

NEXT IAS

Why NASA astronauts were stuck? Challenges faced in Returning back!



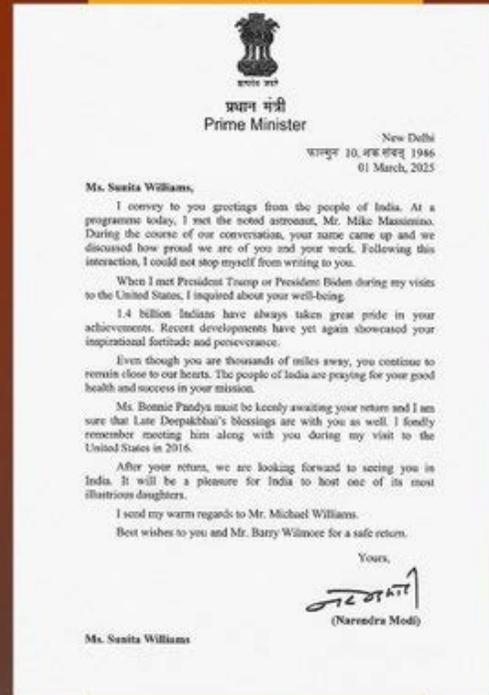
"Sunita Williams, a trailblazer and an icon, has exemplified this spirit throughout her career. We are incredibly proud of all those who worked tirelessly to ensure their safe return. They have demonstrated what happens when precision meets passion and technology meets tenacity. Their unwavering determination in the face of the vast unknown will forever inspire millions."

-Hon'ble PM Narendra Modi

“

1.4 billion Indians have always taken great pride in your achievements. Even though you are thousands of miles away, you continue to remain close to our hearts... we are looking forward to seeing you in India. It will be a pleasure for India to host one of its most illustrious daughters.

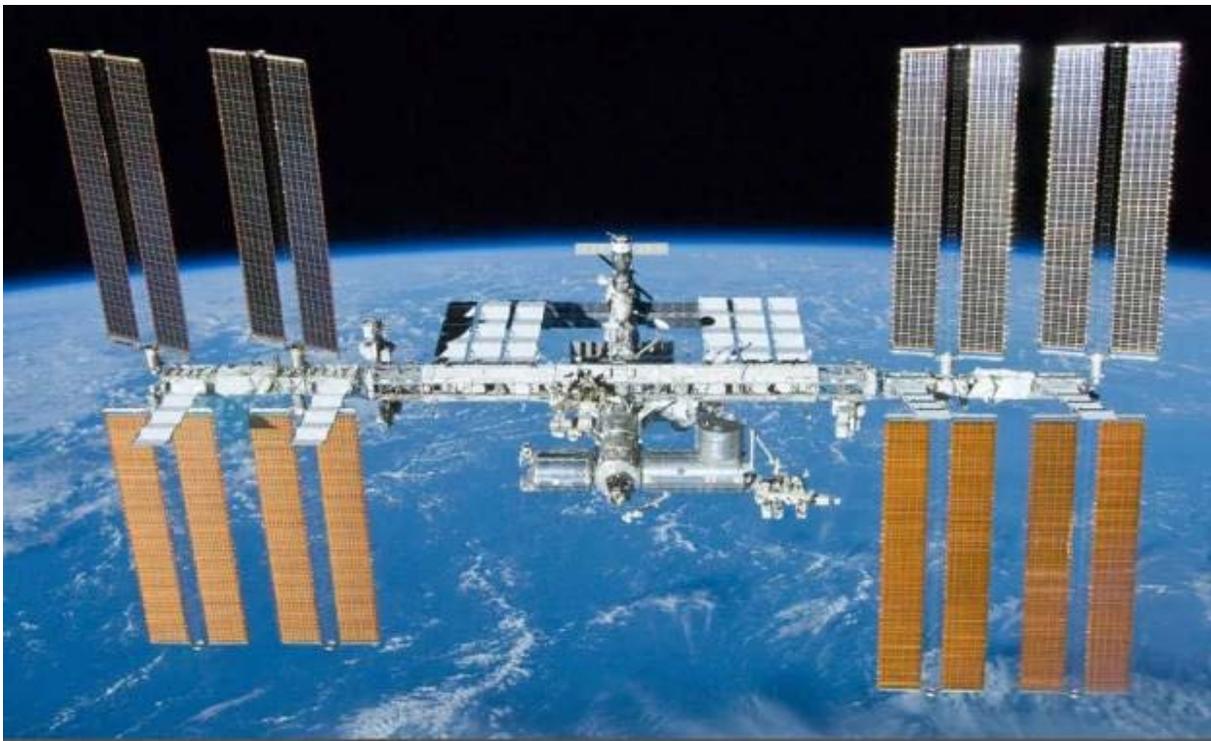
PM Modi's
heartfelt letter to
Sunita Williams!

