Title: Fostering space cooperation in Asia-Pacific through space medicine and biology
Topic: Fostering regional cooperation in space technology development and utilization
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Across the mountainous city of an island in the Pacific, a motorcycle was roaring past villages in the moonlight. It was carrying a mother who just gave birth to her seventh child. The mother bled to death at midnight after a two-hour drive to the hospital. This is a true story of how one of my mother's female workers died. It alarmed me how such a drastic death could still occur in this modern age and especially in a city like ours. That thought remained with me until I found out that a Non-Inflatable Anti-Shock Garment made from astronaut spacesuits was developed a few decades ago to save mothers from dying of post-partum haemorrhage in Asia-Pacific.[1] Then, I thought how are such life-saving technologies not widely utilised to save lives?

Space Medicine and Biology in Asia-Pacific

Several space technologies have been utilised to improve healthcare on Earth, especially in Asia-Pacific where the need for remote care technologies is still essential. Most are space medicine technologies such as telemedicine and the ISS ultrasound, which are being used to conduct accurate and portable diagnostics in low-resource settings.[2] While nowadays, non-medical space technologies have been deemed useful for healthcare such as utilising satellites for vector surveillance and control of endemic infectious diseases in the Philippines and Vietnam. Several technologies have actually been developed and research has been conducted in Asia-Pacific with regards to space medicine and biology (see Figure 1).[3] Recently, Dr Naoyuki Ishikita from Japan even developed a 3D-printed ventilator that was printed Made in Space in the International Space Station and tested by Astronaut Peggy Whitson.[4] However, this was also not widely-utilised during the COVID-19 pandemic when hospitals were struggling to acquire ventilators for millions of patients all over Asia-Pacific.

[1] C. Brees et al., "A Non-Inflatable Anti-Shock Garment for Obstetric Hemorrhage," *International Journal of Gynecology & Obstetrics* 87, no. 2 (November 1, 2004): 119–24, https://doi.org/10.1016/j.ijgo.2004.07.014.
[2] David S Martin et al., "Ultrasound in Space," *Ultrasound in Medicine & Biology* 29, no. 1 (January 1, 2003): 1–12, https://doi.org/10.1016/S0301-5629(02)00692-0; Vikram Kapur and Alex Boulton, "Covid-19 Accelerates the Adoption of Telemedicine in Asia-Pacific Countries," April 27, 2020, https://www.bain.com/insights/covid-19-accelerates-the-adoption-of-telemedicine-in-asia-pacific-countries
[3] Florence Pauline Basubas et al., "Framework for Regional Cooperation, Capacity-Building, and Competitiveness in Space Medicine and Biology Research in Asia-Pacific," accessed October 28, 2022, https://iafastro.directory/iac/paper/id/71254/summary/.
[4] Naoyuki Ishikita, "COVID Ventilator - Making a Manual for the 'VapoJET', accessed October 28, 2022, https://www.avatarmedic.com/post/covid-ventilator

