relative *Drypetes ellisii*.
- This adds to the rich floral wealth of India.
- The new species is a close relative of a medicinal plant known in Sanskrit as *Putrajivah*.
- The new species is found in wet, shaded areas of subtropical moist semi-evergreen forests, at a height ranging 50-100 metres.
- The plant is of pale yellow flowers in clusters and bright orange to red fruits.
- The plant is exclusive to the two national parks Buxa National Park and Jaldapara National Park in West Bengal.

**Note:** NASA had recently named a new bacterium after Dr Kalam.

## 4. INNOVATION

### 4.1 Individual Quantum Dots

#### Why in news?

Researchers have developed an imaging technique that demonstrates imaging of individual nanoparticles at different orientations while in a laser-induced excited state.

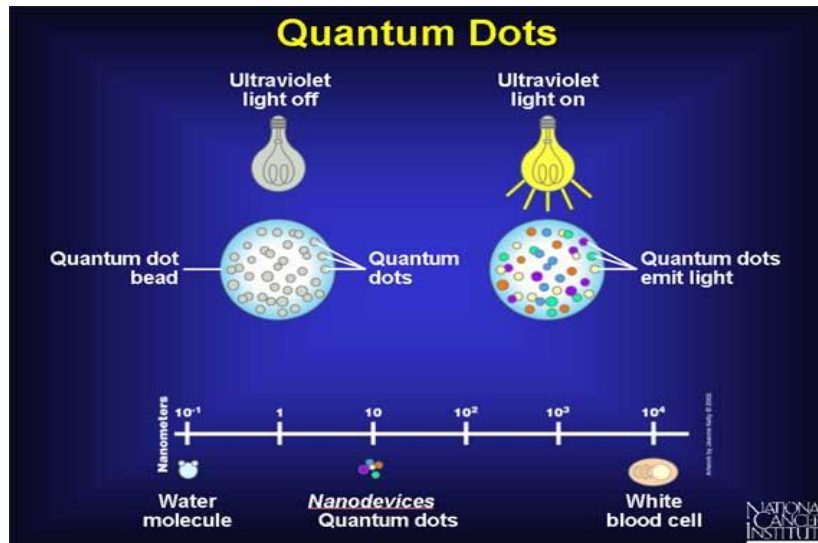
#### What are the advantages of the imaging?

- Nanostructures like microchip semiconductors, carbon nanotubes and large protein molecules contain defects that form during synthesis that cause them to differ in composition from one another.
- However, these defects are not always a bad thing.
- For example, semiconductors are manufactured with intentional defects that form the 'holes'.
- Holes are used in producing electrical conductivity in semiconductors.
- Having the ability to image those defects could let us better characterize them and control their production.
- As advances in technology allow for smaller and smaller nanoparticles, it is critical for engineers to know the precise number and location of these defects to assure quality and functionality.

#### What is a Quantum Dot?

- Any material at the nanoscale is a nanoparticle.

- A quantum dot is a nanoparticle made of any semiconductor material such as silicon, cadmium selenide, cadmium sulfide, or indium arsenide.
- Quantum dots may be able to increase the efficiency of solar cells.
- In normal solar cells, a photon of light generates one electron.
- Experiments with both silicon quantum dots and lead sulfide quantum dots can generate two electrons for a single photon of light.
- Therefore, using quantum dots in solar cells could significantly increase their efficiency in producing electric power.
- Researchers are also working on the use of quantum dots in displays like cell phone or television screen that would consume less power than current displays.



- By placing different size quantum dots in each pixel of a display screen, the red, green, and blue colors used to generate the full spectrum of colors would be available.
- Quantum dots are semiconductor nanoparticles that glow a particular color after being illuminated by light.
- The color they glow depends on the size of the nanoparticle.
- When the quantum dots are illuminated by UV light, some of the electrons receive enough energy to break free from the atoms.
- This capability allows them to move around the nanoparticle, creating a conduction band in which electrons are free to move through a material and conduct electricity.
- When these electrons drop back into the outer orbit around the atom (the valence band), they emit light.
- The color of that light depends on the energy difference between the conduction band and the valence band.

