TIM PEAKE: INSPIRING THE EXPLORERS OF TOMORROW
From the beginnings of the ‘space age’, Europe has been actively involved in spaceflight. Today it launches satellites for Earth observation, navigation, telecommunications and astronomy, sends probes to the far reaches of the Solar System, and cooperates in the human exploration of space.

Space is a key asset for Europe, providing essential information needed by decision-makers to respond to global challenges. Space provides indispensable technologies and services, and increases our understanding of our planet and the Universe. Since 1975, the European Space Agency (ESA) has been shaping the development of this space capability.

By pooling the resources of 22 Member States, ESA undertakes programmes and activities far beyond the scope of any single European country, developing the launchers, spacecraft and ground facilities needed to keep Europe at the forefront of global space activities.

The Member States are: 20 states of the EU (Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, Netherlands, Poland, Portugal, Romania, Spain, Sweden and the United Kingdom) plus Norway and Switzerland.

Seven other EU states have Cooperation Agreements with ESA: Bulgaria, Cyprus, Lithuania, Malta, Latvia, Slovenia and Slovakia. Croatia is negotiating a Cooperation Agreement. Canada takes part in some programmes under a Cooperation Agreement.
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FIRST PRINCIPLES

Mission overview

↑ A spectacular aurora captured from space. The International Space Station’s robotic arm is visible in the foreground (NASA)
ESA astronaut Tim Peake is set to go into space on a long-duration mission packed with science and education activities. For over five months, his home and workstation will be some 400 kilometres above Earth. He will serve as a flight engineer for Expeditions 46 and 47 to the International Space Station (ISS).

Tim will be launched on a Russian Soyuz spacecraft from Baikonur Cosmodrome in Kazakhstan in December, returning to Earth half a year later. He will share the trip with Russian cosmonaut Yuri Malenchenko and NASA astronaut Timothy Kopra.

A former army helicopter pilot, Tim will travel in the right hand seat of the Soyuz capsule.

“Planet Earth is a precious place and we all need to safeguard it.”

Tim Peake
The 43-year-old British astronaut will arrive at a busy Station just before Christmas. This is the eighth long-duration mission for an ESA astronaut, called Principia, after Sir Isaac Newton’s book, *Philosophiae Naturalis Principia Mathematica*, describing the principal laws of motion and gravity. Science is an important part of the Principia mission – Tim will conduct a wide range of experiments on the Space Station, an out-of-this world research outpost that serves as a stepping stone for human exploration.

I hope Principia will encourage people to observe the world as if for the first time – just as Isaac Newton did.

Tim Peake

Thousands of schoolchildren in the UK were invited to design the logo for Tim’s mission. The winning entry came from 13-year-old Troy, who designed a patch that included many references to the mission. The Soyuz rocket taking Tim into space flies over the UK, while the colours of the Union flag run along the border. Fittingly, a stylised Space Station glints in the apple.

↑ One of Newton’s original Principia works. “If I have seen further, it is by standing on the shoulders of giants,” wrote Sir Isaac Newton to Robert Hooke in 1676 (Max Alexander)
Ground support

Day and night, a worldwide network of control centres support the astronauts on the International Space Station. In Europe, operators at the Columbus Control Centre in Oberpfaffenhofen, near Munich, Germany, are the direct link to Tim in orbit. They are there to help him 24 hours a day, seven days a week − they know where everything in the Station is located and how everything works. Teams will be constantly adjusting tasks to make sure that Tim can fulfil his mission.

Simultaneously, researchers on ground can control and monitor experiments performed in the European Columbus laboratory from their offices. Dedicated connections with eight User Support and Operation Centres across Europe make this possible.

Brits in space

Tim Peake will be the first British ESA astronaut to live and work on the International Space Station. Only four other Britons have flown in space, either by securing private funding or having a dual citizenship.

