You & Technology-May 2019

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(MAY-2019)

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General Studies Paper-3 – S&T – May 2019

1. INDIA'S ANTI-SATELLITE (ASAT) MISSILE

Why in News?

Stating that defence and offensive space technologies are being developed with various aims of spying, gaining control, deactivating service and destroying, French Envoy in India Alexandre Ziegler has supported India's Anti-Satellite (ASAT) missile test as a response to these growing threats.

What is it?

• Mission Shakti is a joint programme of the Defence Research and Development Organisation (DRDO) and the Indian Space Research Organisation (ISRO).

• As part of the mission, an anti-satellite (A-SAT) weapon was launched and targeted an Indian satellite which had been decommissioned. Mission Shakti was carried out from DRDO's testing range in Odisha's Balasore.

Significance:

• India is only the 4th country to acquire such a specialised and modern capability, and Entire effort is indigenous. Till now, only the US, Russia and China had the capability to hit a live target in space.

Why do we need such capabilities?

• India has a long standing and rapidly growing space programme. It has expanded rapidly in the last five years. The Mangalyaan Mission to Mars was successfully launched. Thereafter, the government has sanctioned the Gaganyaan Mission which will take Indians to outer space.

• India has undertaken more than 100 spacecraft missions consisting of communication satellites, earth observation satellites, experimental satellites, navigation satellites, apart from satellites meant for scientific research and exploration, academic studies and other small satellites. India's space programme is a critical backbone of India's security, economic and social infrastructure.

• The test was done to verify that India has the capability to safeguard our space assets. It is the Government of India's responsibility to defend the country's interests in outer space.

Raising concerns:

• Outer space has become an "arena of rivalry between major powers." At the same time, there was common concern on space debris. Satellites today have to avoid almost 6,00,000 debris of over 1cm travelling at speed faster than a bullet.

• As space gets increasingly crowded, there is need to regulate space traffic on the lines of air traffic or railways.

What is space debris?

• Space junk is an ever-growing problem with more than 7,500 tonnes of redundant hardware now thought to be circling the Earth. Ranging from old rocket bodies and defunct spacecraft through to screws and even flecks of paint – this material poses a collision hazard to operational missions.

• The rising population of space debris increases the potential danger to all space vehicles, but especially to the International Space Station (ISS), space shuttles, satellites and other spacecraft.

Technologies that can tackle the problem in future are:

• Moving an object out of the way by altering its orbit is one method of diverting a potential crash, but the sheer amount of debris requires constant observation and prediction – by any means necessary.

• Nasa's Space Debris Sensor orbits the Earth on the International Space Station. The sensor was attached to the outside of the space station's

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European Columbus module in December 2017. It will detect millimetresized pieces of debris for at least two years, providing information on whatever hits it such as size, density, velocity, orbit and will determine whether the impacting object is from space or a man-made piece of space debris.

• REMOVEdebris, satellite contain two cubesats that will release simulated space debris so that it can then demonstrate several ways of retrieving them.

• Deorbit mission: There are two emerging technologies being developed under what's known as the "e. Deorbit" mission to grasp the wayward space junk, or to catch it. • Other technologies include moving objects with a powerful laser beam. It is important to start doing that soon, current scientific estimates predict that without active debris removal, certain orbits will become unusable over the coming decades.

Way ahead:

• Arms race in outer space should not be encouraged. India has always maintained that space must be used only for peaceful purposes. It is against the weaponization of Outer Space and supports international efforts to reinforce the safety and security of space-based assets.

• India believes that Outer space is the common heritage of humankind and it is the responsibility of all spacefaring nations to preserve and promote the benefits flowing from advances made in space technology and its applications for all.

2. RISAT 2BR1

Context: India is planning to launch its latest radar imaging satellite RISAT 2BR1 towards the end of May 2019 on board PSLV-C46.

About RISAT:

• The RISAT, which was first deployed in orbit on April 20, 2009 as the RISAT-2, uses synthetic aperture radars (SAR) to provide Indian forces with all-weather surveillance and observation, which are crucial to notice any potential threat or malicious activity around the nation's borders.

• Following the 2008 Mumbai terror attacks, the launch of RISAT-2 was prioritised over RISAT- 1, as its C-band SAR radar was not yet ready and RISAT -2 carried an Israeli-built X-band radar.

• The to-be-deployed RISAT-2BR1 satellite uses the same SAR band and will further improve India's imaging reconnaissance abilities.