## 4.2 Quantum Computers

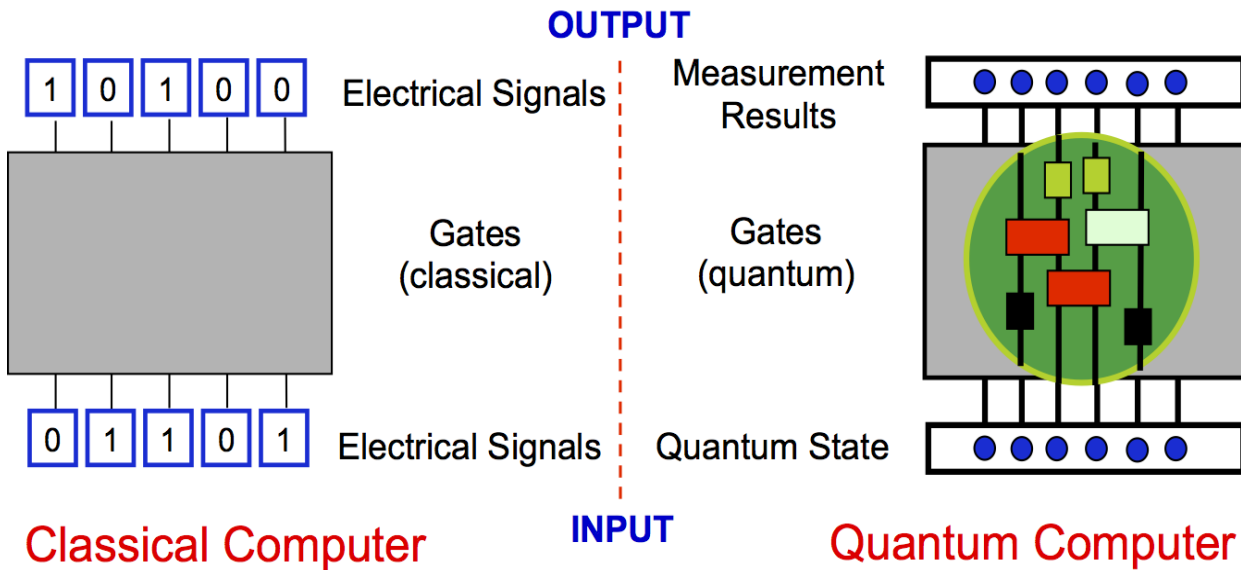
### Why in news?

For the first time, scientists have performed simple algorithms on a silicon-based quantum computer.

### What is quantum computing?

- It takes advantage of the strange ability of subatomic particles to exist in more than one state at any time.
- Due to behaviour of the tiniest particles, operations can be done much more quickly and use less energy than classical computers.
- In classical computing, a bit is a single piece of information that can exist in two states – 1 or 0.
- In quantum computing, a qubit (short for “quantum bit”) is a unit of quantum information.





- Qubits have special properties that help them solve complex problems much faster than classical bits.
- One of these properties is superposition.
- That is instead of holding one binary value (“0” or “1”) like a classical bit, a qubit can hold a combination of “0” and “1” simultaneously.
- When multiple qubits interact coherently, they can explore multiple options and process information in a fraction of the time it would take even the fastest non-quantum systems.
- Unlike a usual bit, they can also store much more information than just 1 or 0, because they can exist in any superposition of these values.

#### What can quantum computers do?

- Quantum systems may unravel the complexity of molecular and chemical interactions.
- This may lead to the discovery of new medicines and materials.
- They may enable ultra-efficient logistics and supply chains, such as optimizing fleet operations for deliveries during the holiday season.
- They may help us find new ways to model financial data and isolate key global risk factors to make better investments.
- And they may make facets of artificial intelligence such as machine learning much more powerful.

#### What are the outcomes of the research?

- It is a major step toward making a quantum computer using everyday materials.
- The demonstration of nearly error-free two-qubit gate is an important early step in building a more complex quantum computing device from silicon, the same material used in conventional electronic devices.
- Silicon-based devices are likely to be less expensive and easier to manufacture than other technologies for achieving a quantum computer.
- Although other research groups and companies have announced quantum devices containing 50 or more qubits, those systems require exotic materials such as superconductors or charged atoms held in place by lasers.