British astronaut candidates Nigel Wood, Richard Farrimond, Peter Longhurst and Christopher Holmes were selected by NASA in 1984, but never flew. In 1991, Helen Sharman flew to the Mir station funded by a private consortium and became the first British citizen − and the first European woman − in space. Michael Foale, Piers Sellers and Nicholas Patrick flew on the US Space Shuttle as NASA astronauts with American citizenship.

The UK is the European Space Agency’s fourth largest contributor. The European Centre for Space Applications and Telecommunications (ECSAT) is ESA’s newest facility and first facility in the United Kingdom. It is based at the Harwell Campus in Oxfordshire, also known as the UK Space Gateway.
Tim Peake was born in 1972, the same year that the last person walked on the Moon. Tim’s interest in space has been a lifelong passion. It started in his childhood, gazing at the stars and wondering about the Universe and he has kept his curiosity since then.

Tim considers himself very fortunate to have been inspired by great teachers and leaders along the way. He graduated in the British Army Air Corps at the age of 20, starting a successful career as a pilot that would take him across the globe. He served for 18 years in the British Army, including tours in Bosnia and Afghanistan.

As a test pilot, Tim has logged over 3000 hours’ flying time on more than 30 types of helicopter and aircraft. He received a science degree in flight dynamics from the University of Portsmouth in 2006. He loves outdoors activities and is a rugby fan. Tim is also fascinated by quantum physics and cosmology.

Previous life and work experiences have provided him with notable strengths for his spaceflight adventure. Tim is used to dealing with international partners and respecting cultural differences. Danger and emergency situations have been part of his career.

Tim was selected as an ESA astronaut in May 2009 after completing a year-long selection process. He described the moment as a wild mix of emotions – elation, shock and trepidation. With no guarantee of even getting a spaceflight, Tim put his career as a test pilot to one side.

Since then, though, his life has radically changed. Besides becoming a parent of two little boys, he has been travelling the entire time, living in Germany and the United States. The gamble of choosing space paid off when, in 2013, he was assigned to fly to the International Space Station on a long-duration mission.

Training
The first stages of training at ESA’s European Astronaut Centre in Cologne, Germany, supplied him with an astronaut’s toolbox of knowledge: scientific, engineering and medical skills, as well as orbital mechanics, Russian language and survival training.

We have to find other resources in the Universe – and that starts now. Space exploration is an insurance policy for the future.

Tim Peake
For all astronauts, the challenge is trying to retain the wealth of information and maintain a good balance in all sorts of topics.

After finishing basic and pre-assignment training, Tim embarked on the next phase of his space journey jumping into the assigned crew training flow, a smoothly operating machine that takes International Space Station astronauts through two and half years of intensive preparations to launch.

Then the pace increased for Tim, training almost without break, travelling between all international partners’ sites. An intense schedule took him to Houston, USA, Star City near Moscow, Russia, Tsukuba near Tokyo, Japan, and Montreal, Canada.

Training is tailored to each astronaut’s skills and needs for a mission. Tim has been trained on Space Station systems in full-size mockups, where he learnt how everything works and how to fix systems in case of breakdowns. He also learned how to run experiments and technology demonstrations, and got to know every corner of Europe’s Columbus laboratory.

Tim learnt to use the robotic arm to help dock spacecraft visiting the Station. There is a high chance he will be involved in berthing one of the US commercial supply spacecraft vehicles – Dragon or Cygnus. He prepared for spacewalks, known as Extravehicular Activities (EVAs), in huge water tanks to simulate working in weightlessness outside the Station. If the opportunity arises, he is fully qualified to venture into outer space.

The ESA astronaut also took part in space-mission analogues for his orbital journey. Tim joined a 12-day exploration mission to a simulated asteroid at the Aquarius base, the world’s only undersea research station. Much like in space, he had to deal with confined living quarters and a total reliance on life-support systems, 20 m below the sea off the coast of Florida, USA. He also participated in ESA’s CAVES training course, as part of an international team of astronauts living underground for a week and exploring a cave system in Sardinia, Italy.

