GS Paper I – Geography

Date: 10.05.26

Small camera reveals hidden world on Arctic seafloor

Researchers have caught a glimpse of life on the Arctic seafloor using a portable camera. After they deployed the device 260 m into a Greenlandic fjord, they saw a bustling ecosystem previously hidden from view. There were hundreds of small organisms, including shrimp-like amphipods and tiny jellyfish, and a snailfish swimming backwards and a narwhal. Using red LED lights, which many deep-sea creatures can't see, the researchers observed these animals without scaring them away.

AI tool excels at identifying cells, even 'new' ones

A powerful AI tool called TranscriptFormer can identify cell types with extreme accuracy, even of species it hasn't seen before. Scientists trained it on 112 million cells from 12 species, spanning 1.5 billion years of evolution. It could rapidly detect disease states in human cells and naturally uncover complex biological patterns, such as how species are related, without new instructions. The model is a new way for comparing biology across all living beings.

GS Paper II – Polity

What is the Governor's role in a hung Assembly?

Why did the Governor refuse to swear in TVK party president Vijay as the new Tamil Nadu Chief Minister for many days? What is the primary objective of the Governor in such situations? What has the Supreme Court ruled in the past? Is the floor test the best way of proving majority?

Krishnadas Rajagopal

The story so far:

Despite the Tamilaga Vettri Kazhagam (TVK) emerging as the single largest party in the 2026 Assembly elections in Tamil Nadu, Governor Rajendra Arlekar refused to swear in party president C. Joseph Vijay as the new Chief Minister for several days. The Lok Bhavan insisted that Mr. Vijay prove majority by handing over physical letters of support from at least 118 MLAs in the 234-seat Legislative Assembly. On May 9, Mr. Vijay met the Governor for the fourth time and staked claim to form the government. He is scheduled to take oath at 10 a.m. on Sunday.

What is the role of the Governor in the formation of a new government if there is a hung Assembly following an election?

The Governor appoints the Chief Minister under Article 164 of the Constitution. The Constitution does not provide a settled procedure for a Governor to choose a Chief Minister in a hung Assembly though constitutional conventions dictate that the Governor's actions must be guided by sobriety.

The primary objective of the Governor, as a constitutional head of the State, is to ensure the formation of a stable government. To this end, the Sarkaria Commission; the five-member Committee of Governors appointed by the President pursuant to the decision taken at the Conference of Governors held in New Delhi in November 1970; and conventions evolved through successive Supreme Court rulings provide that the personal bona fide or any ipse dixit of Governors is irrelevant.

The Lok Bhavan must proceed legally and explore all possibilities with political parties, groups, and independent MLAs within a reasonable time to maintain the constitutional machinery in the State. Only if all alternatives fail, and to avoid any violence to correct constitutional practice, should a Governor, as a last resort, initiate the process for declaration of President's rule in the State under Article 356 of the Constitution.

> The Supreme Court has time and again held that the House, and not Lok Bhavan, 'is the place where democracy is in action'

TVK chief Vijay meets Tamil Nadu Governor Rajendra Vishwanath Arlekar at Lok Bhavan in Chennai on Friday. PTI

The Constitution has not defined the 'reasonable time' a Governor could take to explore possibilities for forming a responsible and stable government. But the Governor cannot wait indefinitely, and in the process, lay the field open for horse-trading. In fact, the Supreme Court has interpreted in the *B.R. Kapur* (2001) and *Rameshwar Prasad* (2006) judgments that the Governor could dissolve a Legislative Assembly under Article 174(2)(b) even before the first meeting of the State Legislature, to avoid a breakdown of the constitutional machinery due to parties' inability to stake claim to form a meaningful government for want of requisite strength. The Governor cannot be in limbo, neither being able to appoint a government nor exercise the power of dissolution.

What is the hierarchy or order of preference to extend an invitation to form a government?

The Sarkaria Commission Report of 1988, endorsed by the Supreme Court, has recommended that a Governor should first invite the pre-poll alliance which has won a majority. However, in Tamil Nadu, no such alliance has a clear majority. The next option is to invite the single largest party that could demonstrate majority support.

A nine-judge Bench in the *S.R. Bommai* judgment (1994) reasoned that the Constitution does not create an obligation that the political party forming the government should necessarily have a majority in the Assembly. "Minority governments are not unknown. What is necessary is that that government should enjoy the confidence of the House," the Supreme Court said.

