Organoids in Space: Applications for Earth and Beyond

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Introduction: With the recent bounds taken by scientists at NASA to grow human brain organoids and prepare them to be sent to space, endless potential has since been opened with regards to research of the human body. Organoids may not only provide invaluable insight into the affects that space travel has on various body systems, but their use in space may also accelerate their growth and increase their value for more general organoid research on Earth. This project explores other organ systems that may be replicated and then studied with organoids, all of which have direct value and importance for study in space and on Earth. These systems are the skeletal, immune, and cardiovascular systems.

Overview/Methods: For each of the three systems described (skeletal, immune, and cardiovascular), methods of organoid development were researched. Then disease modelling within these organoids was explored, as well as applications to their uses in space travel. Research done with brain organoids in space (Fig. 4) takes advantage of the human body's seemingly accelerated aging caused by microgravity, which would increase the efficiency and speed at which various diseases may be studied. While these studies are not the only ones that should be done in this manner, their impacts on human health in space and on Earth are worthy of further investigation.

References:

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Fig. 1

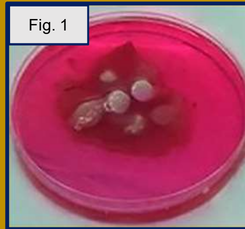

Fig. 2

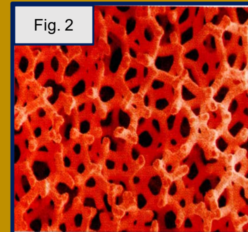

Fig. 1. Courtesy of He et. al, *BMC Biotechnology*. This image depicts a bone tissue organoid developed by the aforementioned researchers, which was later implanted into rat muscle to facilitate successful growth.

Fig. 2. Courtesy of Michael McCarthy, *The Lancet*. This image depicts thymus tissue, for which an organoid has been developed by Mark Poznansky for *Nature Biotechnology*. These organoids recapitulate the ability of the thymus to create T-cells, essential for immune response.

Fig. 3

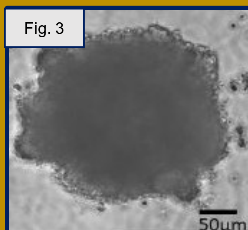

Fig. 4

Fig. 3. Courtesy of Kitsuka et. al, *Plos ONE*. This image depicts phase contrast microscopy of a cardiac organoid developed by the aforementioned research team. These organoids were able to recapitulate the beating and much of the physiology of a heart in vivo.

Fig. 4. Courtesy of Michael Johnson, *NASA*. This image depicts the hardware used in the Space Tango-Human Brain Organoids Investigation. This project explores the response of brain organoids to microgravity, and a similar setup may be used to investigate the other organoids mentioned throughout this project.

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Skeletal System: In order to reduce the threat of bone degradation over prolonged periods of space exposure, bone organoid models could prove immensely useful. Without the constant effects of gravity experienced on Earth, bones lose density at about a rate of 1% per month, putting space travelers at risk for issues such as osteoporosis upon return to Earth (Perez 2016). The growth and analysis of bone organoids (Fig. 1) in space may be used in lieu of research done on astronauts themselves, and will contribute substantially to knowledge about other osteogenic diseases.

Immune System: Due to the differences in the environment aboard ships and the close quarters of the crew, microbes of the body are more apt to transmit from one person to another and put astronauts at risk of suffering from allergies or diseases due to their altered immune systems (Perez 2016). These alterations to the immune system may be explored and analyzed using recent thymus organoid models (Fig. 2), immune organs that produce T-cells to eliminate pathogens such as microbes.

Cardiovascular System: Exposure to galactic cosmic radiation and solar proton events, both of which are common on a lunar or Mars mission, leads to an increased risk of cardiac and circulatory pathologies (Perez 2016). To more safely and efficiently study the effects of this exposure, cardiac organoids (Fig. 3) may prove useful. Research in this field may also contribute to valuable information regarding other degenerative cardiac diseases such as coronary heart disease.