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CASE STUDY

A Space Health Education Curriculum for MD Students at the University of Melbourne (Australia)

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Abstract: **Background**: Since 2022, the University of Melbourne's 4-year MD program has integrated a "Discovery" subject stream with core subjects and clinical placements. "Human Health in the Space Environment (HHiSE)"—one of seven MD1 flagship topics—launched in March 2022; the author curated its content and co-developed an engaging interactive online curriculum with learning designers via the flipped classroom approach. **Description**: This 24-week "mission-based" course is divided into systems-based blocks (e.g., Foundation, Cardiovascular, Respiratory). Students learn through "spacewalks" (learning resource sets), interactive tutorials, "Meet an Expert" virtual lectures, and the NASA/LEGO "Build to Launch" program (for teamwork training). It also explores "Space4Health" and translational space health research via "spinoffs," with three assessments focused on building students' public science communication skills. **Discussion**: This innovative course introduces students to human physiology in extreme environments and aerospace medicine, serving as a stepping-stone for training a space-enabled medical workforce. Its foundational template could be expanded to more space health subjects, adapted for public online access, or used for international collaborations to develop similar courses.

Keywords: Human Health in the Space Environment (HHiSE), space medicine, Space4Health, flipped classroom

1 Introduction

Since 2011, the University of Melbourne has offered a four-year MD (Doctor of Medicine) program. In 2021, the MD program was restructured to make it more modular and accessible. This included removing pre-requisite subjects for admission, and the introduction of clinical time and research training into MD1 (Melbourne Medical School, 2022). The new integrated 'for credit' Discovery subject stream forms an additional innovative component running alongside the core subjects and clinical school placements (Melbourne Medical School, 2024). It now weaves through the entire four years of the MD program, finally being introduced at MD4 level in 2025 (The University of Melbourne, 2025).

The Discovery stream is designed to be both horizontally and vertically integrated into the MD program. Course timing, structure, assessments, and delivery mode are standardised and designed to be consistent between subjects. While Discovery itself is compulsory, students are offered topic choices, some forming pathways that students can follow through their medical degree. Some alternative Faculty subject choices are also offered in MD1 and 2 (Melbourne Medical School, 2024). Vertical integration comes from (1) Discovery pathways, and (2) each year Discovery conceptually building on prior learning, recognising student progression as developing health professionals. The overall Discovery structure is summarised in Table 1.

During 2021, expressions of interest in developing new MD1 Discovery subjects for launch in 2022 were sought from academic staff. Although the author had been advocating for the introduction of a 'space health' subject for several years, the new Discovery stream presented the first concrete opportunity to pitch this idea. "*Human Health in the Space Environment*" ("HHiSE") was chosen as one of the seven 'flagship' Discovery topics for MD1, and launched in early March 2022. By the end of 2025, around 100 medical students will have gained a foundational understanding of human physiology in space. Table 2 contains the breakdown of student numbers relative to the MD1 cohort (Medical Deans Australia and New Zealand, 2025) over the four years that the course has been running. Some students commenced the subject but withdrew subsequently for various reasons.

Table 1 Outline of the MD Discovery subject structure (Melbourne Medical School, 2024)

Subjects by year	Description	Annual Credit (%)
Discovery 1: Foundation	Develop a foundation of knowledge and understanding in your topic of choice.	12.5
Discovery 2: Application	Apply your learning to the clinical setting.	12.5
MD3/4 Research Scholar pathway		
Discovery 3: Research Scholar	Advance your knowledge and skills in the design and conduct of research.	12.5
Discovery 4: Research Scholar	Collect, analyse and interpret data and then present your findings in the form of a journal article-style report, conference poster and oral presentations.	50
MD3/4 Clinical Scholar pathway		
Discovery 3: Integration	Integrate multiple concepts into your practice of medicine.	12.5
Discovery 4: Clinical Scholar	Utilise and apply your MD Discovery learning to, for instance, create a new process, research paper or patient education.	50

Table 2 HHiSE student numbers relative to the MD1 cohort

Year	MD1 Discovery options	HHiSE	Total MD1	HHiSE %
2022	7	32	356	9.0
2023	8	22	359	6.1
2024	8	24	355	6.8
2025	9	19	383	5.0
Total		*97*	*1,453*	*6.7*