The third in the order of preference is a post-poll alliance of parties that can demonstrate a majority in the Assembly. The use of this third option has become more frequent in recent times, with coalition governments becoming the norm. The Court had found nothing wrong in ideologically similar parties engaging in mutually convenient post-poll alliances to cross the Rubicon of the 'golden majority' in the House.

If none of these options work, the Governor can recommend President's rule, although this is an extreme measure. The Court has advised that a "constitutional machinery in the State should, as far as possible, be maintained". This advice has assumed new relevance in recent years, with Governors seen as using their discretionary powers to recommend President's rule to "promote the political interests of the party in power at the Centre."

Has the floor test been a constant, objective means to prove majority?

Critics have said Governor Arlekar's insistence on physical letters of support is the sole reason for the deadlock in Tamil Nadu. A writ petition has been filed in the Supreme Court, arguing that the Governor is "duty-bound" to invite Mr. Vijay to form the new government, swear him in, and immediately subject his claim to a trust vote on the floor of the Assembly.

The Committee of Governors had also concluded that the test of confidence in the government should normally be left to a vote in the Assembly.

Though the *S.R. Bommai* judgment includes a paragraph indicating that a floor test should be confined to testing the strength of an incumbent Chief Minister who is alleged to have lost majority support, and not used in the formation of a new government after elections, successive Supreme Court precedents have nevertheless relied on the floor test as the most objective and transparent way to ascertain majority. These judgments also highlighted that the fate of the electorate's mandate must not be left to the personal discretion of the Governor.

What are some instances where floor tests rescued the constitutional machinery in States?

Repeated occasions of the Court ordering floor tests to assess a claim to govern, whether by an existing or incoming government, has made it the touchstone for ensuring a stable government. In 2017, the Court declined to stay the swearing-in of the Bharatiya Janata Party's Manohar Parrikar as Goa Chief Minister at the head of a post-poll alliance, but reduced the 15-day window allowed to him to prove majority over the Congress, which was the single largest party, and ordered a floor test in 48 hours. Mr. Parrikar won the floor test. The Court intervened in Karnataka the next year after the Governor invited B.S. Yediyurappa to form the government while giving him 15 days to prove majority. On a challenge by the Congress-Janata Dal (Secular) combine, the Court allowed the swearing-in but cut short the time for the floor test to 24 hours and said it must be conducted on live camera and not by secret ballot. Mr. Yediyurappa resigned before the trust vote.

The Supreme Court has held that the House, and not Lok Bhavan, "is the place where democracy is in action." That is, the decision on who should govern must not be left to the subjective satisfaction of the Governor but be determined on the floor of the House.

GS Paper II – Governance

Lt. Gen. N.S. Subramani named next CDS; Vice-Admiral Krishna Swaminathan to be Navy chief

The Hindu Bureau
NEW DELHI

Lieutenant-General N.S. Raja Subramani (retd) and, right, Vice-Admiral Krishna Swaminathan.

The Union government on Saturday announced two major appointments, naming Lieutenant-General N.S. Raja Subramani (retd) as the next Chief of Defence Staff (CDS) and Vice-Admiral Krishna Swaminathan as the next Chief of the Naval Staff.

According to the Ministry of Defence, Lt.-Gen. Subramani will succeed General Anil Chauhan, whose tenure as the CDS ends on May 30. Along with the role of the CDS, he will also serve as Secretary, Department of Military Affairs.

Currently serving as Military Adviser in the National Security Council Secretariat since September 2025, the senior officer has earlier held key positions, including Vice Chief of Army Staff and General Officer Commanding-in-Chief of Central Command.

Commissioned into the 8 Garhwal Rifles in December 1985, Lt.-Gen. Subramani is a graduate of the National Defence Academy and the Indian Military Academy. He has also attended the Joint Services Command Staff College in the U.K. and the National Defence College in New Delhi.

During a distinguished career spanning over four decades, he commanded formations in Assam, Jammu and Kashmir, the Central Sector and along the Western Front, including the prestigious 2 Corps. He has also served in several important operational, instructional and strategic staff appointments. For his distinguished service, he has been awarded the Param Vishisht Seva Medal, Ati Vishisht Seva Medal, Sena Medal, and Vishisht Seva Medal.

