AMSRO
AEROSPACE MEDICINE
STUDENT AND RESIDENT ORGANIZATION

ORBITER NEWSLETTER

A WORD FROM THE PRESIDENT OF THE AEROSPACE STUDENT AND RESIDENT ORGANIZATION

Anita Mantri

Dear returning and new AMSRO Members,

What an amazing year for AMSRO! As we celebrated our 20th anniversary this year, we saw the arrival of a new website, a new logo, new t-shirts, and even an AMSRO-sponsored panel at this year's AsMA conference in San Diego. To all of you who were in attendance at the 2014 conference, thank you so much for representing AMSRO so well! We've definitely left a lasting impression.

In particular, I would like to point out all of the hard work the 2013-2014 officers put in over the past year to make our experience at the 2014 AsMA conference such a success! Angie, Laura, Dana, Joe, Rahul, and Craig, thank you so much for everything you've done in the last 12 months! Each of you played an important role, and I am incredibly grateful.

Our 2014 AMSRO general meeting saw some of the highest attendance numbers we have seen in years! As we discussed during the meeting, we aim to make strides in our efforts to improve connections with AMSRO members throughout the year. In response, we established three new ad hoc committees dedicated to Mentorship, Education, and Outreach. We highly encourage each of you as AMSRO members to become involved in one of these outreach committees or even to serve as a committee chair. We hope to grow AMSRO's potential through this new initiative.

In addition, we hope to gain a greater presence through our social media efforts. If you have not already, please join our Facebook group (https://www.facebook.com/Aerospacemed), follow our Twitter handle (@RocketDocs), and feel free to contribute to the AMSRO conversation. Furthermore, we always encourage you to contribute to our newsletter, the Orbiter, to provide your insight within the field of aerospace and aviation medicine.

If at any time during the year you have an idea, a comment, or a question for any of the AMSRO officers, please do not hesitate to contact us!

Thanks again for a great year! I look forward to seeing you in Orlando!

Sincerely,

Anita Mantri
AMSRO President

OUR EXPERIENCE AT THE UTMB/NASA AEROSPACE MEDICINE SHORT COURSE

Capt. Eric Blacher, MD, MPH
Muska Khpal, MBBS

This past summer we had the opportunity to attend the annual month-long Principles of Aviation and Space Medicine Short Course at the University of Texas Medical Branch (UTMB) in Galveston, Texas. There were thirteen course participants from all over the world, including Japan, Barbados, and the United Kingdom. Amongst our group were several AMSRO members, the Chief JAXA Flight Surgeon, a future Air Force Flight Surgeon, UTMB Aerospace Medicine Residents, medical residents, and medical students from all over the US.

Highlights of this extraordinary four-week experience included a wide range of academic lectures given by worldwide leaders in the field of aviation and space medicine. Some of the many lecture topics included an introduction to the history of aerospace medicine, the impact of aviation and space physiology on the human body, commercial spaceflight topics, and the Physician-Astronaut perspective just to name a few. We also attended aerospace medicine grand-rounds that included talks by NASA crewmembers Scott Parazynski and Serena Aunon at Universities Space Research Association (USRA).

Class participants found ample opportunities to interact with international leaders at organizations such as NASA, the Federal of Aviation Administration (FAA), and National Space Biomedical Research Institute (NSBRI). We were able to gain perspective and insight on careers in aerospace medicine from the astronauts, aviators, administrators, flight surgeons, engineers, and world-class scientists.

In addition, the class toured astronaut and aviator training facilities at JSC, the Neutral Buoyancy Lab, and Flight Safety International, where we "flew" the same aircraft simulators most military and commercial pilots currently train with. We also experienced physiological training at NASA's altitude chamber that simulated the physiological effects of hypoxia at 25,000 feet, and underwent an indoctrination dive in the

NASA hyperbaric chamber. As an added bonus to our experience, our class had the privilege of attending the

ISS 34/35 expedition debriefs at JSC with crewmembers Chris Hadfield and Thomas Marshburn. The course culminated with interesting and diverse oral presentations on various aerospace topics given by our peers. This course was exceptionally exciting, invigorating, and informative, and has left us hungry for more. Anyone interested in aerospace medicine should apply for the Aerospace Medicine Short Course for the opportunity of a lifetime.

