Proteometabolomic Response of Deinococcus radiodurans Exposed to Radiation and Extending its Application to Radiation Protected Spacesuit.

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Abstract

Deinococcus radiodurans has been reported to show remarkable resistance to ionizing radiation, desiccation, oxidizing compounds, UV radiation and mutagens. Since the 1960s, several exposure tests on diverse bacteria in space have been conducted to study the possibility of interplanetary life transfer and this bacterium pertains to a distinct gram-negative eubacterial lineage that is considered to be most closely related to the genus Thermus. The chemical reaction of D. radiodurans after exposure to space-related radiation and vacuum was studied in the concerned research that extends the application of the Tanpopo mission conducted by Japan. Certain tests like Scanning electron microscopy demonstrated that irradiated cell shape and cellular integrity were unaffected, whereas combined proteome and metabolomic research revealed significant molecular modifications in metabolic and stress response pathways. Taking this into account reinforced with simulation studies, we propose fabrication of a wearable radiation-shielding bio-spacesuit to protect the astronauts and prevent the onset of acute radiation damage. The main focus of this study is on the idea of incorporating the organism's composition mechanisms either into the five layers of mylar or aerogel of spacesuit in order to prevent damaging radiation in space.

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PRESENTED AT:

INTRODUCTION:

Throughout history, humankind has been fascinated with space. From believing Earth to be the center of the cosmos to exploring other celestial bodies using satellites and rovers, humans and their knowledge of the universe have evolved a lot. With crewed missions being carried out in the International Space Station (ISS) since the past few decades, scientists are now planning to send humans beyond the LEO.

Space exploration, as fascinating as it sounds, is fraught with complications. Understanding these complications and overcoming them is critical as we plan to travel to the Moon and beyond. One of the major challenges faced by the space industry is the protection of astronauts from hazards of the hostile space environment. Once they cross the protective layer of Earth's atmosphere, astronauts are exposed to high amounts of radiation, micro-gravity or zero-gravity, fluctuating temperatures and pressures, etc. Radiation and microgravity have been active research topics because their potential to harm human health has not yet been fully understood.

Space radiation is made up of particles trapped in the geomagnetic field, protons emitted by large solar particle events (SPE), and galactic cosmic rays (GCR), which are high-energy protons and heavy ions from outside the solar system. Astronauts in Lower Earth Orbit (LEO) are primarily exposed to protons trapped in the Earth's magnetic field, as well as some high-energy GCR and SPE particles capable of passing through LEO. It is sometimes difficult to shield astronauts from high-energy GCR particles with conventional materials, resulting in exposure inside spacecraft. Radiation can cause DNA damage by breaking its strands and can also disrupt the cardiovascular system by damaging the heart and arteries. Aside from radiation, astronauts are subjected to microgravity in LEO or while traveling to the Moon and Mars. Microgravity exposure can have a number of negative health consequences.

OBJECTIVE:

Despite being exposed to ionizing radiation, desiccation, UV radiation, and oxidizing chemicals, Deinococcus radiodurans has been found to be extremely resistant. While the proteome was compressed simultaneously, investigations such as scanning electron microscopy have demonstrated that the generation of light cells and cell integrity were not compromised. Research in metabolomics shows that the metabolic and stress responses of cells alter throughout time. Wearable space suits that shield delicate creatures from space radiation are being proposed as an alternative. This study focuses mostly on the idea of incorporating biological processes of Deinococcus radiodurans into five layers of mylar to protect spacesuits from radiation for which a proposal has been made that needs further research considerations.

PREACHING OF TANPOPO MISSION-PROLOGUE OF DEINOCOCCUS RADIODURANS:

The chemical reactions to D. radiodurans after exposure to space-related radiation and vacuum was investigated in a relevant study, which increased the use of Tanpopo equipment made by Japan.

Tanpopo mission had two objectives:

Test the panspermia hypothesis and

Test whether organic compounds may have been transferred to Earth before the origin of life.

The Tanpopo mission consists of six subthemes:(Subtheme 1), Capture of microbes in space

(Subtheme 2), exposure of microbes in space

(Subtheme 3), analysis of organic compounds in interplanetary dust

(Subtheme 4), exposure of organic compounds in space..

(Subtheme 5), measurement of space debris at the ISS orbit

(Subtheme 6) and evaluation of ultralow-density aerogel developed for the Tanpopo mission.

EXTREMOPHILIC NATURE DEINOCOCCUS RADIODURANS:

Deinococcus radiodurans is an extremophilic bacterium and one of the most radiation-resistant organisms known.

It can survive cold, dehydration, vacuum, and acid conditions, and therefore is known as a polyextremophile.

This prokaryotic bacterium is red pigmented, nonmotile, and gram positive. The color of the cells reflects the red carotenoid pigment the bacteria produces.

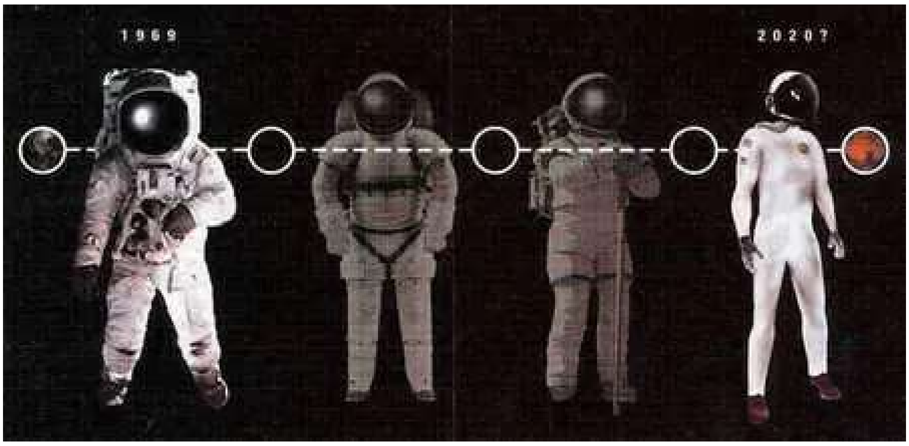
Radiodurans is approximately 1.5 to 3.5μm in diameter and produces smooth, convex colonies that range in color from red to pink.

Holds Guinness World Record for “World’s toughest known Bacterium”.

APPLICATION:

Certain biochemical processes of Deinococcus radiodurans could be replicated in other bacteria and their material can be reinforced. Different kind of chemical process going in Deinococcus radiodurans can be stimulated and placed to action.Replicating the biochemical and genetic process of organism into some bacterial vectors and reinforce of those material in formation of spacesuit .Purely protein filled space suit would be known as protein filled biosuit.

Chemical process occurring in the organism, which could be used during formation of suit.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CONCLUSION:

Thus, for protection during a space expedition astronauts use suits having resiliency towards harmful radiations. However, its heaviness, pricing and selective time condition for radiation resistance have been an issue. To mitigate we are proposing the irradiation of using Deinococcus radiodurans admixture with spacesuit for better yielding in every aspect.

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