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ENVIRONMENT AND HEALTH

**Science
Reporter**



विज्ञान एवं
प्रौद्योगिकी मंत्रालय
MINISTRY OF
SCIENCE AND
TECHNOLOGY



MK Yadav Sir

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What is carbon farming?

What are some techniques within carbon farming which can reduce greenhouse gas emissions? What are the challenges in implementing such practices, especially in developing countries such as India? What are some of the global initiatives?

SPEAKERS

Nandini Chakraborty

Carbon farming is based on all living organisms, including plants, animals, and humans, releasing carbon dioxide into the atmosphere. It is a process of managing the carbon cycle in a way that reduces the amount of carbon dioxide in the atmosphere. This is done by using techniques such as crop rotation, cover cropping, and agroforestry. These practices help to sequester carbon in the soil and plants, reducing the amount of carbon dioxide in the atmosphere.

Carbon farming helps

Carbon farming helps to reduce greenhouse gas emissions by sequestering carbon in the soil and plants. It also helps to improve soil health and increase crop yields. Carbon farming is a sustainable practice that can be used by farmers to reduce their carbon footprint and improve their livelihoods.

Carbon farming challenges

Carbon farming challenges include the need for more research and development, the need for better policies and incentives, and the need for more education and training for farmers. Carbon farming is a complex practice that requires a lot of knowledge and resources. It is not easy to implement, and it can be expensive. However, the benefits of carbon farming are many, and it is worth the effort.

Carbon farming benefits

Carbon farming benefits include reduced greenhouse gas emissions, improved soil health, increased crop yields, and increased biodiversity. Carbon farming is a sustainable practice that can help to reduce the impact of climate change. It is a practice that can be used by farmers to improve their livelihoods and the environment.



The process of emitting and removing greenhouse gas emissions in managed farmland



What are the opportunities in India?

There are several opportunities in India for carbon farming. One is the use of cover crops, which can help to sequester carbon in the soil. Another is the use of agroforestry, which can help to reduce greenhouse gas emissions by planting trees in agricultural landscapes. There are also opportunities for carbon trading and for the development of carbon markets.

What are some carbon farming schemes worldwide?

There are several carbon farming schemes worldwide. One is the Verra VCS program, which is a voluntary carbon market. Another is the World Bank's Climate Change Fund, which provides financing for carbon farming projects. There are also several government-led schemes, such as the UK's Carbon Farming Initiative and the US's Conservation Reserve Program.

Context: Carbon farming, a practice harnessing carbon sequestration in soils through agricultural techniques, as a potential solution to combat climate change.

Carbon Farming

- **About:** It is a system of agricultural management that helps the land store more carbon and reduce the amount of greenhouse gases that it releases into the atmosphere.
- **Also known as:** Carbon sequestration
- **Focus:** It focuses on restoring ecosystem health through sustainable agricultural practices.
- Carbon farming enhances agricultural productivity by optimizing soil health and fertility.
- It plays a crucial role in mitigating climate change by sequestering carbon and reducing greenhouse gas emissions.
- **Methods of Carbon Farming:** Rotational Grazing, Agroforestry, Conservation Agriculture, Integrated Nutrient Management and Agro-ecology.

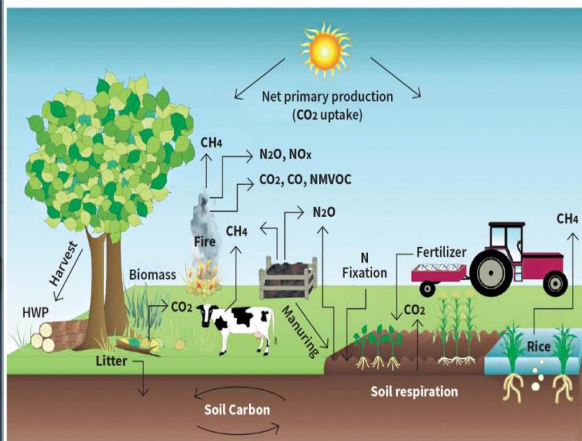
Carbon Farming Schemes

- **Carbon Trading:** It has gained significance globally, notably in the U.S., Australia, New Zealand, and Canada.
- **Carbon Markets:** Exemplified by initiatives like the Chicago Climate Exchange and Australia's Carbon Farming Initiative, incentivize carbon mitigation in agriculture.
- **Global Initiatives:** Projects like Kenya's Agricultural Carbon Project, supported by the World Bank, underscore carbon farming's potential in developing countries for climate mitigation, adaptation, and food security.

Opportunities in India

- **Climate-Resilient Agriculture:** Climate-resilient and emission-reducing agricultural practices present adaptation opportunities crucial for India amidst intensifying climate change.
- **Viability of Organic Farming:** Grassroots initiatives and agrarian research showcase the viability of organic farming for carbon sequestration, potentially generating substantial economic value.
- **Geographical Suitability:** Regions like the Indo-Gangetic plains are well-suited for carbon farming, while mountainous and coastal areas face challenges due to terrain and salinization.

The process of emitting and removing greenhouse gas emissions in managed farmland



WITH VETERAN SUNITA WILLIAMS ON BOARD, BOEING'S STARLINER SET TO LAUNCH: WHAT IS ITS SIGNIFICANCE?

ALIND CHAUHAN
NEW DELHI, MAY 6

Boeing's Starliner spacecraft, carrying two NASA astronauts, will be launched by an Atlas V rocket from Kennedy Space Center in Cape Canaveral, Florida, to the International Space Station (ISS) on Tuesday.

This will be Starliner's first crewed test flight. If the mission is successful, Boeing will become the second private firm to be able to provide NASA crew transport to and from the ISS, alongside Elon Musk's SpaceX.

What is Boeing's Starliner?

Starliner is a partially reusable crew capsule, officially known as CST-100 (crew space transportation). The capsule, which is 5 m tall and 4.6 m wide, consists of two modules. One is the crew module, which can accommodate seven astronauts — although, for trips to the ISS, it will be modified for four astronauts and cargo. The crew module can be reused up to 10 times, with a six-month turnaround.

The other is the service module — the powerhouse of the spacecraft — which supplies electricity, propulsion, thermal control, air, and water in space. This module is not reusable.

What is the mission objective?

The main objective of the mission is to see how Starliner fares in space with a crew on board. It is supposed to dock with the ISS a day after the launch, and return to Earth after around 10 days.