MICROGRAVITY AND CELLS
A brief look into the subcellular responses to reduced gravity

Craig J. Kutz

Often in medicine, including aerospace medicine, we sometimes forget that pathologies stem from detrimental changes at the cellular and molecular level. Many in this field are familiar with the challenges that arise in spaceflight, including physical stress, G-forces, radiation, and microgravity. However, let's take a step back and ask the question – ***How exactly do cells react to these stresses in environments such as space?*** **Or** ***what exactly is causing cells to change their normal function as a result of low gravity?*** Just as identifying HPV as the fundamental cause of cervical cancer drastically improved prevention, it is just as important that we understand the underlying cellular changes taking place during space missions to improve medical support of crewmembers. This isn't strictly referring to human cells, since changes are also seen in microbial and plant phenotypes. Therefore, this short review will provide a very brief synopsis of our current understanding into cell morphology and functional changes that take place during weightlessness. Also, this article will describe current strategies researchers use in order to study simulated microgravity on Earth.

Life on Earth evolved and survived under the constant influence of gravitational forces. Thus, it shouldn't be a surprise that our cells struggle to adapt during periods of weightlessness. As a result, detrimental changes in growth, adhesion, migration, differentiation, and apoptosis can occur. Microgravity facilitates these changes through loss of cell convection, minimal sedimentation, reduced hydrodynamic shear forces, and structural disorganization.[1,2] However, modifications in cellular response to mechanical forces (or lack there of) are not an entirely novel concept. For instance, extensive research has been done on mechanotransduction in the cardiovascular system. Something as familiar to us in the medical community as hypertension-induced cardiac hypertrophy is related to a mechanical stimulus, which results in changes in calcium cycling and myocardial signaling. In microgravity, cells sense the altered

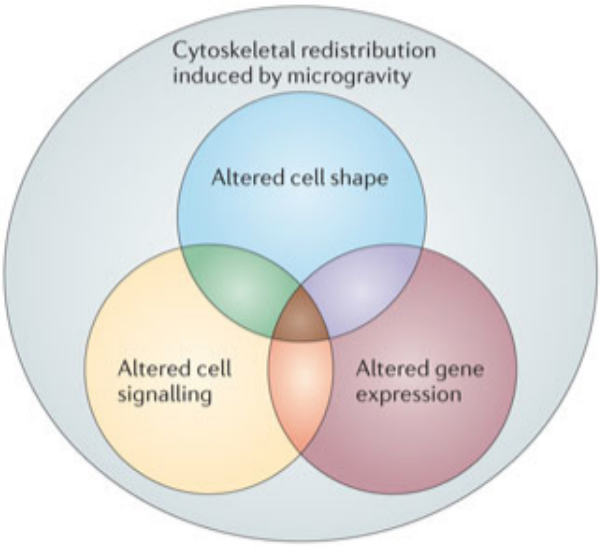

Figure 1. Changes at the cellular level due to microgravity. Becker and Souza. Using space-based investigations to inform cancer research on Earth. *Nature Reviews Cancer.* 13, 315-327 (May 2013).

balance in forces transmitted across the cell membrane through surface adhesion receptors linking the cytoskeleton and the extracellular microenvironment.[1] The field of Tensional Integrity, also known as "Tensegrity", involves the study of cells in states of push-pull within its internal and external environments.[3] An inherent tension placed on structural components within the cell to resist compression imparts spatial integrity and facilitates responsiveness to external stimuli. In regards to spaceflight, microgravity reduces the external load on microfilaments, and alters their gravity-dependent organization within the cell.[3] This can lead to changes in cell shape and architecture, which may influence a cells ability to function properly **(Fig 1)**.

The cytoskeleton is viscoelastic and couples external stimuli to the interior of the cell, and thus, force unloading can lead to modifications of downstream signaling effectors.[1] For instance, surface receptor (eg. integrins) and ion channel (eg. Ca^{2+} channel) activities are modulated by cytoskeletal changes and can regulate gene expression. In 1998, male rats were sent aboard the 17-day NASA STS-90 Neurolab mission and analyzed post-flight for changes in gene expression by DNA microarray.[4] Taylor *et al.* found that a substantial amount of gene expression patterns were altered due to exposure to microgravity, including growth factors, cell cycle regulators, and signal transduction proteins.[4] In addition, specific genetic mouse strains showed greater sensitivity to unloading-induced bone loss, suggesting that genetics may play a partial role in spaceflight-induced changes during reduced gravity.[5] To add to this complexity, recent evidence demonstrated that simulated microgravity modulates enzymes capable of changing gene expression independent of the genome.[6] Therefore, the modifications in gene expression seen during reduced gravity may be multifaceted and highly regulated.

