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SCIENCE AND TECHNOLOGY – JUNE 2018

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SCIENCE AND TECHNOLOGY

JUNE 2018

1. SPACE

1.1 ISRO to manufacture space solar cells

Why in News?

Isro has bought the technology for space solar cells from US and will mass-produce them in the country with the help of industry.

What is the difference between solar panel and solar thermal collector?

- A solar panel is composed of a package of photovoltaic cells.
- It can be used in a larger photovoltaic system for generating and supplying electric energy for residents and other commercial applications.
- Solar radiation that falls directly on the solar panel is converted into direct current.
- The electric energy output of each panel varies from 100 to 320 W.
- A solar thermal collector, on the other hand, collects heat by direct absorption of sunlight.
- It consists of a collector that converts energy from sunlight into a more usable form of energy.
- Solar collectors may be referred to as solar parabolic apparatus for more complex installations and solar air heat for less complex installations.
- The more complex collectors are employed in solar power plants for heating water to produce steam which in turn drives a turbine connected to an electric generator for generating electricity.
- However, the less complex collectors are used in commercial and residential buildings for supplemental space heating.

How its Efficiency is influenced?

- Most of the solar panels are around 11-15% efficient.
- The efficiency of the panels is measured by the amount of sunlight hitting the panel, which in turn gets converted into electricity.
- Solar panels with small surface area are highly efficient.
- Efficiency of the panels is also affected by the orientation of the panel, pitch or tilt of the roof and panel, temperature and shade of the roof.
- The performance of the solar thermal collector depends on the following criteria:
 - Area of the solar collector
 - Total amount of solar radiation incident on the collector
 - Positioning of the collector's tilt and the collector's orientation.
- However, solar collector efficiency is influenced by several factors like heat gain, surface area, the conversion factor and heat loss through conduction and convection.

1.2 Einstein's gravity theory passes extreme test

Why in News?

The new findings show that Einstein's insights into gravity still hold sway, even in one of the most extreme scenario.

How does gravity works according to Einstein?

- It was part of his famous General Theory of Relativity.
- It offered a very different explanation from Newton's Law of Universal Gravitation.
- Einstein didn't believe gravity was a force at all.
- He said it was a distortion in the shape of space-time, otherwise known as "the fourth dimension".
- In general relativity, the effects of gravitation are ascribed to spacetime curvature instead of a force.
- Basic physics states that if there are no external forces at work, an object will always travel in the straightest possible line.
- Accordingly, without an external force, two objects travelling along parallel paths will always remain parallel. They will never meet.
- But the fact is, they do meet. Particles that start off on parallel paths sometimes end up colliding.
- Newton's theory says this can occur because of gravity, a force attracting those objects to one another or to a single, third object.
- Einstein also says this occurs due to gravity -- but in his theory, gravity is not a force. It's a curve in space-time.
- According to Einstein, those objects are still travelling along the straightest possible line, but due to a distortion in space-time, the straightest possible line is now along a spherical path.
- So two objects that were moving along a flat plane are now moving along a spherical plane.
- And two straight paths along that sphere end in a single point.

1.3 Einstein's predictions confirmed

Why in News?

A team of international scientists observing a star in the Milky Way have for the first time confirmed Einstein's predictions of what happens to the motion of a star passing close to a supermassive black hole.

What was Einstein's prediction?

Einstein's 100-year-old general theory of relativity predicted that light from stars would be stretched to longer wavelengths by the extreme gravitational field of a black hole, and the star would appear redder, an effect known as gravitational red shift.

What are Gravitational Waves?

- Gravitational waves are '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.
- Einstein's mathematics showed that massive accelerating objects (such as neutron stars or black holes orbiting each other) would disrupt space-time in such a way that 'waves' of distorted space would radiate from the source (like the movement of waves away from a stone thrown into a pond).
- Furthermore, these ripples would travel at the speed of light through the Universe.
- It carries with them information about their cataclysmic origins, as well as invaluable clues to the nature of gravity itself.
- The strongest gravitational waves are produced by catastrophic events.

What are the events that can create gravitational waves?

1. Colliding black holes
2. The collapse of stellar cores (supernovae)
3. Coalescing neutron stars or white dwarf stars

4. The slightly wobbly rotation of neutron stars that are not perfect spheres and
5. The remnants of gravitational radiation created by the birth of the Universe itself.

1.4 Blood Moon

Why in News?

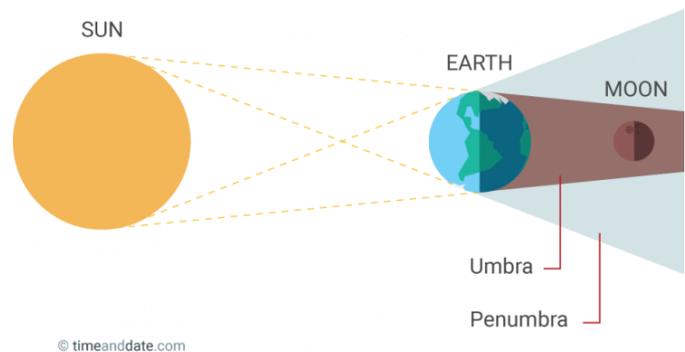
A blood-red moon dazzled star gazers across much of the world on July 27-28 when it moved into Earth's shadow for the longest lunar eclipse of the 21st Century.

What is blood moon?

- A lunar eclipse occurs when the moon passes in the shadow of Earth.
- This is an area known as the umbra, where light from the Sun is blocked by our planet.
- When the light refracts differently in the atmosphere and hits the moon, it makes it appear red.
- During a total eclipse, the entire moon is in shadow and it appears 'blood red'.
- But when it skirts the shadow, known as a partial or penumbral eclipse, the effect is less dramatic.

What Is a Total Lunar Eclipse?

- A total lunar eclipse takes place when the Earth comes between the Sun and the Moon and covers the Moon with its shadow.
- When this happens, the Moon can turn red, earning it the nickname of Blood Moon.
- Total lunar eclipses happen only when the Sun, Earth, and Moon are in a straight line, and there is a Full Moon.



Why don't we see a lunar eclipse every month if a Full Moon is needed for a total lunar eclipse?

- This is because the plane of the Moon's orbital path around Earth is inclined at an angle of 5° to Earth's orbital plane around the Sun, also known as the ecliptic.
- The points where the two orbital planes meet are called lunar nodes. Lunar eclipses occur when a Full Moon happens near a lunar node.

Why are there three shadows?

- During a total lunar eclipse, Earth's umbra completely covers the Moon.
- Earth's shadow can be divided into three parts:
 - Umbra - the darker, central part.
 - Penumbra - the outer part.
 - Antumbra - the partly shaded area beyond the umbra.