But before Starliner automatically docks with the space station, the crew members, who are NASA astronauts Barry "Butch" Wilmore and Sunita Williams, will test flying it manually. The crew will also test seats, onboard life-support, navigation systems, and the system that moves cargo into the ISS. The space suits worn by Wilmore and Williams will also be tested — these blue suits are around 40% lighter than their predecessors and have touchscreen-sensitive gloves.

On the return journey, NASA and Boeing will be keeping an eye on the spacecraft's heat shield and parachutes. They will slow the descent before airbags open to soften the moment of impact with the ground — unlike other crew cap-

sules, Starliner will land on the ground and not in the sea.

How has Boeing's journey been?

After NASA retired its space shuttle fleet in 2011, it invited commercial space companies to help it transport astronauts and cargo to the ISS. Two companies got the contracts: SpaceX and Boeing. While SpaceX has been ferrying astronauts to and from the ISS since 2020, Tuesday's launch will be Boeing's first crewed flight.

Starliner's first uncrewed flight had come after four years of delay. Although it was set to take off in 2015, the company postponed it to 2019. When it did finally happen, a series of software and hardware failures thwarted the spacecraft from getting into its planned orbit and docking with the ISS.

It took more than 80 fixes for Starliner to make its first successful uncrewed flight. Even after achieving the goal, there were concerns about the performance of some thrusters and the spacecraft's cooling system. Additional problems were found subsequently — there were issues with the safety of wiring and parachutes. As a result, Boeing delayed the launch of Starliner's first crewed flight from 2023.

Why is the mission significant?

The mission's success is crucial for both NASA and Boeing. Currently, NASA has only one private company, SpaceX, which can take its astronauts and cargo to the ISS. Starliner getting approval for conducting routine flights to and from the ISS would give NASA a second option.

The success, however, is more important for Boeing. The launch of Starliner has come at a time when the company's airline business — entirely independent of its space program — has been plagued by safety issues in recent years. For instance, in January, a door-size panel blew out of a Boeing 737 Max, leaving a gaping hole shortly after takeoff.

If Starliner completes its objectives, it will help Boeing rebuild its reputation. "The company has been working on the spacecraft for so long, they have had a few problems with the test flights and there's a lot riding on this," Dr Simeon Barber, a space scientist at the UK-based Open University, told the BBC.

BOEING'S STARLINER SPACECRAFT (Syllabus GS Paper 3 – Sci and Tech)

Context: Boeing's Starliner spacecraft, carrying two NASA astronauts, will be launched by an Atlas V rocket from Kennedy Space Center in Cape Canaveral, Florida, to the International Space Station (ISS).

Boeing's Starliner Spacecraft

- **About:** Starliner is a partially reusable crew capsule, officially known as CST-100, developed by Boeing.
- **Structure:** The capsule is 5 meters tall and 4.6 meters wide, consisting of two modules: the crew module and the service module.
- **Service Module:** Supplies electricity, propulsion, thermal control, air, and water in space.
 - Not reusable like the crew module.
- **Mission Objective**
 - To evaluate Starliner's performance in space with a crew onboard.
 - Dock with the ISS a day after launch and return to Earth after around 10 days.

Significance of the Mission:

- **NASA's Need for Options:** The success of Starliner's mission is critical for NASA, providing a second option alongside SpaceX for transporting astronauts and cargo to the ISS.
- **Boeing's Stakes:** The mission's success is especially vital for Boeing, given recent safety issues in its airline business, making its space program a potential redemption opportunity.

How has Boeing's journey been?

- **Post-Space Shuttle Era:** After NASA retired its space shuttle fleet in 2011, commercial space companies like SpaceX and Boeing were invited to aid in transporting astronauts and cargo to the ISS.
- **Challenges:** Starliner, Boeing's spacecraft, faced significant setbacks, including hardware and software failures, delaying its uncrewed flight.
- **Technical Hurdles:** Starliner required over 80 fixes to achieve a successful uncrewed flight, with ongoing concerns about thruster performance and safety systems.

FM announces 1st GSTAT president appointment

Rajeev Jayaswal

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NEW DELHI: Union finance minister Nirmala Sitharaman on Monday announced the appointment of Sanjaya Kumar Mishra as the president of the Goods and Services Tax Appellate Tribunal (GSTAT) and called it as one of the two "significant milestones" in the larger GST architecture.

The second, according to her, was crossing the ₹2 lakh crore monthly revenue collection benchmark for the first time since the indirect tax reform was launched by the Modi government on July 1, 2017.

FM said the growing GST collections is testimony of "heightened" economic activities in India, world's fastest growing major economy.

India's monthly GST collections soared past the ₹2 lakh crore mark for the first time to ₹2,10,267 crore, while collections in FY24 surpassed the ₹20 lakh crore, reflecting a buoyant economy and better compliance.

According to FM, the tax reform augmented revenues of both the Centre and states. "GST has improved tax buoyancy from 0.72 (pre-GST) to 1.22 (2018-23). Despite compensation ending, state revenues



Nirmala Sitharaman, union finance minister

remain buoyant at 1.15. Without GST, states' revenue from subsumed taxes from FY 18-19 to 2023-24 would have been ₹37.5 lakh crore. With GST, states' actual revenue amounted to ₹46.56 lakh crore," she said.

Experts said the appointment of Justice (Retd) Mishra as head of GSTAT would take the indirect tax reform to yet another level as it would expeditiously resolve pending litigations. GSTAT's first president is the former Chief Justice of the Jharkhand High Court, who has been selected by a search-cum-selection committee headed by the Hon'ble Chief Justice of India.

GSTAT could not be set up earlier due to technical reasons and political oppositions by a few states. Even as the Union

cabinet on January 23, 2019 approved the creation of a national bench of the GSTAT, the matter was pending because of various differences among members such as how to maintain a right federal balance and other technical issues. As approved by the GST Council, the government has notified the principal bench, to be located at New Delhi, and 31 state benches at various locations across the country.

Sitharaman took this opportunity to recall the near seven-year tax reform journey in three parts that unified the domestic markets. "The first part explores the origins of GST and its role in streamlining the indirect tax system. The second part discusses how GST has benefited people through a pro-poor approach. The third part underscores GST's role in promoting cooperative and fiscal federalism," she said in a post on X (formerly twitter).

