References

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1. Rooney, Bridgette V., Brian E. Crucian, Duane L. Pierson, Mark L. Laudenslager, and Satish K. Mehta. "Herpes Virus Reactivation in Astronauts during Spaceflight and Its Application on Earth," *Frontiers in Microbiology* 10, no. 16 (February 7, 2019).
2. Zwart, Sara R., Steven S. Laurie, John J. Chen, Brandon R. Macias, Stuart M. C. Lee, Michael Stenger, Bart Grantham, Knox Carey, Millennia Young, and Scott M. Smith. "Association of Genetics and B Vitamin Status with the Magnitude of Optic Disc Edema During 30-Day Strict Head-Down Tilt Bed Rest." *JAMA Ophthalmology* 137 (August 15, 2019).
3. Krittanawong, Chayakrit, Nitin Kumar Singh, Richard A. Scheuring, Emmanuel Urquieta, Eric M. Bershad, Timothy R. Macaulay, Scott Kaplin et al. "Human Health During Space Travel: State-Of-The-Art Review." *Cells* 12, no. 1 (December 22, 2022).
4. NASA Human Research Program. "Integrated Path to Risk Reduction."
5. Zarana S. Patel, Tyson J. Brunstetter, William J. Tarver, Alexandra M. Whitmire, Sara R. Zwart, Scott M. Smith, and Janice L. Huff. "Red Risks for a Journey to the Red Planet: The Highest Priority Human Health Risks for a Mission to Mars." *npj microgravity* 6 (November 5, 2020).
6. NASA. *NASA's Management and Utilization of the International Space Station*. (July 30, 2018).
7. NASA. *NASA's Efforts to Manage Health and Human Performance Risks for Space Exploration*. (October 29, 2015).
8. NASA. *NASA Aerospace Safety Advisory Panel Annual Report for 2018* (January 1, 2019).
9. Bizzarri, Mariano, Paolo Gaudenzi, and Antonio Angeloni. "The Biomedical Challenge Associated with the Artemis Space Program." *Acta Astronautica* 212 (November 2023).
10. National Academies of Sciences, Engineering, and Medicine. *Thriving in*
11. *Space: Ensuring the Future of Biological and Physical Sciences Research: A*
12. *Decadal Survey for 2023-2032*. The National Academies Press, 2023.
13. NASA Human Research Program. Risk Hierarchy website.
14. NASA. Risk of Adverse Health Outcomes & Decrements in Performance due to inflight Medical Conditions website.
15. NASA. We do not have quantified knowledge bases and modeling to estimate medical risk incurred on exploration missions website.
16. Garrett-Bakelman, Francine E., Manjula Darshi, Stefan J. Green, Ruben C. Gur, Ling Lin, Brandon R. Macias, Miles J. Mckenna et al. "The NASA Twins Study: A Multidimensional Analysis of a Year-Long Human Spaceflight." *Science* 364, no. 6436 (April 12, 2019).
17. Zimmer, Carl. "Scott Kelly Spent a Year in Orbit. His Body Is Not Quite the Same." *The New York Times* (April 11, 2019).
18. Atkinson, Nancy. "'Seeing' Cosmic Rays in Space." Phys.org (April 20, 2012).
19. Nelson, Gregory A. "Space Radiation and Human Exposures, a Primer." *Radiation Research* 185 (March 28, 2016).

20. Chancellor, Jeffery, Graham B. I. Scott, and Jeffrey P. Sutton. "Space Radiation: The Number One Risk to Astronaut Health beyond Low Earth Orbit." *Life* 4, no. 3 (June 10, 2014).
21. Committee on Assessment of Strategies for Managing Cancer Risks Associated with Radiation Exposure During Crewed Space Missions. *Space Radiation and Astronaut Health: Managing and Communicating Cancer Risks*. The National Academies Press (2021).
22. Kuhlman, B., S. J. Walker, C. Langefeld, T. Pardee, M. A. Coleman, F. Zenhausern, M. G. Almeida-Porada, P. F. Wilson, and C. D. Porada. Novel Models to Monitor in vivo Effects of SPE/GCR Radiation on human Hematopoietic and GI Systems. Wake Forest School of Medicine.
23. NASA Space Radiation Analysis Group. What is Space Radiation? website.
24. Nelson, Gregory A., Lisa Simonsen, and Janice L. Huff. "Evidence Report: Risk of Acute and Late Central Nervous System Effects from Radiation Exposure." Human Research Program Space Radiation Program Element (January 1, 2016).
25. Nelson, Greg. "Space Radiation Overview." TRISH Red Risk School.
26. Zeitlin, C., D. M. Hassler, F. A. Cucinotta, B. Ehresmann, R. F. Wimmer-Schweingruberd, E. Brinza, and S. Kang. "Measurements of Energetic Particle Radiation in Transit to Mars on the Mars Science Laboratory." *Science* 340, no. 6136 (May 31, 2013).
27. Jones, Jeff. "Radiation Risks from a Flight Surgeon's Perspective." TRISH Red Risk School.
28. Kennedy, Ann R. "Biological Effects of Space Radiation and Development of Effective Countermeasures." *Life Science Space Research* 10, no. 43 (April 1, 2014).
29. Norbury, John W., Tony C. Slaba, Sukesh Aghara, Francis F. Badavi, Steve R. Blattnig, Martha S. Clowdsley, Lawrence H. Heilbronn et al. "Advances in Space Radiation Physics and Transport at NASA." *Life Sciences in Space Research* 22 (August 2019).
30. Committee for Evaluation of Space Radiation Cancer Risk Model. "Technical Evaluation of the NASA Model for Cancer Risk to Astronauts Due to Space Radiation." National Research Council (January 27, 2012).
31. "Space Radiation Roundtable." TRISH Red Risk School website.
32. Chancellor, Jeffery C., et al., "Limitations in Predicting the Space Radiation Health Risk for Exploration Astronauts." *Microgravity* (April 3, 2018).
33. Slaba, Tony C., Amir A. Bahadori, Brandon D. Reddell, Robert C. Singleterry, Martha S. Clowdsley, and Steve R. Blattnig. "Optimal Shielding Thickness for Galactic Cosmic Ray Environments." *Life Sciences in Space Research* 12 (February 2017).
34. Kennedy, Ann R. "Biological Effects of Space Radiation and Development of Effective Countermeasures." *Life Science Space Research* 10, no. 43 (April 1, 2014).
35. Cucinotta, Francis A. Myung-Hee Y. Kim, Lori J. Chappell, and Janice L. Huff. "How Safe Is Safe Enough? Radiation Risk for a Human Mission to Mars," *PLoS ONE* (October 16, 2013).
36. NASA. Space Radiation Risks, website.
37. Afshinnekoo, Ebrahim, Ryan T. Scott, Matthew J. MacKay, Eloise Pariset, Egle Cekanaviciute, Richard Barker, Simon Gilroy et al. "Fundamental Biological Features of Spaceflight: Advancing the Field to Enable Deep-Space Exploration." *Cell* 183, no. 5 (November 25, 2020).

38. da Silveira, William A., Hossein Fazelinia, Sara Brin Rosenthal, Evagelia C.Laiakis,mMan S.Kim, Cem Meydan, Yared Kidane et al. "Comprehensive Multi-omics Analysis Reveals Mitochondrial Stress as a Central Biological Hub for Spaceflight Impact." *Cell* 183, no. 5 (November 25, 2020).
39. Cell Press. "Defects in Mitochondria May Explain Many Health Problems Observed During Space Travel." Phys.org (November 25, 2020).
40. Andrade, Manuella R., Tooyib A. Azeez, McLane M. Montgomery, Jacob T. Caldwell, Hyerim Park, Andy T. Kwok, Alexander M. Borg, S. Anand Narayanan, Jeffrey S. Willey, Michael D. Delp, Justin D. La Favor. "Neurovascular Dysfunction Associated with Erectile Dysfunction Persists After Long-Term Recovery from Simulations of Weightlessness and Deep Space Irradiation." *The FASEB Journal* 37, no 12 (November 22, 2023).
41. Luxton, Jared J., Miles J. McKenna, Lynn E. Taylor, Kerry A. George, Sara R. Zwart, Brian E. Crucian, Viktor R. Drel et al. "Temporal Telomere and DNA Damage Responses in the Space Radiation Environment." *Cell Reports* 33, no. 10 (December 8, 2020).
42. Luxton, Jared J., Miles J. McKenna, Aidan Lewis, Lynn E. Taylor, Kerry A. George, Sameer M. Dixit, Matthew Moniz et al. "Telomere Length Dynamics and DNA Damage Responses Associated with Long Duration Spaceflight ."*Cell Reports* 33, no. 10 (December 8, 2020).
43. Rodman, C., G. Almeida-Porada, S. K. George, J. Moon, S. Soker, T. Pardee, M. Beaty et al. "In Vitro and In Vivo Assessment of Direct Effects of Simulated Solar and Galactic Cosmic Radiation on Human Hematopoietic Stem/Progenitor Cells." *Leukemia* 31 (November 24, 2016).
44. Wake Forest Baptist Medical Center. "Research Uncovers Potential Health Risks of Travel to Mars." (March 8, 2017).
45. Almeida-Porada, Graça, Christopher Rodman, Bradford Kuhlman, Egil Brudvik, John Moon, Sunil George, Peter Guida, et al. "Exposure of the Bone Marrow Microenvironment to Simulated Solar and Galactic Cosmic Radiation Induces Biological Bystander Effects on Human Hematopoiesis." *Stem Cells and Development* 27, no. 18 (September 15, 2018).
46. Garrett-Bakelman, Francine E., Manjula Darshi, Stefan J. Green, Ruben C. Gur, Ling Lin, Brandon R. Macias , Miles J. Mckenna et al. "The NASA Twins Study: A Multidimensional Analysis of a Year-Long Human Spaceflight." *Science* 364, no. 6436 (April 12, 2019).
47. Mencia-Trinchant, Nuria, Matthew J. MacKay, Christopher Chin, Ebrahim Afshinnekoo, Jonathan Foox, Cem Meydan, Daniel Butler et al. "Clonal Hematopoiesis Before, During, and After Human Spaceflight." *Cell Reports* 33 no. 10 (December 8, 2020).
48. Greene-Schloesser, Dana and Mike E. Robbins. "Radiation-Induced Cognitive Impairment--From Bench to Bedside." *Neuro-Oncology* 14 (September 1, 2012).
49. Lee, Sang-Hun, Barna Dudok, Vipan K. Parihar, Kwang-Mook Jung, Miklós Zöldi, Young-Jin Kang, Mattia Maroso et al. "Neurophysiology of Space Travel: Energetic Solar Particles Cause Cell Type-Specific Plasticity of Neurotransmission." *Brain Structure and Function* 222 (November 30, 2016).
50. Acharya, Munjal M., Janet E. Baulch, Peter M. Klein, Al Anoud D. Baddour, Lauren A. Apodaca, Eniko A. Kramár, Leila Alikhani et al. "New Concerns for Neurocognitive

Function during Deep Space Exposures to Chronic, Low Dose-Rate, Neutron Radiation." *ENeuro (*August 5, 2019).
51. Parihar, Vipan K., Barrett Allen, Katherine K. Tran, Trisha G. Macaraeg, Esther M. Chu, Stephanie F. Kwok, Nicole N. Chmielewski et al. "What Happens To Your Brain on the Way to Mars." *Science Advances* 1, no. 4 (May 1, 2015).
52. Raber, Jacob, Joy Yamazaki, Eileen Ruth S. Torres, Nicole Kirchoff, Keaton Stagaman, Thomas Sharpton, Mitchell S. Turker, and Amy Kronenberg. "Combined Effects of Three High-Energy Charged Particle Beams Important for Space Flight on Brain, Behavioral and Cognitive Endpoints in B6D2F1 Female and Male Mice." *Frontiers in Physiology* (March 12 2019).
53. Krukowski, Karen, Katherine Grue, Mckenna Becker, Edward Elizarraras, Elma S. Friasa, Aron Halvorsen, Mckensie Koenig-Zanoff et al. "The Impact of Deep Space Radiation on Cognitive Performance: from Biological Sex to Biomarkers to Countermeasures." *Science Advances* 7, no. 42 (October 15, 2021).
54. Parihar, Vipan K., Barrett D. Allen, Chongshan Caressi, Stephanie Kwok, Esther Chu, Katherine K. Tran, Nicole N. Chmielewski, et al. "Cosmic Radiation Exposure and Persistent Cognitive Dysfunction." *Scientific Reports* 6 (October 10, 2016).
55. Baulch, Janet E. and Charles Limoli. "Astronauts' Brains are Subject to Long-Lasting Damage Due to Low Dose Space Radiation." *The Conversation (*August 5, 2019).
56. Parihar, Vipan K., Mattia Maroso, Amber Syage, Barrett D. Allen, Maria C.Angulo, IvanSoltesz, and Charles L.Limoli. "Persistent Nature of Alterations in Cognition and Neuronal Circuit Excitability after Exposure to Simulated Cosmic Radiation in Mice," *Experimental Neurology* 305 (July 2018).
57. Cherry, Jonathan D., Bin Liu, Jeffrey L. Frost, Cynthia A. Lemere, Jacqueline P. Williams, John A. Olschowka, and M. Kerry O'Banion. "Galactic Cosmic Radiation Leads to Cognitive Impairment and Increased Aβ Plaque Accumulation in a Mouse Model of Alzheimer's Disease." *PLoS ONE (*December 31, 2012).
58. Afshinnekoo, Ebrahim, Ryan T. Scott, Matthew J. MacKay, Eloise Pariset, Egle Cekanaviciute, Richard Barker, Simon Gilroy et al. "Fundamental Biological Features of Spaceflight: Advancing the Field to Enable Deep-Space Exploration." *Cell* 183, no. 5 (November 25, 2020).
59. Frederico, Kiffera, Boerma, Marjan, and Allen, Antiño. "Behavioral Effects of Space Radiation: A Comprehensive Review of Animal Studies." *Life Sciences in Space Research* 21 (May 2019).
60. Mao, Xiao W., Nina C. Nishiyama, Stephanie D. Byrum, Seta Stanbouly, Tamako Jones, Jacob Holley, Vijayalakshmi Sridharan et al. "Spaceflight Induces Oxidative Damage to Blood-Brain Barrier Integrity in a Mouse Model." *The FASEB Journal* 34, no. 11 (September 26, 2020).
61. Cucinotta, Francis A., Murat Alp, Frank M. Sulzman, and Minli Wang. "Space Radiation Risks to the Central Nervous System." *Life Sciences in Space Research* 2 (July 2014).
62. Nelson, Gregory A., Lisa Simonsen, and Janice L. Huff. "Risk of Acute and Late Central Nervous System Effects from Radiation Exposure." NASA NTRS (January 1, 2016).
63. NASA Human Research Program. Risks and Gaps website.
64. Williams, J. M., C. A. Duckworth, M. D. Burkitt, A. J. M. Watson, B. J. Campbell, and D. M. Pritchard. "Epithelial Cell Shedding and Barrier Function." *Veterinary Pathology* 52, no. 3 (May 2015).

