**SPACE BIOLOGY AND THE FUTURE OF THE HUMAN RACE**

Space biology –– even the name of the field sounds like an oxymoron. Little research has been done in space biology, simply because of how difficult (and expensive) it is to get specimens up in space. Moreover, whatever research that does come from such experiments is not easily replicable and thus, often inconclusive.

Yet space biology is a field that deserves to be given more attention, especially if we consider the future of our planet and the human race. Tech mega-moguls like Jeff Bezos and Elon Musk champion space travel as our future; they envision a time where we can take off in search of a new home once this planet becomes uninhabitable. Yet before this science-fiction becomes a reality, less fiction and more science need to happen. And the first question space biologists or anyone interested in space travel must ask is: can humans even colonize space? Our eyes, our cerebrospinal fluids, all of these things that were evolved specifically for the conditions of planet Earth –– are any of these the limiting factors for human space travel?

In 1991, NASA started the Spacelab Life Science Mission to investigate the effects of microgravity on animals and animal development. The ultimate goal was to examine the possibility of human development in space, and essentially determine if humans could one day give birth in space. They blasted over 2,000 jellyfish polyps into space, and induced them to strobilate (to progress through their life cycle from polyp to mature jellyfish). Jellyfish, specifically *Aurelia aurita,* were chosen for the job because of their rapid metamorphosis (less than five days) and the ability of scientists to easily induce metamorphosis in jellyfish by dosing their environment with either iodine or thyroxine.1 Being able to conduct an experiment in space is a privilege; the fact that jellyfish were selected to be grown in space over other animals and experiments demonstrates that NASA believed that this particular study would be illuminating for the future of space travel.

The scientists brought these space jellies back to Earth and compared them to their counterparts and found that there were slightly more jellyfish in the space sample that were unable to swim properly. Scientists hypothesized that microgravity was affecting the development of the jellyfish’s statoliths, or specialized cells that perceive gravity and help orient the jellyfish. Because humans have similar cells, the scientists believed that the jellyfish would serve as a model for humans. If in the future, long-time space travel becomes a reality, humans born and raised in space may struggle returning to Earth or other planets, according to the research of jellyfish in space. As strange as it sounds, jellyfish in space have shown us that perhaps long-term space travel is not as glamorous and as simple as we would like to believe.

Other ways that research on space biology, particularly human physiology in space, is conducted is through Head Down Bed Rest (HDBR) simulations. In these simulations, subjects are required to complete all their daily activities in a bed that places their head at a six-degree tilt from their feet for several months. These studies mimic a zero-gravity environment without having to send people to space. These studies have illuminated many effects of microgravity on humans: loss of accurate spatial orientation, loss of head-eye and hand-eye coordination, muscular atrophy, swelling of the head, loss of bone density, deteriorating bone architecture, among other effects.2 Currently, NASA has a fairly decent understanding of the effects of space on humans for short periods of time (around five/six months, or the length of most space missions and HDRB simulations). Longer than that, however, the amount of research is limited. Here, then, is the frontier of space biology: we do not fully understand how the human body reacts to progressively longer amounts of time in space. Finding the answers to this question is the key to space travel.

NASA is pursuing another research avenue to further their understanding with their twin study of astronauts Scott Kelly and Mark Kelly. One of the twins (Scott) was sent up to space for 340 days while his brother Mark remained on Earth as a control. While full research results have not been released, interesting findings are already emerging. Effects in gene expression, telomeres, and gut microbiome have been observed alongside expected physiological effects such as changes in bone density. Telomeres are DNA caps that protect the ends of our chromosomes, and longer telomeres are generally associated with cell longevity. Scott’s telomeres were observed to *grow* in space –– and once Scott returned to Earth, the length of his telomeres returned to pre-flight levels.3 This interesting and unintuitive finding has prompted NASA to plan a 2018 study of telomere length in ten astronauts. Again, most of the studies here, while interesting, do not offer concrete conclusions due to their small sample size. They do, however, offer interesting suggestions for what the human consequences of space travel will be.

NASA, however, is not the only one invested in human space travel. Both Jeff Bezos and Elon Musk run private space exploration companies that explore the possibility of long-term human space colonization. Bezos is the founder of Blue Origin, a private space company that champions space tourism and space travel. Elon Musk’s company is called SpaceX, and their vision statement writes that their ultimate goal is “of enabling people to live on other planets.”4 Together these companies are the frontrunners in the burgeoning private space exploration industry, and with the help of their money/fame, their vision for the future is rapidly gaining popularity.

Yet it does require a certain kind of arrogance to believe that we can simply escape this world once we make it uninhabitable and find another to colonize. In addition, the reality of space travel is not as chic –– nor as feasible, yet –– as NASA, Bezos, or Musk would have us believe. In the words of Scott Kelly on his first days back on Earth after a year in space,

“I'm seriously nauseated now, feverish, and my pain has gotten worse. This isn't like how I felt after my last mission. This is much, much worse… I wonder whether my friend Misha, by now back in Moscow, is also suffering from swollen legs and painful rashes. I suspect so. This is why we volunteered for this mission, after all: to discover more about how the human body is affected by long-term space flight. Our space agencies won't be able to push out farther into space, to a destination like Mars, until we can learn more about how to strengthen the weakest links in the chain that make space flight possible: the human body and mind.”5

The *idea* of space travel and living on another planet is impossibly alluring. The reality of space travel, and the bodily wear of it isn’t quite as alluring, yet many are working to make us believe in it as our future. And we believe it. We want to make space travel a reality, and so we study jellyfish and gut biomes, all in search of the miraculous –– all in search of a new world.

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