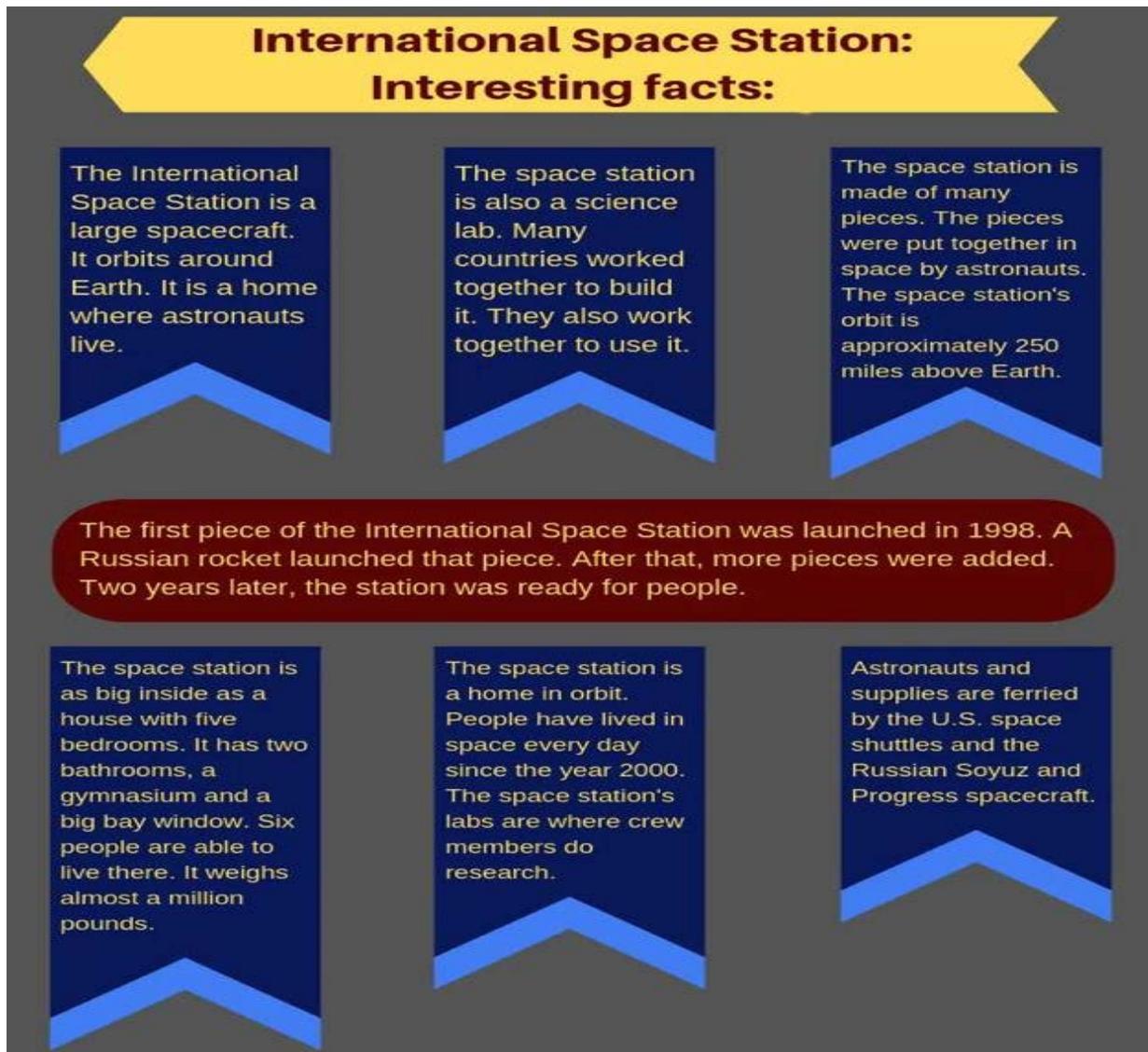
**Context:**

- **NASA astronauts Sunita Williams and Butch Wilmore** have returned to Earth on **March 18, 2025** after their **Crew 9 Dragon Spacecraft** splashdown safely off the coast of Florida.
- According to NASA, the duo successfully undocked from the **ISS**, commencing their **17-hour voyage** home aboard **SpaceX's Dragon spacecraft**.



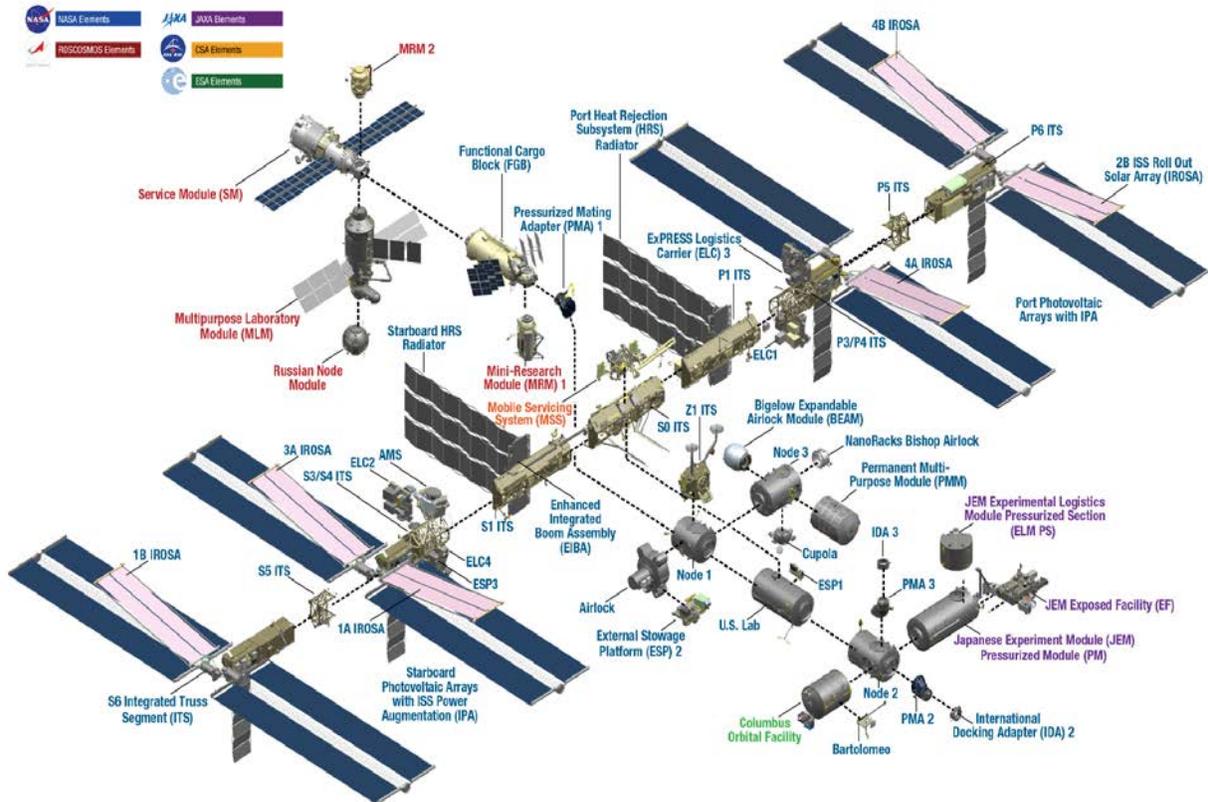
1. What is the International Space Station (ISS)?





- It is a **space station, or a habitable artificial satellite, in Low Earth Orbit (approximately 250 miles above Earth).**
- It was the brainchild of former **US President Ronald Reagan**, who in 1984 proposed building a permanently inhabited spacecraft in cooperation with a few other countries.
- The ISS is one of the **most ambitious international collaborations in human history.**
- The ISS programme is a joint project between five participating space agencies: **NASA (United States), Roscosmos (Russia), JAXA (Japan), ESA (Europe), and CSA (Canada).**

- The ownership and use of the space station are established by intergovernmental treaties and agreements.
- The station is divided into two sections, the **Russian Orbital Segment (ROS)** and the **United States Orbital Segment (USOS)**, which is shared by many nations.



2. What is the timeline of Boeing's Starliner mission that left NASA astronauts aboard ISS for 9 months?

- **Barry "Butch" Wilmore and Sunita "Sunni" Williams** performed the first astronaut-crewed flight of **Boeing's Starliner capsule** to the **International Space Station (ISS)** in **June 2024**.
- However, what was supposed to be a mission **lasting about one week** turned into a **nine-month stay** aboard the ISS due to several issues with Starliner.

- Issues with the spacecraft prompted **NASA and Boeing to send Starliner back to Earth uncrewed and keep Wilmore and Williams onboard the ISS until early 2025**, when they would return home on a **SpaceX Crew-9 Dragon spacecraft once Crew-10 arrived at the ISS.**
- The **SpaceX Crew-9 undocked in the early hours of Tuesday, March 18** and deorbited in the afternoon, before returning to Earth Tuesday evening.
- The **crew splashed down off the coast of Tallahassee, Florida**, where the astronauts got their long-awaited first breath of fresh air after over nine months.



- Here's a timeline of the Starliner mission:

Dates	About
April 2, 2024	• NASA officials say the target date for the Boeing Starliner's first crewed flight test is no earlier than May 6.

<p>May 6, 2024</p>	<ul style="list-style-type: none"> • Starliner's first attempted launch is scrubbed after a problem with an oxygen valve is found on the rocket that launches the spacecraft into orbit.
<p>May 7, 2024</p>	<ul style="list-style-type: none"> • NASA, Boeing and United Launch Alliance Starliner rocket said that they are targeting a launch date no earlier than May 10.
<p>May 14, 2024</p>	<ul style="list-style-type: none"> • Officials say a new pressure regulation valve has been replaced and tested successfully, and that the new Starliner launch target date will be no earlier than May 21.
<p>May 23, 2024</p>	<ul style="list-style-type: none"> • NASA announces a new target Starliner launch date of June 1. • A launch date had been set for May 25 but a small helium leak was discovered in the service module, which contains support systems and instruments for operating a spacecraft.
<p>June 1, 2024</p>	<ul style="list-style-type: none"> • Officials scrub Starliner's launch just a few minutes before liftoff due to a computer ground launch sequencer not loading properly. • A backup date of June 2 is also canceled.
<p>June 2, 2024</p>	<ul style="list-style-type: none"> • NASA and Boeing officials said that they are targeting a June 5 launch date for Starliner.
<p>June 5, 2024</p>	<ul style="list-style-type: none"> • After several delays, Starliner launches, lifting off at 10:52 a.m. ET from Florida's Cape Canaveral Space Force Station. • Wilmore and Williams are scheduled to return to Earth aboard Starliner on June 14.

