Space Science 101 – Microbes

Why is Microbiology important to Space Research?

- Microbes play a vital role in maintaining human health and it is critical to understand how microbes are impacted by the space environment.
- Microbes will play an important role in Bioregenerative Life Support systems and will help sustain agricultural crops needed during extended space exploration.
- Microbes help us process waste products and facilitate the remediation of air and water during spaceflight.

Why is Space Research important to Microbiology ?

- By removing the impact of gravity on microbes, we can gain new insight into the physiology, metabolism, genetics and interactions of microbes.
- The stress conditions of spaceflight may have unknown impacts on interactions between microbes and their hosts potentially revealing previously unknown pathways of how microbes communicate and interface with their plant and animal hosts.

Why Microbiology Space Research is important to Earth?

- Insights into how microbes are altered under the stress conditions associated with spaceflight might help develop treatments for microbiome-related disorders here on Earth.
- Efforts to study the role of microbes in biodeterioration of spacecraft materials may help improve the development of more durable materials for use on Earth.
- Research on the mechanisms by which microbes remediate and detoxify compounds in Biological Life Support Systems could be used to improve waste recycling efforts on Earth.
- The study of microbial communities aboard spacecraft may identify new biological products that could be of value to the development of new medicines or therapies.

Important Questions – what do we need to know about microbes to support space exploration?

The Microbiome of Astronauts– What is the long-term impact of spaceflight on the normal healthy microbiome of astronauts and how do we mitigate the onset of disease during spaceflight?

Microbial Stress Response– How do microbes change their genetic or metabolic activities under stress conditions of spaceflight?

The Microbiome of Spacecraft– Do the interior surfaces of spacecraft, such as the ISS, harbor unique and potentially harmful microbial communities?

The Microbe Exchange– How are microbes transmitted between crew members, plants, and spacecraft surfaces?

Planetary Protection– How do we minimize or avoid microbial contamination of spacecraft using the ISS as test-bed. Such technologies enable NASA to prevent potential harmful extraterrestrial agents from negatively affecting Earth?

One interesting thing about Microbiology relevant to spaceflight is that *microbes help keep us alive and are essential for human-led space exploration!*

Microbes play a major role in maintaining human health.

- Microbes help to detoxify compounds and can help reduce stress on host tissues.
- Disturbances in the microbial community (i.e., microbiome) that associate with human tissues can lead to disease.
- However, beneficial microbes can help maintain and regulate our immune system by preventing pathogens from colonizing host tissues.
- Microbes can also influence our nervous system and can modulate social and communicative behaviors.

Selected Important Answers – what have we learned that could only be revealed in space?

Microbial Physiology and Genetics – In microgravity, microbes can change the physiological responses of many different bacterial species including both beneficial and pathogenic microbes. Some of these changes include:

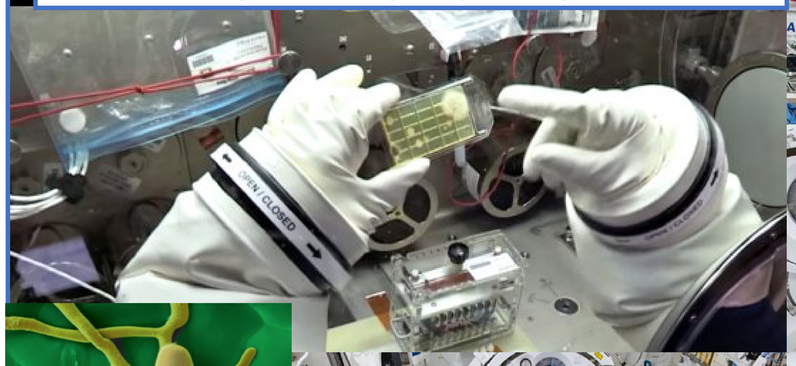
- the growth rate and metabolic activity of some microbes are altered during spaceflight;
- microbes can become more resistant to a range of environmental stresses (e.g. oxidative, osmotic);
- spaceflight can alter the susceptibility of microbes to antibiotics and increase their resistance and virulence;

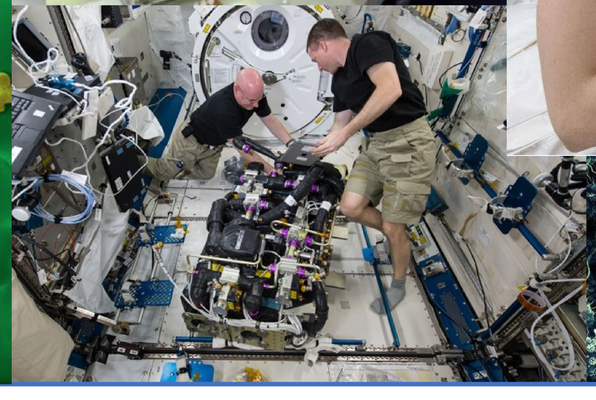
Microbial Behavior - Spaceflight conditions can change the formation of bacterial biofilms of some taxa and cause them to be thicker and form unique structures in microgravity.

Host-Microbe Interactions – Microbes can modulate the immune response of their host innate immune response under microgravity-like conditions.

Microbial Diversity – Molecular microbial community analyses have shown thousands of different microbial (i.e., bacterial, archaeal, and fungal) taxa on the ISS with many species similar to those found in the human microbiome.

Microbial Tracking – New rapid analysis tools have been developed to identify the microbes associated with both the astronauts and spacecraft to closely monitor how microbial diversity changes overtime aboard spacecraft and payloads.





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