According to her, "the idea of GST was first mooted during the former PM Atal Ji-led NDA government. In 10 years, UPA was unable to achieve political consensus on GST. Under the leadership of Prime Minister Shri @narendramodi, the necessary consensus was carefully built, and GST Acts were passed by Parliament in 2016," she said.

Context: Recently, Union Finance Minister declared Sanjaya Kumar Mishra's appointment as the president of the Goods and Services Tax Appellate Tribunal (GSTAT).

Goods and Services Tax Appellate Tribunal (GSTAT)

- **About:** It serves as the second level of appeal within the GST framework, available for challenging any unsatisfactory rulings issued by the First Appellate Authorities under the CGST and SGST.
- **Establishment by:** Section 109 of the CGST Act 2017
- **Composition:** Two judicial members and two technical members.
- The Tribunal is likely to be headed by a former Supreme Court judge or a former Chief Justice of a High Court.
- **Headquarters:** New Delhi
- **Aim:** To provide swift, fair, and effective resolution of GST disputes, thereby reducing the burden on higher courts.
 - It is expected to enhance the efficiency of the GST system and promote transparency in the country's tax environment.

GST Council

- **Article 279-A of the Constitution:** The GST Council functions as a collaborative platform involving both the Central and state governments.
- It grants the President the power to establish the GST Council through an executive order.
- **Function:** To provide recommendations to both the Union and the states on crucial GST-related matters, encompassing the taxation of goods and services, exemptions, and the formulation of model GST Laws.

CBDC pilot programmes for CPs, CDs likely: RBI governor

Das says permanent deletion of transactions can make e-rupee anonymous

ANUJA KUMARI & PTI
Mumbai, 6 May

The Reserve Bank of India (RBI) may start a pilot programme for the wholesale segment of Central Bank Digital Currency (CBDC) in commercial papers (CPs) and certificates of deposits (CDs), said Governor Shaktikanta Das on Monday.

Das said the daily retail transaction volume of CBDC through interoperability with the United Payments Interface (UPI) has reached one million but retail users continue to show a strong preference of the UPI.

He said a more extensive volume of transactions is required to fully grasp the broader economic impact of CBDC, particularly on monetary policy and the banking sector.

Das added that permanent deletion of transactions can make the e-rupee or the CBDC anonymous and at par with paper currency.

"Anonymity can be addressed through legislation and/or through technology. For example, through permanent deletion of transactions," Das said. "The basic principle is that CBDC can have the same degree of anonymity as cash, no more and no less," he added.

The benefits of CBDCs will become more apparent with the



"WE HAVE ENABLED INTEROPERABILITY OF CBDC WITH UPI. WHILE THE NUMBER OF TRANSACTIONS HAS REACHED A HIGH OF 1 MN A DAY, WE STILL SEE PREFERENCE OF UPI AMONG RETAIL USERS. WE HOPE THIS WILL CHANGE GOING FORWARD"

SHAKTIKANTA DAS
RBI GOVERNOR

introduction of offline usage and programmability features. The primary goal of these pilots is to analyse shifts in consumer behaviour regarding bank deposits, he said.

"Now, going forward, other instruments like CPs and CDs will be tried out in the pilots, along with security and securities tokenisation features," said Das while speaking at the BIS Innovation Summit 2024, in Basel, Switzerland.

On November 1, 2022, the Indian central bank started the wholesale pilot of CBDC for settlement in government bonds. A month later, the pilot of the retail CBDC kicked off.

"We have also enabled interoperability of CBDC with UPI.

While the number of transactions has reached a high of one million a day, we still see preference for UPI among the retail users. We of course hope that this will change, going forward," Das said.

"Now, the advantages of CBDCs will be more visible when we enable offline use and programmability features. A key objective of the pilots is to study the change in consumer behaviour vis-a-vis bank deposits. We need many more transactions to understand its wider economic effects, especially on monetary policy and the banking system," he added.

Das outlined significant design principles and insights from the pilots. He called for

efforts to enable offline CBDC transactions and introduce programmability for financial inclusion.

He underscored that the CBDC is crafted to be non-interest-bearing, aiming to alleviate risks linked with bank disintermediation.

The implementation of a two-tier distribution model was noted, where the central bank creates CBDCs and banks facilitate distribution.

CBDC denominations mirror physical currency, enhancing user comprehension. Anonymity is managed through legislation or technology, similar to cash transactions. Furthermore, he said that the engagement of non-banks in distribution broadens CBDC accessibility.

"We have gained significant insights from the two pilots, wholesale and retail, on various aspects, such as design, technology, and user behaviour. These insights are facilitating scalability, resilience, and agility of the CBDC system. The pilots are also enabling us to take informed decisions like positioning the CBDC alongside the UPI. CBDC offers a unique value proposition as a currency system, a store of value and anonymity while complementing the existing digital payment systems," he said.

CENTRAL BANK DIGITAL CURRENCY

(Syllabus: GS Paper 3 – Economy)

Central Bank Digital Currency (CBDC)

- **About:** It represents a legal tender and is a liability of the central bank, with its value denominated in the nation's currency, reflected on the central bank's financial statement.
- **Objective:** To reduce risks and minimize expenses associated with the management of physical currency, including the costs related to replacing worn-out notes, transportation, insurance, and logistical operations.
- **Fiat Currency:** CBDCs hold the same value and function as fiat currency, maintaining a one-to-one exchangeability with traditional paper money.
 - Fiat currency is a national currency devoid of commodity backing, such as gold or silver, relying solely on government regulation and trust.
- **Transaction Medium:** CBDCs are transacted through blockchain-backed wallets, facilitating digital transactions in a secure and decentralized manner.
- **Inspiration:** CBDCs, while initially inspired by Bitcoin, differ significantly from decentralized virtual currencies and cryptocurrencies because they are government-issued and carry the legal status of 'legal tender.'

Commercial Papers (CPs)

- **About:** It is an unsecured money market instrument issued as a promissory note, introduced in India in 1990.
- **Purpose:** It aimed to allow highly rated corporate borrowers to diversify short-term borrowing sources and offer investors an additional instrument.

Certificate of Deposit (CD)

- **About:** A CD is a specialized savings account offering a fixed interest rate for a predetermined duration.

Context: The Reserve Bank of India (RBI) may start a pilot programme for the **wholesale segment of Central Bank Digital Currency (CBDC)** in commercial papers (CPs) and certificates of deposits (CDs).