<p>June 6, 2024</p>	<ul style="list-style-type: none"> • Starliner successfully docks at the ISS after helium leaks and a thruster issue threatened to delay the docking.
<p>June 11, 2024</p>	<ul style="list-style-type: none"> • NASA says Starliner has five "small" helium leaks and that the astronauts' ISS mission will be extended to June 18, pending weather and Starliner's readiness to return them home.
<p>June 14, 2024</p>	<ul style="list-style-type: none"> • NASA and Boeing announce they are targeting June 22 for Starliner's crewed return to Earth. 
<p>June 18, 2024</p>	<ul style="list-style-type: none"> • NASA delays the astronauts' return until June 26 while the team troubleshoots some of Starliner's issues, including the helium leaks and thruster failures.
<p>June 21, 2024</p>	<ul style="list-style-type: none"> • The astronauts' return date is canceled again due to conflicts with previously planned spacewalks. • Mission officials continue to review Starliner data.
<p>June 28, 2024</p>	<ul style="list-style-type: none"> • NASA and Boeing officials say during a press conference that additional testing is being conducted on the spacecraft's propulsion system before the Starliner can be undocked.

<p>July 10, 2024</p>	<ul style="list-style-type: none"> • Wilmore and Williams say they feel "confident" Starliner can bring them home safely.
<p>Aug 7, 2024</p>	<ul style="list-style-type: none"> • During a press conference, NASA officials say Wilmore and Williams may have to come home on a spacecraft other than Starliner.
<p>Aug. 24, 2024</p>	<ul style="list-style-type: none"> • NASA officials confirm that the astronauts will have to return home on a different spacecraft in 2025 and that Starliner will return to Earth uncrewed.
<p>Aug. 29, 2024</p>	<ul style="list-style-type: none"> • NASA and Boeing officials say they will proceed with undocking Starliner no earlier than the evening of Sept. 6.
<p>Sept. 7, 2024</p>	<ul style="list-style-type: none"> • Starliner lands uncrewed at White Sands Space Harbor in New Mexico.
<p>Sept. 13, 2024</p>	<ul style="list-style-type: none"> • During a press conference, Wilmore and Williams say they don't feel "let down" by not returning on Boeing's Starliner or by the delay in their mission.
<p>March 12, 2025</p>	<ul style="list-style-type: none"> • NASA's SpaceX Crew-10 mission is canceled less than 45 minutes before liftoff due to a hydraulic system issue. 

<p>March 14, 2025</p>	<ul style="list-style-type: none">• Members of the Crew-10 mission successfully launch aboard a SpaceX Dragon spacecraft from the Kennedy Space Center in Florida.
<p>March 16, 2025</p>	<ul style="list-style-type: none">• Crew-10 successfully docks at the ISS, bringing four new astronauts to work on the floating lab and setting up the return to Earth of Wilmore and Williams, as well as another NASA astronaut and a Russian cosmonaut.
<p>March 18, 2025</p>	<ul style="list-style-type: none">• Crew-10 undocks from the ISS a few moments after 1 a.m. ET.• The craft moves above and behind the station before beginning a series of departure burns, which send it heading toward Earth, a voyage that's expected to take about 17 hours.• On Tuesday at 5:57 pm EDT, SpaceX Dragon Freedom splashed down off the coast of Tallahassee, Florida. 

3. What is Boeing's Starliner spacecraft?

- The **Boeing Starliner (or CST-100)** is a spacecraft designed to transport crew to and from the **International Space Station (ISS)** and other **low-Earth-orbit destinations**.
- Developed by **Boeing** under **NASA's Commercial Crew Program (CCP)**, it consists of a **reusable crew capsule** and an **expendable service module**.
- The capsule has a diameter of 15 feet, which is slightly larger than the Apollo command module that **went to the Moon and the SpaceX Crew Dragon**, but smaller than the Artemis Orion capsule that's designed to go much further into space.
- It **features a traditional cockpit** with **physical buttons and switches**, offering a familiar interface for astronauts used to legacy spacecraft.
- **Starliner** can hold a **crew of up to seven people** and can remain docked to the **ISS for up to seven months**.
- Starliner is a spacecraft that transports astronauts in space, after being launched there by a rocket.
- The **crew capsule houses the astronauts** and will be able to survive reentry and return to the ground.
- The **service module consists of the equipment and systems the astronauts need to survive in space**, including air and temperature control, water supply, sanitation, etc.
- It also consists of engines and fuel required to maneuver the spacecraft.
- The **service module won't be reusable**.

Boeing Starliner



Atlas V
Starliner
Total height:
171 ft (52m)

Service and crew module



Ascent cover



Forward heat shield

Reusable crew module (up to 7 people)



Parachutes deployed for landing

Landing airbags



Base heat shield

Service module

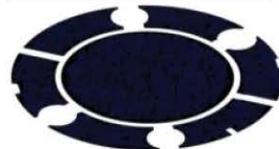


Thrusters

Diameter: 15 ft (4.56 m)



Launch abort engines

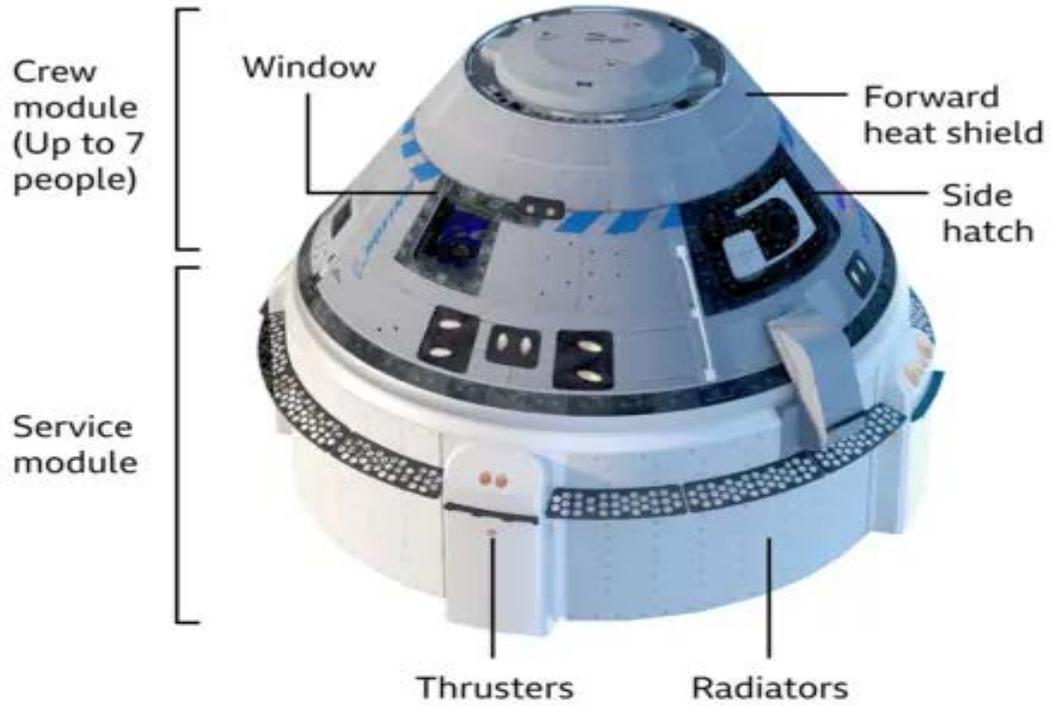


Solar arrays

Boeing Starliner

Height: 5m (16.5ft)

