MICROGRAVITY EXPERIMENTS
ADVANTAGES AND APPLICATIONS

Introduction

Microgravity properties are applied in growing cell cultures in three dimensions, modelling human diseases, analysing proteins and large molecules, studying plant biology. Experiments are taking place on the ISS for future self-sufficient explorations, to apply new and more efficient technologies on Earth, to create new drugs able to cure current untreatable diseases and for so much more.

Knowing the structure of proteins, through crystallization we can develop new ways to prevent and treat diseases, since, in microgravity, protein molecules incorporate into the crystalline lattice more slowly and orderly. This can indeed result in higher- quality crystals, which could help create a pipeline of new drugs able to treat most cancer types and other diseases.

Funding

Funding is mainly needed for the work done in the lab: in particular, for the experiment preparation and the analysis of results, and for the implementation services. The majority of the experiments that are taking place on the ISS are funded by NASA and of course by the companies interested on their outcome. The ISS National Laboratory and Boeing have together funded most of the experiments and allocated more than $4.5 million in funding.

Space Manufacturing

Experiments on Space Manufacturing allow us to understand how we are going to be self-sufficient once we are not in reachable distance for orbital rockets. But are they only useful to solve the logistic problems of deep-space missions? Of course not. This program is developing technologies that could be revolutionary on Earth. For example, the Refabricator is a machine that can transform almost any plastic material in feedstock for additive manufacturing and it’s also developing new materials that are much harder to produce on Earth due to gravity influence. These new materials have the possibility to change the quality aspect of the material itself and of the manufacturing industry. Companies from all around the world are taking interest on the new possibilities that space manufacturing can offer. Industrial manufacturing in space is still a far concept and it will take time to be developed, but, in some sectors, such as the medical and the tech sector, it will become reality.

The Vegetable Production System

Veggie's purpose is to help study plant growth in microgravity, with samples returned to Earth to be analyzed, and to provide astronauts with nutrients in a long-lasting, easily absorbed form.

Cardiovascular progenitor cells

The microgravity environment of the ISS National Lab allows scientists to conduct research that could help develop cell-based regenerative therapies for people with heart disease back on Earth. An example is the study of the effects of microgravity on human cardiovascular progenitor cells (CPCs). The neonatal cardiovascular progenitor cells grown were found to have enhanced proliferation, meaning they were able to divide and increase in number more rapidly. In addition, both the neonatal and adult CPCs exposed to microgravity exhibited an enhanced ability to migrate. Migration is important because, once therapeutic cells are injected into the heart, we want them to be able to move to injured or damaged areas. Ultimately, this kind of cells have enhanced stemness: this could enable a more effective integration of therapeutic cells into heart tissue, improving tissue regeneration after an injury such as a heart attack.

The Flame Extinguishment Experiment

FLEX had three main applications in space and on Earth: efficiency of energy production and propulsion systems, discoveries on combustion generating pollution, partly related to fire hazards with liquid combustibles, and building of the future generation spacecrafts. The experiment was conducted on the ISS and was subject to 225 variations. It consisted of the formation of a fuel droplet in a chamber where it was ignited and of the use of a fire suppressant upon it. There were seven variables in the experiment; most interestingly, pressure variation, oxygen mole fraction and the use of heptane droplets. Firstly, pressure was changed and sometimes decreased so low to simulate venting a cabin to stop a fire. Secondly, the level of oxygen was varied to the extent that chemical burning could not exist or that the fuel droplet burnt to completion before the suppressant stopped the burning. Lastly, the burning of heptane droplets was the most surprising thing, as a droplet would appear to rapidly evaporate after the fire extinguished, almost as burning without a flame, until it became very small and ended up evaporating at a normal rate or even growing due to condensation.