1.5 Parker Solar Probe

Why in News?

Parker Solar Probe, which aims to collect data on the inner workings of the magnetized corona, is scheduled for launch on August 6

Why Parker Solar Probe?

- This mission will provide insight on a critical link in the Sun-Earth connection.

- Data will be key to understanding and, perhaps, forecasting space weather.
- We need to go so close because:
 - The corona is unstable, producing the solar wind, flares and coronal mass ejections – we need to study at the source!
 - Millions of tons of highly magnetized material can erupt from the sun at speeds of several million miles an hour.

What Is the Sun's Corona?

- The **corona** is the outermost part of the Sun's atmosphere.
- The corona is usually hidden by the bright light of the Sun's surface.
- That makes it difficult to see without using special instruments.
- The corona can be seen during a total solar **eclipse**.

How does the corona cause solar winds?

- The corona extends far out into space.
- The corona continually varies in size and shape as it is affected by the Sun's magnetic field.
- The solar wind, which flows radially outward through the entire solar system, is formed by the expansion of the coronal gases and only ends at the heliopause.
- The corona's temperature causes its particles to move at very high speeds.
- These speeds are so high that the particles can escape the Sun's gravity.
- In spite of its high temperature, the corona yields relatively little heat, because of its low density

2. Defence

2.1 Apache and Chinook helicopters - game changers

Why in News?

India is procuring 22 AH-64E Apache attack choppers and 15 CH-47F(I) Chinook heavy-lift helicopters from Boeing.

What is the difference between helicopter and a chopper?

	Helicopter	Chopper
Definition	A type of rotorcraft in which lift and thrust are supplied by engine-driven rotors.	An aircraft without wings that obtains its lift from the rotation of overhead blades.
Usage	Usually for wars and long distance.	Usually for short distances and domestic purposes.
Speed	Faster	Slower
Efficiency	Greater	Lower
Weight	More	Less

What are the features of Apache helicopters?

- The AH-64 Apache is a multi-role combat helicopter.
- It is described as the most lethal attack helicopter in the world.
- It is used by the US Army and a number of international defence forces.
- It is equipped with all-weather and day – night fighting features apart from an advanced weapons system.
- The Apache has advanced laser, infrared, and target acquisition designation, including other systems, to locate, track and attack targets.
- It also has stealth characteristics, advanced sensors and beyond-visual-range missiles.

What are the features of Chinook?

- The massive helicopter can carry 9.6 tons of cargo, including heavy machinery, artillery guns and even light armoured vehicles to high altitude.
- It is suited for mountain operations.
- The Chinook is highly maneuverable and can get in and out of tight valleys.
- Its missions range from ferrying troops to disaster relief operations.
- The Border Roads Organisation has been waiting in particular for the Chinook to complete road building projects in the North East that have been stuck for years for want of a heavy lift chopper that can carry material and equipment through narrow valleys.

2.2 Deadline for FOC missed – Tejas

Why in News?

35 years after approval of Tejas, the indigenous Light Combat Aircraft (LCA) in 1983, it has missed another deadline of getting its final operational clearance (FOC).

What is LCA?

- A Light combat aircraft is a light multirole military aircraft.
- They have been modified or designed for engaging in light combat missions, either in light strike or attack missions, reconnaissance or interdiction roles while some keeping its trainer role.
- They are also slower than their bigger counterparts capable only of subsonic speed though some are capable of reaching mach 1+.
- They are equipped with either guns or short range air-to-air missiles.
- It is usually for self-defense purpose or anti-helicopter missions.
- It is not for air defense as lightweight fighters do.
- Some are capable of air combat missions due to integrated or have variants capable of carrying powerful multi-mode radar systems.
- But most LCAs don't have such due to their small limited design or are less powerful.
- They can still be used to patrol the skies and implement border patrol or air policing.
- These aircrafts are smaller and more lightly armed than the bigger multirole or as strike aircraft.

What are the capabilities of Tejas?

- The Tejas is a indigenously developed single-seat, single-engine, Compound-Delta-Wing, Tailless, lightweight, high-agility supersonic fighter aircraft.
- It is a multi-role fighter aircraft designed for multiple combat roles.

- It is a 4.5 generation plane.
- Tejas-Indian Light Combat Aircraft (LCA) together with its variants is the smallest and lightest Multi-Role Supersonic Fighter Aircraft of its class.
- The aircraft's design and development programme was led by the Aeronautical Development Agency (ADA) of the Indian Department of Defence, with Hindustan Aeronautics Limited (HAL) as the principal partner along with DRDO, CSIR, BEL, DGAQA, IAF and IN.
- It is designed to carry a host of weapons- air-to-air, air-to-surface, precision guided and standoff weaponry.
- In air-to-air ones, Tejas will carry long-range beyond visual range weapons, with highly agile high off-boresight missiles to tackle any close combat threat.

2.3 QRSAM test failed

Why in News?

QRSAM tested at Balasore rolled uncontrollably, fell into the Bay of Bengal. QRSAM tested at Balasore rolled uncontrollably, fell into the Bay of Bengal.

What is QRSAM?

- The QRSAM is a quick reaction, all-weather and network-centric search-on-the-move missile system.
- It can engage multiple targets at a range of about 30 km.
- The missile is a truck-mounted one with 360 degree rotatable, electronic-mechanically operated, turret-based launch unit..
- QR-SAM missile uses solid fuel propellant.
- It has a stated range of strike range of 25-30 km.
- Truck-mounted canister makes the missile system increase the mobility of the missile system ten fold over Akash Air Defence System.
- QRSAM is a highly mobile air defence system which comes with 100 percent kill probability.
- It has the capability to neutralise aerial targets like fighter jets, cruise missiles and air to surface missiles as well as short-range ballistic missiles.
- QRSAM is also a vital component in India's "Cold Start" Doctrine which will ensure the safety of forward Army formations in Enemy territories. (Mach 1.8)
- QR-SAM is more suited to urban combat and close-range combat.
- QR-SAM to have similar characters and is a very effective weapon when used under such scenario.



Why QRSAM is essential?

- A country like India which has hostile neighbors like Pakistan and China , it cannot depend 100% on single Air Defence Cover for such a large country.
- Relying on Single System is a practice which is not even followed by Great Military powers like the United States and Russia.
- India always required Combination of all Air Defence Systems to gives us a multi-layered air defence cover which was always missing for decades now.

What are the categories of Air Defence Systems?

- 1) Quick reaction Range Surface to Air Missile (QRSAM)

2) Short Range Surface to Air Missile (SRSAM)

3) Medium Range Surface to Air Missile (MRSAM) and

4) Long Range SAM (LRSAM) which can handle multi-threat level but also is more robust to deal with various types of Aerial Threat

2.4 Delhi to get Missile shield

Why in News?