Tim went through survival courses in extreme environments, preparing himself to face all kinds of situations in prolonged isolation and under psychological stress. The courses help astronauts to be mentally prepared to handle emergencies, such as spacecraft depressurisation, fire or toxic spills.
The International Space Station has been a workplace for humans since 2000. Because Soyuz capsules ferry only up to three astronauts at a time and have a limited operational lifetime, rotating shifts of new arrivals and departures are part of the Station’s routine.

Keeping the Station permanently crewed requires careful planning. A few times a year, like clockwork, three astronauts leave as a new trio arrives. Crew rotations on the International Space Station are called ‘Expeditions’. Tim is part of Expeditions 46 and 47.

The European astronaut will serve as flight engineer with Soyuz commander Yuri Malenchenko and NASA astronaut Timothy Kopra. Tim acknowledges sharing a very similar army background and temperament with his counterpart Kopra, and praises the experience of Malenchenko, who will be logging his sixth spaceflight.

Tim and his crewmates arrive at the last stage of the year-long mission for US astronaut Scott Kelly and Russian cosmonaut Mikhail Korniyenko. Tim hopes that their arrival will give the resident crew a boost during the last three months of their record-breaking mission.

The crew rotation system allows greater flexibility for operational tasks and maintenance of Station systems, and increases the time spent on research compared to former three-person crews.
**Space Station facts and figures**

- The International Space Station has been visited over **200 times**

- Kelly and Korniyenko’s **340-day stay** will be the longest amount of time anyone has spent aboard the Space Station

- Cosmonaut Gennady Padalka recently broke the all-time record for total time spent in space: **894 days**

**Crew shifts**

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<tbody>
<tr>
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<tr>
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**Astronauts or cosmonauts?**

A person that travels in space can be called an astronaut or a cosmonaut – they refer to the same thing. Cosmonaut is the Russian word for astronaut, derived from the Greek words kosmos, meaning ‘universe’, and nautes, meaning ‘sailor’. While the term astronaut is used mainly in English-speaking countries, cosmonaut refers to Russian space travellers.
A VOYAGE WITH SOYUZ

Commencing countdown, engines on

↑ Night liftoff of the Soyuz launcher from the Baikonur Cosmodrome, in Kazakhstan (NASA)

Soyuz ascent and orbit insertion

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The Soyuz has been used for human spaceflight missions longer than any other launch system. The Russian workhorse is currently the only way astronauts can travel to the International Space Station.

The Soyuz spacecraft shares the same name as its launcher – Soyuz means ‘union’ in Russian – and can manoeuvre, rendezvous and dock automatically or by manual control. Conceived in the 1960s as part of the Soviet space programme during the space race with the United States to land the first man on the Moon, Soyuz’s main use remains to ferry astronauts to low-Earth orbit.

**Launch**

On launch day, the vehicle is loaded with propellant and the final countdown sequence starts three hours before liftoff. Four boosters, each about 20 m in length, provide the main thrust in the first two minutes of flight before they are jettisoned.

In less than five minutes, 225 tonnes of RP-1 fuel and liquid oxygen are consumed. RP-1 is a highly refined form of kerosene, similar to jet fuel. Nearly ten minutes into flight, at an altitude of about 210 km and at speeds of about 25 000 km/h, the Soyuz enters Earth orbit.

Some orbital corrections are required before the spacecraft enters the same orbit as the International Space Station flying at an altitude of 400 km and a speed of about 28 000 km/h. While in orbit, chasing the Space Station, the Soyuz crew perform system checks and keep in touch with controllers at the Russian Mission Control Centre.
Final approach and docking
Tim’s flight will take the Soyuz fast-track to the Space Station. His Soyuz will execute a ‘same-day rendezvous’, docking after just four orbits, less than six hours after launch.

Rendezvous and docking are automated, but the Soyuz crew can execute these operations manually in case of anomalies. The Soyuz spacecraft completes a series of trajectory corrections and manoeuvres to align with one of four available Russian docking ports on the Space Station.