65. Kumar, Santosh, Shubhankar Suman, Albert J. Fornace Jr., and Kamal Datta. "Space Radiation Triggers Persistent Stress Response, Increases Senescent Signaling, and Decreases Cell Migration in Mouse Intestine." *Proceedings of the National Academy of Sciences 115*, no. 42 (October 16, 2018).
66. Georgetown University Medical Center. "Animal Study Suggests Deep Space Travel May Significantly Damage GI Function in Astronauts. EurekAlert! (October 1, 2018).
67. Porada C., at al., Effects of SEP/GCR Radiation on the Hematopoietic and GI Systems, NASA Human Research Program Investigators' Workshop, Wednesday, January 29, 2020.
68. Meerman, Manon, Tom C. L. Bracco Gartner, Jan Willem Buikema, Sean M. Wu, Sailay Siddiqi, Carlijn V. C. Bouten, K. Jane Grande-Allen, Willem J. L. Suyker, and Jesper Hjortnaes. "Myocardial Disease and Long-Distance Space Travel: Solving the Radiation Problem." *Frontiers in Cardiovascular Medicine* (February 12, 2021).
69. Wuu, Yen-Ruh, Burong Hu, Hazeem Okunola, Amber M. Paul, Elizabeth A. Blaber, Margareth Cheng-Campbell, Afshin Beheshti, and Peter Grabham. "LET-Dependent Low Dose and Synergistic Inhibition of Human Angiogenesis by Charged Particles: Validation of miRNAs that Drive Inhibition." *iScience* 23 (December 18, 2020).
70. Bishawi, Muath , Franklin H. Lee, Dennis M. Abraham, Carolyn Glass, Stephanie J. Blocker, Daniel J. Cox, Zachary D. Brown. "Late Onset Cardiovascular Dysfunction in Adult Mice Resulting From Galactic Cosmic Ray Exposure." *iScience* 25, no 4 (April 15, 2022).
71. Elgart, S. Robin , Mark P. Little, Lori J. Chappell, Caitlin M. Milder, Mark R. Shavers, Janice L. Huff, and Zarana S. Patel. "Radiation Exposure and Mortality from Cardiovascular Disease and Cancer in Early NASA Astronauts." *Scientific Reports* 8 (May 31, 2018).
72. Ade, Carl J., Ryan M. Broxterman, Jacqueline M. Charvat, and Thomas J. Barstow. "Incidence Rate of Cardiovascular Disease End Points in the NASA Astronaut Corps." *Journal of the American Heart Association* (August 7, 2017).
73. Delp, Michael D., Jacqueline M. Charvat, Charles L. Limoli, Ruth K. Globus,and Payal Ghosh. "Apollo Lunar Astronauts Show Higher Cardiovascular Disease Mortality: Possible Deep Space Radiation Effects on the Vascular Endothelium." *Scientific Reports* 6 (July 28, 2016).
74. Tian, Jian , Michael J. Pecaut, James M. Slater, and Daila S. Gridley. "Spaceflight Modulates Expression of Extracellular Matrix, Adhesion, and Profibrotic Molecules in Mouse Lung." *Journal of Applied Physiology* (January 2010).
75. Gridley, Daila S., Xiao Wen Mao, Jian Tian, Jeffrey D. Cao, Celso Perez, Louis S. Stodieck, Virginia L. Ferguson, Ted A. Bateman, and Michael J. Pecaut. "Genetic and Apoptotic Changes in Lungs of Mice Flown on the STS-135 Mission in Space." *in vivo* 29 (July 2015).
76. Cucinotta, F. A., F. K. Manuel, J. Jones, G. Iszard, J. Murrey, B. Djojonegro, and M. Wear. "Space Radiation and Cataracts in Astronauts." *Radiation Research* 156, no. 5 (November 2001).
77. Chylack, Leo T., Alan H. Feiveson, Leif E. Peterson, William H. Tung, Mary L. Wear, Lisa J. Marak, Dale S. Hardy, Lori J. Chappell, and Francis A. Cucinotta. "NASCA Report 2: Longitudinal Study of Relationship of Exposure to Space Radiation and Risk of Lens Opacity." *Radiation Research* 178 no. 1 (June 12, 2012).

78. Bigley, Austin B., Nadia H. Agha, Forrest L. Baker, Guillaume Spielmann, Hawley E. Kunz, Preteesh L. Mylabathula, Bridgette V. Rooney. At al. "NK Cell Function is Impaired During Long-Duration Spaceflight." *APS Select* (April 2, 2019).
79. Wall, Mike. "Space Travel May Increase Astronauts' Susceptibility to Cancer." Space.com (January 28, 2019).
80. Kennedy, E. M., D. R. Powell, Z. Li, J. S. K. Bell, B. G. Barwick, H. Feng, M. R. McCrary et al. "Galactic Cosmic Radiation Induces Persistent Epigenome Alterations Relevant to Human Lung Cancer," *Scientific Reports* 8 (April 30, 2018).
81. Cucinotta, Francis A. and Eliedonna Cacao. "Non-Targeted Effects Models Predict Significantly Higher Mars Mission Cancer Risk than Targeted Effects Models." *Scientific Reports* 7 (May 12, 2017).
82. Dunegan, Kevin. "Study: Collateral Damage from Cosmic Rays Increases Cancer Risks for Mars Astronauts." Phys.org (June 5, 2017).
83. Kiffera, Frederico C., Krishna Luitel, Fionya H. Trana, Riya A.Patel, Catalina S. Guzman, Ivan Soler, Rui Xiao, Jerry W. Shay, Sanghee Yun, and Amelia J. Eischae. "Effects of a 33-Ion Sequential Beam Galactic Cosmic Ray Analog on Male Mouse Behavior and Evaluation Of CDDO-EA as a Radiation Countermeasure." *Behavioural Brain Research* 419 (February 15, 2022).
84. Massimo, Mike. Spaceman: *An Astronaut's Unlikely Journey to Unlock the Secrets of the Universe*. Crown Archetype, 2016.
85.
86. Scott, Jonathan P. R., Andreas Kramer, Nora Petersen, and David A. Green. "The Role of Long-Term Head-Down Bed Rest in Understanding Inter-Individual Variation in Response to the Spaceflight Environment: A Perspective Review." *Frontiers in Physiology* 11 (February 2021).
87. Pellis, Neal R. Microgravity Cell Biology delivered talk.
88. NASA. "Blue Origin Partner to Bring Lunar Gravity Conditions Closer to Earth." (March 9, 2021).
89. Pellis, Neal R. Microgravity Cell Biology delivered talk.
90. Bradbury, Peta, Hanjie Wu, Jung Un Choi, Alan E. Rowan, Hongyu Zhang, Kate Poole, Jan Lauko, and Joshua Chou. "Modeling the Impact of Microgravity at the Cellular Level: Implications for Human Disease." *Frontiers in Cell and Developmental Biology* (February 21, 2020).
91. Rosenstein, Aaron H. and Virginia K. Walker. "Fidelity of a Bacterial DNA Polymerase in Microgravity, a Model for Human Health in Space." *Frontiers in Cell and Developmental Biology* (November 29, 2021).
92. Willis, Craig, R. G., Nathaniel J. Szewczyk, Sylvain V. Costes, Ingrid A. Udranszky, Sigrid S. Reinsch, and Timothy Etheridge. "Comparative Transcriptomics Identifies Neuronal and Metabolic Adaptations to Hypergravity and Microgravity in *Caenorhabditis elegans*." *iScience* 23, no. 12 *(*December 18, 2020).
93. He, Jie, Xiaoxian Zhang, Yong Gao, Shuijie Li, and YeqingSun. "Effects of Altered Gravity on the Cell Cycle, Actin Cytoskeleton And Proteome In *Physarum Polycephalum," Acta Astronautica* 63 (October-November 2008).
94. Gaboyard, Sophie, Marie-Pierre Blanchard, Cécile Travo, Michel Viso, Alain Sans, and Jacques Lehouelleur. "Weightlessness Affects Cytoskeleton of Rat Utricular Hair Cells During Maturation *In Vitro*." *NeuroReport* 13, no. 16 (November 15, 2002).

95. Bradbury, Peta, Hanjie Wu, Jung Un Choi, Alan E. Rowan, Hongyu Zhang, Kate Poole, Jan Lauko, and Joshua Chou. "Modeling the Impact of Microgravity at the Cellular Level: Implications for Human Disease." *Frontiers in Cell and Developmental Biology* (February 21, 2020).
96. Grimm, Daniela, Markus Wehland, Thomas J. Corydon, Peter Richter, Binod Prasad, Johann Bauer,Marcel Egli, Sascha Kopp, Michael Lebert, and Marcus Krüger. "The Effects of Microgravity on Differentiation and Cell Growth in Stem Cells and Cancer Stem Cells." *Stem Cells Translational Medicine* 9, no. 8 (April 30, 2020).
97. Andreazzoli, Massimiliano, Debora Angeloni, Vania Broccoli, and Gian C. Demontis. "Microgravity, Stem Cells, and Embryonic Development: Challenges and Opportunities for 3D Tissue Generation." *Frontiers in Astronomy and Space Sciences (*April 25, 2017).
98. Roy-O'Reilly, Meaghan, Ajitkumar Mulavara, and Thomas Williams. "A Review of Alterations to the Brain During Spaceflight and the Potential Relevance to Crew in Long-Duration Space Exploration." *npj microgravity* 7 (February 16, 2021).
99. Eulenburg, Peter zu , Judith-Irina Buchheim, Nicholas J. Ashton, Galina Vassilieva, Kaj Blennow, Henrik Zetterberg, and Alexander Choukér. "Changes in Blood Biomarkers of Brain Injury and Degeneration Following Long-Duration Spaceflight." *JAMA Neurology* 78, no. 12 (October 11, 2021).
100. Sohn, Rebecca. "Long Space Missions Could Cause Brain Damage Similar to Concussions, Study Finds." Space.com (November 2, 2021).
101. Laranjeiro, Ricardo, Girish Harinath, Amelia K. Pollard, Christopher J. Gaffney, Colleen S. Deane, Siva A. Vanapalli, Timothy Etheridge, Nathaniel J. Szewczyk, and MonicaDriscoll. " Spaceflight Affects Neuronal Morphology and Alters Transcellular Degradation of Neuronal Debris in Adult *Caenorhabditis elegans." iScience* 24, no.2 (February 19, 2021).
102. Doroshin, Andrei, Steven Jillings, Ben Jeurissen, Elena Tomilovskaya, Ekaterina Pechenkova, Inna Nosikova, Alena Rumshiskaya et al. "Brain Connectometry Changes in Space Travelers After Long-Duration Spaceflight." *Frontiers in Neural Circuits* (February 18, 2022).
103. Steven Jillings, Ekaterina Pechenkova, Elena Tomilovskaya, Ilya Rukavishnikov, Ben Jeurissen, Angelique Van Ombergen, Inna Nosikova, Alena Rumshiskaya, et al. "Prolonged Microgravity Induces Reversible and Persistent Changes on Human Cerebral Connectivity." *Communications Biology* 6 (January 13, 2023).
104. Liege University. "Space Travel Influences the Way the Brain Works." News release (February 17, 2023).
105. Kramer, Larry A., Khader M. Hasan, Michael B. Stenger, Ashot Sargsyan, Steven S. Laurie, Christian Otto, Robert J. Ploutz-Snyder, Karina Marshall-Goebel, Roy F. Riascos, and Brandon R. Macias. "Intracranial Effects of Microgravity: A Prospective Longitudinal MRI Study." *Radiology* 295, no. 3 (April 14, 2020).
106. Pechenkova, Ekaterina V., Inna Nosikova, Alena Rumshiskaya, Liudmila Litvinova, Ilya Rukavishnikov, Elena Mershina, Valentin Sinitsyn et al. "Alterations of Functional Brain Connectivity After Long-Duration Spaceflight as Revealed by fMRI." *Frontiers in Physiology* (July 4, 2019).
107. Sarker, Poonam, Shubhashish Sarkar, Vani Ramesh, Barbara E. Hayes, Renard L. Thomas, Bobby L. Wilson, Helen Kim, Stephen Barnes, et al. "Proteomic Analysis of