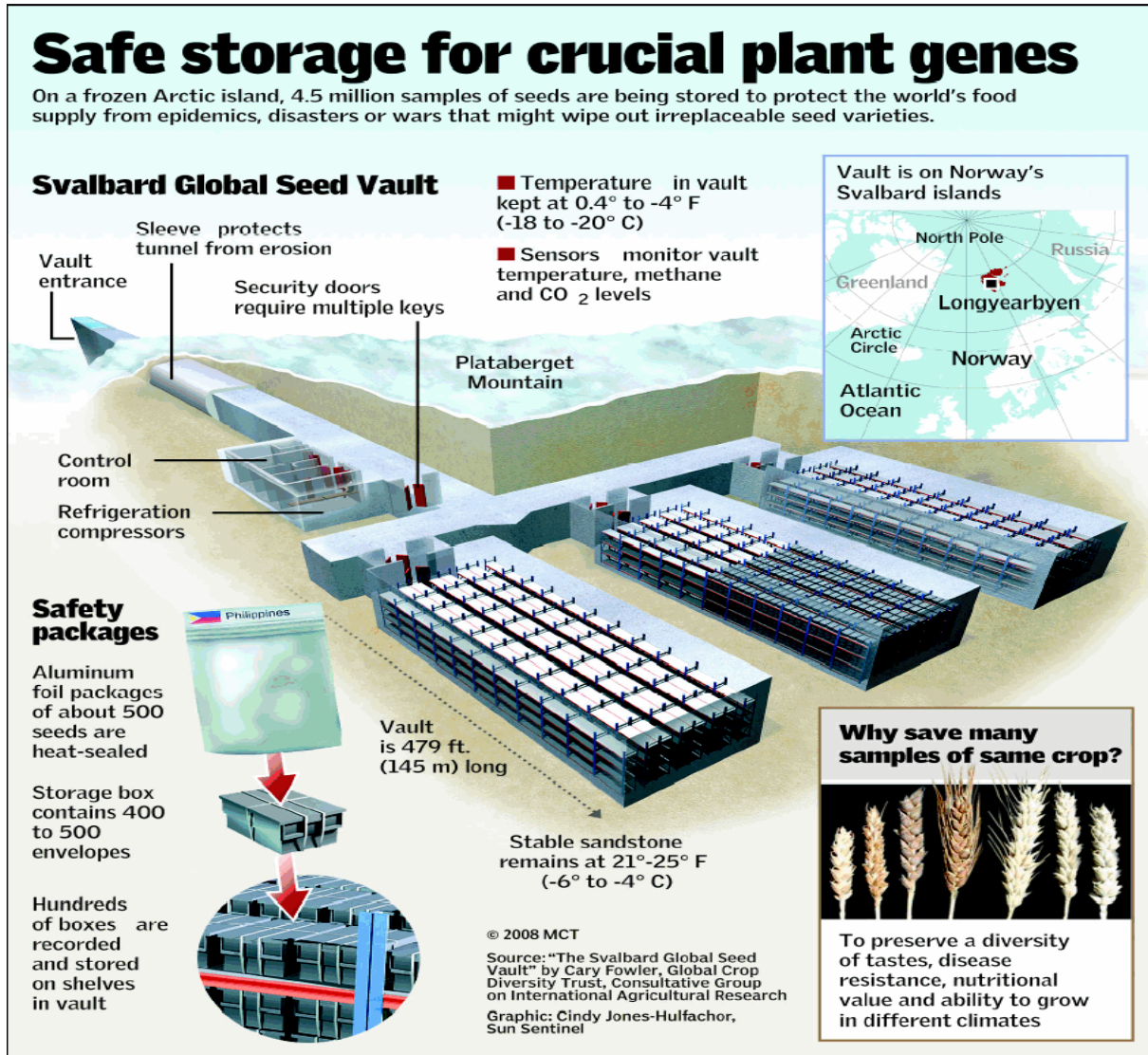
#### 4.3 Seed Vault

##### Why in news?

The Svalbard Global Seed Vault in Norway celebrates the 10th anniversary of its official opening and the Norwegian government has planned to upgrade the vault.

## What is the Svalbard Global Seed Vault?

- The Svalbard Global Seed Vault is a secure seed bank on the Norwegian island of Spitsbergen near Longyearbyen.



- It is a facility located on a remote island in the Arctic Ocean.
- It houses the world's largest collection of seeds.
- The seeds can be of use in the event of a global catastrophe or when some species is lost due to natural disasters.
- It is therefore also referred to as the doomsday vault.

