National Aeronautics and Space Administration

OVERVIEW

SpaceX CRS-21 Mission

SpaceX's 21st contracted cargo resupply mission (CRS) to the International Space Station for NASA will deliver more than 6,400 pounds of science and research, crew supplies and vehicle hardware to the orbital laboratory and its crew.

Launch is targeted for 11:39 a.m. EST Saturday, Dec. 5, 2020

Launch Vehicle
Falcon 9 Rocket

- Fourth flight of this booster
- Previous flights of this booster were Demo-2, K-MILSAT and Starlink 12

Launch Site:
Launch Complex 39A,
NASA's Kennedy Space Center in Florida

Dragon Spacecraft Overview

Height	8.1 m / 26.7 ft
Diameter	4 m / 13 ft
Capsule Volume	9.3 m^3 / 328 ft^3
Trunk Volume	37 m^3 / 1300 ft^3
Launch Payload Mass	6,000 kg / 12,228 lbs
Return Payload Mass	3,000 kg / 6,614 lbs

- First flight of a Dragon 2 Cargo Capsule, first Cargo Dragon to dock to the space station
- In January, it will re-enter Earth's atmosphere and splash down in the Atlantic Ocean near the eastern coast of Florida with 5,200 pounds of return cargo.

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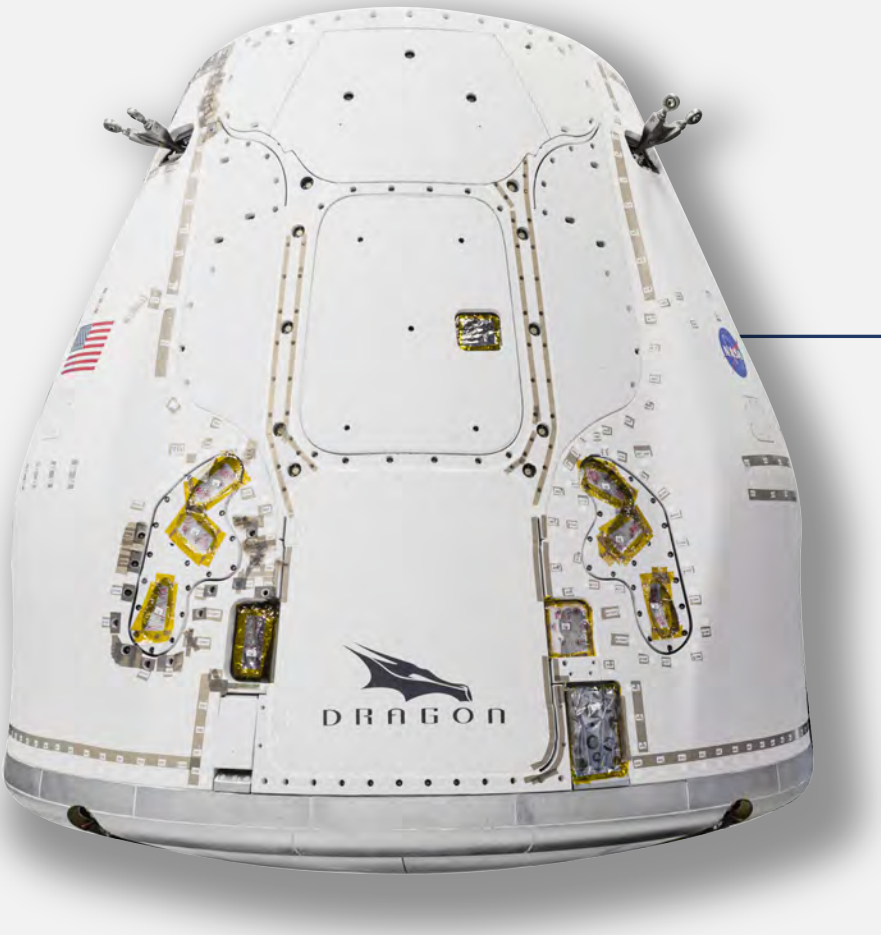
CARGO

SpaceX CRS-21 Mission

*Masses are subject to change prior to launch



Crew Supplies
803 pounds / 364 kilograms

Science Investigations
2,100 pounds / 953 kilograms

Spacewalk Equipment
265 pounds / 120 kilograms

Vehicle Hardware
698 pounds / 317 kilograms

Computer Resources
102 pounds / 46 kilograms

Russian Hardware
53 pounds / 24 kilograms

Unpressurized Payloads
(Nanoracks Bishop Airlock)
2,403 pounds / 1,090 kilograms

Total Cargo:	**6,553 pounds / 2,972 kilograms**
Total Pressurized with Packaging:	**4,150 pounds / 1,882 kilograms**
Unpressurized Payloads:	**2,403 pounds / 1,090 kilograms**

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HARDWARE

SpaceX CRS-21 Mission

Hardware Launching

Nanoracks Bishop Airlock and Installation Hardware: Bishop Airlock assembly with various installation support items to enable to crew to install the new airlock capability.

