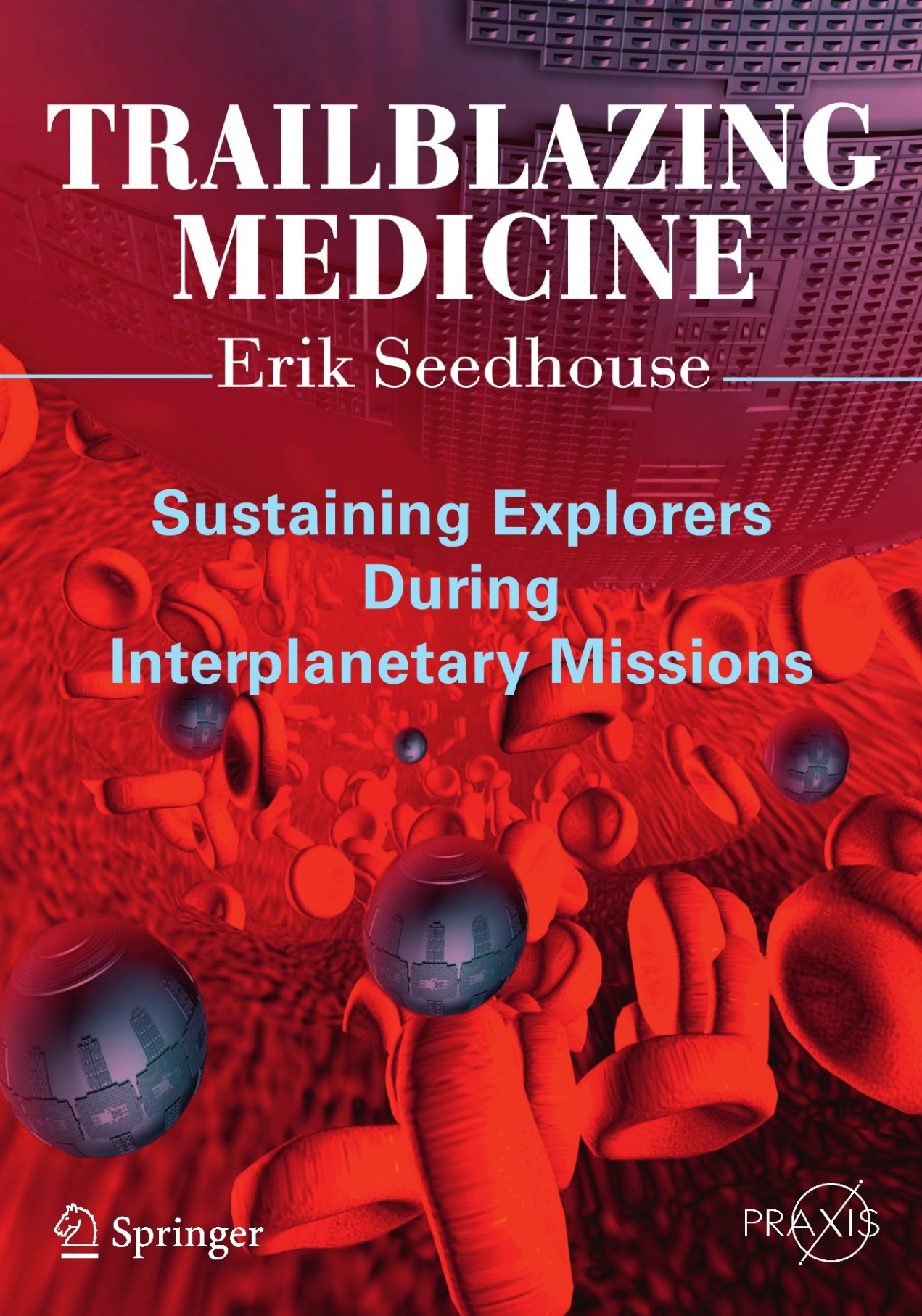
TRAILBLAZING MEDICINE

Erik Seedhouse

Sustaining Explorers During Interplanetary Missions



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Preface

In 2009, with the International Space Station (ISS) declared fully operational, NASA and its partners ushered in a new era of spaceflight: permanent human presence in low Earth orbit (LEO). As the culmination of decades of manned spaceflight activities, the ISS focuses attention on what has been learned to date and on what must still be learned before humans can embark on future exploration endeavors. What we may discover during the forthcoming exploration of the solar system may shape the future of humanity, but before exploration class missions (ECMS) can leave LEO, we must be sure the astronauts will survive, which is why space medicine is the key to the future of humans in space.

Space medicine has undergone a gradual evolution, from developing and implementing selection and retention standards to minimizing the probability of disease in astronauts in space, to providing clinical support for short-duration missions and, most recently, to supporting a permanent human presence in space onboard the ISS. The ISS not only serves as an orbiting laboratory and technology development platform; it also provides clinicians with a unique opportunity to conduct research to optimize crew safety and performance – factors critical in reducing the biomedical risk of extended space missions.