## Where is India's seed vault?

- At Chang La in the Himalayas, at a height of 17,300 feet, there is a storage facility with over 5,000 seed accessions.
- It is the second such seed bank in the world after Svalbard Global Seed Vault.

## Who maintains India's seed vault?

- The vault is a joint venture of

- the National Bureau of Plant Genetic Resources (which comes under the Indian Council of Agricultural Research) and
- the Defence Institute of High Altitude Research (under Defence Research and Development Organisation).

#### How are the seeds stored?

- When a seed needs to be stored for few years, maintaining it at just 10 degree Celsius is enough.
- But in the long run, for 10 to 20 years, they need to be kept at a minus 15 to minus 20 degree Celsius (range).
- Chang La has a prevalent temperature in this sub-zero range.

#### 4.4 Strange properties of Oganesson predicted

##### Why in news?

New study predicted some odd properties of Oganesson.

##### What is Oganesson?

- Oganesson is a radioactive, artificially produced element.

**Atomic Number:** 118  
**Atomic Symbol:** Og  
**Atomic Weight:** [294]

- Oganesson has one known isotope, 294-Og, with a half-life of about 0.89 milliseconds.
- Through alpha decay, it turns into 290Lv (livermorium-290).
- Only a few atoms of the synthetic element have ever been created, each of which survived for less than a millisecond.
- So to investigate oganesson's properties, scientists have to rely largely on theoretical predictions.

##### What are the strange properties of Oganesson?

- Instead of residing in discrete shells oganesson's electrons appear to be a nebulous blob.
- oganesson is the only noble gas that's happy to both give away its electrons and receive electrons i.e. could be chemically reactive.
- At room temperature, scientists expect that these oganesson atoms could clump together in a solid, unlike any other noble gases.
- The sheer number of oganesson's protons — 118 — may help the particles overcome the strong nuclear force, creating a bubble with few protons at the nucleus's center

##### What are Superheavy elements?

- Often shortened to SHE, the term 'superheavy' refers to elements with an atomic number that is heavier than Rutherfordium (element 104).
- They aren't naturally occurring; scientists are restricted to creating them in labs.
- All of these elements are unstable and decay radioactively into other elements.

##### What are the four new SHEs discovered?

Element 113: nihonium (Nh)  
 Element 115: moscovium (Mc)  
 Element 117: tennessine (Ts)  
 Element 118: oganesson (Og)

## 5. BIO TECHNOLOGY

### 5.1 Can DNA editing

#### Why in news?

Kiwi is a native species of New Zealand which is now preyed upon by invasive rodents. Therefore Scientists are thinking about a new twist on "gene drive" technology that could control the pests and save the birds.

### What is genome editing?

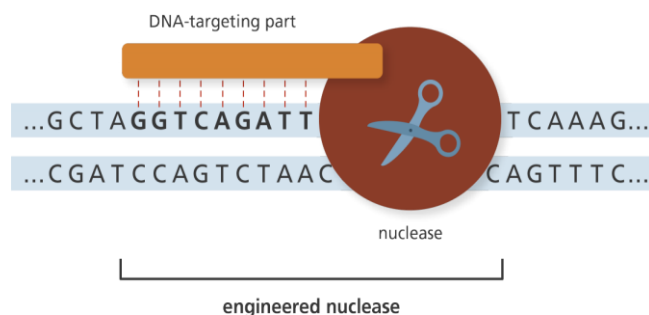
- Genome editing is a way of making specific changes to the DNA of a cell or organism.
- It involves making cuts at specific DNA sequences using enzymes called 'engineered nucleases'.
- Genome editing can be used to add, remove, or alter DNA in the genome.
- By editing the genome the characteristics of a cell or an organism can be changed.

### What is genome editing used for?

- Genome editing could be used to edit the genome of any organism.
- Genome editing can be used:
  - **For research:** to understand biology of organisms and how they work.
  - **To treat disease:** i.e. to modify human blood cells to treat conditions including leukaemia and AIDS.
  - **For biotechnology:** in agriculture to genetically modify crops to improve their yields and resistance to disease and drought.