2 Course overview

Despite set credit requirements for MD1 Discovery, there are several structural options for duration and calendar timing, all providing buffers at the start and end of the academic year, thus allowing students to focus on core activities. The biomedical science content in the main MD1 subject, "*Foundations for Clinical Practice*", is based around physiology blocks spread across approximately 36 weeks during the calendar year (University of Melbourne, 2024). To support and reinforce core learning, a parallel approach is taken for the 24 weeks of HHiSE, aligning topic blocks as far as feasible (with annual variation). This alignment is beneficial, as students can gain both an understanding of normal human terrestrial physiology and how this extrapolates into their understanding of the physiological adaptations that occur in the space environment.

As some University of Melbourne MD students undertake their entire medical degree at a rural clinical school in Shepparton in northern Victoria (University of Melbourne, 2025), it is a diversity and inclusion requirement that the course is universally accessible, and thus is wholly conducted online via the 'Canvas' learning platform and virtual teleconferencing.

Although a general Canvas template for the layout of the new Discovery subjects was followed, latitude was provided to the lead academic/s and learning designers in terms of maximising visual appeal and engagement. This allowed the subject to be badged as a 24- week 'mission', with its own mission patch and space-related iconography throughout. Each block follows a standard on-screen layout with drop-down tabs and descriptive tiles linked to related content, with the iconography and content being adapted to fit each specific topic. Students receive a 'Certification of Successful Mission Completion' at the end of the course.

The Home Page ('Mission Control') has tabs for 'Welcome', 'Mission Outcomes' (learning outcomes), 'Meet your Crew' (lecturer and guest speakers), 'Requirements' (assessments), 'Schedule', 'Uniform' (mission patch and merchandise), 'Health' (student support services), and 'Attendance, SLOA (Special Leave of Absence–which students must apply for in order for absences to be approved), Late Submission and Extensions and Policy'. There are tiles for 'Prepare for Launch' (an introductory video) and for each of the eight topic blocks, as well as a link to the materials for the incorporated NASA/LEGO "*Build to Launch*" program (LEGO Education, 2024).

It is an overarching aim of the subject to encourage students to foster their curiosity, imagination and creativity, and to deepen their collaborative teamwork skills. These skills can be regarded as very important for both space exploration and working in the health professions. Recurring inspirational resources are utilised to support this aim, including quotations, videos, posters, and photographs. The Latin motto on the mission patch, "*Curans bonum valetudinem hominum in caelos, lunae et martis*" ("*Caring for good health of humans who fly out into the heavens, to the Moon and Mars*") is in itself an inspirational prompt to consider the aspirational purpose behind learning about human health and wellbeing in the space environment.

The central components of the course include: (1) the learning resources for the eight topic blocks: (**Semester 1**) *Foundation* (space as an extreme environment, and the history of human spaceflight)*, Cardiovascular, Respiratory,* and *Gastrointestinal,* (**Semester 2**) *Metabolism and Immunity, Musculoskeletal/Renal, Neuroscience*, and *Reproduction*; (2) a virtual tutorial and a one-hour 'Meet an Expert' session for each block; (3) incorporation of the NASA/LEGO "*Build to Launch*" (*Artemis I*) 'STEAM Exploration Series'[8] to enable students to learn about the teamwork and collaboration essential for successful space missions; and (4) three group and individual assessments.

The incorporated LEGO "*Build to Launch*" program consists of three main components: (1) a series of nine animated and live-action videos that students watch progressively across Semester 1; (2) 'thought-based' activities' relating to the video topics that form the basis for the first assessment, a collaborative group video presentation; and (3) 'design-based' activities, that form the basis of two special collaborative design tutorials in Semester 2.

There are five key learning outcomes that are addressed through the subject content and assessments:

(1) Describe how human physiology adapts to the space environment;

(2) Understand the important role that gravity plays in normal physiological homeostasis;

(3) Identify the major physiological and psychological challenges for humans living and working in space;

(4) Describe some of the countermeasures currently in use and recognise their terrestrial translational potential;

(5) Understand that lessons are learned from both the history of human spaceflight and ongoing research.