What is SFJ, alleged to have links with AAP?

ARJUN SENGUPTA
NEW DELHI, MAY 6

DELHI LIEUTENANT-Governor V K Saxena on Monday recommended a National Investigation Agency (NIA) probe against jailed Delhi Chief Minister Arvind Kejriwal for allegedly receiving political funding from Sikhs for Justice (SFJ), a New York-based pro-Khalistan organisation that is banned in India.

Sources in the LG House told *The Indian Express* that the recommendation was made based on a complaint by Ashoo Mongia of the World Hindu Federation, a diaspora-based Hindu advocacy organisation. Mongia alleged that Kejriwal's Aam Aadmi Party received \$16 million from SFJ for "facilitating the release of Devinder Pal Bhullar and espousing pro-Khalistani sentiments".

'Ballots not Bullets'

SFJ was founded in 2007 by Gurpatwant Singh Pannun, a US-based attorney who is



Gurpatwant Singh Pannun, founder and chief of the SFJ. File

currently in his late 40s. According to its website, SFJ seeks to achieve "self-determination for the Sikh people in their historic homeland" in "Indian held Punjab", and "establish a sovereign state, popularly known as Khalistan".

"It was formed with the overt recognition that the wanton use of violence had been the Khalistan movement's Achilles heel," Terry Milewski, Canadian journalist and the author of *Blood for Blood: Fifty Years of the Global Khalistan Project* (2021), had previously told *The Indian Express*. Pannun's motto was "ballots not bullets", Milewski said.

Thus far, SFJ's most notable activity has been the so-called 'Referendum 2020' for the secession of Punjab — specifically the Indian

state and not the Pakistani province — held among the Sikh diaspora in some cities.

"The rules and identification requirements are farcical," Milewski told *The Indian Express*. "I have a friend in London who logged on online to register to vote, put down Angelina Jolie as his name, and was successfully registered for the vote. Pannun and his ilk put up random, unverifiable numbers hailing the referendum's success," he said.

Doublespeak of Pannun, SFJ

Despite supposedly "turning a page" from the violence-ridden Khalistan movement of yesteryears, SFJ and Pannun have not been shy to glorify terrorists and mass murderers.

For instance, the campaign headquarters for the 'referendum' in Canada is named after 'Shaheed' (martyr) Talwinder Singh Parmar, the mastermind behind the 1985 Air India bombing which killed 329 innocents, and remains the most deadly mass murder in Canadian history. SFJ has also repeatedly hailed Indira Gandhi's killers, Beant Singh

and Satwant Singh. In a viral video from 2020, Pannun promised to gift new iPhones to anyone who flew the Khalistan flag in honour of 'Shaheed' Beant Singh.

"Terrorists have been an absolutely essential part in SFJ's iconography... SFJ has completely contradicted themselves," Milewski said. And SFJ does not stop at simply glorifying terrorists. Pannun himself has often mounted veiled threats at Hindus and other non-Sikh members of the Indian diaspora.

Banned in India

India refers to Pannun as a terrorist, and has banned SFJ under the Unlawful Activities (Prevention) Act, 1967. The Home Ministry's 2019 notification issuing the ban says: "In the garb of the so-called referendum for Sikhs, SFJ is actually espousing secessionism and militant ideology in Punjab, while operating from safe havens on foreign soils and actively supported by inimical forces in other countries."

Currently, almost a dozen cases are registered against Pannun and SFJ in India.

Context: The Delhi Lieutenant-Governor recently proposed a National Investigation Agency (NIA) inquiry into the jailed Delhi Chief Minister's alleged receipt of political funding from Sikhs for Justice (SFJ).

Sikhs for Justice (SFJ)

- **About:** It is a New York-based pro-Khalistan organization that is banned in India.
- **Founded:** 2007 by Gurpatwant Singh Pannun, a US-based attorney.
- **Purpose:** SFJ seeks to achieve "self-determination for the Sikh people in their historic homeland" in "Indian-held Punjab", and "establish a sovereign state, popularly known as Khalistan".
- **Campaign Objectives:** SFJ's main campaign, 'Referendum 2020', aims to achieve the "liberation" of Punjab from what they term "Indian occupation."

Banned in India

- **India's Perspective:** India regards Pannun as a terrorist and has banned SFJ under the Unlawful Activities (Prevention) Act, 1967.
- **Official Notification:** The Home Ministry's 2019 notification states that SFJ is promoting secessionism and militant ideology in Punjab under the guise of a Sikh referendum.
- **Operation:** SFJ operates from safe havens abroad and receives active support from hostile forces in other countries.

Understanding the science behind magnetic resonance imaging

MRI scans are used to obtain images of soft tissues within the body. It is a non-invasive diagnostic procedure widely used to image the brain, the cardiovascular system, the spinal cord and joints, various muscles, the liver, arteries etc.

Vasudevan Mahalingam

The story so far:

For those trying to look inside the human body without surgery, magnetic resonance imaging is an indispensable tool. The underlying techniques were worked out in the early 1970s and later in the same decade. Paul Lauterbur and Peter Mansfield refined them to pave the way for their commercial use. For these efforts, they were awarded the Nobel Prize in medicine in 2003, speaking to the significance of the technique and its place in modern medical diagnostics.

What is magnetic resonance imaging?

Magnetic resonance imaging (MRI) is used to obtain images of soft tissues within the body. Soft tissue is any tissue that hasn't become harder through calcification. It is a non-invasive diagnostic procedure widely used to image the brain, the cardiovascular system, the spinal cord and joints, various muscles, the liver, arteries, etc.

Its use is particularly important in the observation and treatment of certain cancers, including prostate and rectal cancer, and to track neurological conditions including Alzheimer's, dementia, epilepsy, and stroke. Researchers have also used MRI scans of changes in blood flow to infer the way the activity of neurons is changing in the brain; in this form, the technique is called functional MRI.

Because of the MRI technique's use of strong magnetic fields, individuals with embedded metallic objects (like shrapnel) and metallic implants, including pacemakers, may not be able to undergo MRI scans. In fact, if they have a credit card in their pocket, the magnetic field will wipe its magnetic strip.

How does MRI work?

An MRI procedure reveals an image of a body part using the hydrogen atoms in

that part. A hydrogen atom is simply one proton with one electron around it. These atoms are all spinning, with axes pointing in random directions. Hydrogen atoms are abundant in fat and water, which are present almost throughout the body.