Diameter: 4.56m (15ft)



Clam-shell design for hardware installation



Flexible cabin design for crew and cargo



4. What is Boeing's test mission?

- The **Starliner CST-100** is a new spacecraft **developed specifically** for the National Aeronautics and Space Administration's (NASA's) **Commercial Crew Program**, which seeks to **enable private aerospace companies to transport astronauts** to and from the ISS.
- With space travel expected to **expand greatly** in the coming years, this **program is intended to free up NASA to focus on building spacecraft** and rockets for deep space missions.
- **SpaceX was the first company to be certified to carry astronauts to the ISS under this program.**
- **Boeing came next.**
- The flight that took **Williams and Wilmore** to the space station was **Starliner's first attempt to carry humans in space.**
- The main aim of their travel was to **validate the capability of Boeing Starliner in taking crewed missions to the ISS.**
- The **spacecraft developed problems even before the launch** — there was a **helium leak in its propulsion system.**
- It was **not a serious enough** problem for **NASA to abandon the journey**, but on its way to the ISS, the **spacecraft developed more problems.**
- However, **it was able to reach its destination safely.**
- The ISS, which is used **primarily by the US and Russia**, has **never been without an astronaut since November 2000.**
- Missions to the ISS are **planned well in advance**, and **spacecraft and rockets are built to meet the schedule.**
- That is why an **alternative space vehicle to bring back Williams and Wilmore could not be arranged immediately.**
- The next spacecraft was scheduled to go to the **ISS only by February 2025.**

- **Williams and Wilmore** are experienced astronauts, and **were in no discernible discomfort**.
- Thus, NASA did not rush to bring them back either.
- The **ISS is large enough** to accommodate **10-12 astronauts at any given time**.



5. Who are the two astronauts who were stuck in space?

- The two astronauts who were stranded on board the **International Space Station (ISS)** are 59-year-old **Sunita “Sunī” Williams** and **Barry “Butch” Wilmore**, 62, both veteran **NASA-trained space travellers**.
- **Williams**, the **current commander of the ISS** and a retired United States Navy officer, joined **NASA in 1998**.
- Over her career, she has **spent 322 days in space** and completed nine spacewalks.

- She previously held the record for the **most spacewalks by a female astronaut**, until 2017 when the title went to Peggy Whitson, who completed 10.
- **Wilmore first flew to space in 2009 on board the Space Shuttle Atlantis.**
- Before the Boeing Starliner mission, **he had logged 178 days in space.**
- He has served as a **flight engineer and commander on previous ISS missions**, conducting research on plant growth in space, the effects of microgravity on the human body and environmental changes on Earth.
- In the **Boeing mission, Wilmore served as the commander and Williams was the pilot.**



6. Who is Sunita Williams?

- **Sunita Williams** is a well-known **NASA Astronaut** and **US Navy Captain (Ret).**
- She was born on **September 19, 1965** in **Euclid, Ohio** to **Dr. Deepak and Bonnie Pandya.**

- She considers **Needham, Massachusetts**, to be her hometown where she studied at **Needham High School, Needham, Massachusetts, in 1983.**
- She holds a **Bachelor of Science in Physical Science** from **US Naval Academy, 1987.**
- She also completed her **Master of Science in Engineering Management** from Florida Institute of Technology in 1995.
- Sunita Williams was the **Starliner Crew Flight Test Pilot.**
- She is the veteran of three space missions (**Expeditions 14/15, 32/33 and 71/72**).
- **She was the ISS commander for Expedition 33.**
- Sunita Williams has roots in India.
- **She was the second American astronaut of Indian heritage to go into space, after Kalpana Chawla.**
- Her father **Deepak Pandya** was a neuroanatomist and was born in the **Jhulasan village in Gujarat, India.**



7. What are Sunita Williams' achievements in Space?

- **Sunita Williams** has completed **62 hours and 6 minutes** of **total spacewalk time** over the course of her career, the **most by any woman astronaut**, and **fourth on NASA's all-time list**.
- Williams has now **logged the second-most time in space by a US astronaut**, with 608 days over her three flights.
- During her latest mission (Starliner and SpaceX), **she spent 286 days in space, more than the average of six months**.
- Sunita Williams have been accorded with these awards:
 - **The Defense Superior Service Medal (DSSM)**
 - **Legion of Merit**
 - **Navy Commendation Medal**
 - **Navy and Marine Corps Achievement Medal**
 - **Humanitarian Service Medal and various other service awards.**



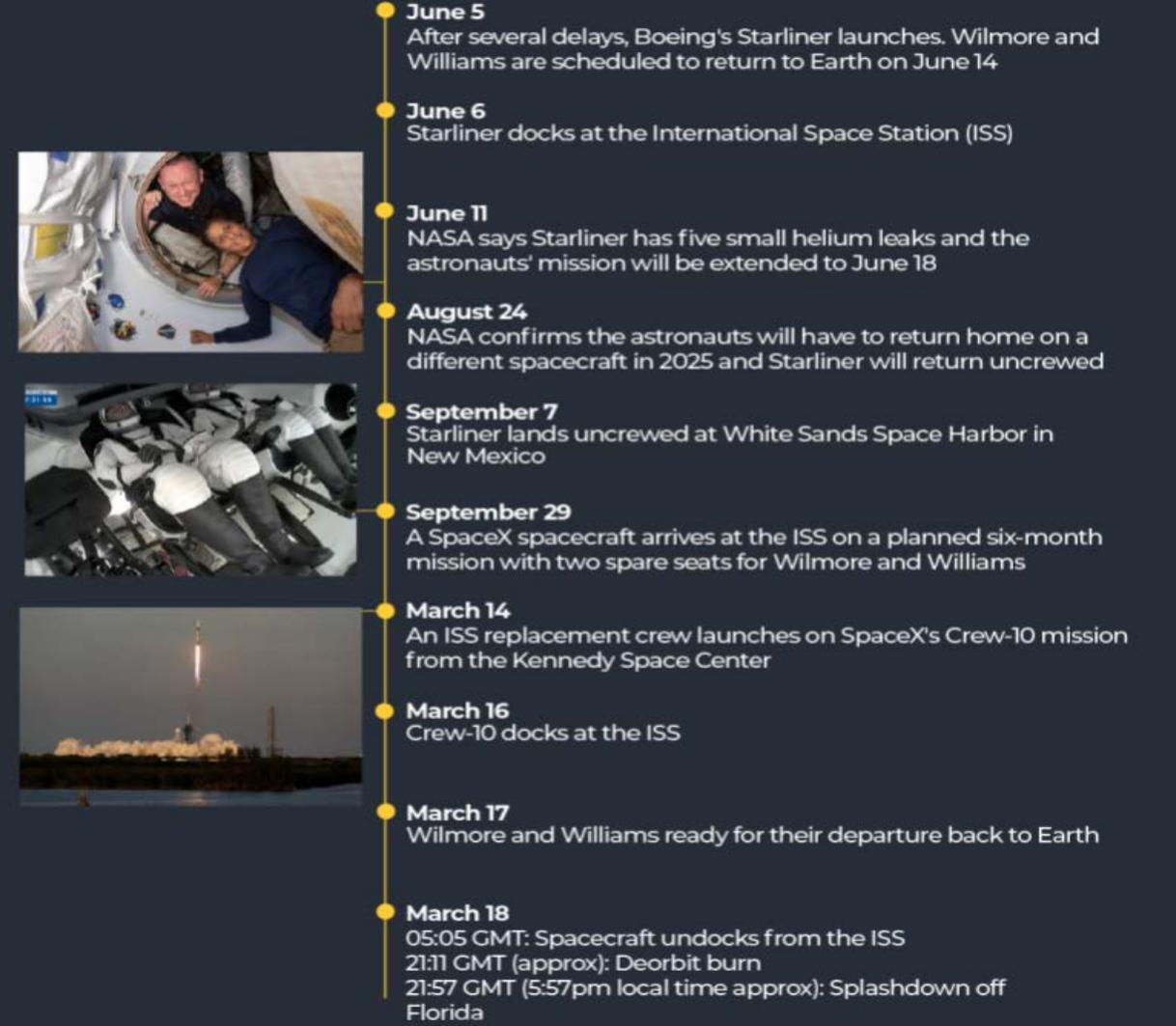
8. How long were the two astronauts stuck in space?