Mice Hippocampus in Simulated Microgravity Environment." *Journal of Proteome Research* 5 no. 3 (January 25, 2006).
108. Kramer, Larry A., Khader M. Hasan, Michael B. Stenger, Ashot Sargsyan, Steven S. Laurie, Christian Otto, Robert J. Ploutz-Snyder, Karina Marshall-Goebel, Roy F. Riascos, and Brandon R. Macias. "Intracranial Effects of Microgravity: A Prospective Longitudinal MRI Study." *Radiology* 295, no. 3 (April 14, 2020).
109. Van Ombergen, Angelique, Ben Jeurissen, Elena Tomilovskaya, Alena Rumshiskaya, Liudmila Litvinova, Inna Nosikova, Ekaterina Pechenkova et al. "Brain Ventricular Volume Changes Induced By Long-Duration Spaceflight," *Proceedings of the National Academy of Sciences* 116, no. 21 (May 6, 2019).
110. McGregor, Heather R., Kathleen E. Hupfeld, Ofer Pasternak, Nichole E. Beltran, Yiri E. De Dios, Jacob J. Bloomberg, Scott J. Wood, Ajitkumar P. Mulavara, et al. "Impacts of Spaceflight Experience on Human Brain Structure." *Scientific Reports* 13 (June 8, 2023).
111. Van Ombergen, Angelique, Ben Jeurissen, Elena Tomilovskaya, R. Maxine Rühl, Alena Rumshiskaya, Inna Nosikova, Liudmila Litvinova et al. "Brain Tissue–Volume Changes in Cosmonauts." *New England Journal of Medicine* 379 (October 25, 2018).
112. Li Ke, Xiaojuan Guo, Zhen Jin, Xin Ouyang, Yawei Zeng, Jinsheng Feng, Yu Wang, Li Yao, and Lin Ma. "Effect of Simulated Microgravity on Human Brain Gray Matter and White Matter—Evidence from MRI." *PloS One* (August 13, 2015).
113. Jandial, Rahul, Reid Hoshide, J. Dawn Waters, and Charles L. Limoli. "Space–Brain: The Negative Effects of Space Exposure on the Central Nervous System." *Surgical Neurology International* (January 16, 2018).
114. Marshall-Goebel, Karina, Steven S. Laurie, Irina V. Alferova, Philippe Arbeille, Serena M. Auñón-Chancellor, Douglas J. Ebert, and Stuart M. C. Lee. "Assessment of Jugular Venous Blood Flow Stasis and Thrombosis during Spaceflight." *JAMA Network Open* (November 13, 2019).
115. Auñón-Chancellor, Serena M., James M. Pattarini, Stephan Moll, and Ashot Sargsyan. "Venous Thrombosis during Spaceflight." *The New England Journal of Medicine* (January 2, 2020).
116. Mundell, E. J. "Clots in Space: Astronaut's Blocked Vein Brings Medical Insight." *U.S. News & World Report* (January 2, 2020.)
117. Michael, Alex P. and Karina Marshall-Bowman. "Spaceflight-Induced Intracranial Hypertension." *Aerospace Medicine and Human Performance* 86, no. 6 (June 2015).
118. Garrett-Bakelman, Francine E., Manjula Darshi, Stefan J. Green, Ruben C. Gur, Ling Lin, Brandon R. Macias , Miles J. Mckenna et al. "The NASA Twins Study: A Multidimensional Analysis of a Year-Long Human Spaceflight." *Science* 364, no. 6436 (April 12, 2019).
119. Roberts, D. R., T. R. Brown, P. J. Nietert, M. A. Eckert, D. C. Inglesby, J. J. Bloomberg, M. S. George, and D. Asemani. "Prolonged Microgravity Affects Human Brain Structure and Function." *American Journal of Radiology* (October 2019).
120. Seidler, Rachael D., Claudia Stern, Mathias Basner, Alexander C. Stahn, Floris L. Wuyts, and Peter zu Eulenburg. "Future Research Directions to Identify Risks and Mitigation Strategies for Neurostructural, Ocular, and Behavioral Changes Induced by

Human Spaceflight: A NASA-ESA Expert Group Consensus Report." *Frontiers in Neural Circuits* 16 (August 4, 2022).
121. Jiang, Shan, YI-Ming Qian, Yuan Jiang, Zi-Qin Cao, Bing-Mu Xin, Ying-Chun Wang, and Bin Wu. "Effects of 15-Days −6° Head-Down Bed Rest on the Attention Bias of Threatening Stimulus." Frontiers in Psychology (June 27, 2022).
122. Spironelli, Chiara and Alessandro Angrilli. "Influence of Body Position on Cortical Pain-Related Somatosensory Processing: An ERP Study." *PLOS ONE* (September 15, 2011).
123. Brauns, Katharina, Anika Werner, Hanns-Christian Gunga, Martina A. Maggioni, David F. Dinges, and Alexander Stahn. "Electrocortical Evidence for Impaired Affective Picture Processing after Long-Term Immobilization." *Scientific Reports* 9 (November 12, 2019).
124. Basner, Mathias, Alexander C. Stahn, Jad Nasrini, David F. Dinges, Tyler M. Moore, Ruben C. Gur, Christian Mühl, Brandon R. Macias, and Steven S. Laurie. "Effects of Head-Down Tilt Bed Rest Plus Elevated CO2 on Cognitive Performance." *Journal of Applied Psychology* (April 19, 2021).
125. NASA TV. Exercising in Space (March 24, 2020).
126. Gabel, Leigh, Anna-Maria Liphardt, Paul A. Hulme, Martina Heer, Sara R. Zwart, Jean D. Sibonga, Scott M. Smith, and Steven K. Boyd. "Incomplete Recovery of Bone Strength and Trabecular Microarchitecture at the Distal Tibia 1 Year after Return from Long Duration Spaceflight." *Scientific Reports* 12 (June 30, 2022).
127. Chang, Douglas G., Robert M. Healey, Alexander J. Snyder, Jojo V. Sayson, Brandon R. Macias, Dezba G. Coughlin, Jeannie F. Bailey, Scott E. Parazynski, Jeffrey C. Lotz, and Alan R.Hargens. "Lumbar Spine Paraspinal Muscle and Intervertebral Disc Height Changes in Astronauts after Long-Duration Spaceflight on the International Space Station." *Spine* 41, no. 24 (December 15, 2016).
128. Bailey, Jeannie F. Priya Nyayapati, Gabriel T. A. Johnson, Lucas Dziesinski, Aaron W. Scheffler, Rebecca Crawford, Richard Scheuring, Conor W. O'Neill, Douglas Chang, Alan R. Hargens, and Jeffrey C. Lotz. "Biomechanical Changes in the Lumbar Spine Following Spaceflight and Factors Associated With Postspaceflight Disc Herniation." *The Spine Journa*l 22, no. 2 (February 1, 2022).
129. Pavlakou, Paraskevi, Evangelia Dounousi, Stefanos Roumeliotis, Theodoros Eleftheriadis, and Vassilios Liakopoulos. "Oxidative Stress and the Kidney in the Space Environment." I*nternational Journal of Molecular Science* 19, no. 10 (October 15, 2018).
130. Wikipedia. "Renal Stone Formation in Space."
131. NASA. "Using Ultrasound to Zap Kidney Stones and Other Health Problems in Space." March 27, 2019.
132. Wikipedia. "Mars suit."
133. NASA. *Risk of Spaceflight Associated Neuro-ocular Syndrome (SANS)*. Human Research Program Human Health Countermeasures Element (April 7, 2022).
134. Aleci, Carlo. "From International Ophthalmology to Space Ophthalmology: The Threats to Vision on the Way to Moon and Mars Colonization." *International Ophthalmology* 40 (November 13, 2019).
135. Lee, Andrew G., William J. Tarver, Thomas H. Mader, Charles Robert Gibson, Stephen F. Hart, and Christian A. Otto. "Neuro-Ophthalmology of Space Flight." *Journal of Neuro-Ophthalmology* 36, no. 1 (March 2016).

136. Alperin, Noam and Ahmet M.Bagci. "Spaceflight-Induced Visual Impairment and Globe Deformations in Astronauts Are Linked to Orbital Cerebrospinal Fluid Volume Increase." *Intracranial Pressure & Neuromonitoring XVI. Acta Neurochirurgica Supplement* (March 1, 2018).
137. Mader, Thomas H., C. Robert Gibson, Anastas F. Pass, Andrew G. Lee, Hanspeter E. Killer, Hans-Christian Hansen, Joseph P. Dervay et al. "Optic Disc Edema in an Astronaut after Repeat Long-Duration Space Flight." *Journal of Neuro-Ophthalmology* 33, no. 3 (September 2013).
138. Lee, Andrew G., Thomas H. Mader, C. Robert Gibson, William Tarver, Pejman Rabiei, Roy F. Riascos, Laura A. Galdamez, and Tyson Brunstetter. "Spaceflight Associated Neuro-Ocular Syndrome (SANS) and the Neuro-Ophthalmologic Effects of Microgravity: A Review and an Update, *npj Microgravity* 6 (August 26, 2020).
139. Mao, Xiao W., Michael J. Pecaut, Louis S. Stodieck, Virginia L. Ferguson, Ted A. Bateman, Mary Bouxsein, Tamako A. Jones, Maria Moldovan, Christopher E. Cunningham, Jenny Chieu, and Daila S. Gridley. "Spaceflight Environment Induces Mitochondrial Oxidative Damage in Ocular Tissue." *Radiation Research* 180, no 4 (September 13, 2013).
140. Mao, Xiao W., Stephanie Byrum ,Nina C. Nishiyama, Michael J. Pecaut, Vijayalakshmi Sridharan, Marjan Boerma, Alan J. Tackett et al. "Impact of Spaceflight and Artificial Gravity on the Mouse Retina: Biochemical and Proteomic Analysis." *International Journal of Molecular Science* 19, no. 9 (August 28, 2018).
141. Mao, Xiao W., Nina C. Nishiyama, Stephanie D. Byrum, Seta Stanbouly, Tamako Jones, Alyson Drew, Vijayalakshmi Sridharan et al. "Characterization of Mouse Ocular Response to a 35-Day Spaceflight Mission: Evidence of Blood-Retinal Barrier Disruption and Ocular Adaptations." *Scientific Reports* 9 (June 3, 2019).
142. Rosenberg, Mark J., Michael A. Coker, James A. Taylor, Milad Yazdani, M. Gisele Matheus, Christopher K. Blouin, Sami Al Kasab, Heather R. Collins, and Donna R. Roberts. "Comparison of Dural Venous Sinus Volumes Before and after Flight in Astronauts with and Without Spaceflight-Associated Neuro-Ocular Syndrome." *JAMA Network* 4, no.10 (October 27, 2021).
143. Marshall-Goebel, Karina, Rahul Damani, and Eric M. Bershad. "Brain Physiological Response and Adaptation during Spaceflight." *Neurosurgery* 85, no. 5 (November 2019).
144. Zhang, Li Fan and Alan R. Hargens. "Spaceflight-Induced Intracranial Hypertension and Visual Impairment: Pathophysiology and Countermeasures," *Physiological Reviews* (November 22, 2017).
145. Strangman, Gary E., Quan Zhang, Karina Marshall-Goebel, Edwin Mulder, Brian Stevens, Jonathan B. Clark, and Eric M. Bershad. "Increased Cerebral Blood Volume Pulsatility during Head-Down Tilt with Elevated Carbon Dioxide: The SPACECOT Study." *Journal of Applied Physiology* (July 1, 2017).
146. Zwart, Sara R. , Steven S. Laurie, John J. Chen, Brandon R. Macias, Stuart M. C. Lee, Michael Stenger, Bart Grantham, Knox Carey, Millennia Young, and Scott M. Smith. "Association of Genetics and B Vitamin Status with the Magnitude of Optic Disc Edema During 30-Day Strict Head-Down Tilt Bed Rest." *JAMA Ophthalmology* 137 (August 15, 2019).

147. Patel, Smit. "The Effects of Microgravity and Space Radiation on Cardiovascular Health: From Low-Earth Orbit and Beyond." *IJC Heart & Vasculature* 30 (October 2020).
148. Navasiolava, Nastassia, Ming Yuan, Ronan Murphy, Adrien Robin, Mickael Coupé, Linjie Wang, Asmaa Alameddine et al. "Vascular and Microvascular Dysfunction Induced by Microgravity and Its Analogs in Humans: Mechanisms and Countermeasures." *Frontiers in Physiology: Environmental, Aviation and Space Physiology* (August 20, 2020).
149. MacNamara, James P., Katrin A. Dias, Satyam Sarma, Stuart M.C. Lee, David Martin, Maks Romeijn, Vlad G. Zaha, and Benjamin D. Levine. "Cardiac Effects of Repeated Weightlessness During Extreme Duration Swimming Compared with Spaceflight." *Circulation* (March 29, 2021).
150. Khine, Htet W., Katarina Steding-Ehrenborg, Jeffrey L. Hastings, Jamie Kowal, James D. Daniels, Richard L. Page, Jeffery J. Goldberger et al. "Effects of Prolonged Spaceflight on Atrial Size, Atrial Electrophysiology, and Risk of Atrial Fibrillation." *Circulation: Arrhythmia and Electrophysiology* (June 18, 2018).
151. Caiani, Enrico, G., Alba Martin-Yebra, Federica Landreani, Juan Bolea, Pablo Laguna, and Pierre Vaïda. "Weightlessness and Cardiac Rhythm Disorders: Current Knowledge from Space Flight and Bed-Rest Studies." *Frontiers in Astronomy and Space Science* (August 23, 2016).
152. Walls, Stanley, Soda Diop, Ryan Birse, Lisa Elmen, Zhuohui Gan, Sreehari Kalvakuri, Santiago Pineda et al. "Prolonged Exposure to Microgravity Reduces Cardiac Contractility and Initiates Remodeling in Drosophila," *Cell Reports* 33 no. 10 (November 25, 2020).
153. Wnorowski, Alexa, Arun Sharma, Haodong Chen, Haodi Wu, Ning-Yi Shao, Nazish Sayed, Chun Liu et al. "Effects of Spaceflight on Human Induced Pluripotent Stem Cell-Derived Cardiomyocyte Structure and Function." *Stem Cell Reports* 13, no. 6 (December 10. 2019).
154. Prisk, G. Kim. "Microgravity and the Respiratory System." *European Respiratory Journal* 43 (2014).
155. NASA. "Space Station Crew Takes a Breather with Lung Tissue Investigation." (October 19, 2017).
156. Prisk, G. Kim. "Pulmonary Challenges of Prolonged Journeys to Space: Taking Your Lungs to the Moon." *Medical Journal of Australia* 211, no. 6 (August 16, 2019).
157. Trudel, Guy, Jessica Shafer, Odette Laneuville, and Tim Ramsay. "Characterizing the Effect of Exposure to Microgravity on Anemia: More Space Is Worse." *American Journal of Hematology* 95, no. 3 (December 9, 2019).
158. Lansiaux, Edouard, Nityanand Jain, Swarali Yatin Chodnekar, Abdelmomen Siddiq, Muiz Ibrahim, Mathieu Yèche, and Inara Kantane. "Understanding the Complexities of Space Anaemia in Extended Space Missions: Revelations from Microgravitational Odyssey." *Frontiers in Physiology* 15 (March 10, 2024).
159. Trudel, Guy, Nibras Shahin, Timothy Ramsay, Odette Laneuville, and Hakim Louati. "Hemolysis Contributes to Anemia during Long-Duration Space Flight." *Nature Medicine* 9 (January 14, 2022).
160. NASA. "Scientists Find Increased Red Blood Cell Destruction during Spaceflight." (February 25, 2022).