Like Washington and Moscow, Delhi too to get missile shield

What is a missile?

- Missile is a rocket-propelled weapon designed to deliver an explosive warhead with great accuracy at high speed.
- Missiles vary from small tactical weapons that are ranging from a few hundred feet to much larger strategic weapons that have ranges of several thousand miles.
- Almost all missiles contain some form of guidance and control mechanism and are therefore often referred to as guided missiles.
- An unguided military missile, as well as any launch vehicle used to propel in the upper atmosphere or place a satellite in space, is usually referred to as a rocket.
- A propeller-driven underwater missile is called a torpedo.
- A guided missile powered along a low, level flight path by an air-breathing jet engine is called a cruise missile.

What are the different stages in ICBM launch?

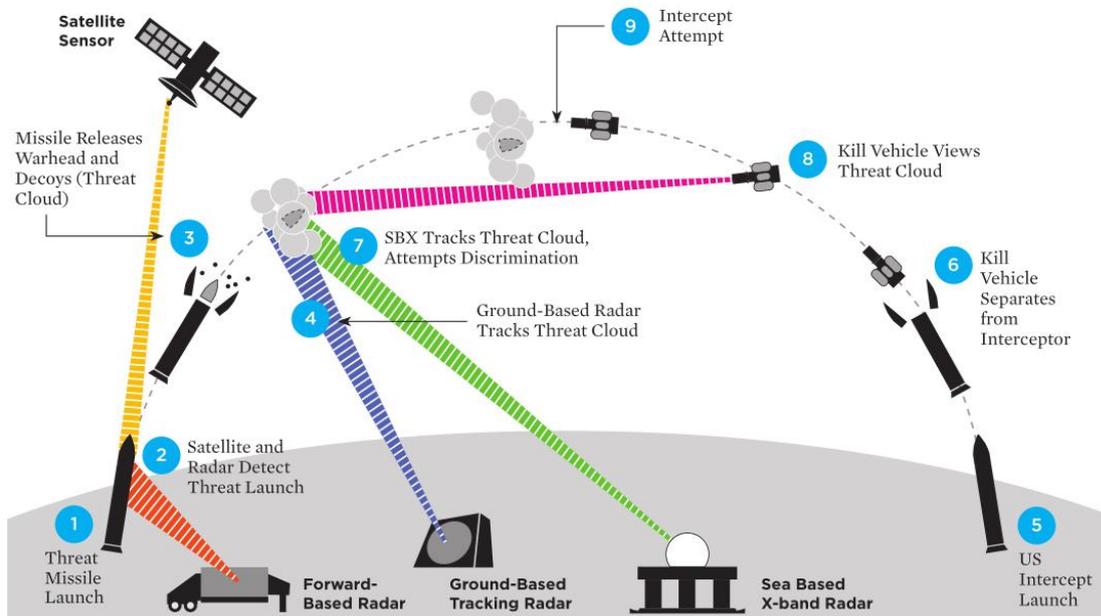
- ICBM launches have three distinct phases of flight.
- During the boost phase, a rocket launches the warhead at high speeds above the atmosphere, where it continues in free-fall through the vacuum of space.
- The midcourse phase begins with the rocket separating from the warhead, which continues unguided and unpowered, hundreds of miles above the Earth.
- The reentry, or terminal, phase sees the warhead descend at high speeds back through the Earth's atmosphere toward the ground.

What is a NASAM?

- National Advanced Surface-to-Air Missile System-II (NASAMS-II).
- NASAMS-II is a mid-range air defense system designed to counter threats from aircraft, UAV, and cruise missiles.
- The system is equipped with 3D surveillance Sentinel radars, fire distribution centers, and command-and-control units.

- Nirmala Sitharaman, has approved the “acceptance of necessity (AoN) for the acquisition of the National Advanced Surface to Air Missile System-II (NASAMS-II)

Anatomy of an Intercept



2.5 India to procure AUVs

Why in News?

The Indian Navy has re-started a process to procure eight ‘high endurance’ autonomous underwater vehicles’.

What is the difference between AUV and ROV?

- AUV stands for autonomous underwater vehicle and is commonly known as unmanned underwater vehicle.
- AUVs can be used for underwater survey missions such as detecting and mapping submerged wrecks, rocks, and obstructions that can be a hazard to navigation for commercial and recreational vessels.
- An AUV conducts its survey mission without operator intervention.
- When a mission is complete, the AUV will return to a pre-programmed location where the data can be downloaded and processed.
- A remotely operated vehicle (ROV) is an unoccupied underwater robot that is connected to a ship by a series of cables.
- These cables transmit command and control signals between the operator and the ROV, allowing remote navigation of the vehicle.
- An ROV may include a video camera, lights, sonar systems, and an articulating arm.
- The articulating arm is used for retrieving small objects, cutting lines, or attaching lifting hooks to larger objects.

What are the classes of submarines in Indian Navy?

Arihant class

- INS Arihant
- INS Aridhaman

Chakra (Akula II) class

- **INS Chakra**

Sindhughosh class

- INS Sindhughosh
- INS Sindhudhvaj
- INS Sindhuraj
- INS Sindhuvir
- INS Sindhuratna
- INS Sindhukesari
- INS Sindhukirti
- INS Sindhuvijay
- INS Sindhurashtra

Shishumar class:

- INS Shishumar (S44)
- INS Shankush (S45)
- INS Shalki (S46)
- INS Shankul (S47)

Kalvari class

- INS Kalvari
- INS Khanderi
- INS Karanj

Vela class

- INS Vela (S40)
- INS Vagir (S41)
- INS Vagli (S42)
- INS Vagsheer (S43)

3. Environment

3.1 Deep Ocean Mission

Why in News?

Govt. plans 'ISRO-like' ocean mission.

What the mission is about?

- It is a Rs. 8,000 crore proposal given to PMO for a revolution in deep sea exploration similar to space exploration
- Looking to emulate the success of the ISRO in designing and launching satellites, the Centre has drawn up a five-year plan to explore the deep recesses of the ocean.
- The Union Earth Sciences Ministry — tasked with coordinating the exercise — unveiled a blueprint of the 'Deep Ocean Mission (DOM)'.
- Among the key deliverables to achieve these goals are:
 - An offshore desalination plant that will work with tidal energy

- Developing a submersible vehicle that can go to a depth of at least 6,000 metres with three people on board.
- The mission proposes to explore the deep ocean similar to the space exploration started by ISRO about 35 years ago

What is India's share?