3. ADITYA- L1 MISSION

Context: The Indian Space Research Organization is planning to launch Aditya- L1 mission to study the sun early in 2020.

About Aditya- L1 mission:

• What is it?

It is India's first solar mission.

• Objectives: It will study the sun's outer most layers, the corona and the chromospheres and collect data about coronal mass ejection, which will also yield information for space weather prediction.

• Significance of the mission: The data from Aditya mission will be immensely helpful in discriminating between different models for the origin of solar storms and also for constraining how the storms evolve and what path they take through the interplanetary space from the Sun to the Earth.

• Position of the satellite: In order to get the best science from the sun, continuous viewing of the sun is preferred without any occultation/ eclipses and hence, Aditya- L1 satellite will be placed in the halo orbit around the Lagrangian point 1 (L1) of the sun-earth system.

What are Lagrangian points and halo orbit?

• Lagrangian points are the locations in space where the combined gravitational pull of two large masses roughly balance each other. Any small mass placed at that location will remain at constant distances relative to the large masses.

• There are five such points in Sun-Earth system and they are denoted as L1, L2, L3, L4 and L5. A halo orbit is a periodic three-dimensional orbit near the L1, L2 or L3.

4. DOUBLE ASTEROID REDIRECTION TEST (DART)

Context: NASA's First Planetary Defense Technology Demonstration to Collide with Asteroid in 2022.

What is it?

• The Double Asteroid Redirection Test, or DART, is a spacecraft designed to determine whether an asteroid can be redirected with a high-speed collision.

• SpaceX will launch the spacecraft toward an asteroid named Didymos about 4 million miles from Earth. It then will ram into the asteroid's small moon at about 13,000 miles per hour.

Significance:

• DART would be NASA's first mission to demonstrate what's known as the kinetic impactor technique – striking the asteroid to shift its orbit – to defend against a potential future asteroid impact.

How it impacts?

• The target for DART is an asteroid that will have a distant approach to Earth in October 2022, and then again in 2024. The asteroid is called Didymos – Greek for "twin" -because it is an asteroid binary system that consists of two bodies: Didymos A, about 780 metres in size, and a smaller asteroid orbiting it called Didymos B, about 160 metres in size.

• DART would impact only the smaller of the two bodies, Didymos B. The Didymos system has been closely studied since 2003. The primary body is a rocky S-type object, with composition similar to that of many asteroids.

• The composition of its small companion, Didymos B, is unknown, but the size is typical of asteroids that could potentially create regional effects should they impact Earth. After launch, DART would fly to Didymos and use an APL-developed onboard autonomous targeting system to aim itself at Didymos B.

• Then the refrigerator-sized spacecraft would strike the smaller body at a speed about nine times faster than a bullet, about six kilometres per second. Earth-based observatories would be able to see the impact and the resulting change in the orbit of Didymos B around Didymos A, allowing scientists to better determine the capabilities of kinetic impact as an asteroid mitigation strategy.

• The kinetic impact technique works by changing the speed of a threatening asteroid by a small fraction of its total velocity, but by doing it well before the predicted impact so that this small nudge will add up over time to a big shift of the asteroid's path away from Earth.

5. MODIS (OR MODERATE RESOLUTION IMAGING SPECTRORADIOMETER)

Context: NASA's Moderate Resolution Imaging Spectroradiometer (MODIS) data shows that China and India are leading the increase in "greening efforts" across the world.

Key findings:

• Global green leaf area has increased by 5% since the early 2000s. This translates to a net increase in leaf area of 2.3% per decade, which is equivalent to adding 5.4 × 106 sq km new leaf area over the 18-year period of the record (2000 to 2017). This is equivalent to the area of the Amazon.

• China alone accounts for 25% of the global net increase in leaf area. India has contributed a further 6.8%.

• The greening in China is from forests (42%) and croplands (32%) but in India is mostly from croplands (82%) with minor contribution from forests (4.4%).

• With only 2.7% of the global vegetated area, India accounts for 6.8% of the global net increase in leaf area. It is as expected because most of the

land cover type in India is cropland. Total cereal production in India increased by 26% during the same period.

• There are only a few forests in India, and that is why their contribution is small. Data show that since Independence, a fifth of India's land has consistently been under forests.

• The Forest Survey of India's State of Forest Report 2017 had recorded that forest cover had increased by 6,600 sq km or 0.21% since 2015.