Exploration Catalytic Reactor: One of the main components of the Water Processor Assembly incorporating newly designed, robust metallic seals, a new catalyst, and oxygen flow regulation. These upgrades will help manage the dynamic temperature environment for a longer period and optimize the ability of the reactor to oxidize organic compounds in the water. Together, these modifications are intended to meet NASA's performance and reliability goals for a future Mars mission.

Nitrogen/Oxygen Recharge System (NORS) Recharge Tank: Supplemental nitrogen flying to support planned cabin repressurization activity aboard the space station.

Universal Waste Management System (UWMS) Spares/Consumables: Critical spares and consumable items to support crew usage of the next generation toilet following the four crew members arriving on Crew-1.

Rodent Research Habitats and Transporters: Live rodents and support hardware required for the Rodent Research-10 through-23 missions to be conducted during the Crew-1 timeframe.

One-handed Tape Dispenser: Through NASA's HUNCH challenge, high school students designed and fabricated a one-handed tape dispenser to provide astronauts an easily assessable tool for their everyday activities on the space station.

Hardware Returning

Failed or expended hardware no longer needed on the space station.

Treadmill Data Avionics Unit: Failed avionics unit that supports the treadmill, a critical item returning to the ground following the on-orbit replacement with a good spare.

Carbon Dioxide Removal Assembly (CDRA) Air Selector Valve: Critical degraded valve returning for repair and refurbishment to support the carbon dioxide removal capability on-orbit.

NORS Recharge Tank: Depressurized tank capable of flying oxygen or nitrogen, and will be utilized for future on-orbit demand in 2021.

Rodent Research Habitats and Transporters: Live rodents from the Rodent Research-23 mission and used habitats and transporters that support future research missions and analysis.

Minus Eighty Laboratory Freezer for ISS (MELFI) Electronics Unit: Failed cold stowage item requiring ground repair to enable future cold stowage missions.

Thermal Amine Bulk Water Save Valve: Failed valve that supports efficient usage of the Thermal Amine system returning to ground for repair, will help inform robustness of similar valve design on Orion.

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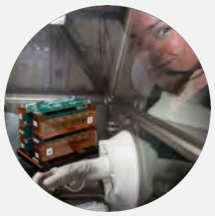
RESEARCH

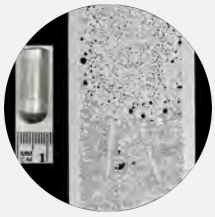
SpaceX CRS-21 Mission

The SpaceX cargo spacecraft will deliver dozens of investigations to the International Space Station, including research on microgravity effects on heart tissue, using microbes for mining on asteroids, how brain cells and tissues are affected by microgravity, how liquid metals behave in microgravity, a new privately funded airlock that can support science, CubeSat deployment, and spacewalks, and other cutting-edge investigations.

Certain microbes form layers on the surface of rock that can release metals and minerals, a process known as biomining. **BioAsteroid** examines biofilm formation and biomining of asteroid or meteorite material in microgravity. Researchers are seeking a better understanding of the basic physical processes that control these mixtures, such as gravity, convection, and mixing. Microbe-rock interactions have many potential uses in space exploration and off-Earth settlement. Microbes could break down rocks into soils for plant growth, for example, or extract elements useful for life support systems and production of medicines.



Microgravity causes changes in the workload and shape of the human heart, and it is still unknown if these changes could become permanent if a person lived more than a year in space. **Cardinal Heart** studies how changes in gravity affect cardiovascular cells at the cellular and tissue level. The investigation uses 3D engineered heart tissues (EHTs), a type of **tissue chip**. Results could provide new understanding of heart problems on Earth, help identify new treatments, and support development of screening measures to predict cardiovascular risk prior to spaceflight.



SUBSA-BRAINS examines differences in capillary flow, interface reactions, and bubble formation during the solidification of brazing alloys in microgravity. Brazing is a type of soldering used to bond together similar materials, such as an aluminum alloy to aluminum, or dissimilar ones such as aluminum alloy to ceramics, at high temperatures. The technology could serve as a tool for constructing human habitats and vehicles on future space missions as well as for repairing damage caused by micrometeoroids or space debris.

Launching in the trunk of the Dragon capsule, the **Nanoracks Bishop Airlock** is a commercial platform that can support a variety of scientific work on the space station. Its capabilities include deployment of free-flying payloads such as CubeSats and externally-mounted payloads, housing of small external payloads, jettisoning trash, and recovering external Orbital Replacement Units. Roughly five times larger than the airlock on the Japanese Experiment Module (JEM) already in use on the station, the Bishop Airlock allows robotic movement of more and larger packages to the exterior of the space station, including hardware to support spacewalks.

The **Effect of Microgravity on Human Brain Organoids** observes the response of brain organoids to microgravity. Organoids are small living masses of cells that interact and grow. They can survive for months, providing a model for understanding how cells and tissues adapt to environmental changes. Organoids grown from neurons or nerve cells exhibit normal processes such as responding to stimuli and stress. Therefore, organoids can be used to look at how microgravity affects survival, metabolism, and features of brain cells, including rudimentary cognitive function.