Once docked with the Station, the crew equalises air pressure between Soyuz and the orbital outpost. After removing their flight suits, they open the hatches to enter what is to be their new home for the next six months.

Emergency exit
A Soyuz space capsule ferried the first crew to the International Space Station in November 2000. Nowadays, one Soyuz for each group of three astronauts has always been at the Station to serve as a safe house and lifeboat should they have to return to Earth unexpectedly. Although the Space Station is the most heavily shielded spacecraft ever, even a piece of space debris with the thickness of a coin could threaten the crew’s lives.

I am excited about sitting on top of the rocket. I cannot wait to experience weightlessness and look down on planet Earth.

Tim Peake
When a piece of space debris is on a trajectory towards the Space Station, astronauts can shelter in their Soyuz spacecraft. If an object hits the Station, the astronauts would be in their capsules ready to return to Earth.

**Undocking and reentry**
After living and working on the Space Station for nearly 170 days, Tim will return to Earth in the Soyuz capsule with his crewmates. Closing the Soyuz hatch will signal the end of his Principia mission, and the astronauts will land on Earth in less than four hours later.

Around three hours after undocking, when Soyuz is at a distance of 19 km from the Space Station, the spacecraft’s engines fire for about four minutes. This ‘deorbit burn’ slows the spacecraft and decreases its orbit. Shortly afterwards, at an altitude of 140 km and less than 30 minutes before landing, the Soyuz spacecraft separates into three parts.

The orbital and service modules burn up on reentry in the denser layers of Earth’s atmosphere. The remaining descent module naturally rotates and places its heat shield towards the direction of travel, so that it absorbs most of the heat caused by friction with the atmosphere.

Reentry begins at an altitude of about 100 km, when the speed at which the capsule travels is reduced dramatically and the crew is pushed back into their seats feeling forces of up to 5g, the equivalent of five times their body weight.

**Landing and rescue**
Parachutes deploy to reduce speed even more and the astronauts sit in custom-fitted seats with springs that absorb the shock of impact. At the last moment, retrorockets fire before touchdown to limit the landing speed to around 5 km/h.

After touchdown, the crew deploy a communication antenna so that rescue teams can pinpoint their location. Soyuz descent modules are not reusable.

Once back to Earth, Tim will fly straight to the European Astronaut Centre, the home base of all ESA astronauts in Cologne, Germany. This early access to Tim allows ESA’s medical team to monitor his health very closely and to start his fitness and rehabilitation programme quickly. Scientists also benefit from continuing with their scientific examinations soon after landing.
ALL THE SPACE YOU CAN USE

The International Space Station

Did you know?

• The International Space Station can be seen as a bright moving star from most places on Earth with the naked eye. Opportunities for observation arise in clear skies up to three hours before sunrise or after sunset, about ten days per month.

• The Space Station has more liveable room than a conventional six-bedroom house, with a 360-degree bay window called Cupola, two toilets and fitness facilities.

• The Station has been inhabited for 15 years. No other space station has been inhabited for longer or received more visitors.
The International Space Station is a shining example of broad cooperation, uniting Europe, USA, Russia, Japan and Canada in one of the largest partnerships in the history of science. The orbital station is one of the greatest engineering works ever achieved by mankind. This human outpost in Earth orbit is a stepping stone for further space exploration.

The endeavour has brought humanity together to live and work in space uninterrupted for over a decade. The orbiting complex is the size of a football field – enough room for the crew and an array of scientific facilities. This weightless laboratory offers the possibility to efficiently perform experiments like no other low-gravity platform on Earth.

Intensive research and effective use of this laboratory leads to new applications and benefits for people on Earth, from space to your doorstep.

**A free-falling research laboratory in space**

For decades, experiments in space have answered many scientific questions, inspired technological development and, sometimes, resulted in unexpected outcomes. The International Space Station was completed after nearly 13 years of construction and now the number of scientific activities concerning the effects of long-duration microgravity on humans has reached a record high.