- **Williams and Wilmore** had been in space since **June 5, 2024**, meaning they **spent more than nine months** in orbit by the time they returned.
- After blasting off from **Cape Canaveral, Florida**, in June, they were originally scheduled to stay in space for **just eight days**.
- The standard **ISS rotation** for astronauts is **roughly six months**.

SPACE

NASA astronauts head back to Earth

After nine months in space, NASA astronauts Butch Wilmore and Suni Williams are finally on their way home with splashdown estimated at 21:57 GMT on Tuesday.



- **June 5**
After several delays, Boeing's Starliner launches. Wilmore and Williams are scheduled to return to Earth on June 14
- **June 6**
Starliner docks at the International Space Station (ISS)
- **June 11**
NASA says Starliner has five small helium leaks and the astronauts' mission will be extended to June 18
- **August 24**
NASA confirms the astronauts will have to return home on a different spacecraft in 2025 and Starliner will return uncrewed
- **September 7**
Starliner lands uncrewed at White Sands Space Harbor in New Mexico
- **September 29**
A SpaceX spacecraft arrives at the ISS on a planned six-month mission with two spare seats for Wilmore and Williams
- **March 14**
An ISS replacement crew launches on SpaceX's Crew-10 mission from the Kennedy Space Center
- **March 16**
Crew-10 docks at the ISS
- **March 17**
Wilmore and Williams ready for their departure back to Earth
- **March 18**
05:05 GMT: Spacecraft undocks from the ISS
21:11 GMT (approx): Deorbit burn
21:57 GMT (5:57pm local time approx): Splashdown off Florida

9. Why were the astronauts stuck in space?

- **Williams and Wilmore** got stuck after **technical issues** with the spacecraft meant to bring them home.
- **NASA astronauts Sunita Williams and Butch Wilmore** launched aboard **Boeing's Starliner spacecraft on June 5, 2024**, for its first crewed flight, arriving at the **International Space Station on June 6, 2024**.
- They had travelled to the **ISS on board Boeing's CST-100 Starliner** as part of its first crewed test flight.
- The mission, under **NASA's Commercial Crew Program**, aimed to develop private spacecraft for transporting astronauts to and from the station.
- Initially expected to last around a week, **their Starliner mission was extended to more than nine months due to issues with their Boeing Starliner capsule, which delayed their return.**
- During the 25-hour flight to the ISS, Starliner experienced **helium leaks and a malfunctioning thruster**, which helps steer and control reentry.
- When it arrived on June 6, four more of the **28 thrusters failed, delaying docking with the station.**
- Although engineers restored four out of five failed thrusters, **NASA deemed the spacecraft too risky for human travel and sent it back empty, leaving Williams and Wilmore stranded on the ISS.**
- In August 2024, **NASA decided to bring them back on a SpaceX vehicle.**
- **Crew Dragon-9, which launched on September 29, 2024**, has been **docked at the ISS since**, but bringing them home earlier would have left only one US astronaut on the space station, limiting research and emergency response.

- Following NASA's decision to return Starliner uncrewed, the duo became **Expedition 71/72 crewmembers** and returned home in **March 2025**, aboard a SpaceX Dragon spacecraft with NASA astronaut **Nick Hague** and Roscosmos cosmonaut **Aleksandr Gorbunov** on NASA's SpaceX Crew-9 mission.
- With their replacement members arriving on **Crew-10**, **Williams** and **Wilmore** were finally able to head home.

10. How did the astronauts survive in space for so long?

- Despite the **unexpected extension** of their stay, **Williams** and **Wilmore remained in good health** and even conducted a spacewalk together in January.
- Life on board the ISS follows a **structured routine of exercise, work and leisure**.
- This includes **regular exercises on both the treadmill and resistance machine** to maintain bone and muscle strength.
- Throughout the year, **several space agencies and private companies** also scheduled missions to **resupply the space station with food, water and oxygen**.
- Over Christmas, **the two astronauts even enjoyed a festive dinner that included smoked oysters, crab, duck foie gras, cranberry sauce, Atlantic lobster and smoked salmon**.
- **Williams** and **Wilmore** were able to **maintain contact** with their families through email and telephone.

11. When and how did they come back to Earth?

- The process for **Williams** and **Wilmore** to return started **late on Monday night**.
- The **SpaceX Crew Dragon capsule** carrying **Wilmore** and **Williams** **undocked from the ISS at 1.05am ET (05:05 GMT) on Tuesday**.
- It splashed into the Atlantic Ocean just before 6pm ET (22:00 GMT).

- The **SpaceX Crew Dragon capsule** had been docked at the station since September 2024.
- This capsule originally brought **NASA astronaut Nick Hague and Russian astronaut Aleksandr Gorbunov to the ISS**, with two empty seats left for Wilmore and Williams's return.
- The four could not return on the **same capsule until an additional crew carrying four other astronauts arrived to replace them.**
- Crew-10, which docked at the ISS on Sunday at 12:04 am ET (04:04 GMT), consists of **NASA astronauts Anne McClain and Nichole Ayers, Japanese astronaut Takuya Onishi and Russian astronaut Kirill Peskov.**