161. Alvarez, Rocio, Cheryl A. Stork, Anica Sayoc-Becerra, Ronald R. Marchelletta, G. Kim Prisk, and Declan F. McCole. "A Simulated Microgravity Environment Causes a Sustained Defect in Epithelial Barrier Function." *Scientific Reports* 9 (November 26, 2019).
162. Pittalwala, Iqbal. "Space Travel Can Make the Gut Leaky." Phys.org (November 26, 2019).
163. Afshinnekoo, Ebrahim, Ryan T. Scott, Matthew J. MacKay, Eloise Pariset, Egle Cekanaviciute, Richard Barker, Simon Gilroy et al. "Fundamental Biological Features of Spaceflight: Advancing the Field to Enable Deep-Space Exploration." *Cell* 183, no. 5 (November 25, 2020).
164. da Silveira, William A., Hossein Fazelinia, Sara Brin Rosenthal, Evagelia C.Laiakis,mMan S.Kim, Cem Meydan, Yared Kidane et al. "Comprehensive Multi-omics Analysis Reveals Mitochondrial Stress as a Central Biological Hub for Spaceflight Impact." *Cell* 183, no. 5 (November 25, 2020).
165. NASA. Apollo Missions website.
166. University of California, San Francisco. "Space Travel Weakens Our Immune Systems: Now Scientists May Know Why." (June 7, 2021).
167. Afshinnekoo, Ebrahim, Ryan T. Scott, Matthew J. MacKay, Eloise Pariset, Egle Cekanaviciute, Richard Barker, Simon Gilroy et al. "Fundamental Biological Features of Spaceflight: Advancing the Field to Enable Deep-Space Exploration." *Cell* 183, no. 5 (November 25, 2020).
168. N., Braun, Thomas S., Tronnier H., and Heinrich U. "Self-Reported Skin Changes by a Selected Number of Astronauts after Long-Duration Mission on ISS as Part of the Skin B Project." *Skin Pharmacology and Physiology* (2019).
169. Olabisi, Ronke and Mae Jemison. "A Review of Challenges & Opportunities: Variable and Partial Gravity." 100 Year Starship (2022)
170. Rooney, Bridgette V., Brian E. Crucian, Duane L. Pierson, Mark L. Laudenslager, and Satish K. Mehta. "Herpes Virus Reactivation in Astronauts During Spaceflight and Its Application on Earth." *Frontiers in Microbiology* 10, no. 16 (February 7, 2019).
171. Knox, Benjamin P., Adriana Blachowicz, Jonathan M. Palmer, Jillian Romsdahl, Anna Huttenlocher, Clay C. C. Wang, Nancy P. Keller, and Kasthuri Venkateswaran. "Characterization of Aspergillus fumigatus Isolates from Air and Surfaces of the International Space Station." *MSphere* (October 26, 2016).
172. Akiyama, Taishin, Kenta Horie, Eiichi Hinoi, Manami Hiraiwa, Akihisa Kato, Yoichi Maekawa, Akihisa Takahashi, and Satoshi Furukawa. "How Does Spaceflight Affect the Acquired Immune System?" *npj Microgravity* 6 (May 7, 2020).
173. Gallardo-Dodd, Carlos J., Christian Oertlin, Julien Record, Rômulo G. Galvani, Christian Sommerauer, Nikolai V. Kuznetsov, Evangelos Doukoumopoulos et al. "Exposure Of Volunteers to Microgravity by Dry Immersion Bed Over 21 Days Results in Gene Expression Changes and Adaptation of T Cells." *Science Advances* 9, no. 34 (August 25, 2023).
174. Meloni, Maria Antoni, Grazia Galleri, Giuseppe Pani, Angela Saba, Proto Pippia, and Marianne Cogoli-Greuter. "Space Flight Affects Motility and Cytoskeletal Structures in Human Monocyte Cell Line J-111." *Cytoskeleton* 68, no.2 (January 11, 2011).
175. Shi, Lu, Hongling Tian, Peng Wang, Ling Li, Zhaoqi Zhang, Jiayu Zhang, and Yong Zhao. "Spaceflight and Simulated Microgravity Suppresses Macrophage

Development via Altered RAS/ERK/Nfκb and Metabolic Pathways." *Cellular & Molecular Immunology* 18 (January 3, 2020).
176. Stratis, Daniel, Guy Trudel, Lynda Rocheleau, Martin Pelchat, and Odette Laneuville." The Transcriptome Response of Astronaut Leukocytes to Long Missions Aboard The International Space Station Reveals Immune Modulation." *Frontiers in Immunology* 14 (June 21, 2023).
177. Spatz, J. M., M. Hughes Fulford, A. Tsai, D. Gaudilliere, J. Hedou, E. Ganio, M. Angst, N. Aghaeepour, and Brice Gaudilliere. "Human Immune System Adaptations to Simulated Microgravity Revealed by Single-Cell Mass Cytometry." *Scientific Reports* 11 (June 7, 2021).
178. Bigley, Austin B., Nadia H. Agha, Forrest L. Baker, Guillaume Spielmann, Hawley E. Kunz, Preteesh L. Mylabathula, Bridgette V. Rooney et al. "NK Cell Function Is Impaired During Long-Duration Spaceflight." *Journal of Applied Physiology* (April 2, 2019).
179. University of Arizona. "Prolonged Spaceflight Could Weaken Astronauts' Immune Systems." ScienceDaily (January 23, 2019).
180. Dunn, Andrea and Abadie, Laurie. "Study Reveals Immune System is Dazed and Confused during Spaceflight." NASA (August 6, 2017).
181. Crucian, Brian E., Sara R. Zwart, Satish Mehta, Peter Uchakin, Heather D. Quiriarte, Duane Pierson, Clarence F. Sams, and Scott M. Smith. " Plasma Cytokine Concentrations Indicate That in Vivo Hormonal Regulation of Immunity Is Altered during Long-Duration Spaceflight." *Journal of Interferon & Cytokine Research* 34, no. 10 (October 2, 2014).
182. Crucian, Brian, Alexander Choukèr, Richard J. Simpson, Satish Mehta, Gailen Marshall, Scott M. Smith, Sara R. Zwart et al. "Immune System Dysregulation During Spaceflight: Potential Countermeasures for Deep Space Exploration Missions." *Frontiers in Immunology* (June 28, 2018).
183. Checinska Sielaff, Aleksandra, Camilla Urbaniak, Ganesh Babu Malli Mohan, Victor G. Stepanov, Quyen Tran, Jason M. Wood, Jeremiah Minich et al. "Characterization of the Total and Viable Bacterial and Fungal Communities Associated With The International Space Station Surfaces." *Microbiome* 7 (April 8, 2019).
184. Crucian, Brian, Adriana Babiak-Vazquez, Smith Johnston, Duane L. Pierson, C. Mark Ott, and Clarence Sams. "Incidence of Clinical Symptoms during Long-Duration Orbital Spaceflight." *International Journal of General Medicine* 9 (November 3, 2016).
185. Mermel, Leonard A. "Infection Prevention and Control during Prolonged Human Space Travel." *Clinical Infectious Diseases* 56, no. 1 (January 2013).
186. Urbaniak, C., A. Checinska Sielaff, K. G. Frey, J. E. Allen, N. Singh, C. Jaing, K. Wheeler, and K. Venkateswaran. "Detection of Antimicrobial Resistance Genes Associated With the International Space Station Environmental Surfaces." *Scientific Reports* 8 (January 16, 2018).
187. Urbaniak, Camilla, Peter van Dam, Alexander Zaborin, Olga Zaborina, Jack A. Gilbert, Tamas Torok, Clay C. C. Wang, and Kasthuri Venkateswaran. "Genomic Characterization and Virulence Potential of Two *Fusarium oxysporum* Isolates Cultured from the International Space Station." *mSystems* (March 19 (2019).
188. Johnson, Doug. "Space Might Wreak Havoc on the Human Gut." *The Atlantic* (November 5, 2022).

189. Bijlani, Swati, Nitin K. Singh, V. V. Ramprasad Eedara, Appa Rao Podile, Christopher E. Mason, Clay C. C. Wang, and Kasthuri Venkateswaran. "*Methylobacterium Ajmalii sp. nov., Isolated from the International Space Station*." *Frontiers in Microbiology* (March 15, 2021).
190. Kim, Wooseong, Farah K. Tengra, Zachary Young, Jasmine Shong, Nicholas Marchand, Hon Kit Chan, Ravindra C. Pangule, Macarena Parra, Jonathan S. Dordick, Joel L. Plawsky, and Cynthia H. Collins. "Spaceflight Promotes Biofilm Formation by *Pseudomonas aeruginosa*." *PLOS ONE* (April 29, 2013).
191. Barko, P. C., M. A. McMichael, K. S. Swanson, and D. A. Williams. "The Gastrointestinal Microbiome: A Review." *Journal of Veterinary Internal Medicine* 32, no. 1 (November 24, 2017).
192. Kim, Yong-Ku and Cheolmin Shin. "The Microbiota-Gut-Brain Axis in Neuropsychiatric Disorders: Patho-physiological Mechanisms and Novel Treatments." *Current Neuropharmacology* (2018).
193. Kuehnast, Torben, Carmel Abbott, Manuela R. Pausan, David A. Pearce, Christine Moissl-Eichinger, and Alexander Mahnert. "The Crewed Journey to Mars and Its Implications for the Human Microbiome." *Microbiome* 10 (February 7, 2022).
194. Turroni, Sylvia, Marciane Magnani, Pukar K. C., Philippe Lesnik, Hubert Vidal, and Martina Heer. "Gut Microbiome and Space Travelers' Health: State of the Art and Possible Pro/Prebiotic Strategies for Long-Term Space Missions." *Frontiers in Physiology* (September 8, 2020).
195. Garrett-Bakelman, Francine E., Manjula Darshi, Stefan J. Green, Ruben C. Gur, Ling Lin, Brandon R. Macias , Miles J. Mckenna et al. "The NASA Twins Study: A Multidimensional Analysis of a Year-Long Human Spaceflight." *Science* 364, no. 6436 (April 12, 2019).
196. Voorhies, Alexander A., C. Mark Ott, Satish Mehta, Duane L. Pierson, Brian E. Crucian, Alan Feiveson, Cherie M. Oubre et al. "Study of the Impact of Long-Duration Space Missions at the International Space Station on the Astronaut Microbiome." *Scientific Reports* 9 (July 9, 2019).
197. Breretona, N. J. B., F. E. Pitrea, and E.Gonzalez. "Reanalysis of the Mars500 Experiment Reveals Common Gut Microbiome Alterations in Astronauts Induced by Long-Duration Confinement." *Computational and Structural Biotechnology Journal* 19 (2021).
198. Jiang, Peng, Stefan J. Green, George E. Chlipala, Fred W. Turek, and Martha Hotz Vitaterna. "Reproducible Changes in the Gut Microbiome Suggest a Shift in Microbial and Host Metabolism during Spaceflight." *Microbiome 7 (*August 9, 2019).
199. Voorhies, Alexander A. and Lorenzi, Hernan A. "The Challenge of Maintaining a Healthy Microbiome during Long-Duration Space Missions." *Scientific Reports* 9 (July 9, 2019).
200. Douglas, Grace L., Sara R. Zwart, and Scott M. Smith. "Space Food for Thought: Challenges and Considerations for Food and Nutrition on Exploration Missions." *The Journal of Nutrition* 150, no. 9 (September 2020).
201. Perchonok, Michele, Grace Douglas, and Maya Cooper. *Risk of Performance Decrement and Crew Illness Due to an Inadequate Food System*." NASA Human Research Program Space Human Factors and Habitability Element (June 26, 2012).