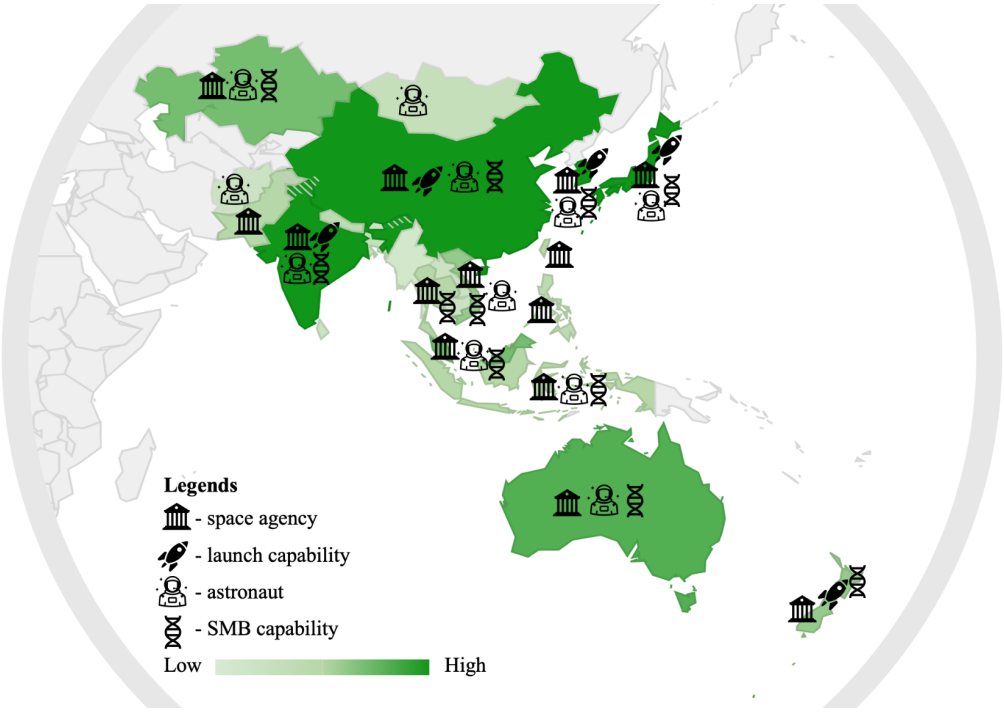

Fig. 1. Current capabilities of APAC countries in space medicine and biology

Need for a Shared Long-term Space Development Vision and Roadmap

For years, space technologies have been useful in the advancement of healthcare and further research. Meanwhile, the development of space medicine and biology on Earth has led to the advancement of astronautics and the survival of humans in space. With its diversity and competence, Asia-Pacific has a favourable landscape in leading space development through space medicine and biology. Literally, Asia-Pacific has several terrains (e.g. Himalayas, Mongolia, Australia) that are geosimilar to outer space environments (e.g. Mars, Moon), which are beneficial for analogue astronaut programs.[5] There are also several countries in Southeast Asia that are near the equator and are suitable for launching orbital research and crewed missions. Moreover, Asia-Pacific is home to a competitive biotechnology landscape not only in medicine but also in other areas, such as agriculture and environmental management, which could be useful in developing *in situ* utilisation technologies. Lastly, with centuries of history in traditional medicine, Asia-Pacific is a source of knowledge for drug discovery and manufacturing in space.

[5] Siddharth Pandey et al., "Ladakh: Diverse, High-Altitude Extreme Environments for off-Earth Analogue and Astrobiology Research," *International Journal of Astrobiology* 19, no. 1 (February 2020): 78–98, https://doi.org/10.1017/S1473550419000119; Goro Komatsu, James M. Dohm, and Trent M. Hare, "Hydrogeologic Processes of Large-Scale Tectonomagmatic Complexes in Mongolia–Southern Siberia and on Mars," *Geology* 32, no. 4 (2004): 325, https://doi.org/10.1130/G20237.2.

Regional Framework for Space Medicine and Biology Cooperation

Despite all of the advantages and opportunities of developing space medicine and biology in Asia-Pacific, there has been very minimal development in the three niche opportunities mentioned above. The lack of regional cooperation has led to disparities in the capabilities and development of space medicine and biology across the region. After considering the significant challenges of cooperation between the sub-regions and nations within Asia-Pacific, Basubas et al. developed a Regional Framework for Space Medicine and Biology Cooperation, patterned after Ho's suggestion that an *ad hoc long-term non-exclusive approach* to space cooperation is the most ideal for Asia-Pacific.[6] The most successful example of this approach has been the Asia-Pacific Regional Space Agencies Forum (APRSAF), which is why a Space Medicine and Biology (SMB) Working Group under APRSAF was proposed to be the coordinating body of such a framework. The SMBWG is aimed to organize space medicine and biology cooperation following the guiding principles of space law instruments. It will also coordinate both further research and development of space medicine and biology, as well as the safe utilisation of space technologies to improve lives The framework will encompass the fields of: a) Radiation Biology, b) Preventive Medicine, c) Synthetic Biology & Regenerative Medicine, d) Omics Research, e) Food Safety Research, f) Biosensors & Edge Computing Research, g) Telemedicine & Robotics, h) Drug Discovery and Astropharmaceuticals (see Figure 2). As spacefaring nations continue to advance their biomedical research capabilities, a coordinated effort will be needed to improve their competitive advantage with regard to economic growth and R&D-fostered innovation.

[6] David L.X. Ho and Eren Gorur, "SPACE AMONGST THE GIANTS: A NEW COURSE FOR ASIA-PACIFIC SPACE COOPERATION," *68th International Astronautical Congress*, no. IAC-17-E3.1.10 (2017).