### How does genome editing work?

- Genome editing uses a type of enzyme called an 'engineered nuclease' which cuts the genome in a specific place.
- Engineered nucleases are made up of two parts:
  - A nuclease part that cuts the DNA.
  - A DNA-targeting part that is designed to guide the nuclease to a specific sequence of DNA.
- After cutting the DNA in a specific place, the cell will naturally repair the cut.
- We can manipulate this repair process to make changes (or 'edits') to the DNA in that location in the genome.



## 5.2 CRISPR mechanism to prevent errors

### Why in news?

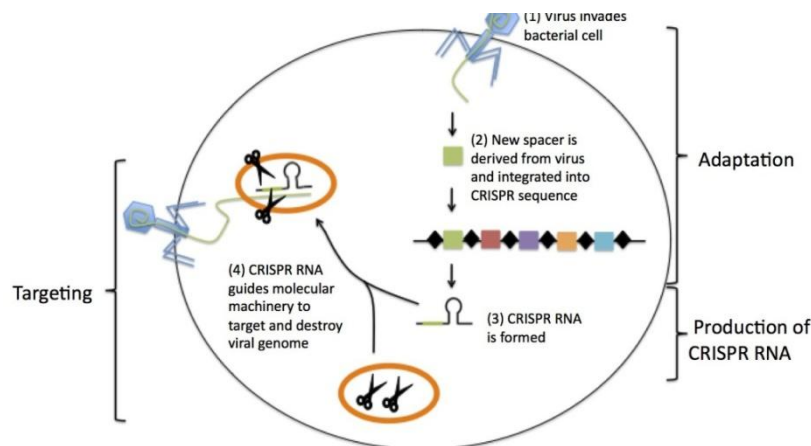
Researchers report that they've figured out the mechanism by which the CRISPR gene-editing enzyme Cas9 determines where and when to cut DNA strands which could help prevent gene-cutting errors.

### What is Gene editing?

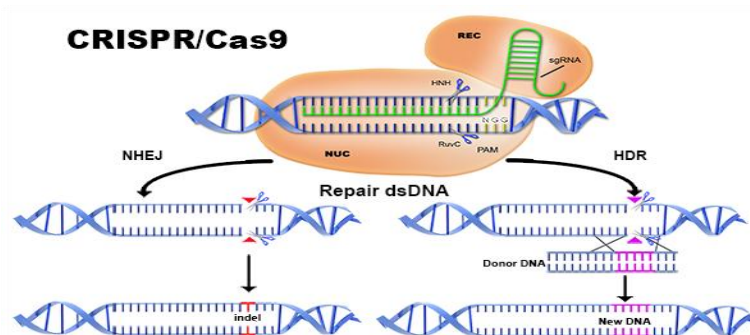
- It is also called Genome editing.
- It gives scientists the ability to change an organism's DNA.
- These technologies allow genetic material to be added, removed, or altered at particular locations in the genome.
- Several approaches to genome editing have been developed.
- A recent one is known as CRISPR-Cas9.
- CRISPR is an acronym for Clustered Regularly Interspaced Short Palindromic Repeat.

### What is a CRISPR-Cas9 system?

- The CRISPR-Cas9 system has generated a lot of excitement in the scientific community because it is faster, cheaper, more accurate, and more efficient than existing genome editing methods.
- CRISPR-Cas9 was adapted from a naturally occurring genome editing system in bacteria.
- The bacteria capture snippets of DNA from invading viruses and use them to create DNA segments known as CRISPR arrays.
- The CRISPR arrays allow the bacteria to "remember" the viruses (or closely related ones).
- If the viruses attack again, the bacteria produce RNA segments from the CRISPR arrays to target the viruses' DNA.
- The bacteria then use Cas9 or a similar enzyme to cut the DNA apart, which disables the virus.
- The CRISPR-Cas9 system works similarly in the lab.
- Researchers create a small piece of RNA with a short "guide" sequence.
- This in turn attaches (binds) to a specific target sequence of DNA in a genome.



- The RNA also binds to the Cas9 enzyme.
- As in bacteria, the modified RNA is used to recognize the DNA sequence, and the Cas9 enzyme cuts the DNA at the targeted location.
- Although Cas9 is the enzyme that is used most often, other enzymes (for example Cpf1) can also be used.
- Once the DNA is cut, researchers use the cell's own DNA repair machinery to add or delete pieces of genetic material, or to make changes to the DNA by replacing an existing segment with a customized DNA sequence.