An MRI machine has four essential components. The machine itself looks like a giant doughnut. The hole in the centre, called the bore, is where the person whose body is to be scanned is inserted. Inside the doughnut is a powerful superconducting magnet whose job is to produce a powerful and stable magnetic field around the body. Once the body part to be scanned is at the centre of the bore, the magnetic field is switched on.

Each hydrogen atom has a powerful magnetic moment, which means in the presence of a magnetic field, the atom's spin axis will point along the field's direction. The superconducting magnet applies a magnetic field down the centre of the machine, such that the axes of roughly half of the hydrogen atoms in the part to be scanned are pointing one way and the other half are pointing the other way. This matching is almost exact: in around a million atoms, only a handful remain unmatched – that is, a small population of 'excess' atoms pointing one way or the other.

The machine's third component is a device that emits a radiofrequency pulse to the part under the scanner. When the pulse is 'on', only the small population of 'excess' atoms absorbs the radiation and gets excited. When the pulse goes 'off', these atoms emit the absorbed energy and return to their original, lower energy states. The frequency of pulse the 'excess' atoms have to absorb is called the Larmor frequency. Its value depends on the strength of the magnetic field and the type of tissue in which the atoms are present. The fourth and final component, a detector, receives the emissions and converts them to signals, which are sent to a computer that uses them to recreate two- or three-dimensional images of that

part of the body.

What are the pros of MRI?

After the big, powerful magnetic field comes on, the MRI machine activates three magnets that produce smaller magnetic fields that are weaker than the main field by about 80 times, if not more. These fields also have a gradient, that is, they are not uniform. These fields interfere with the main field at the part to be scanned such that the resulting field highlights very specific portions, which can be the focus of the scan.

By turning the gradient magnets on and off in specific sequences, the MRI machine can thus scan portions that are just a few millimetres wide. The sequences can also be organised such that the machine scans different parts of the individual's body without asking them to move inside the bore.

In fact, because of the way the machine is built and the magnets are organised inside it, an MRI scan can practically image the body from all useful directions and, if required, in very small increments.

When the 'excess' atoms emit the energy they'd absorbed to return to their lower energy states, the return happens over a duration called the T1 relaxation time. The hydrogen atoms in water have different values of T1 depending on the tissue in which they're present. An MRI machine exploits this fact to show different tissues in different shades of grey. Clinicians may also inject an individual with a contrast agent – typically a gadolinium-based compound – that lowers the T1 time in some tissues, improving their visibility in an MRI scan.

Finally, researchers have deeply investigated the effects of strong magnetic fields on the body. MRI scans don't pose any threats; once the magnetic fields are taken away, the atoms in the scanned part don't remain affected. There is no long-term harm associated with scans. However, a scan's effects on pregnant women aren't as well-studied, so many

scanning facilities simply refuse such appointments.

What are the cons of MRI?

MRI machines are expensive: depending on the specifications, including the strength of the magnetic fields and the imaging quality, they cost from a few tens of lakh rupees to a few crores. Diagnostic facilities pass this cost on to its patients. Based on the clinical requirements, scans often cost 70,000 or more each – a sizeable sum in India, especially for those without insurance, and more so for those required to get multiple MRI scans.

These costs are compounded by the discomfort of using the machine. While it's an advantage that an individual inside the bore doesn't have to move for the machine to scan different parts, the individual is actually expected to be still for tens of minutes, until the scan is complete. If the individual moves, the resulting image will be distorted and the scan will have to be repeated. The problem is exacerbated if the individual is claustrophobic (although some 'open-bore' MRI machine designs can alleviate this issue).

Generating a magnetic field of strength 1 tesla or more – as the main magnet does – is no mean feat. To do so, a heavy current is passed through coils of wire made of a superconducting material. When the setup is cooled with liquid helium, the wires become superconducting and the current passing through them plus the geometry of the wires produces a strong magnetic field. While the wires don't lose any energy as heat – which a non-superconducting material would – maintaining the setup is energy-intensive, which is expensive. Further, the switching of such heavy currents within the machine, as the gradient coils are operated in sequence, means the machine produces loud noises when operating. This can be an additional source of discomfort for the individual.

MAGNETIC RESONANCE IMAGING

(Syllabus: GS Paper 3 – Sci and Tech)

Context: Magnetic resonance imaging (MRI) emerges as a vital non-surgical technique for exploring the human body, offering unparalleled insights without invasive procedures.

Magnetic Resonance Imaging (MRI)

- **About:** It is a non-invasive diagnostic procedure used to obtain images of soft tissues within the body. MRI is particularly adept at imaging soft tissues, which are tissues that have not undergone calcification and become harder.
- **Development of MRI Techniques:** It was established in the early 1970s.
 - Paul Lauterbur and Peter Mansfield refined MRI techniques in the late 1970s, making them commercially viable.
- **Recognition:** Lauterbur and Mansfield were jointly awarded the Nobel Prize in Medicine in 2003.
- **Applications:**
 - MRI is used to image various parts of the body including the brain, cardiovascular system, spinal cord, joints, muscles, liver, and arteries.
 - **Importance in Cancer Diagnosis:** MRI plays a crucial role in the observation and treatment of certain cancers such as prostate and rectal cancer.
 - **Tracking Neurological Conditions:** MRI is instrumental in tracking and diagnosing neurological conditions like Alzheimer's, dementia, epilepsy, and stroke.
 - **Functional MRI for Brain Activity:** It utilizes changes in blood flow to infer neuronal activity in the brain, enabling researchers to study brain function.

Pros of MRI

- Precise imaging with powerful magnetic fields.
- Gradient magnets highlight specific portions for scanning.
- Sequenced scans enable focused examination without movement.
- Versatile imaging from various angles and small increments.
- Safe procedure with no long-term harm to individuals.

Cons of MRI

- MRI machines are costly, ranging from lakhs to crores.
- Patients bear high scan costs, around ₹10,000 or more.
- Patients must lie still during scans, causing discomfort.
- Claustrophobia may worsen during MRI scans.
- Energy-intensive setup leads to expensive operation and loud noises.

Centre issues warning against 'drip pricing'. What is it?

Context: The Centre recently warned about “drip pricing”, saying it can surprise consumers with “hidden charges” and advised them to seek assistance if they encounter such surges in charges on a product's MRP (maximum retail price).