As a philosophical approach, the course content undergoes a 'continuous improvement' process, with reflection particularly focused on the effectiveness of the small group tutorial activities, guest speaker performance, and the core assessments. Student feedback opportunities are provided at the end of each block tutorial and at the end of the year. Assessment revisions are subject to a peer-review approval process. The key learning content and resources are updated at least annually to incorporate more recent publications and important developments. The Medical School also undertakes an end-of-year voluntary student survey for each separate subject.

3 Course content by block

Each block was extensively researched to locate accessible resources that are pitched at a suitable level for the students. The curated course materials rely heavily on websites, videos, textbooks, and journal articles offered up by international space agencies and experts.

Each block ('Mission') is laid out based on a standard template, with tabs on the home page for 'Introduction', 'To-Do List' (key dates and tasks), 'Inspiration', and 'Extension' (additional optional resources for students to explore). Individual tiles are provided for the 'Mission Roundtable/Debrief' (tutorial), 'Extravehicular Activities' (core learning resources), the 'Meet an Expert' session, and additional relevant activities, such as the "*Build to Launch*" program and 'Spinoff' resources relevant for the third assessment (discussed in more detail below).

The 'Extravehicular Activities' ("EVAs") are also referred to as 'Spacewalks'. Aside from the Foundation block, which has two 'Spacewalks', all other blocks have a single 'Spacewalk'. Students can complete the core learning resources in their own time, and are expected to be able to bring what they have learned together for the small group discussion during the tutorials at the end of each block.

The EVAs have their own sets of standardised tabs. There is a set of overview tabs, 'Introduction', 'To Do List', and 'Photograph' (for inspiration). Underneath this there is a further set for the EVA content: 'Start Here' (introduction), 'Spacewalk Aims' (learning outcomes), 'Explore' (core learning resources), 'Discuss' (six Padlet-based discussion points to reinforce collaborative learning), 'Review' (reinforcing activities, including quiz questions and crosswords), and 'Extra

Resources' (optional topical content to extend student learning). The learning resources are divided into topics specific to each block, and presented sequentially for students to work through. Resources commonly include web pages, videos, and journal articles, and are in some cases interspersed with quiz questions to reinforce learning. Table 3 outlines the learning topics for each block.

Table 3 Learning resource topics for each block

Primary Category	Secondary Category	Tertiary Topics (Specific Content)
Foundation Block	Space as an Extreme Environment	• Warm-up • Extreme environments • Atmosphere, pressure, altitude, and temperature • Space Radiation • Staying alive in space • Gravitational forces, 'free-fall', and 'weightlessness'
	A Brief History of Human Spaceflight & Ongoing Hazards	• Sailing across the skies • History, future plans and visions • The International Space Station • The Five hazards of human spaceflight
Human System Topics	Cardiovascular System in Space	• Hydrostatic pressure, gravity, and baroreceptors • The cardiovascular system in space – overview • 'Puffy face and bird legs' – fluid shifts in microgravity • Cardiac arrhythmias in space • Changes in blood components and production in space • Blood flow and venous thrombosis • Research studies: the cardiovascular system and spaceflight • Orthostatic hypotension and countermeasures
	Respiratory System in Space	• An expert overview – Professor Kim Prisk and colleagues • Lunar dust resources • Respiratory research in space • Spacesuits and spacewalks • Depressurisation and decompression sickness
	Gastrointestinal System in Space	• The gastrointestinal system response to spaceflight • The gut microbiome • Dental care in space • Food and nutrition • Growing plants in space
	Metabolism and Immunity in Space	• Metabolic health in space • The stress response and oxidative stress • Hibernation in deep space • Immunology in space • Space microbiology
	Musculoskeletal System in Space	• The musculoskeletal system in microgravity • Bone loss in microgravity • Muscle loss in microgravity • Back pain in space and in terrestrial bed-rest studies • Musculoskeletal injuries and rehabilitation • Renal stones
	Human Brain and Behaviour in Space	• Neuroscience - the brain in space • Space motion sickness • Vestibular and sensorimotor responses • Special senses • Fluid shifts, intracranial pressure, and vision problems • Behavioural health and wellbeing
	Reproductive Health in Space	• The effects of microgravity and space radiation on reproductive function • Gender-based differences • Gynaecological issues, birth control and menstruation • Practical and ethical challenges for reproduction in space

4 The 'flipped classroom'

As the course delivery is required to be wholly online, the 'flipped classroom' approach has been adopted. This approach 'flips' upside down the traditional idea of didactic educator-led instruction being followed by 'homework'. Students first complete preparatory online learning activities in their own time, and then come together with the educator as facilitator and their classmates to engage in interactive reinforcing activities, such as small group discussion (Hew & Lo, 2018). This concept is well-suited to the combination of a virtual learning platform such as Canvas and online teleconferencing platforms that allow for 'breakout rooms' to facilitate small group discussion during tutorials. Figure 1 demonstrates how the 'flipped classroom' is applied to the activities for each block.