Vice-Admiral Krishna Swaminathan, who has been appointed as the next Chief of Naval Staff, will succeed Admiral Dinesh Kumar Tripathi, who retires on May 31.

He currently serves as the Flag Officer Commanding-in-Chief of the Western Naval Command. Commissioned into the Indian Navy in 1987, he is a specialist in Communication and Electronic Warfare. Over the course of his Naval career, he commanded several frontline warships, including *INS Mysore* and aircraft carrier *INS Vikramaditya*, and held key appointments in operations, personnel and training.

A recipient of the Param Vishisht Seva Medal, Ati Vishisht Seva Medal, and Vishisht Seva Medal, the Vice-Admiral has also served as Vice Chief of the Naval Staff and holds multiple postgraduate degrees, including a Ph.D. in International Studies.

GS Paper III – Science & Technology

India test-fires Agni missile that can deploy multiple warheads

Press Trust of India
NEW DELHI

India has successfully test-fired an advanced Agni missile with the strategic ability to deploy multiple payloads to separate targets simultaneously – a milestone that places the country among a select league of global powers.

The testing of the missile with Multiple Independently Targeted Re-Entry Vehicle (MIRV) system was carried out from Odisha's A.P.J. Abdul Kalam Island on Friday, according to the Defence Ministry.

The MIRV feature ensures that a single missile can deploy multiple warheads at different locations simultaneously.

The missile was flight-tested with multiple payloads, targeted to different targets spatially distributed over a large geographical area in the Indian Ocean Region, the Ministry added.

An image from the flight trial of an advanced Agni missile on Friday. DEFENCE MINISTRY

Incredible capability

Defence Minister Rajnath Singh has complimented the Defence Research and Development Organisation (DRDO), Indian Army, and the industry partners concerned on the successful flight-test of the missile. This will add an incredible capability to the country's defence preparedness against the growing threat perceptions, he said.

The Ministry said the telemetry and tracking was carried out by multiple ground and ship-based stations. "These systems tracked the entire missile trajectory from lift-off till the impact of all payloads. Flight data confirmed that all mission objectives were met during the trial," it said.

"With this successful trial, India once again demonstrated the capability to target multiple strategic targets using a single missile system," the Ministry said in a statement.

GS Paper III – Environment

Tiger sighted in Arunachal wildlife sanctuary after nearly two decades

The Hindu Bureau
GUWAHATI

A tiger has been photographed by a camera trap in Arunachal Pradesh's D'Ering Memorial Wildlife Sanctuary for the first time in almost two decades, bringing cheers to wildlife enthusiasts, conservationists, and officials.

The 190-sq. km sanctuary near Pasighat, the East Siang district headquarters, was believed to have lost the species years ago. The first-ever camera-trap photograph of the striped cat has established its return to the protected area.

The sanctuary is named after Daying Ering, a former Union Minister and chairman of the Ering Commission, which influenced the Panchayati Raj system in India.

Kempi Ete, the Divisional Forest Officer, said forest officials and frontline staff documented indirect signs of tiger presence over the past year. Multiple rounds of systematic monitoring and camera trapping were undertaken to verify these observations.

The image of the tiger captured in a camera trap inside the D'Ering Memorial Wildlife Sanctuary. SPECIAL ARRANGEMENT

Although earlier efforts yielded no photographic evidence, monitoring continued with renewed intensity and persistence. In the latest phase of surveys, camera traps installed at strategic locations successfully captured images of a tiger, conclusively establishing its presence in the landscape.

The surveys, conducted with technical support from the Ashoka Trust for Research in Ecology and the Environment (ATREE), also recorded other animals, including the critically endangered Chinese pangolin and the endangered hispid hare.

"The return of the tiger after nearly two decades reflects the resilience of the ecosystem and the cumulative impact of sustained conservation efforts on the ground. This achievement belongs equally to our forest officials, frontline staff, Eco-Development Committee members and the community-based organisations that have continuously supported conservation initiatives in the landscape," Ms. Ete said.

Local MLA Oken Tayeng said that the tiger's return indicated a "healthy sign" and improving ecological conditions in the sanctuary. He stated it could improve tourism prospects and create employment opportunities for youth living in fringe villages around the protected area.