About MODIS:

• MODIS (or Moderate Resolution Imaging Spectroradiometer) is a key instrument aboard the Terra (originally known as EOS AM-1) and Aqua (originally known as EOS PM-1) satellites.

• Terra's orbit around the Earth is timed so that it passes from north to south across the equator in the morning, while Aqua passes south to north over the equator in the afternoon.

• Terra MODIS and Aqua MODIS are viewing the entire Earth's surface every 1 to 2 days, acquiring data in 36 spectral bands, or groups of wavelengths.

• **Significance**: These data will improve our understanding of global dynamics and processes occurring on the land, in the oceans, and in the lower atmosphere. MODIS is playing a vital role in the development of validated, global, interactive Earth system models able to predict global change accurately enough to assist policy makers in making sound decisions concerning the protection of our environment.

6. ARTEMIS MISSION

Context: NASA's next mission to the Moon will be called Artemis.

• The mission was named Artemis after the Greek mythological goddess of the Moon and twin sister to Apollo, namesake of the program that sent 12 American astronauts to the Moon between 1969 and 1972.

About Artemis Mission:

• ARTEMIS stands for Acceleration, Reconnection, Turbulence and Electrodynamics of Moon's Interaction with the Sun.

• **Objective**: It consists of spacecraft to measure what happens when the Sun's radiation hits our rocky moon, where there is no magnetic field to protect it.

• **Background**: The ARTEMIS mission uses two of the five in-orbit spacecraft from another NASA Heliophysics constellation of satellites (THEMIS) that were launched in 2007 and successfully completed their mission earlier in 2010. The ARTEMIS mission allowed NASA to repurpose two in-orbit spacecraft to extend their useful science mission, saving tens of millions of taxpayer dollars instead of building and launching new spacecraft.

7. CHANGE-4

Context: Scientists have said they could be a step closer to solving the riddle behind the Moon's formation, unveiling the most detailed survey yet of the far side of Earth's satellite.

• In January, the Chinese spacecraft Chang'e-4 — named after the moon goddess in Chinese mythology — became the first ever craft to touch down on the far side of the lunar surface.

Key findings:

• China landed its probe in the Von Karmen Crater in the Aitken Basin at the Moon's south pole — home to one of the largest impact craters known in the solar system.

• They detected materials such as olivine and low-calcium pyroxene that are rare elsewhere on the surface. Researchers suggest that these materials were ejected from the Moon's upper mantle when it was struck by a meteor.

How was moon born?

• The most widely accepted theory is that moon was born when a massive protoplanet slammed into young Earth, sending plenty of terrestrial building blocks into orbit around it.

• Scientists suspect that the moon was covered in a magma ocean during its very early days. As it progressively cooled and solidified, denser minerals remained in the ocean's depths while less dense minerals floated to the surface. This meant the geochemical compositions of the eventual mantle and crust layers turned out to be distinct from each other.

About the mission:

• Chang'e 4 is the fourth mission in the country's lunar mission series which is being named after the Chinese moon goddess.

• The tasks of the Chang'e-4 probe include low-frequency radio astronomical observation, surveying the terrain and landforms, detecting the mineral composition, and measuring the neutron radiation and neutral atoms to study the environment on the far side of the moon.

Significance of the mission:

• According to experts, landing on the far side of the moon is undoubtedly one of the most challenging missions ever launched by any of the world's superpowers.

8. CRISPR TECHNOLOGY

Why in news?

CRISPR anti-venom: Antidote to world's most venomous sting made with gene editing.

• Chironex fleckeri is among the deadliest box jellyfish species, with an explosive sting that causes cardiac arrest in humans. Scientists are still unsure exactly how its venom works. But a team of researchers has managed to develop an antidote to block its venom using the powerful gene-editing tool CRISPR. The drug, cyclodextrin, is already tested safe for humans, cheap and readily available.

What are Genes and what is gene- editing?

• Genes contain the bio-information that defines any individual. Physical attributes like height, skin or hair colour, more subtle features and even behavioral traits can be attributed to information encoded in the genetic material.

• An ability to alter this information gives scientists the power to control some of these features. Gene "editing" — sometimes expressed in related, but not always equivalent, terms like genetic modification, genetic manipulation or genetic engineering — is not new.

What is CRISPR-Cas9?