Although characterization of microgravity- and spaceflight-associated alterations in the human proteome are currently being explored, research in space life sciences continues to study what fundamental mechanisms underlay physiologic changes during missions. However, there is a huge limitation in these research endeavours – only a limited amount of experimental samples, at a large cost, can fly aboard the ISS. Yet, researchers have developed a series of resourceful techniques to simulate microgravity on Earth. For instance, a

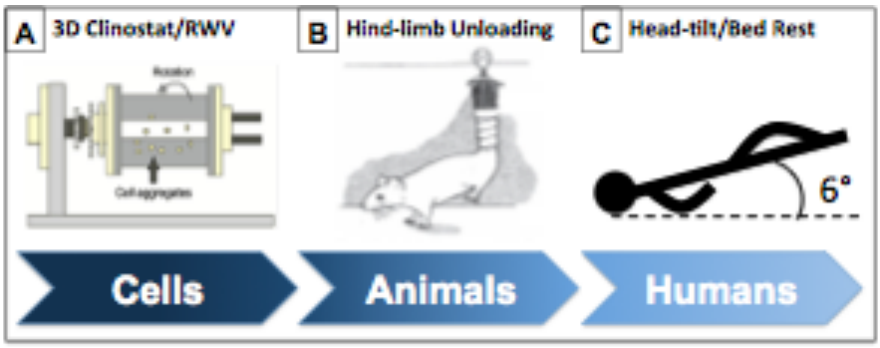

Figure 2. Experimental terrestrial models for simulated microgravity. (A) Barzegrari and Saei. An update to space biomedical research: Tissue engineering in microgravity bioreactors. *BioImpacts*, 2(1), 23-32 (2012). (B) Bone mineral density of rat femurs after hindlimb unloading and different physical rehabilitation programs. *Rev. Ceres*, 58 (4), 407-412 (2011).

Rotating Wall Vessel (RWV) bioreactor or 3D Clinostat can be used to grow cells under near laminar flow and present a state of constant "free-fall" by eliminated directional force vectors **(Fig. 2a).**[1] In addition, *in vivo* studies using Hindlimb Unloading (HUL) rodents are widely used and to date, have enabled extensive understanding of disuse atrophy in multiple organ systems, including the musculoskeletal system. HUL mimics cephalic fluid shifts and elimination of weight-bearing loads as seen in spaceflight **(Fig. 2b)**.[1] Finally, clinical studies with humans performing head down bead-rest for months provide a unique experimental setting to simulate reduced gravity environments (**Fig. 2c)**.[1] Using all three of these model systems provide researchers with options for simulating microgravity in a terrestrial environment.

Clearly, this short review could not touch upon the array of complexities that arise at the cellular and subcellular level during spaceflight, nor portray the depth of these mechanisms. However, the goal was to provide insight into the general challenges and adaptations cells undergo during spaceflight and touch on a few of the techniques currently being used to study them. Understanding the fundamental causes of weightlessness-induced cellular dysfunction will help future preventative measures for flight crew on long duration missions. For further information on research being performed through the NASA Space Biosciences Divisions, please visit http://spacebiosciences.arc.nasa.gov/.

Craig Kutz is a fourth year MD/PhD candidate in the Medical Scientist Training Program at the Medical University of South Carolina working in the Department of Drug Discovery and Department of Cardiology. He is the current AMSRO Vice President and an active member for 2 years.
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UPCOMING OPPORTUNITIES

INTERNATIONAL SPACE UNIVERSITY (ISU)
ISU is hosting its 2014 Summer Studies Program in Montreal, Quebec, Canada. A variety of scholarships are available through the Canadian Federation of ISU, the National Space Society, and the International Space University. The 2014 Summer Studies Program will convene in Montreal, Canada and applications are accepted on a rolling basis.

INTERNATIONAL ASTRONAUTICAL CONGRESS (IAC)
All eyes will be on Toronto, Ontario, Canada for the annual meeting of the International Astronautical Congress (IAC) in 2014. Students and young professionals can be sponsored through their national space agency through International Space Education Board (ISEB). NASA, CSA, ESA, and JAXA offer a variety of scholarships; as well there are youth grants that are given on a competitive basis through the International Astronautical Federation committee.

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