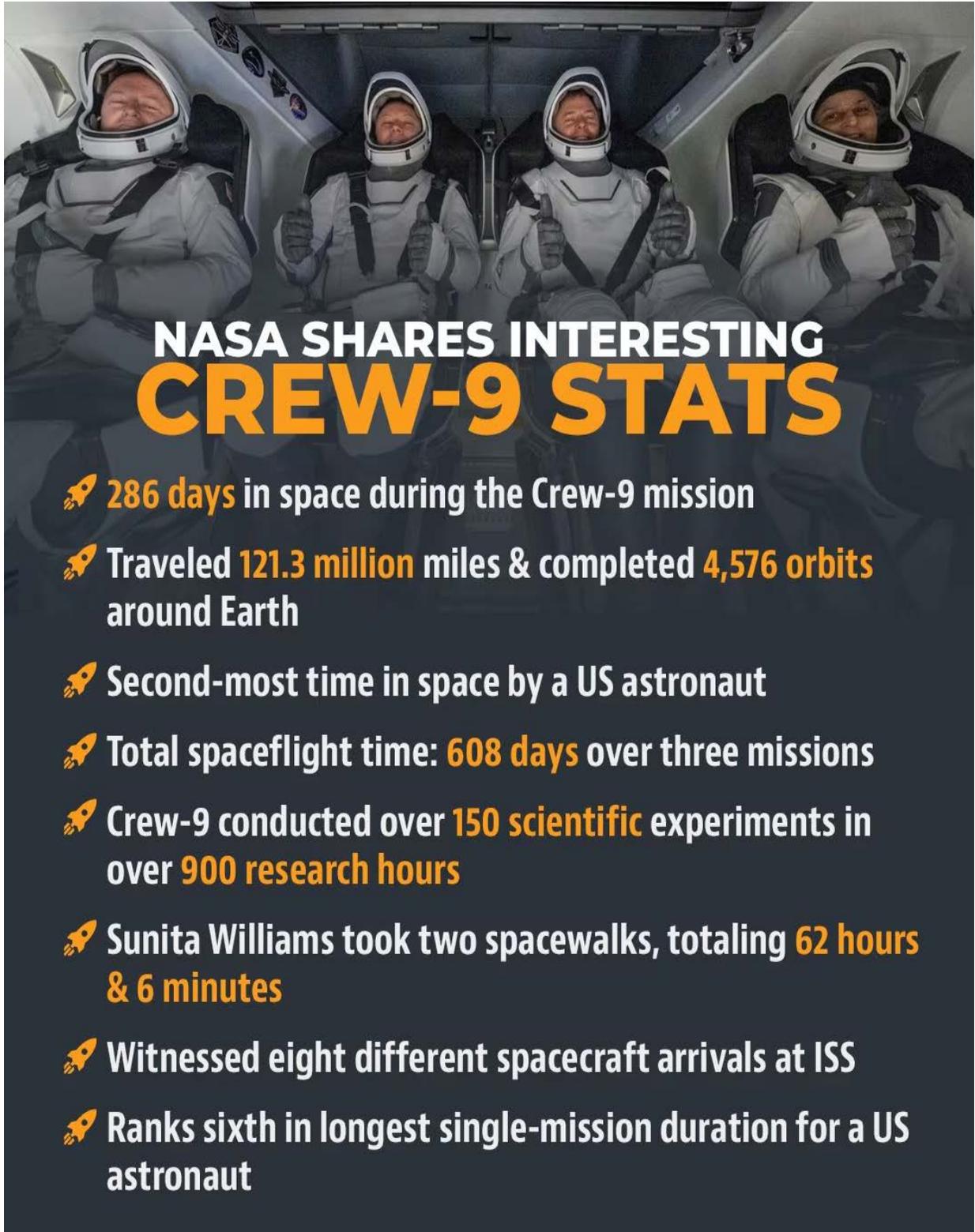
12. What is the SpaceX Crew-9 mission?

- **NASA's SpaceX Crew-9** completed the **agency's ninth commercial crew rotation mission** to the **International Space Station** on Tuesday, splashing down safely in a SpaceX Dragon spacecraft off the coast of Tallahassee, Florida, in the Gulf of America.
- **NASA astronauts Nick Hague, Sunita Williams, and Butch Wilmore, and Roscosmos cosmonaut Aleksandr Gorbunov,** returned to Earth at **5:57 p.m. EDT.**
- **Teams aboard SpaceX** recovery vessels retrieved the spacecraft and its crew.
- After returning to shore, the **crew will fly to NASA's Johnson Space Center in Houston** and reunite with their families.
- The **Crew-9 mission was the fourth flight of the Dragon spacecraft named Freedom.**
- It also previously supported **NASA's SpaceX Crew-4, Axiom Mission 2, and Axiom Mission 3.**
- The **Crew-9 flight is part of NASA's Commercial Crew Program,** and its return to Earth follows on the heels of **NASA's SpaceX Crew-10** launch, which docked to the station on **March 16, beginning another long-duration science expedition.**

- The **goal of NASA's Commercial Crew Program is safe, reliable, and cost-effective transportation** to and from the space station and low Earth orbit.
- The program provides **additional research time and has increased opportunities for discovery aboard humanity's microgravity testbed for exploration**, including helping NASA prepare for human exploration of the Moon and Mars.

13. Mention a few contributions of Crew- 9 Mission?

- Throughout its mission, **Crew-9** contributed to a **host of science and maintenance activities and technology demonstrations**.
- Williams conducted **two spacewalks**, joined by **Wilmore** for one and **Hague** for another, removing a **radio frequency group antenna assembly from the station's truss**, collecting samples from the station's external surface for analysis, installing patches to cover damaged areas of light filters on an X-ray telescope, and more.
- Williams now holds the **record for total spacewalking time by a female astronaut**, with **62 hours and 6 minutes** outside of the station, and is fourth on the all-time spacewalk duration list.
- The **American crew members conducted more than 150 unique scientific experiments** and technology demonstrations between them, with over **900 hours of research**.
- This research included investigations on plant growth and quality, as well as the **potential of stem cell technology to address blood diseases, autoimmune disorders, and cancers**.
- They also tested lighting systems to help **astronauts maintain circadian rhythms**, **loaded the first wooden satellite for deployment**, and took samples from the space station's exterior to study whether microorganisms can survive in space.



NASA SHARES INTERESTING **CREW-9 STATS**

- 🚀 **286 days** in space during the Crew-9 mission
- 🚀 Traveled **121.3 million** miles & completed **4,576 orbits** around Earth
- 🚀 Second-most time in space by a US astronaut
- 🚀 Total spaceflight time: **608 days** over three missions
- 🚀 Crew-9 conducted over **150 scientific** experiments in over **900 research hours**
- 🚀 Sunita Williams took two spacewalks, totaling **62 hours & 6 minutes**
- 🚀 Witnessed eight different spacecraft arrivals at ISS
- 🚀 Ranks sixth in longest single-mission duration for a US astronaut

14. Have astronauts been stuck in space before?

- **Williams and Wilmore** are not the first astronauts to face an extended stay in space due to unforeseen circumstances.
- There have been previous cases where astronauts had to remain in orbit longer than planned due to **technical problems or geopolitical events**.
- The **longest single spaceflight by a US astronaut was Frank Rubio’s 371-day mission on board the ISS**, from 2022 to 2023, which was extended due to issues with the **Soyuz spacecraft** that brought him to orbit. He ultimately returned on a different Soyuz capsule.
- In **1991, Soviet astronaut Sergei Krikalev** was stranded on board the now-decommissioned **Mir space station for 311 days** due to the **dissolution of the Soviet Union**.
- **Political turmoil and funding shortages delayed his return**, forcing him to remain in orbit for far longer than planned. When he finally landed in **March 1992**, he returned not to the Soviet Union, but to a newly independent Russia.

15. Mention Top 10 Longest Space Missions By Astronauts?

Missions	About
Valeri Polyakov - 437 days	Holds the record for the longest single space flight aboard Mir (1994-1995) , orbiting Earth over 7,000 times.
Sergei Avdeyev - 379 days	Spent 379 days on Mir (1998-1999) after an unexpected mission extension.
Frank Rubio - 371 days	Set the US spaceflight record aboard ISS (2022-2023) after a coolant leak extended his mission .

Vladimir Titov & Musa Manarov - 365 days	First to complete a full orbit around the sun while in space aboard Mir (1987-1988) .
Mark Vande Hei - 355 days	Spent 355 days on ISS (2021-2022) , contributing to research on muscle loss and space farming.
Scott Kelly & Mikhail Kornienko - 340 days	Completed NASA's " One-Year Mission " aboard ISS (2015-2016), aiding Mars exploration studies.
Christina Koch - 328 days	Spent 328 days on ISS (2019-2020) , completing six spacewalks, including the first all-female ones.
Peggy Whitson - 289 days	Held the record for the longest spaceflight by a woman (2016-2017), with 675 total days in space .
Sunita Williams and Butch Wilmore - 286 days	Stayed aboard ISS longer than planned (2024-2025) due to propulsion issues with the Boeing Starliner .
Andrew Morgan - 272 days	Spent 272 days on ISS , performing seven spacewalks and conducting dark matter research.

