Bone Proteomics

Long periods of weightlessness induce bone mass loss in astronauts. Previous experiments indicate that this negative effect is mainly due to a reduced activity of osteoblasts, the cells that physiologically produce the bone material throughout our life.

Weightlessness alters both the maturation and the bone-production activity of osteoblast cell cultures, but the mechanisms involved are not yet fully understood.

The Bone Proteomics experiment will study the molecular mechanisms that regulate the physiology of human osteoblasts in weightlessness. The experiment consists in stimulating osteoblast cells in microgravity with a molecule know as ATP.

The specific objectives of the experiment are:

- To study whether ATP can stimulate osteoblast cells in weightless conditions, possibly balancing or overcoming the negative effects of weightlessness.
- To study, for the first time, the whole protein content of these cells, looking for possible explanations of the altered physiology of osteoblasts in weightlessness. This is called a proteomics approach, thus the name of the experiment.

Bone Proteomics flight hardware (Image: ESA)

This experiment will be the first proteomic study on mammalian cells in space, possibly revealing new aspects of osteoblast biology, and it will provide new data for a better understanding of osteoblast physiology at the molecular level. The results of this experiment are beneficial for both space and ground research. The former, in the field of bone physiology in microgravity and microgravity-induced bone loss, particularly for long-duration space missions, and the latter for bone disease research on Earth (e.g. osteoporosis).

How is it done?

Samples of osteoblast cells that have been stimulated with ATP in weightlessness will be compared to a ground-based reference experiment. The samples will be analysed by means of an approach that allows for the identification of proteins under different conditions. The experiment hardware consists of a stack of electrical heated culture chambers, a liquid handling system and a glove bag. The osteoblast cells grow in separate culture chambers that are equipped with thin membranes to allow liquid exchange. Liquid exchange is necessary to provide the cells with nutrient, to stimulate the cells and to wash the cells. All fluids are injected and extracted with syringes (the liquid handling system).

Bone proteomics experiment culture chamber (Image: ESA)

The operations to be performed by the crew on the payload are basically to exchange liquids in the culture chambers through the use of the syringes at different times during the mission. Liquid exchange is conducted in a glove bag. The culture chambers with the samples of the cells inside will be returned to Earth for analysis.

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Amateur Radio on ISS (ARISS)

ARISS is an international working group of national amateur radio societies of the countries participating in the ISS programme. For this mission, the specific objectives of ARISS are:

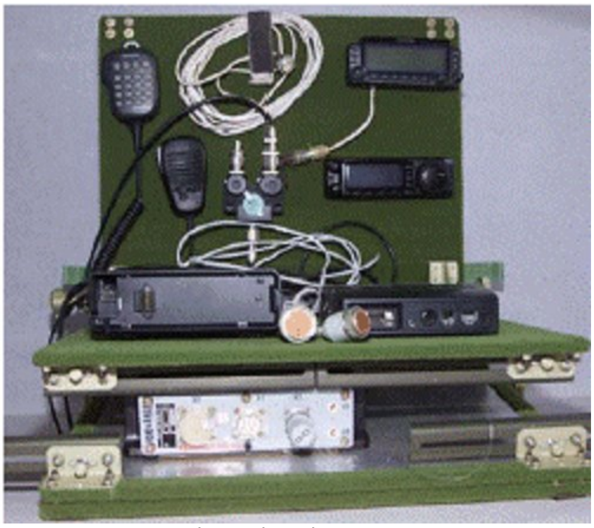
- Providing real time radio transmissions from the ISS, during which pupils in selected Italian primary schools will put questions to astronaut Roberto Vittori.
- To build, develop and maintain the amateur radio activities on board the ISS.

Curiosity is the source of all knowledge. A major role of education is stimulating curiosity. Children experience spaceflight and space research as a very inspiring environment. Making them actively participate in a space mission provides children with first hand information. ARISS is an educational experiment par excellence because it provides children with more information on space, a subject that normally is ignored in schoolbooks.

How is it done?
ESA's ISS Education Office has set up a space-oriented competition in Italian primary schools, "Talk ISS". The two winning classes will be invited to a venue and selected students will have the opportunity to talk with astronaut Roberto Vittori over amateur radio. The students will prepare 20 questions, and at each favourable pass of the ISS, offering 10 minutes of direct radio contact, they will put these questions to the Italian astronaut.

Vittori will be in possession of an amateur radio licence, delivered by the Italian telecommunications licensing authority. This licence allows the astronaut to operate the ARISS station using his call sign "IZ6ERU operating NA1SS". Under these provisions, the astronaut is entitled to answer the questions of students through a ground station of the amateur radio service.

The ground stations will be provided by local amateur radio clubs, members of AMSAT Italia. If the orbital movement of the ISS does not allow direct radio contacts during ISS passes over western Europe in a suitable timeframe, telebridges can be set up with ARISS ground stations elsewhere in the world (e.g. USA, Honolulu, Australia, South Africa). Workload permitting, further ARISS School Contacts will be set up with another Italian school.


ARISS station on board ISS (Image: G. Bertels)

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Electrostatic Self-Assembly Demonstration (ESD)

Self-assembly of components larger than molecules into ordered arrays is an efficient way of preparing microstructured materials with interesting properties.

Electrostatic self-assembly occurs when different types of components charge with opposite electrical polarities. The interplay of repulsive interactions between like-charged objects and attractive interactions between unlike-charged ones results in the self-assembly of these objects into highly ordered, closed arrays.

This education experiment aims at demonstrating the electrostatic self-assembly of two different types of macroscopic components or spheres of identical dimensions to create different molecular structures in weightless conditions on board the ISS, by means of filming 3 demonstrations.

For all demonstrations comparable on-ground experiments will be performed and filmed in order to familiarize students with the differences between the Earth and space environments.

How is it done?
For each demonstration in space, two kinds of spheres will be used, made up of different materials (polymethylmethacrylate (PMMA) and polytetrafluoroethylene (PTFE)) that charge with opposite electrical polarities when agitated inside a clear, polycarbonate cube container.

The interplay of repulsive interactions between like-charged spheres and attractive interactions between unlike-charged ones results in the self-assembly of these spheres into ordered 3D molecular structures in weightless conditions.

The experiment concept has already been "tested" successfully during an ESA Professional Parabolic Flight Campaign in October 2003.

Video of both the 'on-ground' and 'in space' demonstrations will be recorded, and the footage will be used to develop an ISS DVD Lesson, fitting the basic European science and technology curriculum of the target age group: 12-18 year olds.

The DVD will be distributed in 12 languages to secondary school teachers in ESA Member States

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