Missions to Mars and beyond will test space medicine to the extreme. First, there is the question of how to protect astronauts from radiation that can pepper an astronaut's body like machine-gun fire. While mission planners are confident they can protect astronauts by using polyethylene shielding, there is a second kind of radiation for which there is no protection: cosmic rays possess too much energy for shielding to be effective. They pass through tissue, leaving cells mutated or dead, which means understanding their biological effects will be a priority. To protect themselves, astronauts may have to take anticancer drugs or, as suggested in this book, be infused with nanobots capable of repairing the damage inflicted by the radiation.

In addition to being fried by radiation, spacefarers embarking upon ECMs also face weakened muscles and significant bone loss. The obvious countermeasure to keep the muscles and bones fit is exercise, and the message to long-duration astronauts is clear: do the exercise and you will be okay – don't and you'll be carried

off the spacecraft. However, even with rigorous daily exercise, astronauts still lose bone mass and scientists don't know when or if the body stops losing bone. If bone loss can't be prevented, there is the real risk that astronauts landing on some distant planet or moon will fracture bones. To counteract the bone loss, it has been suggested that astronauts take drugs normally given to osteoporosis patients, while another idea is to use artificial gravity to provide astronauts with doses of gravity to counteract the effects of weightlessness. These interventions and others, many of which are discussed in this book, will be vital in preparing for Mars missions and beyond. Chapter by chapter, this book examines the future of space medicine as it relates to human space exploration and describes what is necessary to keep a crew alive in space, how it is done today and how it will be accomplished in the future.

Acknowledgments

In writing this book, the author has been fortunate to have had five reviewers who made such positive comments concerning the content of this publication. He is also grateful to Maury Solomon at Springer and to Clive Horwood and his team at Praxis for guiding this book through the publication process. The author also gratefully acknowledges all those who gave permission to use many of the images in this book, especially scientists Dr Robert Freitas and Philippe van Nedervelde.

The author also expresses his deep appreciation to Christine Cressy, whose attention to detail and patience greatly facilitated the publication of this book, to Jim Wilkie for creating the cover of this book, and to Stewart Harrison, who sourced several of the references that appear in this book. Thanks also to Dr Gary Gray for his insight into the medical challenges of interplanetary missions.

Once again, no acknowledgment would be complete without special mention of our cats, Jasper, MiniMach, and Lava, who provided endless welcome (and occasionally unwelcome!) distraction and entertainment.

To Roald Amundsen, Sir Ernest Shackleton, Fridtjof Nansen, and the polar explorers who accepted the dangers and challenges of human endeavor and to the trailblazers of the future.

About the author

Erik Seedhouse is an aerospace scientist whose ambition has always been to work as an astronaut. After completing his first degree in Sports Science at Northumbria University, the author joined the legendary 2nd Battalion the Parachute Regiment, the world's most elite airborne regiment. During his time in the "Para's", Erik spent six months in Belize, where he was trained in the art of jungle warfare and conducted several border patrols along the Belize–Guatemala border. Later, he spent several months learning the intricacies of desert warfare on the Akamas Range in Cyprus. He made more than 30 jumps from a Hercules C130 aircraft, performed more than 200 abseils from a helicopter, and fired more light anti-tank weapons than he cares to remember!

Upon returning to the comparatively mundane world of academia, the author embarked upon a master's degree in Medical Science at Sheffield University. He supported his master's degree studies by winning prize money in 100 km ultradistance running races. Shortly after placing third in the World 100 km Championships in 1992 and setting the North American 100 km record, the author turned to ultradistance triathlon, winning the World Endurance Triathlon Championships in 1995 and 1996. For good measure, he also won the inaugural World Double Ironman Championships in 1995 and the infamous Decatriathlon, the world's longest triathlon, an event requiring competitors to swim 38 km, cycle 1,800 km, and run 422 km. Non-stop!

Returning to academia once again in 1996, Erik pursued his Ph.D. at the German Space Agency's Institute for Space Medicine. While conducting his Ph.D. studies, he still found time to win Ultraman Hawaii and the European Ultraman Championships as well as completing the Race Across America bike race. Due to his success as the world's leading ultradistance triathlete, Erik was featured in dozens of magazines and television interviews. In 1997, *GQ* magazine nominated him as the "Fittest Man in the World".

In 1999, Erik decided it was time to get a real job. He retired from being a professional triathlete and started his post-doctoral studies at Vancouver's Simon Fraser University's School of Kinesiology. In 2005, the author worked as an astronaut training consultant for Bigelow Aerospace in Las Vegas and wrote

Tourists in Space, a training manual for spaceflight participants. He is a Fellow of the British Interplanetary Society and a member of the Aerospace Medical Association. Recently, he was one of the final 30 candidates of the Canadian Space Agency's Astronaut Recruitment Campaign. Erik currently works as a manned spaceflight consultant, triathlon coach, and author. He is the Training Director for Astronauts for Hire (*www.astronautsforhire.org*) and plans to travel into space with one of the private spaceflight companies.

In addition to being a triathlete, sky-diver, pilot, and author, Erik is an avid scuba-diver and mountaineer and is currently pursuing his goal of climbing the Seven Summits. *Trailblazing Medicine* is his seventh book. When not writing, he spends as much time as possible in Kona on the Big Island of Hawaii and at his real home in Sandefjord, Norway. Erik lives with his wife and three rambunctious cats – Jasper, Mini-Mach, and Lava – on the Niagara Escarpment in Canada.

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