Drip Pricing

- **About:** It is a strategy where only a portion of an item's cost is initially displayed, with the full amount revealed later during the purchase process.
- **Withholding Charges:** Charges often involve withholding essential fees like local taxes or booking charges, or omitting necessary add-ons like internet access or amenities, which may be required for product or service usage.
- **Misleading Headline Prices:** The price advertised, whether in print, email, or on a website (referred to as the “headline price”), may not accurately reflect the final cost to the consumer.
- **Lower Initial Price:** Companies prefer to present a lower initial price and later disclose mandatory fees to avoid alarming customers with unexpectedly high prices.
- **Impact on Transparency:** This technique can penalize sellers who are transparent with their pricing, as it obscures the true cost of a product or service and makes it harder for consumers to make informed decisions.
- **Example of Drip Pricing:** A classic example is the cost of an airplane ticket, which may not include baggage fees until later in the booking process.

How does it work?

- **Psychological Commitment:** The rationale for employing drip pricing is that shoppers who are invested in the shopping process may commit to a purchase once additional fees are revealed, even if they had not initially factored in.
- **Reduced Shopping Friction:** Businesses might employ a drip pricing tactic to attract customers into initiating the purchasing process, banking on the likelihood that once started, customers may be less inclined to restart their search upon discovering additional costs.

A mouth bacteria has starring role in colorectal cancer: study

According to a research team's experiments, some genetic factors could be boosting the ability of *Fusobacterium nucleatum* bacteria to associate with cancers of the gut. The team also showed that when mice were infected with this type of *Fusobacterium*, their tumours developed adenomas.

Associated Data

The bacteria known as *Fusobacterium nucleatum* live in the human mouth and are rarely found elsewhere. But in cases of cancer of the colon or the rectum, the bacteria are found in tumours in the gut, where they help cancer cells escape from the immune system and spread to other parts of the body.

In a new study, a group of researchers from the Fred Hutchinson Cancer Center in the U.S. has identified a distinct subtype of the bacterium that's found in relatively greater quantities in colorectal cancer (CRC) tumours.

CRC is the seventh most common type of cancer in India, where the number of cases rose by 20% from 2009 to 2016. Worldwide, the overall CRC incidence has declined but, experts wrote in the journal *Science* last year, the incidence of age-adjusted early-onset CRC "has risen at an alarming rate of 2-4% in many countries, with even sharper increases in individuals younger than 30 years."

According to the team's experiments, described in a paper in *Nature* in March, some genetic factors could be boosting *Fusobacterium*'s ability to associate with cancers of the gut.

The team also showed that when mice were infected with this type of *Fusobacterium*, their tumours developed precancerous formations called adenomas.

Experts said the study's findings could be used to figure out how to develop tests to detect CRC early and develop targeted treatment options.

A clue of its own

The researchers began by culturing *Fusobacterium* bacteria collected from 10 human CRC tumours in the laboratory.

Then they mapped the entire genetic composition of the isolated bacteria and found that out of the four known *Fusobacterium* nucleatum subtypes, only *Fusobacterium nucleatum* *ATCC 25461* (Fus C) was significantly associated with CRC tumours.

Individual members of the same species have slightly different DNA. Haplotypic analysis helps researchers map all the genes in a species as well as those parts of the genome that come but not all members of the species have.

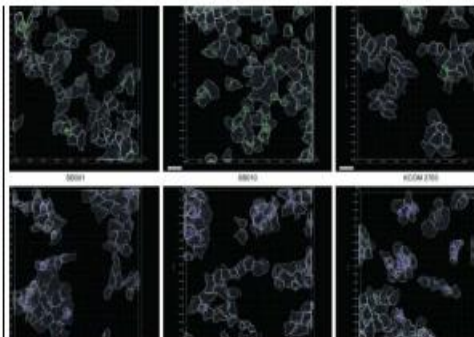
This part is called the accessory genome. The members of a species can be further subclassified depending on the accessory genomes they have.

In their analysis, the researchers found Fus C was the smallest core genome (the part that all members of the species have), indicating there could be different subtypes of Fus C.

In response, they traced the evolutionary history of the bacteria by tracing the changes in its genes. This analysis revealed that Fus C, instead of being one homogeneous group, is composed of bacteria from two different evolutionary lineages.

Scientists call a group of life forms having a recent evolutionary lineage a clade. Thus, the researchers had identified two different clades of Fus C they called Fus C1 and Fus C2.

They further found Fus C2 bacteria are significantly associated with CRC tumours.



Representative Fus C1 and Fus C2 bacteria collected with human colon cancer cells. The grid shows the results of super-resolution analysis of confocal imaging. Independent images for cancer epithelial cells (grey) and intracellular bacterial cells (Fus C1 green, Fus C2 lavender) were generated. The stacks were used to calculate the percent of cancer cells with intracellular Fus C. The scale bar is 20µm. (APRIL 2018, N. S. ADITHYAN, et al.)

and that they have extra genetic factors to help them in this regard.

Colonizing the gut

Both physical and genetic differences between the two clades seemed to contribute to Fus C2 bacteria's ability to associate with CRC tumours. Physically, the Fus C2 bacteria looked longer and thinner than Fus C1 bacteria. Such differences are able to live in host tissue as well as evade the body's immune system, the authors wrote in their paper.

Genetically, Fus C2 bacteria had genes required to match two compounds for energy in the human gut: riboflavin and L2 propionamide. These genes were missing in Fus C1. So the researchers concluded Fus C2 bacteria's ability to associate with CRC tumours was at least partly contingent on their "having increased nutrient scavenging mechanisms and enhanced metabolic potential".

The researchers validated their findings by analyzing genomes present in more than 1,000 human stool samples, roughly half of which were from people with CRC while others were from healthy individuals. They found that the Fus C2 genes required to metabolize riboflavin and L2 propionamide were more or less in their stool samples than CRC patients than in samples from people without CRC.

Mouth to gut

Scientists previously believed *Fusobacterium* bacteria could go from the mouth to the gut by hitchhiking the bloodstream when, say, someone brushed their teeth too hard or during medical dental procedures. The authors of the new *Nature* paper picked a new route: that the bacteria could have descended through the gastrointestinal tract to reach the colon.