Focus on mental and emotional

Uttarakhand flood maps may be underestimating risk, study warns

Jacob Koshy
NEW DELHI

Flood hazard assessments for Uttarakhand have routinely underestimated the danger to its towns and villages because they have leaned on long-term average rainfall figures rather than the extreme downpours that actually trigger disasters, according to a study in *Current Science*. The findings arrive at a moment when the Himalayan State is grappling with what climate scientists describe as a sharpening pattern of cloudbursts, glacial lake outbursts, and flash floods.

The study, led by researchers at the Malaviya National Institute of Technology, Jaipur, tracked how flood hazard zones have intensified in 2017-2021. Areas classified as 'high' or 'severe hazard' zones rose noticeably over that period, with 2021 showing the largest extent of 'high-hazard' land. Across all the years examined, more than 90% of Uttarakhand fell within moderate or high-hazard categories.

The researchers mapped flood hazard zones the State using a Geographic Information System), a popular digital mapping technology used by planners everywhere. They combined six factors to assess where floods are most likely: elevation, slope, drainage density, topographic wetness, land use, and rainfall. Each factor was assigned a weight reflecting its influence on flooding. Slope, elevation, and rainfall were judged the most important; land use, drainage density, and wetness were treated as secondary.

The map was then drawn once using the highest rainfall recorded in a given year and once using the average of those annual peaks across three decades. The contrast was stark. When the heaviest yearly rainfall was used, severe and high-hazard zones expanded across the State. When long-term averages were used instead, those zones appeared to shrink. The authors argued that conventional methods relying on average values may give planners a false sense of safety.

Risky terrain

The findings carry weight in a State that has witnessed a series of catastrophes over the last two decades, from the Malpa landslide of 1998 and the Kedarnath disaster of 2013, in which Uttarakhand received 375% of its benchmark monsoon rainfall, to the Chamoli flood of 2021. Climate scientists have linked the rising frequency of extreme rainfall in the Himalayas to a warming atmosphere. Built-up areas, the study noted, have also expanded across the State, leaving less land able to absorb sudden runoff. The authors recommend flood maps be redrawn around extreme rainfall scenarios rather than long-term averages, and that buffer zones be created around the most vulnerable terrain.

GS Paper III – Environment

Vulnerable communities in Nepal need insect pollinators

A study in Nepal has found that insect pollinators are essential for both human health and financial survival. Researchers tracked the diets and incomes of smallholder farming families and found that insects are responsible for 44% of a family's farming income and over 20% of its intake of vital nutrients, like vitamin A and folate. The native honeybee was the single most critical species. The study also found that actively managing these species could reverse malnourishment trends.

GS Paper III – Environment

Hope for pancreatic cancer as new drug shows promise

Pancreatic cancer has been one of medicine's most unforgiving challenges, often offering little time and few options; new results from a phase 3 trial suggest daraxonrasib could be a 'game changer' with mild to moderate side-effects

Arun Panchapakesan

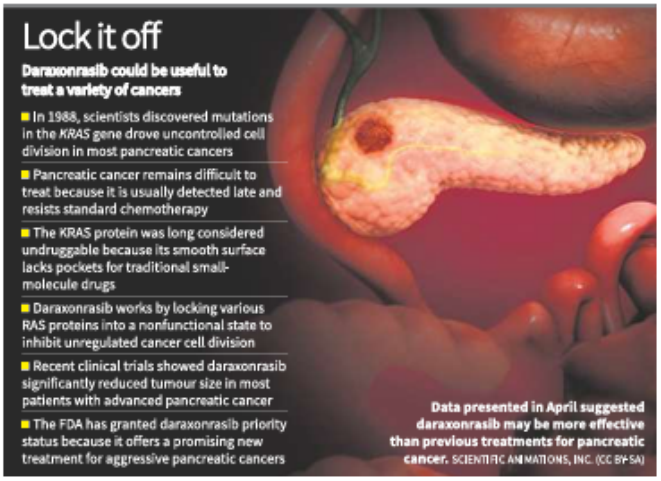
In 1988, a landmark paper in *Cell* said that in around 95% of pancreatic cancers, a gene called *KRAS* carried mutations at a particular location. It was one of the first demonstrations of a mutation with near-universal frequency identified in a cancer.