202. Tang, Hong, Hope Hui Rising, Manoranjan Majji, and Robert D. Brown. "Long-Term Space Nutrition: A Scoping Review." *Nutrients* 14, no 1 (December 23, 2021).
203. Tack, N., G. W. W. Wamelink, A. G. Denkova, M. Schouwenburg, H. Hilhorst, H. T. Wolterbeek, and P.W. Goedhart. "Influence of Martian Radiation-like Conditions on the Growth of *Secale cereale* and *Lepidium sativum*." *Frontiers in Astronomy and Space Sciences* (August 2, 2021).
204. Zwart, Sara R., Jennifer L. L Morgan, and Scott M. Smith. "Iron Status and Its Relations with Oxidative Damage and Bone Loss during Long-Duration Space Flight on the International Space Station." *The American Journal of Clinical Nutrition (*May 29, 2013).
205. Zwart, Sara R., Steven S. Laurie, John J. Chen, Brandon R. Macias, Stuart M. C. Lee, Michael Stenger, Bart Grantham et al. "Association of Genetics and B Vitamin Status With the Magnitude of Optic Disc Edema During 30-Day Strict Head-Down Tilt Bed Rest." *JAMA Ophthalmology* (August 15, 2019).
206. Preston, Elizabeth. "How NASA Is Solving the Space Food Problem." *Eater (*September 17, 2015).
207. Smith, Scott M., Sara R. Zwart, Grace L. Douglas, and Martina Heer. *Human Adaptation to Spaceflight: The Role of Nutrition*. NASA (2021).
208. Gohd, Chelsea. "NASA's Big Astronaut Trash Problem." Space.com (July 12, 2018).
209. Hadhazy, Adam. "Talking (space) trash." Aerospace America (March 2019).
210. NASA. "Boldly Go! NASA's New Space Toilet Offers More Comfort, Improved Efficiency for Deep-space missions." (September 17, 2020).
211. NASA. "Recycling in Space: Waste Handling in a Microgravity Environment Challenge." (October 10, 2018).
212. Pennsylvania State University. "Microbes May Help Astronauts Transform Human Waste into Food." ScienceDaily (January 25, 2018).
213. Jason Hutt on Twitter website.
214. Former NASA Astronaut Explains How Hygiene Is Different in Space. *Wired* (September 18, 2019).
215. Baran, Caner, Mustafa Erkoç, and Alper Ötünçtemur. "The Place of Urology in Aerospace Medicine; A New Horizon." *European Archive of Medical Research* 38, vol. 1 (2022).
216. University of Birmingham. "Chemical Contamination on International Space Station Is Out of This World." Eurekalert! (August 8, 2023).
217. Harrad, Stuart, Mohamed Abou-Elwafa Abdallah, Daniel Drage, and Marit Meyer. "Persistent Organic Contaminants in Dust from the International Space Station." *Environmental Science & Technology Letters* 10, vol. 9 (August 8, 2023).
218. Afshinnekoo, Ebrahim, Ryan T. Scott, Matthew J. MacKay, Eloise Pariset, Egle Cekanaviciute, Richard Barker, Simon Gilroy et al. "Fundamental Biological Features of Spaceflight: Advancing the Field to Enable Deep-Space Exploration." *Cell* 183, no. 5 (November 25, 2020).
219. Kanas, Nick. *Humans in Space: The Psychological Hurdles*, Springer/Praxis, 2015.
220. Alfano, Candice A., Joanne L. Bower, Christopher Connaboy, Nadia H. Agha, Forrest L. Baker, Kyle A. Smith, Christine J. So, and Richard J. Simpson. "Mental

Health, Physical Symptoms and Biomarkers of Stress during Prolonged Exposure to Antarctica's Extreme Environment." *Acta Astronautica* 181 (April 2021).
221. Afshinnekoo, Ebrahim, Ryan T. Scott, Matthew J. MacKay, Eloise Pariset, Egle Cekanaviciute, Richard Barker, Simon Gilroy et al. "Fundamental Biological Features of Spaceflight: Advancing the Field to Enable Deep-Space Exploration." *Cell* 183, no. 5 (November 25, 2020).
222. European Space Agency. Mars-500: study overview website.
223. NASA. Crew Health and Performance Exploration Analog website.
224. Rich, Nathaniel. "Can Humans Endure the Psychological Torment of Mars?" *The New York Times* (February 25, 2024).
225. Wang, Yue, Xiaolu Jing, Ke Lv, Bin Wu, Yanqiang Bai, Yuejia Luo, Shanguang Chen, and Yinghui Li. "During the Long Way to Mars: Effects of 520 Days of Confinement (Mars500) on the Assessment of Affective Stimuli and Stage Alteration in Mood and Plasma Hormone Levels." *PLoSONE* (April 2, 2014).
226. Basner, Mathias, David F. Dinges, Daniel J. Mollicone, Igor Savelev, Adrian J. Ecker, Adrian Di Antonio, Christopher W. Jones, et al. "Psychological and Behavioral Changes during Confinement in a 520-Day Simulated Interplanetary Mission to Mars." *PLoSONE* (March 27, 2014).
227. Basner, Mathias, David F. Dinges, Daniel Mollicone, Adrian Ecker, Christopher W. Jones, Eric C. Hyder, Adrian Di Antonio et al. "Mars 520-D Mission Simulation Reveals Protracted Crew Hypokinesis and Alterations of Sleep Duration and Timing." *Proceedings of the National Academy of Sciences* 110 (February 12, 2013).
228. Tahimic, Candice C. G. T., Amber M. Paul, Ann-Sofie Schreurs, Samantha M. Torres, Linda Rubinstein, Sonette Steczina, Moniece Lowe et al. "Influence of Social Isolation during Prolonged Simulated Weightlessness by Hindlimb Unloading." *Frontiers in Physiology* (September 13, 2019).
229. Barger, Laura K., Erin E Flynn-Evans, Alan Kubey, Lorcan Walsh, Joseph M Ronda, Wei Wang, Kenneth P Wright Jr, and Charles A Czeisler. "Prevalence of Sleep Deficiency and Use of Hypnotic Drugs in Astronauts Before, During, and After Spaceflight: An Observational Study." *The Lancet* 13, no. 9 (September 1, 2014).
230. Jones Christopher W., Mathias Basner, Daniel J. Mollicone, Christopher M. Mott, and David F. Dinges. "Sleep Deficiency in Spaceflight is Associated with Degraded Neurobehavioral Functions and Elevated Stress in Astronauts on Six-Month Missions Aboard the International Space Station." *Sleep* 45, no 3 (March 2022).
231. Wu, Bin, Yue Wang, Xiaorui Wu, Dong Liu, Dong Xu, and Fei Wang. "On-Orbit Sleep Problems of Astronauts and Countermeasures." *Military Medical Research*18 (May 30, 2018).
232. Afshinnekoo, Ebrahim, Ryan T. Scott, Matthew J. MacKay, Eloise Pariset, Egle Cekanaviciute, Richard Barker, Simon Gilroy et al. "Fundamental Biological Features of Spaceflight: Advancing the Field to Enable Deep-Space Exploration." *Cell* 183, no. 5 (November 25, 2020).
233. Pavlakou, Paraskevi, Evangelia Dounousi, Stefanos Roumeliotis, Theodoros Eleftheriadis, and Vassilios Liakopoulos. "Oxidative Stress and the Kidney in the Space Environment." *International Journal of Molecular Science* 19, no.10 (October 15, 2018).

234. Cucinotta, Francis A., Myung-Hee Y. Kim, Veronica Willingham, and Kerry A. George. "Physical and Biological Organ Dosimetry Analysis for International Space Station Astronauts." *Radiation Research* 170 (July 1, 2008).
235. Yamanouchi, Sakuya, Jordan Rhone, Jian-Hua Mao, Keigi Fujiwara, Premkumar B. Saganti, Akihisa Takahashi, and Megumi Hada. "Simultaneous Exposure of Cultured Human Lymphoblastic Cells to Simulated Microgravity and Radiation Increases Chromosome Aberrations." *International Journal of Molecular Sciences 2*0, no. 1 (December 22, 2018).
236. Paul, Amber M., Margareth Cheng-Campbell, Elizabeth A. Blaber, Sulekha Anand, Sharmila Bhattacharya, Sara R. Zwart, Brian E. Crucian et al. "Beyond Low-Earth Orbit: Characterizing Immune and microRNA Differentials following Simulated Deep Spaceflight Conditions in Mice." *IScience* 23, no. 12 (December 18, 2020).
237. Farley, Antoine, Vasily Gnyubkin, Arnaud Vanden-Bossche, Norbert Laroche, Mieke Neefs, Sarah Baatout, Bjorn Baselet, Laurence Vico, and Carmelo Mastrandrea. "Unloading-Induced Cortical Bone Loss is Exacerbated by Low-Dose Irradiation During a Simulated Deep Space Exploration Mission." *Calcified Tissue International* 107 (May 25, 2020).
238. Hodkinson, P. D., R. A. Anderton, N. Posselt, and K. J. Fong. "An Overview of Space Medicine." *British Journal of Anaesthesia* 119, supplement 1 (December 2017).
239. Scott, Ryan T., Lauren M. Sanders, Erik L. Antonsen, Jaden J. A. Hastings, Seung-min Park, Graham Mackintosh, Robert J. Reynolds, et al. "Biomonitoring and Precision Health in Deep Space Supported by Artificial Intelligence." *Nature Machine Intelligence* 5 (March 23, 2023).
240. Blue, Rebecca S., Jeffery C. Chancellor, Erik L. Antonsen, Tina M. Bayuse, Vernie R. Daniels, and Virginia E. Wotring. "Limitations in Predicting Radiation-Induced Pharmaceutical Instability during Long-Duration Spaceflight." *npj microgravity* 5 (June 6, 2019).
241. Wright, Tim. "Space Station ER." *Air & Space* (September 2015).
242. Overbey, Eliah G., JangKeun Kim, Braden T. Tierney, Jiwoon Park, Nadia Houerbi, Alexander G. Lucaci, Sebastian Garcia Medina, et al. "The Space Omics and Medical Atlas (SOMA) and International Astronaut Biobank." *Nature* (June 11, 2024).
243. Achenbach, Joel. "Spaceflight is Hard on Humans, but Scientists See No Showstoppers." *The Washington Post* (June 11. 2024).
244. NASA. Orbital Debris Program Office FAQ website.
245. Astroscale. Astroscale website.
246. Surrey Space Centre. RemoveDEBRIS website.
247. Net Zero Space. Net Zero Space website.
248. SpaceX. Starlink website.
249. Space Safety Magazine. Kessler Syndrome website.
250. Zhang, Shenyi, Robert F. Wimmer-Schweingruber, Jia Yu, Chi Wang, Qiang Fu, Yongliao Zou, Yueqiang Sun et al. "First Measurements of the Radiation Dose on the Lunar Surface." *Science Advances* 6, no. 39 (September 25, 2020).
251. Hall, Shannon. "The Moon Is a Hazardous Place to Live." *The New York Times* (July 8, 2019).
252. Stubbs, Timothy J., Richard R. Vondrak, and William M. Farrell. "Impact of Dust on Lunar Exploration." NASA Goddard Space Flight Center.

253. Prisk, G. Kim. "Pulmonary Challenges of Prolonged Journeys to Space: Taking Your Lungs to the Moon." *Medical Journal of Australia* 211, no. 6 (August 16, 2019).
254. David, Leonard. "Moon Dust Could Be a Problem for Future Lunar Explorers." Space.com (October 21, 2019).
255. Human Research Roadmap. "What are the Effects of Lunar Gravity on Permissible Exposure Limits for Inhalation of Lunar Dust?" NASA (March 26, 2021).
256. Meyers Valerie E, Hector D Garcìa, Kathryn Monds, Bonnie L Cooper, and John T James. "Ocular Toxicity of Authentic Lunar Dust." *BMC Ophthalmology* 12 (July 20, 2012).
257. NASA Lunar Airborne Dust Toxicity Assessment Group. *Lunar Dust Toxicity Final Report* (February 7, 2014).
258. NASA. *Lunar Dust and Its Impact on Human Exploration: A NASA Engineering and Safety Center (NESC) Workshop* (September 2020).
259. Lam, Chiu-wing, Robert R. Scully, Ye Zhang, Roger A. Renne, Robert L. Hunter, Richard A. McCluskey, Bean T. Chen et al. "Toxicity of Lunar Dust Assessed in Inhalation-Exposed Rats." *Inhalation Toxicology* 25, no 12 (October 9, 2013).
260. Oberdörster, G., Z. Sharp, V. Atudorei, A. Elder, R. Gelein, W. Kreyling, and C. Cox "Translocation of Inhaled Ultrafine Particles to the Brain." *Inhalation Toxicology* 16, no. 6-7 (2004).
261. Caston, Rachel, Katie Luc, Donald Hendrix, Joel A. Hurowitz, and Bruce Demple. "Assessing Toxicity and Nuclear and Mitochondrial DNA Damage Caused by Exposure of Mammalian Cells to Lunar Regolith Simulants." *GeoHealth* 2, no. 4 (April 12, 2018).
262. Grush, Lauren. "High-Speed Lunar Dust Could Cloud the Future of Human Missions to the Moon." *The Verge* (July 17, 2019).
263. NASA. "NASA Selects University Teams to Develop Ways to Deal with Moon Dust." (January 21, 2021).
264. NASA. "How Investing in the Moon Prepares NASA for First Human Mission to Mars."
265. Explore Mars. *The Human to Mars Report 2020* (2020).
266. NASA. Generalizable Skills and Knowledge for Exploration Missions (July 2019).
267. Robyn Gatens. ECLSS. The Humans to Mars Virtual Summit Series 2020.
268. Vera, Alonso H. "AI for Progressive Earth Independence," in seminar "How Can Artificial Intelligence Enable Mars?" Humans to Mars 2024 (May 8, 2024.
269. NASA. "Apollo 13: Mission Details." (July 8, 2009).
270. Zeitlin, C., D. M. Hassler, F. A. Cucinotta, B. Ehresmann, R. F. Wimmer-Schweingruberd, E. Brinza, and S. Kang. "Measurements of Energetic Particle Radiation in Transit to Mars on the Mars Science Laboratory." *Science* 340, no. 6136 (May 31, 2013).
271. NASA. Space Radiation website.
272. Atri, Dimitra, Caitlin MacArthur, Sriram Devata, Shireen Mathur, Giulia Carla Bassani, Roberto Parisi, Dionysios Gakis, Konstantin Herbst, Azza Al Bakr, and Tammy Witzens. "Crewed Missions to Mars: Modeling the Impact of Astrophysical Charged Particles on Astronauts and Assessing Health Effects." *Space Physics* (August 2022).