### 5.3 New molecule that reveals Tuberculosis

#### Why in news?

Scientists invented a new molecule that reveals active tuberculosis bacteria in coughed-up mucus and saliva.

#### What is TB?

- Tuberculosis (TB) is caused by bacteria, *Mycobacterium tuberculosis*.
- It most often affects lungs.

- Tuberculosis is curable and preventable.
- TB is spread from person to person through the air.
- You get TB when you breathe in TB bacteria, released by someone in air through cough or sneeze.

#### What are the advantages of the discovery?

- Tuberculosis killed 1.7 million people worldwide in 2016, according to the World Health Organization.
- Also rampant resistance to drugs is making the disease harder to fight.
- Standard tests use dyes that stain a bunch of different bacteria, so technicians have to bleach the dye off everything except the TB cells.
- Chemical washing is time-consuming and prone to error.
- This synthetic molecule is a modified version of a sugar that TB bacteria consume to help build their cell walls.
- The invention simplifies TB diagnoses and speed up tests for detecting strains of the disease that are resistant to drugs.
- The new TB screening technique may also have an edge in checking whether patients respond to treatment.
- While current drug-resistance tests can take weeks or months, the new method reveals how drug-treated bacteria are faring within a few hours.

#### 5.4 Stem cells

##### Why in news?

Scientists have found a dual mechanism that keeps specific genes off, which helps the embryonic stem cells maintain pluripotency.

##### What are stem cells?

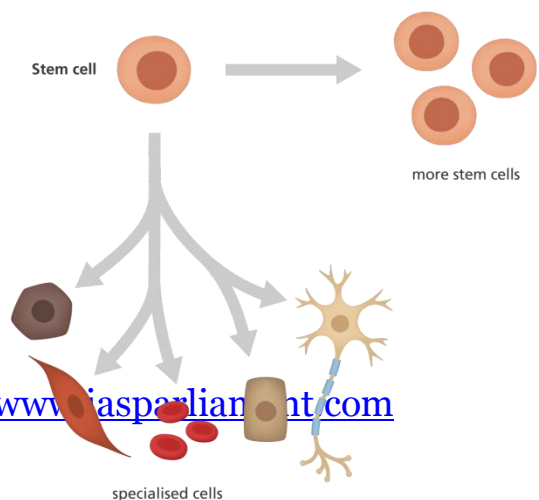
- Our body is made up of many different types of cell.
- Most cells are specialised to perform particular functions, such as red blood cells that carry oxygen around our bodies in the blood, but they are unable to divide.
- Stem cells provide new cells for the body as it grows, and replace specialised cells that are damaged or lost.
- They have two unique properties that enable them to do this:
  - They can divide over and over again to produce new cells.
  - As they divide, they can change into the other types of cell that make up the body.
- A stem cell is a cell with the unique ability to develop into specialised cell types in the body.
- In the future they may be used to replace cells and tissues that have been damaged or lost due to disease.
- In other words Stem cells are a class of undifferentiated cells that are able to differentiate into specialized cell types.

##### What are the sources of stem cells?

- Commonly, stem cells come from two main sources:
  - Embryos formed during the blastocyst phase of embryological development (embryonic stem cells) and
  - Adult tissue (adult stem cells).
- Both types are generally characterized by their potency, or potential to differentiate into different cell types (such as skin, muscle, bone, etc.).
- An illustration showing a stem cell giving rise to more stem cells or specialised cells.

##### What are the different types of stem cell?

- There are three main types of stem cell:



- embryonic stem cells
- adult stem cells
- induced pluripotent stem cells

### **Embryonic stem cells**

- Embryonic stem cells supply new cells for an embryo as it grows and develops into a baby.
- These stem cells are said to be pluripotent, which means they can change into any cell in the body.

### **Adult stem cells**

- Adult stem cells supply new cells as an organism grows and to replace cells that get damaged.
- Adult stem cells are said to be multipotent, which means they can only change into some cells in the body, not any cell, for example:
  - Blood (or 'haematopoietic') stem cells can only replace the various types of cells in the blood.
  - Skin (or 'epithelial') stem cells provide the different types of cells that make up our skin and hair.