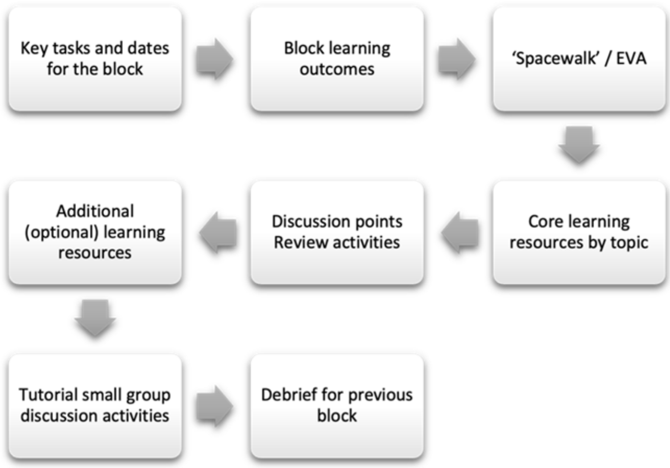

Figure 1 Applying the 'flipped classroom'

5 Tutorials

Each block contains a virtual tutorial (referred to as a 'Mission Roundtable/Debrief') and a 'Meet an Expert' session. Student attendance at both is compulsory. Aside from the introductory tutorial in the Foundation block, tutorials are held at the end of each block to maximise the opportunity for students to complete the learning activities and then reinforce these through the tutorial activities. Each tutorial commences with a short inspirational YouTube video, followed by an allocated student-led recap of the key learning points from the previous block. Small block-related group activities in virtual breakout rooms account for the remainder of the tutorial time. There are two dedicated interactive tutorials in Semester 2 for the collaborative LEGO "*Build to Launch*" 'design-based' activities. Each block-specific tutorial concludes with a debriefing opportunity for the students to provide feedback about the previous block.

The 'Meet an Expert' series consists of one-hour interactive online sessions that provide an opportunity for students to hear a talk from a local or international expert, and ask questions. Speakers have included Australian, US-based, and other international experts, with some recurring presenters. Subject to consent, the sessions are recorded and uploaded to YouTube as an open-access aerospace medicine education and outreach initiative (The ad astra vita project, 2024).

6 Assessments

While the core characteristics of the three assessments, including the general description, percentages, and timing is standardised across Discovery subjects, topics are subject-specific. For HHiSE, the assessment tasks are designed to build the skills of the students in science communication, and include a group video presentation due at the end of Semester 1 based on the LEGO "*Build to Launch*" program, a written article to introduce 'space health' to a general audience (due late in Semester 2), and a final individual 'Space4Health' presentation on 'spinoffs' to demonstrate the translational power of space research for health on Earth (due after the course end-date) that includes a peer-review component. A detailed rubric has been prepared for each assessment to ensure a standardised approach to marking. In MD1, as assessments are on a "pass/fail" basis to reduce competitive pressure on students and enhance their learning experience, all students have thus far successfully completed the three assessments.

A key student objective listed for each block in support of the second and third assessments is the preparation of two short digital 'ePortfolio' reflections. The first is to reflect on the key learning points from the block, and the second is to reflect on the translational research aspects and/or 'spinoffs' that could be used to improve the health of people here on Earth. All assessment tasks are required to be pitched at an accessible level for members of the general public. As such, there is a secondary aim to give students experience with preparing outputs that could be presented as part of a space event or conference, or utilised for outreach purposes.

7 Conclusion

HHiSE is one of only a handful of university courses globally focusing on space medicine, and the first of its kind in the southern hemisphere specifically designed for medical students. In the English-speaking world, it appears there are currently only two other space medicine programs for academic credit offered to medical students – the *Space Medicine Pathway* at Baylor College of Medicine, Texas, USA (Center for Space Medicine, 2025), and the *Aerospace Medicine Medical School Concentration* at the University of Texas Medical Branch, USA (UTMB Health, 2024).