Bacteria don't usually take this path



Across the world, overall CRC incidence has declined but the incidence of age-adjusted early-onset CRC "has risen at an alarming rate of 2-4%."

because they can't survive the highly acidic environment of the stomach. But the researchers found Fus C2 could. These bacteria could grow in more acidic conditions than could Fus C1 bacteria – and they also had specific genes that could resist the effects of acids. These genes came online when the acidity was comparable to that of stomach acid.

In mice as in humans

Next, the researchers investigated whether Fus C2 could induce the development of tumours in the gut. For this, they introduced Fus C2 bacteria in the inflamed guts of some mice and Fus C1 bacteria in the inflamed guts of others. (These mice are a common animal model used to investigate conditions that also affect humans.) They found a significantly higher incidence of adenomas in the tumours of the mice treated with Fus C2 bacteria.

They also noted that the lineages of Fus C2-treated mice had different metabolic profiles – changes consistent with previously reported associations between differential metabolic levels and tumour progression.

"Overall, our results demonstrate the ability of Fus C2, but not Fus C1, to metabolically affect the intestinal (and now) conditions conducive to CRC," the authors wrote.

Finally, the researchers tested their hypotheses in a cohort of human patients. Working with CRC tissue and

non-cancerous tissues from the same individual, the authors confirmed that Fus C2 was the only *Fusobacterium* subtype enriched in CRC tumours. They found similar results in stool samples from those with CRC but not in those from healthy individuals.

Long road to clinical trials

According to Naveen Katta, a cancer therapeutics researcher at All India Institute of Medical Sciences, "The study presents promising prospects for the advancement of microbial cellular therapies, which involve the use of modified bacterial strains to directly stimulate responses like tumours."

Vijay Aggarwal is an assistant professor at Jo Institute, Mumbai, who also works on faecal transplants for infection and inflammatory bowel diseases. He called the study "very promising" and said "it really does provide a solid foundation for the broader community to design targeted microbial interventions and colonize for CRC."

He added that future research should track the gut and oral microbiome of high-risk individuals and their tumour microbiomes after a CRC diagnosis to understand how certain strains of bacteria can cause cancer.

Similarly, Dr. Katta said studies to come could look at the "colonisation timeline" of Fus C2 bacteria. The CRC stage at which the bacteria become associated with the tumours, "if colonisation occurs early," he explained, "it could facilitate early CRC diagnosis."

On the flip side, the authors said developing a drug that could selectively suppress Fus C2 bacteria without affecting Fus C1 or other gut bacteria "presents a significant challenge".

Scientists date a science journalist and a faculty member at Iowa University. Data source at (qipwqprgqgq).

COLORECTAL CANCER

(Syllabus: GS Paper 3 – Sci and Tech)

Context: In a new study, a group of researchers from the Fred Hutchinson Cancer Center in the U.S. has identified a distinct subtype of the bacterium that's found in relatively greater quantities in colorectal cancer (CRC) tumours.

Colorectal Cancer (CRC)

- **Definition:** Colorectal cancer is a disorder affecting the colon or rectum caused by abnormal growth of glandular cells.
- **Types of CRC:** There are three main types: sporadic, hereditary, and colitis-associated.
- **Symptoms:** Hemorrhoids, diarrhea, infection, or irritable bowel syndrome.
- **Risk Factors:** Both environmental and genetic factors play a role, with increased risk for those with long-standing ulcerative colitis or Crohn's disease.
- **Inflammation:** Studies show diet, lifestyle, family history, and chronic inflammation are risk factors.
- **Alarming Rise in Young Adults:** While overall CRC incidence might be declining, early-onset CRC is increasing significantly, especially in people under 30.
- **India Specific:** CRC is the seventh most common cancer in India, with a 20% case increase from 2004 to 2014.

Fusobacterium nucleatum and Colorectal Cancer

- **About:** *Fusobacterium nucleatum*, a bacterium normally found in the mouth, is surprisingly present in colon and rectal cancer tumors.
- **Aiding Cancer Spread:** The bacteria's presence in tumors helps cancer cells evade the immune system and metastasize (spread) to other organs.
- **Genetic Link to Cancer:** Studies suggest specific genetic factors in *Fusobacterium* might enhance its ability to associate with gut cancers.

Time to talk

T.N. Kerala should discuss dam safety; legal recourse must be the last resort

Tamil Nadu's latest application in the Supreme Court of India on the Mullaperiyar dam row shows that even 10 years after the Court's decisive judgment allowing water to be stored till 142 ft. from the previously reduced 136 ft., several issues with Kerala still remain unresolved. In a rejoinder to Kerala's reply in a case filed by an activist, Tamil Nadu, the beneficiary-owner State, has accused Kerala, where the dam is located, of "crying foul" about the safety of the 129-year-old structure, while at the same time "willfully obstructing" work essential for its maintenance. Despite the constitution of three panels, i.e., a Supervisory Committee (which was reconstituted by having a technical member from each State in June 2022) and two sub-committees (one of which is under the National Executive Committee of the National Disaster Management Authority) to ensure a high level of preparedness to face any disaster related to the dam, no one is any closer to finding a solution to the pending issues. Tamil Nadu's grievance is that the reconstituted Supervisory Committee, despite having powers under the Dam Safety Act, 2021, had "miserably failed" to ensure that Kerala and its instrumentalities permit and facilitate dam strengthening and other related works. Tamil Nadu has also been pressing for the early completion of a comprehensive dam safety evaluation within five years, by December 30, 2026, as stipulated under the 2021 law.

But despite unresolved issues, judicial intervention has seen the adoption of rule curve, a tool in decision-making for smooth operation of the dam's shutters, especially during floods, and the gate operation schedule, notwithstanding Kerala's reservations. Apart from the dam-related issues, the proposal of a mega car parking project of the Kerala government is a matter of litigation. The conclusion of the Survey of India that the project site is outside the leased area has been disputed by Tamil Nadu. As for Kerala, dam safety has been its primary concern and it wants to proceed cautiously. It is time that the two State governments, which enjoy good relations, resumed bilateral negotiations to find a solution to pending problems while retaining their liberty to adopt legal recourse. Courts take their own time to arrive at their conclusion, even though Tamil Nadu has a more favourable track record with the Supreme Court than the other State on Mullaperiyar, going by the 2006 and 2014 judgments. As water and dam safety can be used by some elements to arouse emotions, the political leadership in both States should be proactive in thrashing out the differences. The proposed talks, even in the event of not leading to any major breakthrough, may at least provide both States an opportunity to appreciate each other's position better and leave no room for vested interests to vitiate the atmosphere.