Cancer is uncontrolled cell division. In a healthy individual, cells grow and divide in a tightly controlled cycle, with specific signals telling the cell when to divide or not. If something goes amiss in this process, cells can repair themselves or undergo programmed cell death. In cancer, this balance is disturbed, causing unregulated cell division. As a result, mistakes tend to accumulate in the DNA, leading to tumours that can invade surrounding tissues and spread to other organs.

The 1988 *Cell* paper showed the *KRAS* gene acts as a switch, regulating whether a cell divides. The KRAS protein – the product of the gene – exists in either an 'off' state, which suppresses cell division or an 'on' state that promotes it. The mutations reported in the study locked KRAS in its 'on' state, driving uncontrolled cell division, leading to pancreatic, colorectal, and lung cancers.

Pancreatic cancer is particularly deadly because it is usually detected late, when the disease has already spread to neighbouring tissues.

There are very few surgical options; even after surgery, recurrence is common. Standard chemotherapy is also not very effective.



For decades, the medical fraternity considered KRAS to be an attractive drug target. However, it proved exceptionally difficult to inhibit because most small-molecule drugs work by fitting into well-defined pockets or grooves on a protein's surface, blocking its activity, whereas KRAS has a relatively smooth, compact surface with few binding sites.

Despite this difficulty, several research groups attempted to target the *KRAS* gene, but nearly all efforts fared poorly in clinical trials. As a result, KRAS was long labelled "undruggable".

In June 2024, a California-based company called Revolution Medicines reported a molecule later called daraxonrasib. It works by targeting a range of the RAS family of proteins, including KRAS, when they are in their 'on' state and signalling the cell to divide. Daraxonrasib first binds to another protein called cyclophilin-A, then locking it with KRAS into a nonfunctional state.

Since daraxonrasib inhibits multiple RAS variants, it could be useful to treat a variety of cancers.

In a phase 1/2 clinical trial, researchers evaluated daraxonrasib for safety and its ability to shrink tumours in patients with advanced cancers driven by RAS mutations. Results from these tests were encouraging enough for the drug to move forward into a phase 3 trial, where investigators tested daraxonrasib's actual effectiveness.

These results were presented at a meeting of the American Association for Cancer Research in April. The findings suggested daraxonrasib may be more effective than previous treatments for pancreatic cancer. In 51% of patients, it reduced the size of tumours, and in 97% it caused their cancers to either shrink or not grow further.

However, daraxonrasib also had many side effects. Nearly all patients experienced mild to moderate effects, including skin rash, diarrhoea, mouth sores, nausea, and fatigue. However, importantly, no life-threatening side-effects were reported in any patients.

While the peer-reviewed data are still awaited, the early results have generated considerable excitement in the cancer research community. Many researchers are already calling daraxonrasib a potential "game changer", particularly for cancers like pancreatic cancer, where treatment options are limited.

The strong clinical results have also led the U.S. Food and Drug Administration (FDA) to include daraxonrasib among eight other therapies in the first-ever group of drugs to receive "National Priority Voucher" status. The FDA created this designation for highly promising drug candidates that address urgent national health needs.

The voucher also allows the FDA to shorten what would typically be a year-long review process to just one or two months. The results of the FDA review are awaited as well, and there is growing optimism that it will be positive. Meanwhile, the FDA has also given Revolution Medicines 'expanded access' to use daraxonrasib with patients who lack other treatment options.

For many decades, pancreatic cancer has stood as one of medicine's most unforgiving challenges, often offering little time, few options, and even less hope. Today, that narrative may finally be beginning to change. For a scientist, daraxonrasib is not a cure in the real sense of the word, at least not yet – but for patients and their families around the world, it is a long-awaited ray of hope.

(Arun Panchapakesan is an assistant professor at the Y.R. Gaitonde Centre for AIDS Research and Education, Chennai)

GS Paper III – Environment

Why is hantavirus drawing global attention?

What is hantavirus? What happened on the expedition cruise ship MV Hondius early this month? How does hantavirus spread? Why are health agencies monitoring recent cases? What are the symptoms and treatment options? How concerned should the public be?