16. Why was Sunita Williams carried away on a stretcher after landing?

- **Sunita Williams and Barry Wilmore** have returned to Earth after spending 286 days in space.
- Their troubles may not be over as **readjusting to Earth can be difficult due to the damage caused to the human body during space travel**.

- **Sunita Williams' and Barry Wilmore** returned to Earth aboard a SpaceX Crew Dragon capsule, along with astronauts **Nick Hague and Alexander Gorbunov**.
- After their capsule splashed down off the **coast of Tallahassee**, they were both immediately taken for medical tests on reclining stretchers.
- After experiencing **microgravity** for more than nine months, the rescued astronauts will face some changes to their body as well as added health risks, which could **become permanent without proper care and treatment**.



17. How does space change the human body?



- After experiencing **microgravity for more than nine months**, the rescued astronauts **will face some changes to their body** as well as **added health risks**, which could become permanent without proper care and treatment.
- Here are a **few bodily changes that astronauts are likely to face** after an extended stay in space.

What happens if astronauts stay in space too long?

Prolonged exposure to microgravity leads to:

- **Increased risk of kidney stones** due to excess calcium loss
- **Weakened immune system**, making astronauts more prone to infections
- **Vision impairment**, as fluids press against the optic nerve
- **Radiation exposure**, increasing cancer risks

Every extra day in space pushes the body to its limits.



Bodily changes	Analysis
<p>Baby feet, loss of bone density and muscle</p>	<ul style="list-style-type: none"> ● An astronaut's bones and muscles operate differently in microgravity, and after returning to Earth, it can make it difficult for one to stand, walk or hold things. ● In space, without the weight of the gravity experienced on Earth, the spine elongates, causing a temporary height gain. ● However, on the flip side, cells that build bone tissue become slower and those which damage bones continue to grow at a normal pace, making bone deterioration faster.

	<ul style="list-style-type: none"> • Muscles also begin to weaken due to the lack of pull from gravity. • Every month in space, an astronaut's weight-bearing bones lose one percent of their density, making them weaker and more brittle. • As calluses decrease, and the body becomes less used to the use of muscles and bone in the legs, astronauts end up developing “baby feet”, a condition that causes you to lose the thick part under your feet, hindering the ability to walk.
<p>Puffy-head bird-legs syndrome</p>	<ul style="list-style-type: none"> • The human heart, brain and circulatory system are also affected due to a prolonged stay in space. • In microgravity, fluids from the rest of the body tend to shift upward toward the head. • This fluid redistribution results in facial puffiness, nasal congestion, and increased pressure inside the skull, while the legs experience a loss of fluids. • This makes the head appear bigger, while the legs appear smaller and weaker. • This phenomenon is called "puffy-head bird-legs syndrome". • The increase of fluid in the brain can also lead to hearing loss, vision loss and a disorder known as Spaceflight Associated Neuro-ocular Syndrome (SANS) caused by added pressure to the brain. • The heart in space changes from an oval shape to a round shape, and muscle atrophy constricts blood vessels, which causes damage to the circulatory system.

- The loss of blood volume upon an astronaut's return to Earth, can make it difficult to regulate blood pressure, and cause dizziness, nausea and fainting spells.

While under the effect of microgravity, people even look different



Neuro-ocular Syndrome (SANS)

- Sunita Williams, along with **Butch Wilmore**, experienced **Spaceflight-Associated Neuro-ocular Syndrome (SANS)** during their extended nine-month stay on the International Space Station, which caused **fluid shifts, increased intracranial pressure, and potential vision impairment.**
- Specific changes observed in the eye include:
- **Optic Disc Edema:** The optic nerve, responsible for transmitting visual information from the eye to the brain, can become swollen and inflamed.
- **Globe Flattening:** The shape of the eyeball itself can change, becoming slightly flattened posteriorly.

	<ul style="list-style-type: none"> • Choroidal Folds: The choroid, a layer of tissue beneath the retina, can develop wrinkles or folds. • Cotton Wool Spots: These are small white patches on the retina caused by tiny areas of decreased blood flow. • Hyperopic Shift: Many astronauts experience a shift in their vision towards farsightedness (hyperopia), making it difficult to focus on near objects. • Factors that play a role in SANS are as follows: • Increased Intracranial Pressure: The upward fluid shift increases pressure within the skull, which can compress the optic nerve and affect its function. • Altered Fluid Dynamics: Changes in fluid distribution within the eye can impact the shape of the globe and the structure of the retina and choroid. • Vascular Changes: Microgravity can affect blood flow to the eyes, potentially leading to ischemia (reduced blood flow) and damage to the retina.
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SANS

Spaceflight Associated Neuro-ocular Syndrome



70%
Incidence

Space Station astronauts experience some amount of swelling in the back of the eye.

What is it?

Eye and brain changes during long-duration spaceflight

Most astronauts' eyes and brain structure change in space. The long-term health consequences are unknown, but are currently being monitored and investigated.

What is causing it?

Headward fluid shifts that occur in weightlessness

Weightlessness causes blood and cerebrospinal fluid to shift toward the head. This fluid shift is believed to be the underlying cause of the eye and brain structural changes.

Brain Structural Change

- Ventricular volume enlargement
- Upward shift of brain
- Pituitary gland shape changes

Cerebrospinal Fluid Shift

Upward redistribution of fluid around the brain

Eye Changes

- Swelling of the nerve as it enters the eye
- Folds develop in retina
- Back of eye flattens
- Vision becomes blurry

Venous Blood Shift

Weightlessness causes blood in veins to shift toward head and eye

Mission Impact

Long-duration astronauts may experience some or all of these changes; there is biological variation. Vision changes may impact an astronaut's inflight performance. The longer they are in space, the more they may be impacted. Many astronauts only experience effects in space, but some changes may be permanent in some astronauts. Researchers are studying ways, including fluid shift countermeasures, to prevent SANS during spaceflight and determine any long-term health effects in astronauts.

Visual Impairment/Intracranial Pressure

- 10 cases identified (7 of 34 US long duration astronauts) with in-flight visual changes and pre-to-postflight refractive changes.
- Elevated Intracranial Pressure measured post flight (n=3)
- All males, average age 50.2 ± 4.2 years.

Hyperopic Shifts
-Up to +1.75 diopters (5)

Globe Flattening (same 5 as above)

Altered Blood flow
• "cotton wool" spots (3)

Choroidal Folds - parallel grooves in the posterior pole (5)

Optic Disc Edema (swelling) (5)

Increased Optic Nerve Sheath Diameter by OCT (6)

Normal Globe Flattened Globe

MRI Orbital Image showing globe flattening

Permanent risks	<ul style="list-style-type: none">• In space, astronauts are exposed to high levels of radiation from the Sun, which can cause significant long-term health issues for astronauts, putting them at risk for cancer, degenerative diseases and issues with the central nervous system.• In nine months, Sunita Williams would have been exposed to radiation levels equal to almost 270 chest X-rays.• This coupled with bone density loss and lowered immune levels can increase risks of osteoporosis and make recovery difficult as well.• According to a 2019 research case, named the Twins Study, NASA stated that while most genes in the human body reset after returning to Earth, about 7 percent of them remain disrupted by the experience.• Space travel can also permanently alter many aspects of an astronaut's mental health.• Due to disturbed sleep cycles and circadian rhythms (internal body clock), isolation and stress, astronauts have an increased risk for mental health conditions such as depression, anxiety as well as cognitive decline.
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18. Why Sunita Williams's unscheduled nine months long space stay may be a blessing in disguise for researchers

- Williams and Wilmore could be very useful in NASA's ongoing study to assess the response of human bodies to long stays in space.