- India has been allotted a site of 75,000 square kilometres in the Central Indian Ocean Basin (CIOB) by the UN International Sea Bed Authority for exploitation of polymetallic nodules (PMN).
- These are rocks scattered on the seabed containing iron, manganese, nickel and cobalt.
- It is envisaged that 10% of recovery of that large reserve can meet the energy requirement of India for the next 100 years.
- It has been estimated that 380 million metric tonnes of polymetallic nodules are available at the bottom of the seas in the Central Indian Ocean.
- India's Exclusive Economic Zone spreads over 2.2 million square kilometres and in the deep sea, lies unexplored and unutilised.
- The focus will be on technologies for deep-sea mining, underwater vehicles, underwater robotics and ocean climate change advisory services, among other aspects.

3.2 Yellowstone

What is special about Yellowstone?

- It is a long-dormant Yellowstone super-volcano — more correctly a complex of volcanoes in the United States.
- It has unique origins and an activation process that is completely different from that typically associated with volcanoes.
- The Yellowstone Caldera is a part of the Rocky Mountains and located mostly in Wyoming.
- As is typical, it was assumed to be powered by heat from the earth's core.
- However, reconstruction of an "image" of what the earth beneath using seismographic data, suggests that the Yellowstone volcanoes were produced by a gigantic ancient oceanic plate that dove under the western U.S. about 30 million years ago.
- This ancient oceanic plate broke into pieces, which resulted in perturbations of unusual rocks in the mantle.
- In turn, this led to volcanic eruptions in the past 16 million years.
- Thus, an ancient oceanic plate could be the cause of the hotspot.

What is special about Yellowstone national park?

- Yellowstone National Park is a national park in the United States. It was the world's first national park.
- The name was taken from the Yellowstone River, which flows through the park.
- Yellowstone was made a UNESCO World Heritage Site in 1978.
- Yellowstone National Park is famous for its geysers and hot springs.
- The park contains about half the world's geysers.
- The world's most famous geyser, the Old Faithful Geyser, is in Yellowstone National Park.
- It also is a home to grizzly bears, wolves, bison and elk.

3.3 Uncertainty in Cloud seeding

Why in News?

Report finds cloud seeding increased rain in Karnataka.

What is project Varshadhare?

- Last year, there was visible scepticism when the State government, fearing another year of drought, initiated Project Varshadhare, a ₹35-crore cloud seeding programme.
- Though the monsoon picked up, perhaps unconnected to the project itself, planes that flew around seeding clouds may have increased localised rain by over 27.9% leading to an increase in 2.5 tmcft of water, said an evaluation report that was submitted to the State government

What is cloud seeding?

- Cloud seeding is the process of stimulating the precipitation process and form rain.
- Spreading either dry ice, or more commonly, silver iodide aerosols, into the upper part of clouds is used in the process.
- Since most rainfall starts through the growth of ice crystals from super-cooled cloud droplets (droplets colder than the freezing point, 32 deg. F or 0 deg. C) in the upper parts of clouds, the silver iodide particles are meant to encourage the growth of new ice particles.
- The history of cloud seeding has experienced uncertain results because it can never be known whether a cloud that rains after seeding might have rained anyway.
- This is because seeding is performed on clouds that look like they have some potential for producing rain.

Is cloud seeding harmful?

- When studying the efficacy and consequences of cloud seeding experiments, the experimenters tend to be biased in saying cloud seeding with silver iodide enhances precipitation without negative consequences.
- However, much of the literature substantiates that not only does cloud seeding fail to achieve the desired effect, it also yields harmful consequences.
- Some of these consequences include rain suppression, flooding, tornadoes, and silver iodide toxicity.

3.4 Complexity and irregular occurrence of El Niño

Why in News?

A new research study, published isolates key mechanisms that cause El Niño events to differ amongst each other.

What is ENSO?

- ENSO is nothing but El Nino Southern Oscillation.
- It is an irregular periodic variation of wind and sea surface temperature that occurs over the tropical eastern Pacific Ocean.
- ENSO affects the tropics (the regions surrounding the equator) and the subtropics (the regions adjacent to or bordering the tropics).
- The warming phase of ENSO is called El Nino, while the cooling phase is known as La Nina.

What is El Nino?

- El Nino is a climatic cycle characterised by high air pressure in the Western Pacific and low air pressure in the eastern.
- In normal conditions, strong trade winds travel from east to west across the tropical Pacific, pushing the warm surface waters towards the western Pacific.
- The surface temperature could witness an increase of 8 degrees Celsius in Asian waters.
- At the same time, cooler waters rise up towards the surface in the eastern Pacific on the coasts of Ecuador, Peru, and Chile.
- This process called upwelling aids in the development of a rich ecosystem.

What causes El Nino?

- El Nino sets in when there is anomaly in the pattern.
- The westward-blowing trade winds weaken along the Equator and due to changes in air pressure, the surface water moves eastwards to the coast of northern South America.
- The central and eastern Pacific regions warm up for over six months and result in an El Nino condition.
- The temperature of the water could rise up to 10 degrees Fahrenheit above normal.
- Warmer surface waters increase precipitation and bring above-normal rainfall in South America, and droughts to Indonesia and Australia.

3.5 Chromium in Water

Why in News?

A team of hydrogeologists from has found levels of chromium in groundwater in and around Chromepet to be 10 times the permissible limit.

What is Chromium and how is it used?

- Chromium is a metal found in natural deposits as ores containing other elements.
- Chromium is an odorless and tasteless metallic element.
- Chromium is found naturally in rocks, plants, soil and volcanic dust, and animals.
- The most common forms of chromium that occur in natural waters in the environment are:
 - Trivalent chromium (chromium-3)
 - Hexavalent chromium (chromium-6)
- Trivalent chromium is needed to help people break down glucose.
- It is found in many vegetables, fruits, meats, grains, and yeast.
- Chromium-6 occurs naturally in the environment from the erosion of natural chromium deposits.
- It can also be produced by industrial processes.
- Chromium is released to the environment by leakage, poor storage, or inadequate industrial waste disposal practices.
- The greatest use of chromium is in metal alloys such as stainless steel; protective coatings on metal; magnetic tapes; and pigments for paints, cement, paper, rubber, composition floor covering and other materials.
- Its soluble forms are used in wood preservatives.

What are the health effects?

Short-term: chromium can potentially cause the following health effects when people are exposed to it at levels above the Maximum Contaminant Level (MCL) for relatively short periods of time: skin irritation or ulceration.

Long-term: Chromium has the potential to cause the following effects from a lifetime exposure at levels above the MCL: damage to liver, kidney circulatory and nerve tissues; skin irritation.

3.6 Aphids can construct their own niche

Why in News?

Researchers have found out that aphids are able to influence the quality of their food, and that this may enable them to construct a niche on their own host plants.

What is an aphid?

- Aphids are soft-bodied insects that use their piercing sucking mouthparts to feed on plant sap.
- There are hundreds of different aphid species. They all feed on plant sap, known as phloem sap.