Athira Elssa Johnson

The story so far:

Following a hantavirus outbreak on the MV *Hondius* expedition cruise ship in early May, in which three deaths were reported and at least five others were infected, global attention has once again turned to the group of viruses. Hantavirus had made headlines last year following the passing of Betsy Hackman, wife of renowned American actor Gene Hackman.

What happened on the ship?

The Dutch expedition cruise ship was travelling from Ushuaia in Argentina across parts of the South Atlantic towards Cape Verde and the Canary Islands when cases were identified among both the passengers and the crew.

The World Health Organization (WHO) said 147 passengers and crew were onboard, and 34 passengers and crew had previously disembarked. It said that as of May 8, there were eight cases (six confirmed and two probable cases) reported. Three of them died (two confirmed and one probable) after contracting the Andes strain of hantavirus. Several others were hospitalised with symptoms including fever and breathing difficulties.

WHO has stated that hantavirus does not spread easily between humans like airborne viruses such as influenza or SARS-CoV-2

MV Hondius docks off Cape Verde's Praia port on May 4, as health authorities investigate suspected hantavirus cases. REUTERS

After confirmed and suspected cases had been identified among passengers after they left the ship and travelled to different countries, health authorities in Singapore, Switzerland, South Africa, Spain, and the U.S. began tracking and monitoring passengers.

What is hantavirus?

Hantaviruses are a group of viruses mainly carried by rodents such as rats and mice. Human beings can get infected after coming into contact with infected rodent urine, saliva, or droppings, especially while cleaning or disturbing contaminated areas, which can release virus particles into the air.

Hantavirus infections can affect either the lungs or the kidneys. Some strains can cause hantavirus pulmonary syndrome, a severe respiratory illness, while others can lead to haemorrhagic fever with renal syndrome, affecting the kidneys and blood vessels. WHO states that even though most hantaviruses do not spread from one human to another, the Andes virus strain found in parts of South America has shown some human-to-human transmission, usually among close contacts.

Why are health agencies concerned now?

The outbreak linked to the MV *Hondius* cruise ship drew attention because passengers travelled across several countries before the infection was identified. WHO reported that cases were characterised by fever, gastrointestinal symptoms, pneumonia, respiratory distress, and shock. Reacting to fears of another pandemic, officials from WHO and the Disease Control and Prevention have stressed that hantavirus spreads very differently from viruses such as COVID-19 and is far less transmissible.

What are the symptoms?

WHO states that symptoms usually appear between one and eight weeks after exposure. Early symptoms are often flu-like and can include fever, muscle aches, fatigue, headache, chills, nausea, vomiting, abdominal pain, and dizziness.

In severe cases, the infection can affect the lungs, causing coughing, chest tightness, breathing difficulty, and fluid build-up in the lungs. Some forms of the disease can also affect the kidneys and blood vessels, leading to kidney complications or bleeding problems. Since the symptoms can resemble illnesses such as influenza, COVID-19, dengue, or pneumonia, diagnosis may sometimes be delayed. Even though infections remain rare overall, severe respiratory forms of hantavirus infection can be dangerous, particularly without early medical care.

Who is at risk?

People living or working in rodent-prone environments face the highest risk. Farmers, forestry workers, campers, construction workers, and people cleaning poorly ventilated or abandoned buildings are vulnerable. Health agencies also advise caution while handling pet rodents or entering rodent-infested spaces.

Is there a treatment or cure?

WHO notes that early diagnosis and timely medical attention can significantly improve outcomes. Prevention is important, particularly through rodent control, proper sanitation, and safe cleaning practices in potentially contaminated environments.

Currently, there is no specific antiviral cure or approved vaccine for hantavirus infection. Treatment mainly focuses on supportive medical care, including oxygen therapy, fluid management, and intensive care support during severe illness. Some patients may require mechanical ventilation.

Could this become another pandemic?

Public health agencies say current evidence does not suggest a COVID-19-like global pandemic scenario. WHO has repeatedly stated that the overall risk to the wider public remains low and that hantavirus does not spread easily between humans like airborne viruses such as influenza or SARS-CoV-2.

The outbreak has also drawn attention to zoonotic diseases – infections that spread from animals to humans – and highlighted the importance of staying prepared as global travel and human-animal interactions increase. At the same time, WHO and other health agencies have stressed that stronger surveillance, quicker reporting, testing systems, and coordination between countries are helping health authorities respond effectively.