• The clustered, regularly interspaced, short palindromic repeats, or CRISPR/CRISPR-associated protein 9 (Cas9) (CRISPR-Cas9) system has revolutionised genetic manipulations and made gene editing simpler, faster and easily accessible to most laboratories.

• CRISPR technology is basically a gene-editing technology that can be used for the purpose of altering genetic expression or changing the genome of an organism.

• The technology can be used for targeting specific stretches of an entire genetic code or editing the DNA at particular locations.

• CRISPR technology is a simple yet powerful tool for editing genomes. It allows researchers to easily alter DNA sequences and modify gene function.

• Its many potential applications include correcting genetic defects, treating and preventing the spread of diseases and improving crops. However, its promise also raises ethical concerns.

How it works?

• CRISPR-Cas9 technology behaves like a cut-and-paste mechanism on DNA strands that contain genetic information.

• The specific location of the genetic codes that need to be changed, or "edited", is identified on the DNA strand, and then, using the Cas9 protein, which acts like a pair of scissors, that location is cut off from the strand. A DNA strand, when broken, has a natural tendency to repair itself.

• Scientists intervene during this auto-repair process, supplying the desired sequence of genetic codes that binds itself with the broken DNA strand.

Concerns:

• Tampering with the genetic code in human beings is more contentious. Leading scientists in the field have for long been calling for a "global pause" on clinical applications of the technology in human beings, until internationally accepted protocols are developed.

Way ahead:

• This CRISPR technology is indeed a path-breaking technology, to alter genes in order to tackle a number of conventional and unconventional problems, especially in the health sector. However, experiments and tests to validate its use must be subjected to appropriate scrutiny by the regulators, and their use must be controlled to prevent commercial misuse.

9. GENETIC STUDIES ON THE PEOPLE OF THE LAKSHADWEEP ARCHIPELAGO

Context: Genetic studies on the people of the Lakshadweep archipelago was done by a team of CSIR-Centre for Cellular and Molecular Biology (CCMB), for the first time.

Key findings:

• A majority of human ancestry in Lakshadweep is largely derived from South Asia with minor influences from East and West Eurasia.

• There is a close genetic link of Lakshadweep islanders with people from Maldives, Sri Lanka and India.

Background:

• The islands were known to sailors since ancient times and historical documents say that the spread of Buddhism to these islands happened during 6th century B.C. and Islam was spread by in 661 A.D. by Arabians.

• Cholas ruled the islands in 11th century, Portuguese in 16th century, Ali Rajahs in 17th, Tipu Sultan in 18th before the British Raj of 19th century.

About Centre for Cellular and Molecular Biology:

• The Centre for Cellular & Molecular Biology (CCMB) is a premier research organization which conducts high quality basic research and trainings in frontier areas of modern biology, and promote centralized national facilities for new and modern techniques in the interdisciplinary areas of biology.

• It was set up initially as a semi-autonomous Centre on April 1, 1977 with the Biochemistry Division of the then Regional Research Laboratory (presently, Indian Institute of Chemical Technology, IICT) Hyderabad.

• It is located in Hyderabad and operates under the aegis of the Council of Scientific and Industrial Research (CSIR).

• It is designated as "Center of Excellence" by the Global Molecular and Cell Biology Network, UNESCO.

10. MANAV: HUMAN ATLAS INITIATIVE

Context: Department of Biotechnology (DBT) has launched MANAV: Human Atlas Initiative, towards improving knowledge on human physiology.

What is MANAV: Human Atlas Initiative?

• It is a project funded by DBT.

• aims at creating a database network of all tissues in the human body from the available scientific literature.

• It is a project that involves scientific skill development for annotation, science outreach along with handling big data.

• The programme will involve gaining better biological insights through physiological and molecular mapping, develop disease models through predictive computing and have a wholistic analysis and finally drug discovery.

Who can participate in this project?

• The project can be signed up by students who are in their final year graduation and above. Students from the fields of biochemistry, biotechnology, microbiology, botany, zoology, bioinformatics, health sciences, systems biologists, pharmacologists and data sciences can associate with this project.

• Even participants having a science background but not necessarily involved in active scientific research can be part of this network.

Why is MANAV important?

• So far, researchers and students have had little or no expertise in reading scientific literature and develop or build further information on the same. This platform will impart key skills to the student community to read classified scientific literature, in this case, on individual tissue-basis, and perform annotation and curation.