- They usually occur in colonies on the undersides of tender terminal growth.
- Heavily-infested leaves can wilt or turn yellow because of excessive sap removal.
- While the plant may look bad, aphid feeding generally will not seriously harm healthy, established trees and shrubs.
- However, some plants are very sensitive to feeding by certain aphid species.
- Saliva injected into plants by these aphids may cause leaves to pucker or to become severely distorted, even if only a few aphids are present.
- Also, aphid feeding on flower buds and fruit can cause malformed flowers or fruit.

What is a niche?

- Every species is adapted to a restricted selection of properties of the environment.
- These properties are certain general conditions (mostly climatic), but also specific resources (food, shelter, etc.).
- This specific set of environmental properties provides a species with the required living conditions called its *niche*.”
- As a property of the environment: nature consists of thousands and millions of potential niches occupied by the various species adapted to them.
- It really is what is called an *n*th dimensional hypervolume that represents all the components of what a species is, does, and need
- In other words Niche, in ecology is all of the interactions of a species with the other members of its community, including competition, predation, parasitism, and mutualism.
- A variety of abiotic factors, such as soil type and climate, also define a species’ niche.
- Each of the various species that constitute a community occupies its own ecological niche.
- Informally, a niche is considered the “job” or “role” that a species performs within nature.

3.6 Ocean acidification

Why in News?

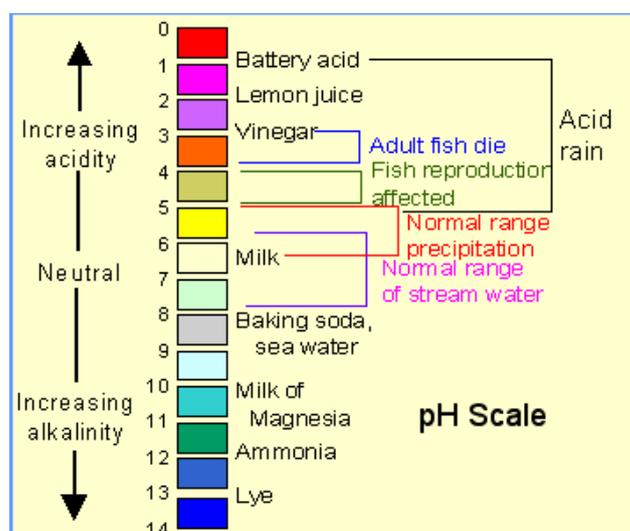
A new study found Seagrass meadows could play a limited, localized role in alleviating ocean acidification in coastal ecosystems.

What is ocean acidification?

- The oceans have been absorbing large amounts of carbon dioxide since the Industrial Revolution
- When carbon dioxide enters the ocean, it combines with seawater to produce carbonic acid.
- This increases the acidity of the water, lowering its pH.
- Although it is unlikely that the ocean will ever become actual acid (fall below a pH of 7.0), the term acidification refers to the process of the oceans becoming more acidic.

What are its consequences?

- A consequence of the oceans becoming more acidic is the binding up of carbonate ions, which are used by marine creatures to make their calcium carbonate shells and skeletons.



- As the availability of carbonate ions decreases, it becomes more difficult for these animals to build their calcium carbonate structures.
- Imagine trying to build a house while someone keeps stealing your bricks.
- As the oceans become more acidic, it will become progressively more difficult, if not impossible, to build calcium carbonate shells and skeletons.
- By the middle to end of this century, parts of the oceans will be corrosive enough that they will cause already formed calcium carbonate to dissolve.

4. Innovation

4.1 Superconductivity at ambient temperature

Why in News?

For the first time, researchers from IISc Bengaluru have been able to achieve superconductivity at ambient temperature and pressure.

What is superconductivity?

- Superconductors are materials that conduct electricity with no resistance.
- The temperature, at which the metals change from normal conducting state to superconducting state, is called critical temperature/transition temperature.
- This means that, unlike the more familiar conductors such as copper or steel, a superconductor can carry a current indefinitely without losing any energy.
- They also have several other very important properties, such as the fact that no magnetic field can exist within a superconductor.
- The transition from normal conducting state to superconducting state is reversible.
- Below critical temperature the superconductivity can be abolished either by passing sufficient large current through conductor itself or by applying sufficient strong external magnetic field.

What is the achievement?

- To achieve superconductivity they need to be cooled to very low temperatures, which restrict their use in our everyday life.
- The ability to achieve superconductivity at ambient temperature and pressure therefore becomes very significant.
- Gold and silver are not known to exhibit a superconducting state independently.
- But the team was able to achieve superconductivity in nanostructures made by embedding silver particles of 1 nanometre size into a gold matrix.

What is Meissner effect?

Meissner effect is the expulsion of a magnetic field from the interior of a material that is in the process of becoming a superconductor, that is, losing its resistance to the flow of electrical currents when cooled below a certain temperature, called the transition temperature, usually close to absolute zero.

4.2 Voltage fade

Why in News?

Research shows that heat treatment eliminated most of the defects and restored the original voltage.

What is a voltage fade?

- It is the bane of batteries, including phone batteries, and is said to be a key reason for lowering their performance.

- Voltage fade reduces the energy density of a battery which in turn limits the practical applications of these materials despite their high energy density in the initial charge-discharge cycles.
- Voltage fade is of concern now as it affects a promising class of cathode materials called Lithium-rich NMC (nickel magnesium cobalt) layered oxides.
- These cathode materials have drawn attention to their potential as components for better rechargeable batteries for electric vehicles.
- Researchers have now identified nanoscale defects or dislocations which result in voltage fade. There is hope, though.