Context: Recently, Tamil Nadu expressed dissatisfaction with the reconstituted Supervisory Committee's failure, despite its powers under the Dam Safety Act, 2021, to enforce dam strengthening and related works by Kerala.

Dam Safety Act, 2021

- **About:** A National Committee on Dam Safety is established to oversee dam safety policies and regulations.
- **Implementation Authority:** A National Dam Safety Authority is created for implementation and resolving dam safety disputes at the State level.
- **National Committee on Dam Safety (NCDS):** Sets policies and recommends regulations.
- **National Leadership:** The Chairman of the Central Water Commission (CWC) heads national dam safety protocols.
- **State-Level Bodies:** Each state establishes a State Committee on Dam Safety (SCDS) and a State Dam Safety Organisation (SDSO). (Example: Sikkim with SCDS formed on August 17, 2021).
- **Dam Owners:** These are accountable for safe construction, operation, maintenance, and supervision.
 - Must establish a dam safety unit in each dam and conduct inspections before/after monsoon season, and after seismic events, floods, or distress signs.
- **Functions of Dam Owners:** Prepare emergency action plans, conduct risk assessments at regular intervals, and undertake comprehensive dam safety evaluations with expert panels.
- **Offences and Penalties:** Offenders obstructing or refusing to comply with directives may face imprisonment up to a year.
 - **Loss of Life:** In cases involving loss of life, imprisonment for up to two years may be imposed.

Mullaperiyar Dam

- **About:** It was constructed during 1887-1895 and owned, operated, and maintained by Tamil Nadu Government.
- **Location:** It is located in upper reaches of river Periyar, which flows into Kerala after originating in Tamil Nadu.
- The dam is erected at an elevation of 53.66 meters and spans a length of 365.85 meters.

Maharashtra: HC stays exemption to pvt schools from RTE admissions

OMKARGOKHALE
MUMBAI, MAY 6

THE BOMBAY High Court on Monday stayed until further orders the February 9 notification of the Maharashtra government that exempted private schools within one-km radius of government or aided schools from Right to Education Act quota admissions.

Maintaining that the matter contained "overwhelming public interest", a division bench of Chief Justice Devendra Kumar Upadhyaya and Justice Aril S Doctor held that the impugned amendments contravened the Right of Children to Free and Compulsory Education Act, 2009, also known as the RTE.

The RTE Act requires private schools to ensure that 25% of Class 1 students belong to "weaker section and disadvantaged group in the neighbourhood". Students ad-

mitted under this quota are given fee concessions, and the state government reimburses private schools for the same. Earlier, Maharashtra, Karnataka, and Kerala diluted private schools' obligations under the RTE Act.

"It is a settled principle of law that any piece of subordinate legislation cannot be made in contravention of the principal Act itself," the bench noted.

"Even otherwise, by adding impugned provisions, the right of children to get elementary education is being hampered, which is otherwise guaranteed in Article 21-A of the Constitution," it added.

The bench granted interim relief in a batch of pleas, including a writ petition by 17 people, mostly members of management of aided schools and parents from economically backward classes.

Appearing for the petitioners, senior advocate Cayatri Singh argued that the notification be-

stayed as it was contrary to the RTE Act that provides quota at municipal schools, aided schools and private unaided schools.

Due to the government's decision, many needy students are unable to seek admission, she added. While around 5,00,000 students applied through RTE last year, fewer than 50,000 students have applied so far this year, she said.

On April 29, the state government informed the high court that the last date for submitting online applications for admissions under the RTE Act would be extended from April 30 to May 10.

On Monday, the petitioners urged that an interim stay be granted in the matter because of impending admissions to be made in school starting May 10.

The petitioners argued that the amendment was not only unconstitutional, being violative of Articles 14 (equality before law) and 21 of the Constitution, but

was also in contravention of the principal Act of 2009, under which rules were formulated.

The petitioners argued that newly added rules excluded private unaided schools while the 2009 law mandated them to be included. Additional Government Pleader Jyoti Chavan for the state argued that the exclusion applied only to certain unaided schools and was "not absolute" as the government or local authority has established schools within 1-km radius of private unaided schools.

The bench said everyone is bound by the mandate under the 2009 law for 25% reservation in admission in Class 1 to children from weaker sections. Therefore, prima facie, the rule cannot be amended on the ground that sufficient numbers of government schools are available in the area concerned.

It asked the respondent authorities to file their reply before the next hearing on June 12.

Context: The Bombay High Court recently issued a stay on the Maharashtra government's February 9 notification exempting private schools within a one-km radius of government or aided schools from RTE Act quota admissions until further orders.

Right of Children to Free and Compulsory Education Act, 2009

- **Origin:** It is an Act of the Parliament of India enacted on 4 August 2009.
- **Objective:** aims to provide primary education to all children aged 6 to 14 years in India under Article 21A of the Indian Constitution.
- **Features**
 - **Creating inclusive spaces for all:** 25% reservation for disadvantaged groups which include SCs and STs, Socially Backward Class and differently abled. Five States namely Goa, Manipur, Mizoram, Sikkim and Telangana have not issued notification regarding 25% seats for underprivileged children of society under the RTE.
 - **Compulsory and free education for all:** It is obligatory for the Government to provide free and compulsory elementary education to each and every child, in a neighbourhood school within 1 km, up to class 8 in India.
 - **Benchmark mandate:** Specifies standards and norms for Pupil Teacher Ratios (PTR), infrastructure and buildings, working days of the school and for the teachers.
 - **No Detention Policy:** It was introduced as a part of the Continuous and Comprehensive Evaluation (CCE) under the Right to Education Act (RTE) in 2010.
 - **Justiciable:** The Right to Education Act is justiciable and is backed by a Grievance Redressal (GR) mechanism that allows people to take action against non-compliance of provisions of the Right to Education Act 2009.

Constitutional Provisions

- **Article 21:** Unnikrishnan JP vs State of Andhra Pradesh & Others (1993): SC held that Education is a Fundamental right under Article 21.
- **Article 21A:** 86th Constitutional Amendment (2002): It inserted Article 21A which made Right to Education a fundamental right for children between 6-14 years.
- **Article 45:** It states that the state should provide free and compulsory education to children up to the age of 14.

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