• Since all the information generated will pass through multiple levels of reviews, it will be an Atlas or a reliable collection on human body tissues. This collated data can be useful for both future researchers and parallelly, to the clinicians and drug developers, who finally handle human bodies in disease conditions.

What are the applications of information generated through MANAV?

• The aim of the project remains to understand and capture the human physiology in two stages – in a normal stage and while in a disease stage. Such a database on individual tissues, once ready, can come handy in tracing the causes of a disease, understanding specific pathways and ultimately decode the body's disease stage linked to tissues and cells. The teams will also study any potent elements or molecules that have never been used in the form of drugs, to target the specific cells or tissues.

11. CCMB SCIENTISTS SEQUENCE ASIATIC LION GENOME

Context: For the first time, the entire genome of Asiatic lion has been sequenced by scientists from CSIR-Centre for Cellular and Molecular Biology, Hyderabad. • The objective is to understand the species at DNA level and study if there are any specific problems with regard to adaptability to environment or behaviour vis-à-vis other big cats.

Need and significance:

• This firsthand information would help researchers to better understand the evolution of Asiatic lions and also make possible comparative analysis with other big cats.

• The genome sequencing would enable scientists to develop specific markers to study population genetics (the differences at the gene level within a population) and get newer insights into its population status and subsequent management.

• The study will enable better disease and population management of the endangered big cat by identifying characteristics which are specific to Asiatic lions.

About Asiatic Lion:

• IUCN Red List Status: Endangered

• Listed in Schedule I of Wildlife (Protection) Act 1972, in Appendix I of Convention on International Trade in Endangered Species (CITES).

• At present the only home of Asiatic lion is Gir National Park and Wildlife Sanctuary in Gujarat.

• The population of the endangered Asiatic lion is very low — only 523 animals are present in the Gir forests.

12. RADAR AND ITS OPERATION

Context: Recently, there was a controversy about a statement made by Prime Minister Narendra Modi, ostensibly making a connection between cloud cover and the efficiency of Radar.

What is a radar?

• In simplest terms, a radar comprises of a transmitter which sends radio waves along specific directions. The signals are reflected off

the target which are used to construct an image of the target. If the target is moving at a specific velocity, there is a shift in the frequency of the signal which can be used to identify the target speed. As the received signal is just above the noise floor, a number of factors can influence the radar system and rainfall and clouds can certainly influence the measured signal.

Impact of weather conditions:

• Although radio waves are transparent to weather conditions like fog, clouds and rain, change in weather conditions can influence scattering and overall propagation. The presence of moisture in air can influence propagation of signal in space.

• Radar bands in general, operate over broad frequency ranges. Radars operating at high frequencies are not significantly affected by change in weather conditions. However, when the weather conditions are extreme, they can find it hard to detect a fighter aircraft zooming at very high speeds.

• According to a report by Rand Corporation for US Air Force, for a dense cloud, the attenuation of the signal could be 0.1 dB/km for X band radar. It implies signal attenuation by a factor of 10 if the target is 50 Km from the source. The attenuation could increase by a factor of 10 if there is rainfall at the rate of 25 cm/hr.

• According to Meneghini et al. (1986), signal attenuation by cloud and precipitation is a serious problem associated with airborne or spaceborne millimetre wave operation. Lhermitte (1990) wrote in the Journal of Atmospheric and Oceanic Technology, that at 15 GHz the attenuation coefficient is 0.12 dB per mm per hour of rain intensity. It implies that if the rain intensity is 1 cm/hr, the attenuation of signal power can be in the range of 1.2 dB or approximately 31%. For a 30 GH z signal, the attenuation under heavy tropic rain could be in the range of 30 dB (a factor of 1,000). Besides rain, lightning-based scattering can also attenuate radar signals over short periods which can open new opportunities for fighter aircraft.

• In fact, attenuation of radio waves is widely used in measuring rain intensity and moisture content. Below 1 GHz, the attenuation is not that significant, but heavy rains, clouds and lightning effects can still make some impact on the measurement process.

Conclusion:

• To sum up, Modi's statement does hold strong scientific basis which can be corroborated by existing research on the subject. The X band radar is significantly attenuated by rains, clouds and fog and related climatic conditions. For lower bands, the attenuation is less significant, but in high-speed warfare, slight change in conditions can offer huge leverage.

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Hope this material will help you.
God bless...
Jai Hind

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All the Best
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