- They had **not trained to spend so much time** at the ISS and their bodies might have reacted differently compared to others who prepare sufficiently for extended stays.
- **Williams and Wilmore** can provide the opportunity for researchers to study the **mental and psychological impacts** of being stranded in space.
- Past studies have shown that **bone density and muscle quality** deteriorate faster in space than on Earth.
- **Low gravity impacts brain fluids, and extended stays can potentially alter brain structure.**
- Extended stays can also **increase the risk of heart disease.**
- NASA and other space agencies are preparing to set up a **permanent science facility on the Moon** that will require humans to remain in space for extended periods.
- As such, it has been running a **program to study the health impacts of long-period stays in space.**
- US astronauts flying to the ISS can now volunteer to be part of such experiments.

19. How India responded to Sunita Williams' return?

- Prime Minister Narendra Modi on Wednesday extended a warm welcome to Indian-origin astronaut Sunita Williams as she returned to earth in a **SpaceX's Dragon capsule** after an extended stay of 9 months in space.
- Praising the grit, courage and boundless human spirit of the NASA astronauts, PM Modi said that **Sunita Williams and the Crew9 astronauts have once again shown us what perseverance truly means.**
- The Prime Minister added that **space exploration is about pushing the limits of human potential, daring to dream, and having the courage to turn those dreams into reality.**

**Narendra Modi** ✓

@narendramodi

Follow

Welcome back, [#Crew9](#)! The Earth missed you.

Theirs has been a test of grit, courage and the boundless human spirit. Sunita Williams and the [#Crew9](#) astronauts have once again shown us what perseverance truly means. Their unwavering determination in the face of the vast unknown will forever inspire millions.

Space exploration is about pushing the limits of human potential, daring to dream, and having the courage to turn those dreams into reality. Sunita Williams, a trailblazer and an icon, has exemplified this spirit throughout her career.

We are incredibly proud of all those who worked tirelessly to ensure their safe return. They have demonstrated what happens when precision meets passion and technology meets tenacity.

[@Astro_Suni](#)[@NASA](#)



New Delhi
बुधवार 10, 09:07:11 2016
01 March, 2025

Ms. Sunita Williams,

I convey to you greetings from the people of India. At a programme today, I met the noted astronaut, Mr. Mike Massimino. During the course of our conversation, your name came up and we discussed how proud we are of you and your work. Following this interaction, I could not stop myself from writing to you.

When I met President Trump or President Biden during my visits to the United States, I inquired about your well-being.

1.4 billion Indians have always taken great pride in your achievements. Recent developments have yet again showcased your exceptional fortitude and perseverance.

Even though you are thousands of miles away, you continue to remain close to our hearts. The people of India are praying for your good health and success in your mission.

Ms. Bhanu Prasad must be keenly awaiting your return and I am sure that Late Deshpande's blessings are with you as well. I fondly remember meeting him along with you during my visit to the United States in 2016.

After your return, we are looking forward to seeing you in India. It will be a pleasure for India to host one of its most illustrious daughters.

I send my warm regards to Mr. Michael Williams.
-wishes to you and Mr. Barry Wilmore for a safe-

PM Modi Invites NASA Astronaut Sunita Williams To India As SpaceX Capsule Departs ISS



'Looking Forward To Seeing You In India' 🇮🇳 🤝



प्रधान मंत्री
Prime Minister

New Delhi
फाल्गुन 10, शक संवत् 1946
01 March, 2025

Ms. Sunita Williams,

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Even though you are thousands of miles away, you continue to remain close to our hearts. The people of India are praying for your good health and success in your mission.

Ms. Bonnie Pandya must be keenly awaiting your return and I am sure that Late Deepakbhai's blessings are with you as well. I fondly remember meeting him along with you during my visit to the United States in 2016.

After your return, we are looking forward to seeing you in India. It will be a pleasure for India to host one of its most illustrious daughters.

I send my warm regards to Mr. Michael Williams.

Best wishes to you and Mr. Barry Wilmore for a safe return.

Yours,

(Narendra Modi)

Ms. Sunita Williams

20. What is Boeing's Starliner competitive future?

- **Boeing** is also **eyeing Starliner** as a taxi to and from privately built space stations that are in early development - the kind of **non-government revenue** that **SpaceX** has brought in with fully private Dragon missions.



- **Starliner's future** was thrown into **uncertainty** when it suffered **five thruster failures** during its flight to the ISS last year, as well as leaks of helium that is used to pressurize the thrusters.
- NASA made **Starliner return to Earth without its crew** in September, deeming it too risky for astronauts to ride.
- A NASA safety advisory panel in January said the agency and Boeing were making "**significant progress**" in their **post-flight** technical investigations but that the propulsion system issues remain unresolved.

21. What is the relevance of the topic for UPSC CSE?

- **For Prelims:** International Space Station, Outer Space Treaty of 1967, United Nations, Space Launch System, Chandrayaan-3 mission, Gaganyaan.
- **For Mains:** Various space missions of ISRO and NASA.

Some previous years prelims questions.

Q1. Which one of the following countries has its own Satellite Navigation System? (2024)

- (a) Australia
- (b) Canada
- (c) Israel
- (d) Japan

Ans: (d)

Q2. Consider the following pairs: (2023)

Objects in space : Description

- 1. Cepheids : Giant clouds of dust and gas in space
- 2. Nebulae : Stars which brighten and dim periodically
- 3. Pulsars : Neutron stars that are formed when massive stars run out of fuel and collapse

How many of the above pairs are correctly matched?

- (a) Only one
- (b) Only two
- (c) All three
- (d) None

Ans: (a)

Some previous years mains questions.

Q1. What are asteroids? How real is the threat of them causing extinction of life? What strategies have been developed to prevent such a catastrophe? (2024-15M)

- Q2. What is the main task of India's third moon mission that could not be achieved in its earlier mission? List the countries that have achieved this task. Introduce the subsystems in the spacecraft launched and explain the role of the Virtual Launch Control Centre' at the Vikram Sarabhai Space Centre which contributed to the successful launch from Sriharikota. (2023-15 Marks)
- Q3. Launched on 25th December 2021, the James Webb Space Telescope has been much in the news since then. What are its unique features which make it superior to its predecessor Space Telescopes? What are the key goals of this mission? What potential benefits does it hold for the human race? (2022-15 Marks)

Some questions from this year and previous years interview transcripts.

Board Sheel Vardhan sir:

- Tell me something about India's successful space mission?
- What Changes have we made in Chandrayaan 3?
- Tell me any special mission conducted by nasa recently?
- What are your views on space privatisation?

Board Sheel Vardhan sir:

- Mention various areas in which ISRO excels NASA?

Board Suman Sharma mam:

- What do you think about commercialisation of the space sector?
- What comes to your mind when I say space?
- What is the global space sector?
- What about privatisation in space?

- Tell its pros and cons
- What is the recent isro project?

Some questions for QUIZ.

Q1. Consider the following Countries:

1. US
2. Thailand
3. UAE
4. India
5. Saudi Arabia

How many of the above countries are part of the ARTEMIS ACCORD?

- (a) Only two
- (b) Only three
- (c) Only four
- (d) All five

Ans: (d)

Some questions for POLL.

Q1. Do you think Boeing is trustworthy to carry astronauts to the ISS ?

- (a) YES
- (b) NO
- (c) Can't say.

Q2. Do you think private players should be regulated in the space sector?

- (a) YES
- (b) NO
- (c) Can't say.