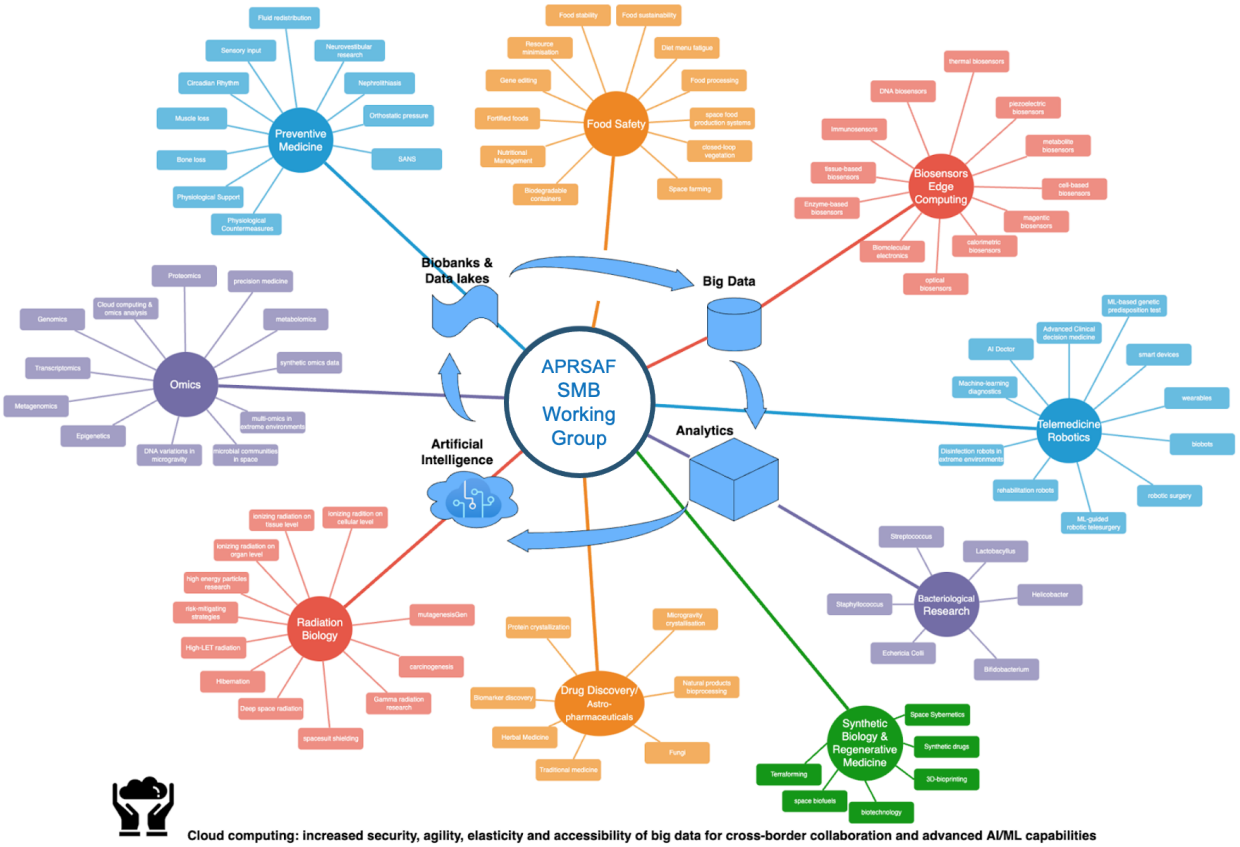

Fig. 2. Framework for Regional Cooperation, Capacity-building, and Competitiveness in Space Medicine and Biology Research in Asia-Pacific

Space cooperation in Asia-Pacific is a complex endeavour embroiled with various geopolitical, cultural, social, and economic differences. Improving lives, particularly in health, especially after the COVID-19 pandemic, is a great way for the entire region to have a shared purpose in space development. Human health is also very important in the colonization of space and developing space medicine and biology will be essential for nations to participate in such an endeavour. Having a regional framework in space medicine and biology will be the first step for the region to inspire such cooperation, providing opportunities for space powers to facilitate the advancement of space medicine projects and empowering the participation of emerging space nations.