Gravity affects almost everything we do on Earth. Freefalling around the planet, the astronauts on the Space Station live in microgravity. Up there, scientists are conducting pioneering investigations, testing theories, and pushing the boundaries of our knowledge.

The high-flying international laboratory is packed with sophisticated facilities that support a wide range of research in human physiology, biology, fundamental physics, materials sciences, Earth observation and space science.

The orbital outpost offers a unique view of Earth for collecting scientific data. Observations of glaciers, agricultural fields, cities and coral reefs can complement satellite data to create a comprehensive view of our planet. Science in space supports competitive technology developments and fosters scientific research and education.
European parts of the International Space Station

Columbus
The Columbus laboratory is the first permanent European research facility in space. Since 2008, this multifunctional lab has been generating scientific data across a range of disciplines. External platforms are supporting experiments and applications in space science, Earth observation and technology.

Harmony and Tranquility
Node-2 Harmony is a connecting module between Columbus, Destiny and Kibo laboratories. It also has three docking ports for visiting vessels. Node-3 Tranquility, connects to Node-1 Unity and houses life-support and exercise equipment for six crewmembers as well as accommodating Cupola and more docking ports.
Cupola
The Cupola observatory is the most recent European module on the Station. The seven-window dome is the crew’s panoramic window to Earth, as well as giving astronauts a clear view when controlling outside equipment from inside the Station.

One of the most interesting things about being in space is the amount of space that you can use. There is no up or down. It opens up a new dimension.

Tim Peake
“And all this science I don’t understand, it’s just my job five days a week,” sings Elton John, about an astronaut in his classic 1972 song Rocket Man. But Tim does understand the science, and he is excited about being involved in research that brings real benefits to people back on Earth.

The Principia mission’s extensive scientific programme consists of dozens of experiments orbiting 400 km above Earth. Tim will run a set of European experiments covering human research, biology and radiation, as well as demonstrating new technology on the Space Station. He will take full advantage of the Station’s scientific facilities and perform valuable science for Europe in the European Columbus laboratory.

His contribution is not limited to European science. During Principia, Tim will play a role in about 15 other human research experiments from the US, Canadian and Japanese space agencies. Scientists hope to gain more insight into cognition, motor skills as well as bones and eye health for future space exploration missions.

The science being studied on board the Station is incredibly exciting and has the potential to deliver major breakthroughs in several areas, such as medical treatments, new materials and our fundamental knowledge of the universe.

Tim Peake
HEAD
Understanding how the neural processes of perception adapt to weightlessness is the focus of the Brain-DTI experiment. Tim’s brain will be examined in detail on ground before and after his mission. This research could lead to new tools for further research on spatial cognition. He will also register any headaches and other symptoms while in orbit. The results of the Space Headaches experiment will help develop measures to reduce migraines.

LUNGS
Dust particles float in the Station’s atmosphere and often irritate eyes and lungs. The Airway Monitoring experiment will monitor Tim’s lungs and airways to test their reaction as a tool to monitor lung inflammation. More than 300 million people suffer from asthma, so patients on Earth could benefit from the quick and simple lung test developed for this research.

STOMACH
Humans lose body mass in space. Tim will measure changes in energy expenditure to derive an equation for an astronaut’s needs in weightlessness. The Energy experiment will contribute to planning the right amount of food on long-duration missions to the International Space Station and beyond.

BONES
Scientists think that reduced stress on bones may be responsible for the progressive cartilage loss seen in long-term space residents. The results of the Cartilage experiment are expected to help develop technologies to counteract bone loss for space travellers and bedridden patients on Earth. Astronauts lose up to 1% of their bone mass each month in space. The Early Detection of Osteoporosis in Space experiment will look at changes in cosmonaut’s bone structure. This research will help detect and hopefully prevent osteoporosis in large population segments, especially those over 55 years old.

MUSCLES
Living in microgravity leads to the loss of muscle mass, function and motor control. By taking samples of Tim’s soft tissue, the Muscle Biopsy experiment looks for the root of the problem of maintaining muscle mass in space. The European astronaut will provide feedback on how his muscles perform before and after his flight.