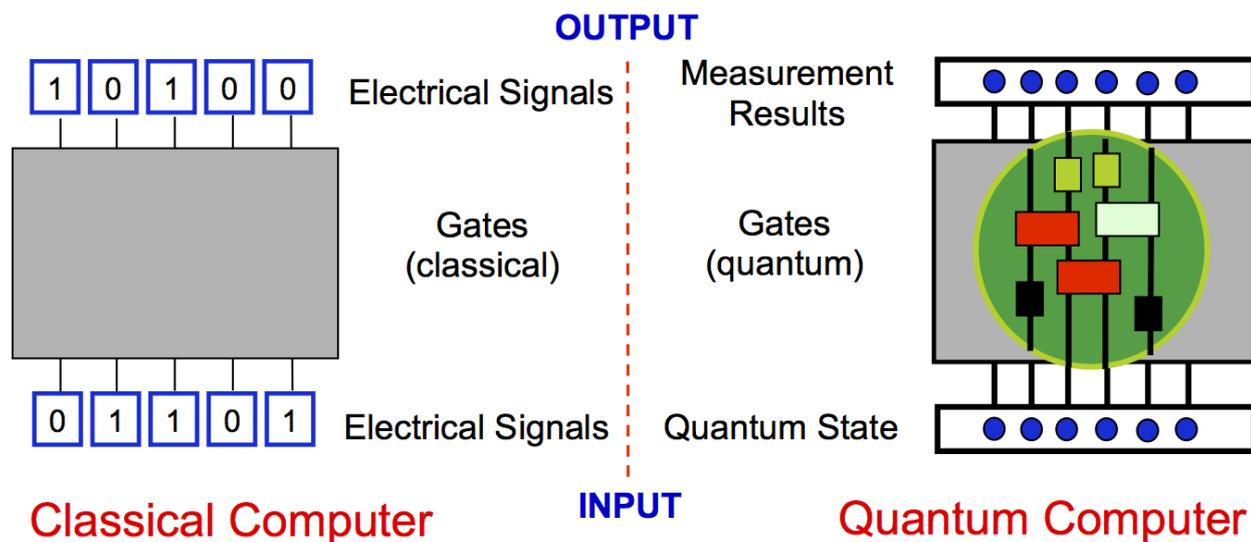
4.3 Quantum computers have an edge over classical ones

Why in News?

Quantum computers have an edge over classical ones in the field of computational complexity using innovative techniques that are extremely new.

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.



What can quantum computers do that normal ones can't?

- Quantum computers operate on completely different principles to existing computers.
- This makes them really well suited to solving particular mathematical problems, like finding very large prime numbers.
- It's likely that quantum computers would quickly be able to crack many of the systems that keep our online information secure.
- Because of these risks, researchers are already trying to develop technology that is resistant to quantum hacking.
- On the flipside of that, it's possible that quantum-based cryptographic systems would be much more secure than their conventional analogues.

4.4 Perovskites Performance Enhanced

Why in News?

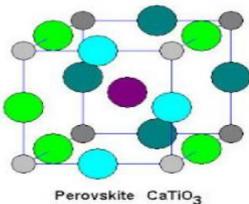
Researchers boost performance quality of perovskites for solar cells.

Why need for advancement?

- Solar cells are devices that absorb photons from sunlight and convert their energy to move electrons.
- Most solar cells used widely today are thick, fragile and stiff, which limits their application to flat surfaces and increases the cost to make the solar cell.
- "Thin-film solar cells" could be 1/100th the thickness of a piece of paper and flexible enough to cover a range of profiles.
- To make thin-film solar cells, scientists are moving beyond the "classic" semiconductor compounds, such as gallium arsenide or silicon.
- They are working instead with other light-harvesting compounds that have the potential to be cheaper and easier to mass produce.

What is a Perovskite?

- Perovskite is a calcium titanium oxide mineral, with the chemical formula CaTiO_3 .
- The term perovskite and perovskite structure are often used interchangeably – but,
 - A true perovskite (the mineral) is formed of calcium, titanium and oxygen in the form CaTiO_3 .
 - A perovskite structure is anything that has the generic form ABX_3 and the same crystallographic structure as perovskite (the mineral).



- The simplest way to describe a perovskite structure is as a cubic unit cell with titanium atoms at the corners (gray), oxygen atoms at the midpoints of the edges (green and blue), and a calcium atom (purple) in the center. (Dark shades are used to indicate layers further back.)

5. Bio-Technology

5.1 Antimicrobial resistance in leprosy

Why in News?

Study shows Increasing antimicrobial resistance in leprosy cases.

What is leprosy?

- Leprosy is caused by infection with the bacterium *Mycobacterium leprae*.
- It mainly affects the skin, eyes, nose and peripheral nerves.
- Symptoms include light-coloured or red skin patches with reduced sensation, numbness and weakness in hands and feet.
- Leprosy can be cured with multi-drug therapy. Early treatment avoids disability.

What is Antimicrobial resistance?

- Antimicrobial resistance occurs when microorganisms such as bacteria, viruses, fungi and parasites change in ways that render the medications used to cure the infections they cause ineffective.
- When the microorganisms become resistant to most antimicrobials they are often referred to as "superbugs".

- This is a major concern because a resistant infection may kill, can spread to others, and imposes huge costs to individuals and society.
- Antimicrobial resistance is the broader term for resistance in different types of microorganisms and encompasses resistance to antibacterial, antiviral, antiparasitic and antifungal drugs.
- Antimicrobial resistance occurs naturally but is facilitated by the inappropriate use of medicines.
- For example using antibiotics for viral infections such as cold or flu, or sharing antibiotics.
- Low-quality medicines, wrong prescriptions and poor infection prevention and control also encourage the development and spread of drug resistance.

What is the difference between antibiotic and antimicrobial resistance?

- Antibiotic resistance occurs when bacteria change in response to the use of antibiotics used to treat bacterial infections making them ineffective.
- Antimicrobial resistance is a broader term, encompassing resistance to drugs that treat infections caused by other microbes as well, such as parasites, viruses and fungi.

5.2 Plant breeding comes under the purview of GMO

Why in News?

Crops obtained by plant breeding technique mutagenesis should fall under laws restricting the use of genetically modified organisms (GMOs), Europe's highest court said.

What is mutagenesis?

- Mutagenesis is the process of generating a genetic mutation.
- This may occur spontaneously or be induced by mutagens.
- Researchers also use a number of techniques to create mutations, including transposon mutagenesis to generate random gene knockouts, and site-directed mutagenesis.
- This utilises the polymerase chain reaction to introduce specific mutations.

What Is Genetic Modification?

- Genetic modification involves making changes to an organism's genes to give it new traits that wouldn't occur in nature or to eliminate undesirable traits.
- These changes can include turning off, or silencing, a gene or inserting a foreign gene into an organism's genome, which is the complete set of genes present in an organism.
- Genetic modification gives humans the power to determine the genetic make-up of any living creature, including human beings.
- While farmers have been selectively breeding plants and animals for thousands of years, they relied on natural selection, which meant they had to wait for a random mutation to occur to get an organism with desirable traits, such as really big cows or chickens.

What are the types of genetic modification?

- Gene silencing turns off genes that are harmful or not useful from the human perspective.
- An example of genetic silencing is the Arctic Apple.
- These genetically modified apples will not turn brown after being sliced because the genes that control the enzymes responsible for browning have been turned off.
- Organisms also can be genetically modified via the addition of new genes to their genome, which can impart new traits, such as frost-, drought-, or pest-resistance.
- GloFish are an example of such a genetically modified organism.
- These pets have been modified through addition of a gene that produces a neon pigment that glows in black light.

What is a GMO?

- A GMO, or genetically modified organism, is a plant, animal, microorganism or other organism whose genetic makeup has been modified in a laboratory using genetic engineering or transgenic technology.
- This creates combinations of plant, animal, bacterial and virus genes that do not occur in nature or through traditional crossbreeding methods.
- Genetic modification affects many of the products we consume on a daily basis.