273. NASA. Generalizable Skills and Knowledge for Exploration Missions (July 2019).
274. Jandial, Rahul, Reid Hoshide, J. Dawn Waters, and Charles L. Limoli. "Space–Brain: The Negative Effects of Space Exposure on the Central Nervous System." *Surgical Neurology International* (January 16, 2018).
275. Robinson, Julie. Human Research Program Investigators' Workshop 2020: Day 1. Presentation on video begins at 2:03:53 (January 27, 2020).
276. NASA Jet Propulsion Laboratory. "7 Minutes to Mars: NASA's Perseverance Rover Attempts Most Dangerous Landing Yet." (February 12, 2021).
277. ExploreMars. Technical Session 2b: Entry, Descent, and Landing. Humans to Mars 2020. (September 16, 2020).
278. NASA. Regolith Adaptive Modification System (RAMs) to Support Early Extraterrestrial Planetary Landings (and Operations). Video: Regolith Adaptive Modification Systems (RAMs)
279. NASA. Autonomous Robotic Demonstrator for Deep Drilling (ARD3) website.
280. NASA. Ablative Arc Mining for In-Situ Resource Utilization website.
281. Kelly, Scott. *Endurance: A Year in Space, A Lifetime of Discovery*. Knopf Doubleday Publishing Group (2017).
282. NASA. "The Human Body in Space." (February 2, 2021).
283. NASA. "The Fact and Fiction of Martian Dust Storms." (August 6, 2017).
284. Davila, Alfonso F., David Willson, John D. Coates, and Christopher P. McKay. "Perchlorate on Mars: A Chemical Hazard and a Resource for Humans." *International Journal of Astrobiology* (June 12, 2013).
285. Wadsworth, Jennifer and Charles S. Cockell. "Perchlorates on Mars Enhance the Bacteriocidal Effects of UV Light." *Scientific Reports* 7 (July 6, 2017).
286. NASA. NASA Visitors Centers website.
287. NASA. Gateway: The Deep Space Launch Complex website.
288. NASA. How We Are Going to the Moon - 4K
289. NASA. NASA's Visions of the Future.
290. NASA. First Woman: NASA's Promise for Humanity website.
291. [52] NASA, NASA main website.
292. NASA, Artemis Program website.
293. Haberman, Clyde. "How NASA Sold the Science and Glamour of Space Travel." *The New York Times* (June 23, 2019).
294. NASA. "Space Radiation Won't Stop NASA's Human Exploration."
295. NASA. Human Research Roadmap website.
296. The Planetary Society. Your Guide to NASA's Budget website.
297. Goldsmith, Donald and Martin Rees. *The End of Astronauts: Why Robots Are the Future of Exploration*. Harvard University Press, 2022.
298. The White House. National Space Council website.
299. The White House National Space Council. United States Space Priorities Framework website.
300. Kennedy, Brian and Alec Tyson. "Americans' Views of Space: U.S. Role, NASA Priorities and Impact of Private Companies." Pew Research Center (July 20, 2023).
301. Morning Consult. "Nearly Half the Public Wants the U.S. to Maintain Its Space Dominance. Appetite for Space Exploration Is a Different Story. (February 25, 2021).

302. Coalition for Deep Space Exploration website.
303. Mars Society website.
304. Earthlight Foundation website.
305. Explore Mars, Inc. website.
306. National Space Society website.
307. Goldsmith, Donald and Martin Rees. *The End of Astronauts: Why Robots Are the Future of Exploration*. Harvard University Press, 2022.
308. Kamin, Debra, "Maybe in Your Lifetime, People Will Live on the Moon and Then Mars." *The New York Times*. (October 1, 2023).
309. Garver, Lori. *Escaping Gravity: My Quest to Transform NASA and Launch a New Space Age.* Diversion Books, 2022.
310. NASA Artemis Partners website.
311. Berger, Eric. "NASA Chief Says Cost-Plus Contracts are a 'Plague' on the Space Agency." *Ars Technica* (May 3, 2022).
312. NASA. Space Launch System website.
313. Berger, Eric. "NASA Will Award Boeing a Cost-Plus Contract for up to 10 SLS Rockets," *Ars Technica*, October 17, 2019.
314. NASA Office of Inspector General. *NASA's Management of Space Launch System Programs and Contracts*. (March 10, 2020).
315. US Government Accountability Office. "Space Launch System: Cost Transparency Needed to Monitor Program Affordability." (September 7, 2023).
316. NASA Office of Inspector General. *NASA's Management of Crew Transportation to the International Space Station* (March 10, 2020).
317. NASA. *NASA's Management of the Orion Multi-Purpose Crew Vehicle Program* (July 16, 2020).
318. Roulette, Joey. "A Costly and Difficult Path to the Launchpad." *The New York Times* (December 25, 2021).
319. Garver, Lori. *Escaping Gravity: My Quest to Transform NASA and Launch a New Space Age.* Diversion Books, 2022.
320. OpenSecrets website.
321. MoonWalker Associates website.
322. Schouten, Fredreka, Ted Barrett, and Lauren Fox. "Boeing A Major Lobbying Player on Capitol Hill." CNN Politics. (March 3, 2019).
323. Scoles, Sarah. "PRIME MOVER: Starship Will be the Biggest Rocket Ever. Are Space Scientists Ready to Take Advantage of It?" *Science* 377, no. 6607 (August 12, 2022).
324. Morris, Charles. "Cool Factor: Elon Musk and SpaceX Play a Role as NASA Rises in Popularity." EVAnnex (September 5, 2020).
325. Venditti, Bruno. "The Cost of Space Flight before and after SpaceX." Visual Capitalist (January 27, 2022).
326. Roberts, Thomas G. "Space Launch to Low Earth Orbit: How Much Does It Cost?" Aerospace (September 1, 2022).
327. Garver, Lori. *Escaping Gravity: My Quest to Transform NASA and Launch a New Space Age.* Diversion Books, 2022.
328. SpaceX website.

329. Smith, Rich. "America's Next Space Station Will Be Twice as Big Thanks to SpaceX." The Motley Fool (February 19, 2024).
330. SpaceX. Mars & Beyond website.
331. Foust, Jeff. "Delivering a Business Case for Rocket Cargo." The Space Review (February 19, 2024).
332. Blue Origin website.
333. Wikipedia, List of private spaceflight companies website.
334. Starlink website.
335. Foust, Jeff. "NASA Selects Blue Origin to Develop Second Artemis Lunar Lander." Space News (May 19, 2023).
336. NASA. "As Artemis Moves Forward, NASA Picks SpaceX to Land Next Americans on Moon." April 16, 2021).
337. NASA. "NASA Awards Artemis Contract for Gateway Logistics Services." (March 27, 2020).
338. Wall, Mike. "1st Mars Colonists Should Be 'Prepared to Die,' Elon Musk Says," Space.com (September 30, 2016.).
339. Wikipedia. "The Martian."
340. NASA. "The Fact and Fiction of Martian Dust Storms. (September 18, 2015).
341. David, Leonard. "Toxic Mars: Astronauts Must Deal with Perchlorate on the Red Planet." Space.com (June 13, 2013).
342. Coady, David, "Mars soil is likely toxic to cells — does this mean humans won't be able to grow vegetables there?" The World Today, July 6, 2017.
343. Wikipedia, "*For All Mankind*."
344. Wikipedia. "*The Expanse*."
345. [92] Fandom. The Expanse Wiki, Technology website.
346. Wikipedia. Inertial Confinement Fusion website.
347. Myers, Maddy, "Starfield Makes Space Travel Feel Way Too Safe." Polygon.com, September 9, 2023.
348. Ruiz, Fran, "'Starfield' is an inspiring odyssey that could rekindle mainstream interest in space exploration." Space.com (October 8, 2023).
349. NASA. NASA and 'The Martian' website.
350. Peroomian, Vahe. "Young Americans deserve a 21st-century Moonshot to Mars." *The Conversation*. (July 15, 2019).
351. National Research Council. *Pathways to Exploration: Rationales and Approaches for a US Program of Human Space Exploration*. The National Academies Press (2014).
352. Goldsmith, Donald and Martin Rees. *The End of Astronauts: Why Robots Are the Future of Exploration*. Harvard University Press, 2022.
353. Donaldson, Abbey A. "NASA Shares Progress Toward Early Artemis Moon Missions with Crew." NASA (January 9, 2024).
354. Wikipedia. James Webb Space Telescope website.
355. Mars Mission Architecture: Advancing Technology for Humans on Mars (25:00), ExploreMars, May 7, 2020.
356. McQuail, Kim, "Sputnik Reconsidered: Image and Reality in the Early Space Age." *Canadian Review of American Studies*, Vol. 37, No. 3 (Winter 2007).
357. Muir-Harmony, Teasel. *Operation Moonglow: A Political History of Project Apollo*. Basic Books, 2020.

358. Peoples, Columba. "Sputnik and 'Skill Thinking' Revisited: Technological Determinism in American Responses to the Soviet Missile Threat." *Cold War History* 8, no. 1 (September 18, 2008).
359. Tumlinson, Rick. "First Space Race: Foundation, Inspiration, Motivation, Stagnation." Mars Society Conference, 2020. Also BrainyQuote
360. Oldroyd, David R. *The Earth Inside and Out: Some Major Contributions to Geology in the Twentieth Century* Geological Society, London, 2002.
361. Logsdon, John. "The Space Shuttle Program: A Policy Failure? " *Science* 232 no. 4754 (May 30, 1986).
362. National Aeronautics and Space Administration. *America's Next Decades in Space: A Report for the Space Task Group* (September 1969).
363. Higginbotham, Adam. *Challenger, A True Story of Heroism and Disaster on the Edge of Space*. Avid Reader Press/Simon & Schuster (May 14, 2024)
364. Texas Space Grant Consortium. "Doomed from the Beginning:The Solid Rocket Boosters for the Space ShuttleChapter VI: An Accident Rooted in History."
365. Encyclopedia Astronautica. SRB website.
366. Berger, Eric. "SpaceX Pushing Iterative Design Process, Accepting Failure to Go Fast." *Ars Technica* (February 1, 2020).
367. Salisbury, David F. "Roger Noll Thinks He's Got Answer to Inept Government." *Christian Science Monitor* (August 25, 1983).
368. NASA. *NASA Aerospace Safety Advisory Panel Annual Report for 2021* (January 1, 2022).
369. Goldsmith, Donald and Martin Rees. *The End of Astronauts*. Harvard University Press, 2022.
370. Encyclopedia Astronautica. ISS website.
371. NASA. Research & Technology on the ISS website.
372. NASA. "Groundbreaking Results from Space Station Science in 2023." (February 27, 2024).
373. Robinson, Julie. "International Space Station's Top 10 Science Accomplishments. Explore Deep Space (October 29, 2013).
374. Dorrian, Gareth. "Five Key Scientific Findings from 15 Years of the International Space Station." *The Conversation* (December 29, 2015).
375. Goldsmith, Donald and Martin Rees. *The End of Astronauts: Why Robots Are the Future of Exploration*. Harvard University Press, 2022.
376. NASA Office of Inspector General. *NASA's Management and Utilization of the International Space Station* (July 30, 2018).
377. NASA Office of Inspector General. *Examining the Future of the International Space Station* (May 16, 2018).
378. Defresne, Steven. "Lost in Space: How Materials Degrade in Space." Hackaday (March 12, 2018).
379. De Rooij, A. "Corrosion in Space."
380. Bartels, Meghan. The International Space Station Can't Last Forever. Here's How it Will Eventually Die by Fire. Space.com (February 4, 2022).
381. NASA. "The International Space Station Transition Plan." (September20, 2023).
382. Wikipedia. "Programs Canceled before Crewed Launch."

383. Weed, Ryan. "Powering Up in Space: Is Nuclear the Answer?" War the Rocks (July 11, 2022).
384. Campbell-Dollaghan, Kelsey. "9 Forgotten NASA Concepts For Space Stations That Never Flew." Gizmodo (June 14, 2014).
385. NASA. NASA Spinoff website.
386. NASA. NASA Technology Transfer Program website.
387. NASA. Entering the Decade of Results: International Space Station Benefits for Humanity Publication Released. (July 22, 2022).
388. NASA. Six Earthbound Benefits Thanks to the International Space Station. (July 25, 2022).
389. NASA. NASA Home & City website.
390. Paikowsky, Deganit. "The Space Race's Shifting Center of Gravity." *Foreign Policy* (December 11, 2022).
391. Butow, Steven J., Thomas Cooley, Eric Felt, and Joel B. Mozer.
392. *State of the Space Industrial Base 2020: A Time for Action to Sustain US Economic & Military Leadership in Space* (July 2020).
393. China Shenzhou space station
394. Jones, Andrew. "China Aims for Space-Based Solar Power Test in LEO In 2028, GEO in 2030." Space News (June 8, 2022).
395. Landspace website
396. Pollpeter, Kevin, Timothy Ditter, Anthony Miller, and Brian Waidelich. *China's Space Narrative: Examining the Portrayal of the US-China Space Relationship in Chinese Sources and Its Implications for the United States*. US Air Force Air University China Aerospace Studies Institute.
397. Bradsher, Keith. "China Maps Out Plans to Put Astronauts on the Moon and on Mars." *The New York Times* (December 12, 2022).
398. Tumlinson, Rick. "The Future of The Space Force Isn't on Earth — It's in the Solar System." Space News (March 20, 2024).
399. Olson, J., S. Butow, E. Felt, and T. Cooley. *State of the Space Industrial Base 2022*. United States Space Force, Defense Innovation Unit, Department of the Air Force, and Air Force Research Laboratory. (August 2022).
400. Mohon, Lee and Catherine E. Williams. "Artemis III: NASA's First Human Mission to the Lunar South Pole." NASA (January 13, 2023).
401. NASA, Mobile Launcher website.
402. Venditti, Bruno. "The Cost of Space Flight before and after SpaceX." Visual Capitalist (January 27, 2022).
403. Smith, Rich. "The Secret to SpaceX's $10 Million Starship, and How SpaceX Will Dominate Space for Years to Come." The Motley Fool. (February 11, 2024).
404. Foust, Jeff. "Starship Lunar Lander Missions to Require Nearly 20 Launches, NASA Says." Space News (November 17, 2023).
405. Clark, Stephen. "Biden Backs Artemis Moon Program; Watchdog Says It'll Cost $86 Billion." Spaceflight Now (February 10, 2021).
406. NASA Office of Inspector General. *Artemis Status Update* (April 19, 2021).
407. NASA Office of Inspector General. *NASA's Management of Space Launch Booster and Engine Contracts* (May 25, 2023).
408. NASA. Mobile Launcher website.