SKIN
As we grow older, our skin becomes more fragile and takes longer to heal from injuries. Astronauts lose more skin cells and age faster during spaceflight. The aim of the Skin-B experiment is to gain insights on skin physiology in space and, in particular, the skin-ageing process.

IMMUNE SYSTEM
Living in space can take its toll on an astronaut’s body. More than half of the space travellers show significant signs of immune dysfunction after long missions. Using brain scans, monitoring breathing and looking at samples of hair, the Immuno-2 experiment looks at how stress affects the immune system.

WRIST WATCH
We all have an inner clock—the circadian timing system—that tells us roughly what time of day it is, and makes us sleepy at night. That cycle is disrupted in orbit, where astronauts experience 16 sunrises and sunsets every day. The Circadian Rhythms experiment will look at how long-duration spaceflight affects Tim’s biological clock. The findings will help future missions but also people working irregular hours on Earth, such as doctors and emergency workers.
**MARITIME CONTROL**
The Vessel ID system is the marine equivalent of air traffic control. Attached to Europe's Columbus laboratory, its satellite receiver can identify more than 22,000 ships a day. The data are contributing to develop global maritime surveillance.

**3D TRAINING**
Tim will test novel ways for training on board. ESA has developed a system with 3D animations and augmented reality features that will allow the astronaut to perform new tasks without previous training. He will use a tablet to run the 3D Visual Training (3D ViT) tool, and follow instructions. The system has already proved to be helpful for spacecraft operations during the last visit of Europe’s Automated Transfer Vehicle to the Station.

**FEEL THE FORCE**
ESA is investigating the limits of human perception and ability to apply fine forces with their limbs and hands in space. Tim will use a force-reflecting joystick in space (Haptics/Interact). The tests will help improve the equipment to support robotic and human interaction in weightlessness.

**REMOTE CONTROL**
To help turn robotics and remote operations into a standard tool for space missions, ESA is linking the Space Station with Earth. Tim will operate ESA’s Eurobot in the Netherlands while orbiting Earth using a laptop and a joystick. The Meteoron SUPVIS-E activity is the continuation in a series of experiments of increasing complexity.
BACTERIA
Scientists are testing the survival skills of terrestrial organisms in outer space with the Expose-R2 facility. The size of a suitcase, this platform is housing a variety of organic samples for more than a year outside the Space Station. Special windows allow the Sun’s ultraviolet light to reach the samples. One of the goals of this package is to evaluate the impact of light and radiation on cells and their molecules.

HUMAN CELLS
Astronauts have shown problems in their muscles, bones and heart after long stays in orbit. In weightlessness, the internal machinery of the human cell is affected in ways that cannot be mimicked on ground. The Cytoskeleton and Spheroid experiments will look at cell proliferation and their life cycle in space, as well as how it affects their genes. These investigations could not only help improve astronauts’ health and performance, but could also be linked to clinical medical research to treat common diseases in the elderly.

PLASMA
Plasma is an ionised gas. It is considered to be the fourth state of matter, distinct from gas, liquid and solid matter. The PK-4 experiment investigates the creation of plasma-microparticles in weightlessness to simulate how molecules interact in three dimensions.

METALS
Super-alloy metals are in high demand to optimise industrial casting processes. A set of experiments will investigate the effects of microgravity on metal microstructures, especially on liquid metals when forming alloys. The Electromagnetic Levitator facility will allow the melting and solidifying of metallic samples with no need for containers in an ultra-high vacuum, as well as in extremely pure gases. Another batch of experiments in the ESA’s Materials Science laboratory will examine growth patterns and how microstructures evolve when metallic alloys crystallise in microgravity.
SPACE FOR EDUCATION

Inspiring the next generation

↑ Tim with participants of the Mission X challenge
Tim invites students of all ages to share the trip and the excitement of his space adventure. Principia’s large education and outreach programme comprises over 25 activities and teaching resources that will help trigger the interest of students in science, technology, engineering and maths before, during and after the mission. Tim wants to use his mission as an educational launch pad for the next generation.