5.3 Unraveling the immune recognition

Why in News?

An extensive experiment testing the immune effects found varying and specific responses from different immune cells, depending on each particle's shape and formulation.

What is immune system?

- The immune system is spread throughout the body and involves many types of cells, organs, proteins, and tissues.
- It can distinguish our tissue from foreign tissue — self from non-self.
- Dead and faulty cells are also recognized and cleared away by the immune system.

What are the main characters of immune system?

- White blood cells are also called leukocytes.
- They circulate in the body in blood vessels and the lymphatic vessels that parallel the veins and arteries.
- White blood cells are on constant patrol and looking for pathogens.
- When they find a target, they begin to multiply and send signals out to other cell types to do the same.
- Our white blood cells are stored in different places in the body, which are referred to as lymphoid organs. These include the following:
 - **Thymus** — a gland between the lungs and just below the neck.
 - **Spleen** — an organ that filters the blood. It sits in the upper left of the abdomen.
 - **Bone marrow** — found in the center of the bones, it also produces red blood cells.
 - **Lymph nodes** — small glands positioned throughout the body, linked by lymphatic vessels.

There are two main types of leukocyte:

1. Phagocytes

These cells surround and absorb pathogens and break them down, effectively eating them. There are several types, including:

- **Neutrophils** — these are the most common type of phagocyte and tend to attack bacteria.
- **Monocytes** — these are the largest type and have several roles.
- **Macrophages** — these patrol for pathogens and also remove dead and dying cells.
- **Mast cells** — they have many jobs, including helping to heal wounds and defend against pathogens.

2. Lymphocytes

- Lymphocytes help the body to remember previous invaders and recognize them if they come back to attack again.
- Lymphocytes begin their life in bone marrow.
- Some stay in the marrow and develop into B lymphocytes (B cells).
- Others head to the thymus and become T lymphocytes (T cells).

- These two cell types have different roles:
 - **B lymphocytes** – they produce antibodies and help alert the T lymphocytes.
 - **T lymphocytes** – they destroy compromised cells in the body and help alert other leukocytes.

5.4 Human Evolution

Timeline: Human Evolution

55 million years ago (MYA) - First primitive primates evolve

8 – 6 MYA - First gorillas evolve. Later, chimp and human lineages diverge

5.8 MYA - *Orrorintugenensis*, oldest human ancestor thought to have walked on two legs

5.5 MYA - Ardipithecus, early “proto-human” shares traits with chimps and gorillas, and is forest-dwelling

4 MYA - Australopithecines appear. They have brains no larger than a chimpanzee’s – with a volume around 400 – 500 cm³ -, but walk upright on two legs. First human ancestors to live on the savannah

3.2 MYA - Lucy, famous specimen of *Australopithecus afarensis*.

2.7 MYA - Paranthropus, lives in woods and grasslands, has massive jaws for chewing on roots and vegetation. Becomes extinct 1.2 MYA

2.5 MYA - *Homo habilis* appears. Its face protrudes less than earlier hominids, but still retains many ape features. Hominids start to use stone tools regularly, created by splitting pebbles – this starts Oldowan tradition of toolmaking.

Some hominids develop meat-rich diets as scavengers.

2 MYA - Evidence of *Homo ergaster*, with a brain volume of up to 850 cm³, in Africa

1.8 – 1.5 MYA - *Homo erectus* is found in Asia. First true hunter-gatherer ancestor, and also first to have migrated out of Africa in large numbers. It attains a brain size of around 1000 cm³

1.6 MYA - Possible first sporadic use of fire suggested by discoloured sediments.

600,000 YA - *Homo Heidelbergensis* lives in Africa and Europe. Similar brain capacity to modern humans

500,000 YA - Earliest evidence of purpose-built shelters – wooden huts – are known from sites near Chichibu, Japan

400,000 YA - Early humans begin to hunt with spears

280,000 YA - First complex stone blades and grinding stones

230,000 YA - Neanderthals appear and are found across Europe, from Britain in the west to Iran in the east, until they become extinct with the advent of modern humans 28,000 years ago

195,000 YA - Our own species *Homo sapiens* appears on the scene – and shortly after begins to migrate across Asia and Europe.

150,000 YA - Humans possibly capable of speech.

140,000 YA - First evidence of long-distance trade

110,000 YA - Earliest beads – made from ostrich eggshells – and jewellery

50,000 YA - human culture starts to change much more rapidly than before; people begin burying their dead ritually; create clothes from animal hides; and develop complex hunting techniques, such as pit-traps.

Colonisation of Australia by modern humans

33,000 YA - Oldest cave art. Later, Stone Age artisans create the spectacular murals at Lascaux and Chauvet in France

Homo erectus dies out in Asia – replaced by modern man

18,000 YA - *Homo Floresiensis*, “Hobbit” people, found on the Indonesian island of Flores. They stand just over 1 metre tall, and have brains similar in size to chimpanzees, yet have advanced stone tools

12,000 YA - Modern people reach the Americas

10,000 YA - Agriculture develops and spread. First villages. Possible domestication of dogs

5,500 YA - Stone Age ends and Bronze Age begins. Humans begin to smelt and work copper and tin, and use them in place of stone implements

5,000 YA - Earliest known writing

4,000 to 3,500 BC - The Sumerians of Mesopotamia develop the world’s first civilisation