409. NASA Office of Inspector General. *NASA's Management of the Mobile Launcher 2 Contract* (June 9, 2022).
410. NASA. *NASA's Management of the Orion Multi-Purpose Crew Vehicle Program* (July 16, 2020).
411. US Government Accountability Office. "NASA: Actions Needed to Improve the Management of Human Spaceflight Programs." (September 18, 2019).
412. US Government Accountability Office. "NASA Human Space Exploration: Significant Investments in Future Capabilities Require Strengthened Management Oversight." (December 2020).
413. US Government Accountability Office. "NASA Lunar Programs: Significant Work Remains, Underscoring Challenges to Achieving Moon Landing in 2024." (May 26, 2021).
414. US Government Accountability Office. "NASA: Assessments of Major Projects." (April 29, 2020).
415. Howell, Elizabeth. "Bill Nelson Pledges Action on Artemis, Mars and China in 1st Hearing as NASA Chief." Space.com (May 19, 2021).
416. Berger, Eric. "With Artemis, NASA at Risk of Repeating Apollo Mistakes, Scientist Warns." *Ars Technica* (August 20, 2019).
417. Berger, Eric. "Are We Really Going to the Moon? History Isn't Kind to Presidential Plans." *Ars Technica* (October 6, 2017).
418. NASA Office of Inspector General. "Termination of Audit, NASA's Challenges to Safely Return Humans to the Moon by 2024." (December 1, 2020).
419. Dreier, Casey and Jason Davis. "With Starship, NASA is buying the Moon, but investing in Mars." The Space Review (April 26, 2021).
420. Roulette, Joey. "NASA Suspends SpaceX's $2.9 Billion Moon Lander Contract After Rivals Protest." *The Verge* (April 30, 2021).
421. Foust, Jeff. "Who Will Race SpaceX to the Moon?" Space News (May 31, 2021).
422. NASA. Lunar Gateway website.
423. Berger, Eric. "NASA Officials Outline Plans for Building a Lunar Gateway in the Mid-2020s." *Ars Technica* (March 30, 2020).
424. Zubrin, Robert. "At Today's NASA, Success Is Not an Option," *National Review* (June 12, 2019).
425. Berger, Eric. "Former NASA Administrator Says Lunar Gateway Is "A Stupid Architecture." *Ars Technica* (November 15, 2018).
426. Carpineti, Alfredo. "Crewed Missions To The Moon Need To Get A Move On To Avoid Upcoming Solar Storms." IFL Science (May 21, 2021).
427. Dixit, Mrigakshi and Clara Early. "The Threat of Space Radiation." Supercluster (January 3, 2023).
428. Smith, O. Glenn and Paul D. Spudis. "Mars for Only $1.5 Trillion." (March 8, 2015).
429. Berger, Eric. "Report: NASA's Only Realistic Path for Humans on Mars Is Nuclear Propulsion." *Ars Technica* (February 12, 2021).
430. SpaceX. Starship Mission to Mars.
431. National Academies of Science, Engineering, and Medicine. *Space Nuclear Propulsion for Human Mars Exploration* (2021).

432. Chang, Kenneth. "NASA Seeks a Nuclear-Powered Rocket to Get to Mars in Half the Time." *The New York Times* (July 26, 2023).
433. NASA. Media Briefing: Update on NASA, DARPA Nuclear Rocket Program (July 26, 2023)
434. Foust, Jeff. "Nuclear Space Gets Hot." *The Space Review* (July 31, 2023).
435. Video from Space. "Watch Astronauts Put On Spacesuits in Awesome Space Station Time-lapse."
436. NASA. *Risk Of Injury and Compromised Performance Due to EVA Operations*. Human Research Program (April 3, 2017).
437. Newsthink. "The Astronaut Who Almost Drowned in Space." (February 10, 2024).
438. NASA Office of the Inspector General. *NASA's Development of Next-Generation Spacesuits* (August 10, 2021).
439. Wall, Mike. "NASA Picks Spacesuit Maker for 1st Artemis Moonwalkers." (September 7, 2022).
440. Collins Aerospace. Space Suits website.
441. NASA. MOXIE website.
442. NASA. "NASA's Perseverance Mars Rover Extracts First Oxygen from Red Planet." (April 21, 2021).
443. OxEon. Solid Oxide Electrolysis Cells (SOEC), and Methane Synthesis Reactor website.
444. Foust, Jeff. "NASA Plans for Lunar Fission Power Systems Face Fiscal Challenges." Space News (July 20, 2023).
445. Astroport website.
446. NASA. (ASPECT) Autonomous Site Preparation: Excavation, Compaction, and Testing
447. NASA. ISRU Pilot Excavator website.
448. NASA. Automated Reconfigurable Mission Adaptive Digital Assembly Systems (ARMADAS)
449. Coldewey, Devin. "NASA's Robotic, Self-Assembling Structures Could Be the Next Phase of Space Construction." TechCrunch (January 17, 2024).
450. Gregg, Christine E., Damiana Catanoso, Olivia Irene B. Formoso, Irina Kostitsyna, Megan E. Ochalek, Taiwo J. Olatunde, In Won Park, Frank M. Sebastianelli, Elizabeth M. Taylor, Greenfield T. Trinh, and Kenneth C. Cheung. "Ultralight, Strong, and Self-Reprogrammable Mechanical Metamaterials." *Science Robotics* 9, No 86 (January 17, 2024).
451. GITAI Inchworm Robot website.
452. GITAI. GITAI's Tech-Demo of Lunar Base Construction in a Mock Lunar Surface Environment. YouTube, 2023.
453. DuAxel robot website.
454. Bandyopadhyay, Saptarshi. "Lunar Crater Radio Telescope (LCRT) on the Far-Side of the Moon." NASA (April 7, 2020).
455. NASA Techport website.
456. van Susante, P. J. and R. Alger. "Proposed New Testing Facility for Cold and Operational Long Duration Testing Of Lunar and Mars ISRU and Mobility." (2019)
457. Michigan Technological University. Planetary Surface Technology Lab website.

458. *Lunar ISRU 2019: Developing a New Space Economy Workshop Report*. July 15-17, 2019).
459. Through Lunar Resources and Their Utilization
460. AP-NORC. "Space Exploration: Attitudes towards the US Space Program." (May 2019).
461. Kennedy, Brian and Alec Tyson. "Americans' Views of Space: U.S. Role, NASA Priorities and Impact of Private Companies." Pew Research Center (July 20, 2023).
462. Chase, Patrick. "NASA, Space Exploration, and American Public Opinion." *Medium* (July 13, 2020).
463. NASA Office of Inspector General. *NASA's Plans for Human Exploration beyond Low Earth Orbit (*April 13, 2017).
464. Linck, Evan, Keith W. Crane, Brian L. Zuckerman, Benjamin A. Corbin, Roger M. Myers, Sharon R. Williams, Sara A. Carioscia, Rodolfo Garcia, and Bhavya Lal. *Evaluation of a Human Mission to Mars by 2033, IDA Science & Technology Policy Institute* (February 2019).
465. Smith, O. Glenn and Paul D. Spudis. "Mars for Only $1.5 Trillion." (March 8, 2015).
466. Griffin, Michael. "Why are We Not on Mars?" 2020 Mars Society Convention (October 2020).
467. Bryan Mattfeld, Chel Stromgren, Hilary Shyface, David R. Komar, William Cirillo, and Kandyce Goodliff. "Trades between Opposition and Conjunction Class Trajectories for Early Human Missions to Mars." Conference paper, American Institute of Aeronautics and Astronautics (August 4, 2014).
468. Nordeen, Claire A. and Sandra L. Martin. "Engineering Human Stasis for Long-Duration Spaceflight." *Physiology* (February 6, 2019).
469. NASA. *Moon to Mars Objectives and Strategy*. (September 2022).
470. NASA Planetary Science website.
471. NASA. NASA Science Missions website.
472. NASA. Space Telescope Science Institute website.
473. NASA. James Webb Space Telescope website.
474. Corrado, Luisa, Maureen Cropper, and Akhil Rao. "Space Exploration and Economic Growth: New Issues and Horizons." *Proceedings of the National Academy of Sciences* 120, vol. 43 (October 16, 2023).
475. Space Foundation. The Space Report.
476. Roberts, Thomas G. "Space Launch to Low Earth Orbit: How Much Does It Cost?" Aerospace (September 1, 2022).
477. Bockel, Jean-Marie. The Future of the Space Industry. NATO (November 17, 2018).
478. Satellite Industry Association. *2023 State of the Satellite Industry Report*
479. Space Foundation. The Space Report.
480. Morgan Stanley. Space: Investing in the Final Frontier. (July 2, 2019.)
481. Sheetz, Michael. "The Space Industry Will Be Worth Nearly $3 Trillion in 30 Years, Bank of America Predicts."CNBC (October 31, 2017).
482. NASA. *A Researcher's Guide to Microgravity Materials Research.*

483. Giulianotti, Marc, Arun Sharma , Rachel Clemens , Orquidea Garcia , Lansing Taylor , Nicole Wagner , Kelly Shepard et al. "Opportunities for Biomanufacturing in Low Earth Orbit: Current Status and Future Directions." (August 2, 2021).
484. Grimm, Daniela, Markus Wehland, Thomas J. Corydon, Peter Richter, Binod Prasad, Johann Bauer, Marcel Egli, Sascha Kopp, Michael Lebert, and Marcus Krüger. "The Effects of Microgravity on Differentiation and Cell Growth in Stem Cells and Cancer Stem Cells."*Stem Cells Translational Medicine* 9, no. 8 (April 30, 2020).
485. Low, Lucie A., Christine Mummery, Brian R. Berridge, Christopher P. Austin, and Danilo A. Tagle. "Organs-on-Chips: Into the Next Decade." *Nature Reviews Drug Discovery* 20 (September 10, 2020).
486. NASA. ISS U.S. National Laboratory website.
487. NASA. Space Station Research Explorer, All Facilities website.
488. NASA. ISS Researcher's Guide Series website.
489. Made in Space. Best in Class Flouride-Based Fiber for Medical, Telecom and Research website.
490. Made in Space. Developing New Materials in Space website.
491. Made in Space. First Commercial 3D Printer in Space website.
492. Made in Space. Providing Robust Manufacturing Capabilities in Space website.
493. Made in Space. Commercial Ceramics for Terrestrial Use website.
494. FOMS. Fiber Optic Manufacturing in Space website.
495. TechShot. About the 3D BioFabrication Facility (BFF) website.
496. LambdaVision. Protein-based Artificial Retinas website.
497. Redwire. Redwire Brief: LSII Excavation & Construction Focus Group website.
498. Techshot. Techshot In-space Manufacturing website.
499. Axiom Space website.
500. NASA. "NASA Selects Companies to Develop Commercial Destinations in Space." (December 2, 2021).
501. LIFE habitat. Sierra Space website.
502. Max Space website.
503. Nanoracks. Outpost website.
504. European Space Agency. "Microgravity on demand with Earth return through ESA's Boost." (September 27, 2021).
505. Made in Space. Archinaut website.
506. National Space Society. The Orbital Economy: Challenges & Opportunities along the Path to a Trillion-Dollar Economy. (September 30, 2020).
507. NASA Office of Inspector General. *NASA's Management and Utilization of the International Space Station*. (July 30, 2018).
508. Clery, Daniel. "Is NASA Too Down on Space-Based Solar Power?" *Science* (January 22, 2024).
509. Axiom Space website.
510. SpaceX website.
511. Blue Origin website.
512. Virgin Galactic website.
513. Space Perspective website.
514. Space Adventures website.
515. Space Perspective website.

516. Wall, Mike. "Russia Wants You to Buy a Seat on a Soyuz Mission to the Space Station." Space.com (June 9, 2021).
517. Rivers, Lydia. "Medical Emergencies in Space: Is Private Space Tourism Ready for a Worst Case Scenario?" *Astronomy* (June 7, 2021).
518. Tenebruso, Joe. "Here's How to Profit From the $800 Billion Space Industry." The Motley Fool (December 10, 2019).
519. SpaceX. "Starship: Earth to Earth" (2018).
520. ICON. "ICON 3D Prints the First Simulated Mars Surface Habitat for NASA Designed by Renowned Architecture Firm BIG-Bjarke Ingels Group." (August 8, 2021).
521. Sauro, Francesco, Riccardo Pozzobon, Matteo Massironi, Pierluigi De Berardinis, Tommaso Santagata, and JoDe Waelea. "Lava Tubes on Earth, Moon And Mars: A Review on Their Size And Morphology Revealed by Comparative Planetology." *Earth-Science Reviews* 209 (October 2020).
522. Farrell, W.M., D. M. Hurley, M. J. Poston, P. O. Hayne, J. R. Szalay, and J. L. McLain. "The Young Age of the LAMP-observed Frost in Lunar Polar Cold Traps." *Geophysical Research Letters* (July 1, 2019).
523. Li, Shuai, Paul G. Lucey, Ralph E. Milliken, Paul O. Hayne, Elizabeth Fisher, Jean-Pierre Williams, Dana M. Hurley, and Richard C. Elphic. "Direct Evidence of Surface Exposed Water Ice in the Lunar Polar Regions." *Proceedings of the National Academy of Sciences* (August 20, 2018).
524. Orosei, R., S. E. Lauro, E. Pettinelli, A. Cicchetti, M. Coradini, B. Cosciotti, F. Di Paolo et al. "Radar Evidence of Subglacial Liquid Water on Mars." *Science* 361, no. 6401 (August 3, 2018).
525. Cooper, Ken. "Water Ice Buried at Mars' Equator Is Over 2 Miles Thick." Space.com (January 18, 2024).
526. Space Nutrition and Health 1: Plant Molecular Foundries, August 9, 2023.
527. Berliner, Aaron J., Jacob M. Hilzinger, Anthony J. Abel, Matthew J. McNulty, George Makrygiorgos, Nils J. H. Averesch, et al. "Towards a Biomanufactory on Mars." *Frontiers in Astronomy and Space Science* 8 (July 2021).
528. Brophy, John, Fred Culick, Louis Friedman, Carlton Allen, David Baughman, Julie Bellerose, Bruce Bet et al., "Asteroid Retrieval Feasibility Study." Keck Institute for Space Research (April 2, 2012).
529. Asteroid Mining Corporation website.
530. Trans Astra Corporation website.
531. OffWorld website.
532. SpaceFab website.
533. Fickling, David. "We're Never Going to Mine the Asteroid Belt." Bloomberg (December 21, 2020).
534. NASA. Institutional Review Board: Levels of Risk website.
535. NASA. Institutional Review Board: Overview website.
536. NASA, Institutional Review Board: Guidance on Space Flight, Reduced Gravity Aircraft, Ground Studies, Human-In-The-Loop Studies, and Multi-Experiment Projects website.
537. Tenbrunsel, Ann E. and Bazerman, Max H. "Launching into Unethical Behavior." *Freakonomics* (June 1, 2011).