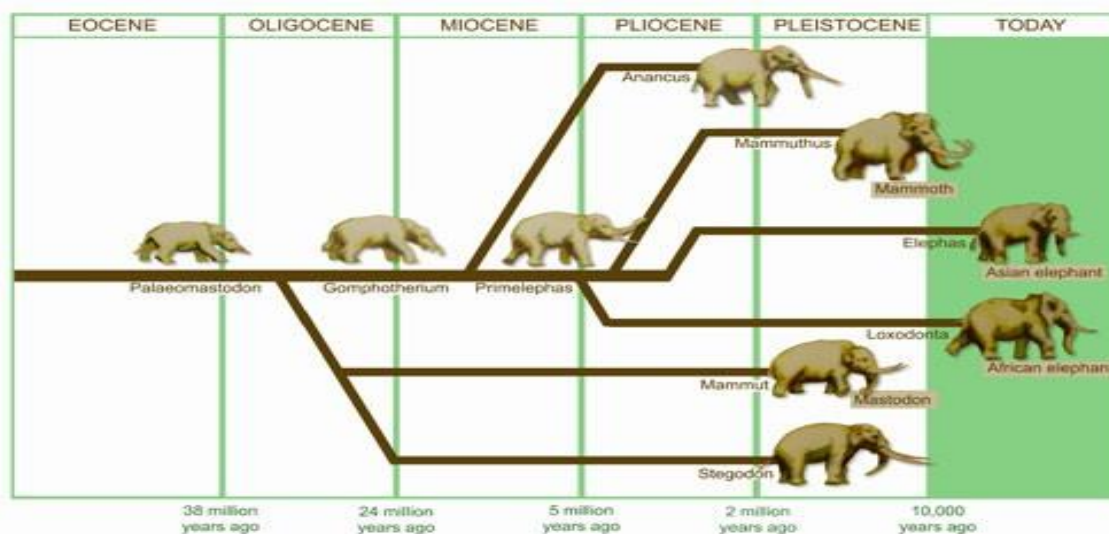
## **5.5 Third Species of Elephant**

### **Why in news?**

A Third Species of Elephant Has Been Discovered.

### **Why is the finding and why it is important?**

- There are three living species of elephants, not two.
- Their family tree is more complex than anyone realized, genetic analysis has revealed.



- Scientists have found prehistoric elephants interbred frequently and it played a crucial role in shaping elephant evolution over thousands of years.
- *Paleoloxodons*, are grouped with Asian elephants due to their physical similarities.
- They are descendent from a complex mixture of lineages related to the woolly mammoth and the present-day African forest elephant, scientists found.
- The finding is important because it adds urgency to the quest to save the African forest elephant.
- It also represents the debut of a genetic technique that could help us understand other animals' heritage.
- Elephants famously come in African and Asian species, with differences in size and whether the females have tusks.

- Biologists have suspected for some time that Africa hosts two species.
- The above mentioned research confirmed the existence of three different species of elephant.
- There are two species in Africa i.e. forest (*Loxodonta cyclotis*) and savannah (*Loxodonta africana*) elephant, and one species in Asia.
- Forest elephants are far more threatened than their savannah cousins.
- Only by getting *L. cyclotis* recognized as a different and endangered species might they gain the attention needed to save them.

#### **What were the classifications of elephant?**

- Previously, elephants were classified into two species, the African (*Loxodonta africana*) and Asian (*Elephas maximus*) elephants. (Now three)
- Two subspecies of African elephants (now recognized as separate species)
  - Savanna (*Loxodonta africana africana*)
  - Forest (*Loxodonta africana cyclotis*) elephants.
- There are four recognized subspecies of Asian elephants,
  - Sri Lankan subspecies (*Elephas maximus maximus*)
  - Mainland subspecies (*Elephas maximus indicus*)
  - Borneo subspecies (*Elephas maximus borneensis*), and
  - Sumatran subspecies (*Elephas maximus sumatranus*).

#### **What is a Palaeoloxodon?**

- **Palaeoloxodon** was an extinct subgenus of elephants, containing the various species of straight-tusked elephant.
- Palaeoloxodon belongs to the genus *Elephas* and so is more closely related to the Asian Elephant
- Palaeoloxodon is known informally as the "straight-tusked elephant" because of the straight tusks of *Elephas* (*Palaeoloxodon*) antiquus.

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