To make a career in space you should be passionate about what you do, study hard and persevere to make your dreams come true.

Tim Peake

Computing – Astro Pi

Primary and secondary schools in the UK are turning to the ‘Raspberry Pi’ mini computer to take advantage of its flexibility. Two of these credit card-sized computers called Astro Pi will go to the Station equipped with a host of sensors and gadgets. Students can devise and code their own apps or experiments to run in space.

During his mission, Tim Peake will place the tiny computers in different locations. He will load the winning codes, set them running, collect the generated data and then send the results back to Earth.

Five themes are set to stimulate the students’ creativity and scientific reasoning: spacecraft sensors, imaging and remote sensing, environmental measurements, data fusion and space radiation.

Mission-X – Keep on running

Mission-X fever is spreading across the planet. Future space explorers will get on their marks and invade gyms to train like astronauts for the 2016 challenge. ‘Mission-X: Train like an astronaut’ is an educational programme in which thousands of schoolchildren aged 8 to 12 years old from more than 25 countries do science activities and learn how to get fit.

Tim will kick off the worldwide challenge by talking about regular exercise and nutrition, both on Earth and in space. He will answer questions, give tips on having a healthy lifestyle and share his experiences in weightlessness.
Tim’s space bites

Astronauts eat a varied diet and exercise at least two hours a day to maintain their health and avoid the harmful effects of space on their body, such as bone and muscle loss.

Michelin-star chef Heston Blumenthal has prepared food for Tim’s mission to the International Space Station. Heston’s journey to create the best dining experience for the astronaut relied on the help of schoolchildren joining ‘The Great British Space Dinner’ competition. Get a taste of the British-inspired menus Tim and Heston chose for the Principia mission.

Biology – Rocket science

When ESA astronaut Andreas Mogensen flew to the International Space Station in September, he carried a very special cargo for Tim: 2 kg of rocket seeds, also known as rucola, a popular ingredient in salads.

The seeds will orbit the planet at approximately 28 000 km/h and be exposed to the weightlessness and radiation of space. After several months, the rocket seeds will return to Earth and distributed across 10 000 schools in the UK, along with another batch of seeds that did not leave our planet.

Schoolchildren will plant both types of seeds and compare their growth. The pupils will learn whether space travel impacts growth and whether humans could one day produce their own food in space.

↓ Tim and top chef Heston Blumenthal selecting the winning entries of ‘The Great British Space Dinner’ competition (Max Alexander)
More space fun?
Teachers can access a special package of teaching resources prepared for Tim’s mission. The European Space Education Resource Office (ESERO), together with the UK Space Agency and British partners, are providing tools to inspire students throughout the space adventure. Check it out! http://www.nationalstemcentre.org.uk/timpeake

Calling occupants of interplanetary craft
Space technology is not all high-tech. Radios operated by amateur enthusiasts can be used to communicate with the International Space Station. As he flies above the United Kingdom, Tim will talk to children using handheld-radios over ARISS, the Amateur Radio on the International Space Station.

An ARISS conversation usually lasts for about 10 minutes, which is the window when the Station flies over a certain area and radio contact is possible from orbit. During that time, students will be able to ask him questions about his life and work in space. Tim will use the amateur radio callsign GB1SS.

Space science – watch and learn
Astronaut Tim Peake joins the efforts of teachers on Earth in the quest to explain physics to their pupils. The astronaut will record videos from the International Space Station demonstrating the phenomena that mentors find hard to show during their earthbound lessons.

The suite of resources for teachers includes demonstrations of gas particle motion, conservation of momentum, harmonic and planetary motions. The experiments will help students to better understand Newton’s three laws of motion and the idea of gravitational forces – the inspiration behind Tim’s mission name, Principia.

Some lucky students and teachers will also have the chance to see and talk to the astronaut through live video calls with the International Space Station. Tim will connect with them for a few minutes to answer their questions.
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