538. NASA Aerospace Safety Advisory Panel. *Annual Report for 2020* (January 1, 2021).
539. NASA. Human Research Roadmap. Med 08 website.
540. NASA. Risk of Adverse Health Outcomes & Decrements in Performance due to Inflight Medical Conditions website.
541. Rahimzadeh, Vasiliki, Jennifer Fogarty, Timothy Caulfield, Serena Auñón-Chancellor, Pascal Borry, Jessica Candia, I. Glenn Cohen, Marisa Covington et al. "Ethically Cleared to Launch?" *Science* 381, No. 6665 (September 28, 2023).
542. Vidaurri, Monica. "Building an Ethical Consensus for Space Exploration." *Physics World* (November 27, 2019)
543. Wikipedia. Corporate Manslaughter website.
544. Mason, Christopher. "Could Humans Have Contaminated Mars With Life?" BBC Future (May 10, 2021).
545. Quote from ALFAMars website
546. Lea, Robert. "Astronauts May Accidentally Threaten Mars Missions with Their Gut Bacteria, Scientists Warn." Space.com (February 13, 2024).
547. Benner, Steven. "The Case for Extant Life on Mars." 25th Annual International Mars Society Convention. (September 15, 2022).
548. Carrier, B. L. , D. W. Beaty, M. A. Meyer, J. G. Blank, L. Chou, S. DasSarma, D. J. Des Marais et al. "Mars Extant Life: What's Next? Conference Report." *Astrobiology* 20, no. 6 (June 10, 2020).
549. Horne, William H., Robert P. Volpe, George Korza, Sarah DePratti, Isabel H. Conze, Igor Shuryak, Tine Grebenc et al. "Effects of Desiccation and Freezing on Microbial Ionizing Radiation Survivability: Considerations for Mars Sample Return." *Astrobiology* 22, no. 11 (October 31, 2022).
550. Northwestern University. "Ancient Bacteria Might Lurk beneath Mars' Surface." Phys.org (October 25, 2022).
551. Committee on Planetary Protection. *Report Series Committee on Planetary Protection: Evaluation of Bioburden Requirements for Mars Missions*. National Academy of Sciences, Engineering and Medicine (2021).
552. NASA. "4 Agencies Select 8 Research Projects to Extend Longevity of 3D Tissue Chips to 6 Months. (March 1, 2022).
553. NASA. "What is Biosentinel?" (Matrch 15, 2022).
554. Sanders, Lauren M., Ryan T. Scott, Jason H. Yang, Amina Ann Qutub, Hector Garcia Martin, Daniel C. Berrios, Jaden J. A. Hastings, et al. "Biological Research and Self-Driving Labs in Deep Space Supported by Artificial Intelligence." *Nature Machine Intelligence* 5 (March 23, 3023).
555. Tavakol, Daniel Naveed. "Astronaut-On-A-Chip: Human Multi-Organ Platform for Assessing Extended Effects of Cosmic Radiation, Human Tissues Avatars for Space Radiation." NASA 2022 Human Research Program Investigators' Workshop (February 8, 2022).
556. NASA. "Space Health Institute Awards 5 Ground-breaking Research Grants to Mitigate the Effects of Space Radiation on Healthy Human Cell-Derived Organs-On-A-Chip." (September 18, 2020).

557. Aleci, Carlo. "From International Ophthalmology to Space Ophthalmology: The Threats to Vision on the Way To Moon And Mars Colonization." *International Ophthalmology*40 (November 13, 2019).
558. Sharma, Tasneem P., Stacy M. Curry, Husain Lohawala, and Colleen McDowell. "Translaminar Autonomous System Model for the Modulation of Intraocular and Intracranial Pressure in Human Donor Posterior Segments." *Jove* (April 24, 2020).
559. Sharma, Tasneem Putliwala. "Pathogenesis of Space Associated Neuro-Ocular Syndrome examined using the Ex-Vivo Human Translaminar Autonomous System." ARVO Annul Meeting 62, no. 8 (June 2021).
560. AxoSim. The NerveSim platform website.
561. Di Lullo, Elizabeth and Kriegstein, Arnold R. "The Use of Brain Organoids to Investigate Neural Development and Disease." *Nature Reviews Neuroscience* 18 (September 7, 2017).
562. Setia, Harpreet and Alysson R. Muotri. "Brain Organoids as a Model System for Human Neurodevelopment and Disease." *Seminars in Cell & Developmental Biology* 95 (November 2019).
563. Brookhaven National Laboratory. NASA Space Radiation Laboratory website.
564. NASA, ISS National Laboratory. "Investigation to Explore Brain Aging in Space to Fly on SpaceX CRS-29."
565. Space Tango. "First-in-kind Investigations Utilizing 3-Dimensional Human Brain Organoid Models and Advanced Automated Cell Culturing Capabilities Launched to ISS on SpaceX CRS-18 Mission." (July 25, 2019).
566. Emulate. Brain-Chip Overview website.
567. Emulate. Human-Relevant Models for Complex Biology website.
568. AxoSim. The BrainSim Platform website.
569. Yan, Yuanwei, Xueyan Li, Yu Gao, Sakthikumar Mathivanan, et al. "3D Bioprinting of Human Neural Tissues with Functional Connectivity." *Cell Stem Cell* 31, no. 2 (February 1, 2024).
570. Dyer, Rebecca. "World's First 3D-Printed Neural Tissue Grows And Functions Like a Human Brain." Science Alert (February 6, 2024).
571. Wyss Institute at Harvard University. Lung-on-a-Chip website.
572. NASA Johnson. Tissue Chips in Space website.
573. Wyss Institute at Harvard University. Human Organs-on-Chips website.
574. University of Florida. "UF Researcher Sends Cells to Space to Understand Muscle Loss." (April 12, 2021).
575. Wnorowski, Alexa, Arun Sharma, Haodong Chen, Haodi Wu, Ning-Yi Shao, Nazish Sayed, Chun Liu et al. "Effects of Spaceflight on Human Induced Pluripotent Stem Cell-Derived Cardiomyocyte Structure and Function." *Stem Cell Reports* 13, no. 6 (December 10. 2019).
576. Chicco, Adam. "Effects Of Chronic High Let Radiation On The Human Heart." HRP Investigators' Workshop 2021.
577. Gerecht, Sharon. "Using Human Stem Cell Derived Vascular, Neural and Cardiac 3D Tissues to Determine Countermeasures for Radiation." HRP Investigators' Workshop 2021.

578. Donkers, Joanne M., Hossein Eslami Amirabadi, and Evitavan de Steeg. "Intestine-on-a-Chip: Next Level in Vitro Research Model of the Human Intestine." *Current Opinion in Toxicology* 25 (March 2021).
579. Jalili-Firoozinezhad, Sasan, Rachelle Prantil-Baun, Amanda Jiang, Ratnakar Potla, Tadanori Mammoto, James C. Weaver et al. "Modeling Radiation Injury-Induced Cell Death and Countermeasure Drug Responses in a Human Gut-on-a-Chip." *Cell Death & Disease* 9 (February 14, 2018).
580. Blutt, Sarah. "Use Of Microbial Based Countermeasures To Mitigate Radiation Induced Intestinal Damage." HRP Investigators' Workshop 2021.
581. Committee on Space Radiation Effects Testing Infrastructure for the U.S. Space Program. "Chapter 2: The Space Radiation Environment and Its Effect on Electronics," *Testing at the Speed of Light: The State of U.S. Electronic Parts Space Radiation Testing Infrastructure.* The National Academies of Sciences, Engineering & Medicine (2018).
582. Howell, Elizabeth. "Radiation Resistance Is Baked into the Perseverance Mars Rover. Here's Why That's Important." Space.com (May 6, 2021).
583. NASA. Materials International Space Station Experiment (MISSE) website.
584. Pavone, Marco. "ReachBot: Small Robot for Large Mobile Manipulation Tasks in Martian Cave Environments." Stanford University (February 25, 2021).
585. NASA Jet Propulsion Laboratory. "Duaxel: A Versatile Rover for Accessing High-Risk Terrain."
586. NASA Jet Propulsion Laboratory. Freeclimber: Lemur 3 website.
587. NASA Jet Propulsion Laboratory. Llama: A Fast-Moving Legged Robot That Can Traverse Challenging Environments website.
588. Howell, Elizabeth. "Moon's Best Friend: Robot Dogs Could Be Future Lunar Explorers." Space.com (September 27, 2022).
589. Weisberger, Mindy. "Meet Au-Spot, the AI robot dog that's training to explore caves on Mars." Space.com (January 12, 2021).
590. NASA Jet Propulsion Laboratory. "Rollocopter: An Innovative Robot That Can Either Roll or Fly website.
591. NASA. Mars Helicopter Tech Demo website.
592. Allyn-Feuer, Ari. "The Case for a Fleet of Martian Helicopters." *The Space Review* (February 5, 2024).
593. Dieckman, Emily. "Engineers Design Motorless Sailplane for Mars Exploration." University of Arizona College of Engineering (June 30, 2022).
594. Bouskela, Adrien, Alexandre Kling, Tristan Schuler, Sergey Shkarayev, Himangshu Kalita, and Jekan Thangavelautham. "Mars Exploration Using Sailplanes." *Aerospace* 9, no. 6 (March 25, 2022).
595. NASA. "Mars Aerial and Ground Global Intelligent Explorer (MAGGIE)." (January 4, 2024).
596. Howell, Elizabeth. "Wild Mars Plane Concept Could Seek Water from High in the Red Planet's Atmosphere." Space.com (January 21, 2024).
597. Lea, Robert. "NASA Outlines Plan to Deploy Burrowing 'Cryobots' On Icy Moons of Saturn and Jupiter." Space.com (December 27, 2023).
598. Schaler, Ethan. "Sensing with Independent Microswimmers." NASA Jet Propulsion Laboratory (February 25, 2021).

599. Tingley, Brett. "Swarms Of Tiny Robots May One Day Explore Oceans on Other Worlds." Space.com (June 30, 2022).
600. NASA Jet Propulsion Laboratory. BRUIE: An Under-Surface Rover Designed to Explore Alien Oceans website.
601. NASA Jet Propulsion Laboratory. EELS (Exobiology Extant Life Surveyor).
602. NASA. "NASA's Dragonfly Will Fly Around Titan Looking for Origins, Signs of Life."(June 27, 2019).
603. Turtle, Elizabeth, presenter. "AGU Fall Meeting 2022 Press Conference: Space Helicopters! Aircraft for Other Worlds."
604. Williams, Matt. "NASA Selects a Sample Return Mission to Venus." Universe Today (January 17, 2024).
605. Autonomous Robotic Networks to Help Modern Societies (ARCHES) website.
606. Clark, Stuart. "Meet the Autonomous Moon Robots About To Change Space Travel Forever." *BBC Science Focus* (December 20, 2022).
607. Blueplanet VR website.
608. BRINK Traveler website.
609. Mars 2030 website.
610. National Research Council. *Pathways to Exploration: Rationales and Approaches for a US Program of Human Space Exploration*. The National Academies Press (2014).
611. NASA. "NASA Names First Chief Artificial Intelligence Officer." (May 13 2024).
612. NASA Jet Propulsion Laboratory. Artificial Intelligence Group website
613. NASA Jet Propulsion Laboratory. Machine Learning and Instrument Autonomy Group website.
614. NASA. Intelligent Systems Division website.
615. Marr, Bernard. "Artificial Intelligence in Space: The Amazing Ways Machine Learning Is Helping to Unravel the Mysteries of the Universe." *Forbes* (April 10, 2023).
616. Gupta, Sakshi. "7 Incredible Ways AI Is Being Used in Space Exploration." Springboard (February 8, 2023).
617. New Space Economy. "How can Artificial Intelligence be used in Space Technology?"
618. NASA Jet Propulsion Laboratory. NeBula Autonomy Solution website.
619. NASA. Entry, Descent, and Landing. Mars 2020 Mission, Perseverance Rover.
620. Wiens, Roger. "Perseverance Now Selects its Own Targets to Zap." NASA (May 31, 2022).
621. NASA. What is Astrobee? website.
622. NASA. "Astrobee Space-Bots Mark a New Milestone in Human-Robot Teamwork." (July 22, 2022).
623. NASA. Special Purpose Dextrous Manipulator website.
624. NASA. Mars Helicopter Tech Demo website.
625. University of Arizona Lunar and Planetary Laboratory. RAVEN: Rover–Aerial Vehicle Exploration Network website.
626. NASA. CADRE website
627. NASA. OSAM-1 Mission: On-orbit Servicing, Assembly, and Manufacturing 1 website.
628. MAXAR. Spider website.

629. Erwin, Sandra. "DARPA's Robot Could Start Servicing Satellites in 2025." Space News (November 8, 2022).
630. Space Logistics services website.
631. Nanoracks. "GITAI & Nanoracks Announce Technical Demonstration of a GITAI Robot inside the Nanoracks Bishop Airlock. (September 9, 2020).
632. Astrobotic. Surface Autonomy and Multi-Agent Robotic Missions website.
633. ANA Avatar XPRIZE website.
634. Lea, Robert. "Artificial Intelligence Could Help Hunt for Life on Mars and Other Alien Worlds." Space.com (March 25, 2023).
635. Weiss, Todd R. "NASA's Perseverance Rover Lands on Mars: Here's How It Is Using AI." EnterpriseAI (February 19, 2021).
636. NASA. "10 Years Since Landing, NASA's Curiosity Mars Rover Still Has Drive."(August 5, 2022).
637. Pultarova, Tereza. "Mars Helicopter Ingenuity Aces 1st Flight after Major Software Update." Space.com. (November 25, 2022).
638. Apptronik website.
639. Boston Dynamics. Meet Atlas website.
640. Goldsmith, Donald and Martin Rees. *The End of Astronauts: Why Robots Are the Future of Exploration*. Harvard University Press, 2022.
641. InterPlanetary Networking Special Interest Group website.
642. Sturm, Karin. "Laser Communication: The Future of Communicating in Space." NASA Spaceflight (December 15, 2023).
643. NASA Jet Propulsion Laboratory. "NASA's Deep Space Communications to Get a Laser Boost." (August 7, 2023).
644. Sanchez Net, Marc, Etienne Pellegrini, Wilson Parker, Joshua Vander Hook, and Robyn Woollands. "Cycler Orbits and Solar System Pony Express." Aerospace Research Central 59, no. 3 (January 31, 2022).