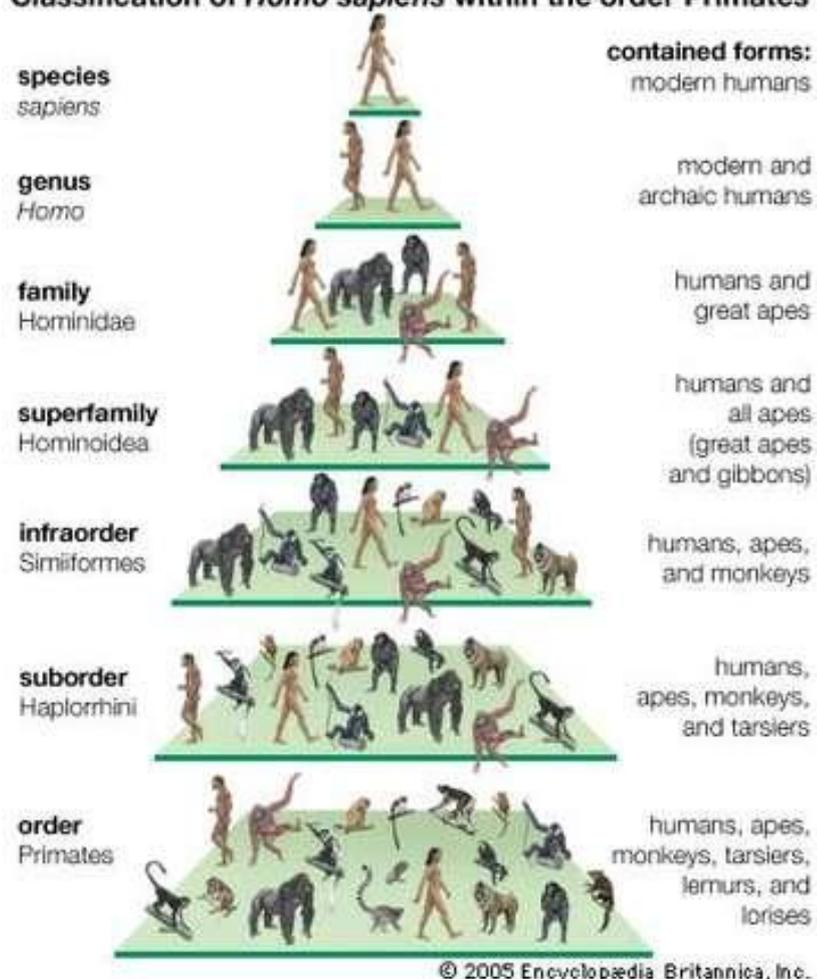
Homo sapiens developed a new ecological niche

Why in News?

A new study argues *Homo sapiens* developed a new ecological niche that separated it from other hominins.

How *Homo sapiens* are classified?

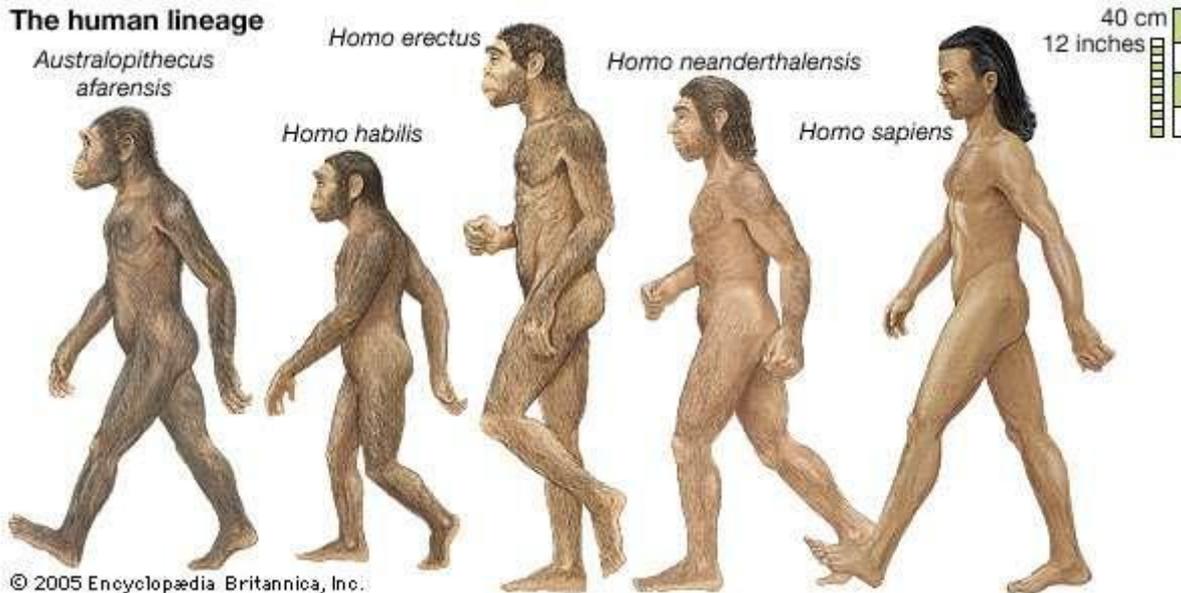
Classification of *Homo sapiens* within the order Primates



What is a human evolution?

- *Homo sapiens* - the species to which all modern human beings belong.
- Human evolution is the process by which human beings developed on Earth from now-extinct primates.
- It is very likely first evolved in Africa about 315,000 years ago.
- We are now the only living members of what many zoologists refer to as the human tribe, Hominini.

- We and our predecessors have always shared the Earth with other apelike primates, from the modern-day gorilla to the long-extinct Dryopithecus.
- Also we and the extinct hominins are somehow related and that we and the apes, both living and extinct, are also somehow related is accepted by anthropologists and biologists everywhere.
- The exact nature of our evolutionary relationships has been the subject of debate and investigation since Charles Darwin published his books *On the Origin of Species* (1859) and *The Descent of Man* (1871).



Paleogene period

Why in News?

A new study has warned that unless we mitigate current levels of carbon dioxide emissions, Western Europe and New Zealand could revert to the hot tropical climate of the early Paleogene period

What is Paleogene period?

- The Paleogene Period marks the beginning of the Cenozoic Era. It began 65 million years ago and lasted more than 40 million years.
- The Paleogene is made up of three epochs:
 - The Paleocene Epoch
 - The Eocene Epoch
 - The Oligocene Epoch
- Each epoch has unique characteristics for climate, geography, plants and animals.

Era	Periods	Epochs	Millions of Years Ago
C E N O Z O I C	Neogene	Holocene	11,000 yrs ago to present
		Pleistocene	1.8 mya to 11,000 yrs ago
		Pliocene	5 to 1.8 mya
		Miocene	24 to 5 mya

Paleogene	Oligocene	38 to 24 mya
	Eocene	54 to 38 mya
	Paleocene	65 to 54 mya

What are the Geographical events in the paleogene period?

Epoch	Geographic event
The Oligocene	<ul style="list-style-type: none"> • Australia separates from Antarctica • India crashes into Asia creating the Himalayan Mountains • Antarctica is covered by glaciers • Sea levels are low
The Eocene	<ul style="list-style-type: none"> • North America and Europe separate
The Paleocene	<ul style="list-style-type: none"> • Europe and North America are joined together • Australia is joined with Antarctica • India is not yet connected with Asia • The Atlantic Ocean is small because South America and Africa have just separated

What is paleogene climate?

- The cooling and drying trend began in earnest following a sudden temperature spike about 55 million years ago.
- Sea surface temperatures rose between 9 and 14 degrees Fahrenheit (5 and 8 degrees Celsius) over a period of a few thousand years, killing off numerous single-celled marine organisms called foraminifera, along with some other invertebrates.
- This event also profoundly affected northern forests, previously full of deciduous hardwoods with sequoias and pines.
- The new, more humid subtropical conditions nurtured abundant palms and guavas.
- Land mammals responded in kind, radiating and diversifying into many new forms.



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