Now running for the fourth time, HHiSE has demonstrated its value in providing solid foundational knowledge relating to human health and wellbeing in space. This innovative course provides an opportunity to introduce students to human physiology in extreme environments, and aerospace medicine as a discipline. During fifteen years of teaching in the medical school, many students have remarked that they did not know that aerospace medicine "was a thing" until it was mentioned by the author. As a result, the course also functions as a stepping-stone in training and building a future space-enabled workforce. With growing international interest in space activities and expanding commercial spaceflight opportunities for both professional astronauts and civilian spaceflight participants, this comprehensive introductory space health course would potentially be of benefit to any aspiring aerospace medicine practitioner.

Although a Discovery space health pathway has been precluded in the current setting due to the requirement for clinical placements in MD2 and 3 Discovery subjects, the online learning template that has been developed would have the potential to be adapted for further space health offerings, whether as part of a multi-level academic pathway or otherwise. As the author has received many enquiries from interested external parties about undertaking the course, developing a 'massive open online course' (University of San Diego Professional and Continuing Education, 2024) ("MOOC") version could potentially have considerable global appeal.

In terms of developing further space health subjects, the potential topics are limited only by imagination. However, to give some examples as a possible starting point, future focus areas might include examining the practical challenges relating to clinical medicine and surgery in space, translational space health, and formal research projects. Participating in international research endeavours could be particularly beneficial for students at any level.

Since launching the subject, the author has devoted considerable effort to sharing openly with others what has been achieved. This has included in-person presentations in Australia, the US, and Europe, poster presentations, international virtual presentations, and short news articles. The innovative nature of this space health course has been recognised through the Australian Space Awards. International awareness of the now-demonstrated successful track record might perhaps also open up opportunities to collaborate with other academic institutions around the world that are interested in making space health education available to their own students.

Conflicts of interest

The author is a current employee of the University of Melbourne, but otherwise has no potential conflicts of interest to declare with respect to the research, authorship, and/or publication of this article.

References

Center for Space Medicine. (2025). Space Medicine Education. Baylor College of Medicine (BCM). https://www.bcm.edu/academic-centers/space-medicine/education

Hew, K. F., & Lo, C. K. (2018). Flipped classroom improves student learning in health professions education: a meta-analysis. BMC Medical Education, 18(1). https://doi.org/10.1186/s12909-018-1144-z

LEGO Education. (2024). Build To Launch: A STEAM Exploration Series In collaboration with NASA and the Artemis I Mission. https://education.lego.com/en-us/build-to-launch

Medical Deans Australia and New Zealand. (2025). Data Dashboard. https://medicaldeans.org.au/data

Melbourne Medical School. (2022). Towards 2022: The new Doctor of Medicine. The University of Melbourne. https://medicine.unimelb.edu.au/news-and-events/towards-2022-the-new-doctor-of-medicine

Melbourne Medical School. (2024). MD Discovery. The University of Melbourne. https://medicine.unimelb.edu.au/school-structure/medical-education/study/md-discovery#overview

The *ad astra vita* project. (2024). Human Health in the Space Environment – 'Meet an Expert' talks. https://www.youtube.com/playlist?list=PL4PAynk-yILu0NxQcB9D4IfcV1B8Cc29B

The University of Melbourne. (2025). MD Discovery 4: Research Scholar (MEDS90044). The The University of Melbourne. https://handbook.unimelb.edu.au/subjects/meds90044

University of Melbourne. (2024). Doctor of Medicine. https://study.unimelb.edu.au/find/courses/graduate/doctor-of-medicine/structure/#nav

University of Melbourne. (2025). Rural Pathway to the Doctor of Medicine. https://study.unimelb.edu.au/lp/mdhs/md-rural-pathway

University of San Diego Professional and Continuing Education. (2024). What is a MOOC? [Explained + 6 Point Guide]. University of San Diego. https://pce.sandiego.edu/what-is-a-mooc-explained-6-point-guide

UTMB Health. (2024). Aerospace Medicine Medical School Concentration. https://www.utmb.edu/spph/aerospace-medicine/asm-concentration