Highlighted Topics series: Physiology of a Microgravity Environment

July 1, 2000, marks the first anniversary of my editorship of the Journal of Applied Physiology. During the past year, my editorial team has introduced significant changes in the Journal. Notable among these changes is the implementation of the on-line submission and review system, which has resulted in a dramatic improvement in review time for manuscripts; the time from submission to first decision is down from over 50 days a year ago to under 21 days at the present time. However, there is still room for improvement, and we are actively striving to pare down the review time even further. We are also making every effort to improve the ease with which a manuscript is submitted on-line. In this regard, you will notice several improvements in the on-line submission and review process that were recently implemented. These have been included as a direct result of positive feedback from authors and reviewers.

Another prominent change in the Journal is the introduction of the Highlighted Topics series, in which important areas of applied physiology, such as the Physiology of a Microgravity Environment, are featured. Each of these series has a corresponding call for papers, which has had a profound impact on the number of manuscripts submitted to the Journal. From the calls for papers, we have received over 150 manuscripts, and our total submission rate is up approximately 25% from last year. We will continue to feature the Highlighted Topics series to redefine and expand the scope of the Journal.

This issue introduces a new Highlighted Topics series on the Physiology of a Microgravity Environment. Gravity is one of the defining forces shaping life on Earth, and the microgravity environment of space has been shown to affect multiple body systems: bone and mineral metabolism, muscle structure and function, motor control, vestibular and proprioceptive sensation, cardiovascular function, pulmonary function and gas exchange, hematology, and endocrine function. Through research conducted in space, we have discovered a number of maladaptations to a microgravity environment, such as bone demineralization, muscle atrophy, and reduced blood volume. It is clear that, for optimal physiological performance of humans in space, it will be necessary to develop effective measures to counter these maladaptive effects of microgravity. Currently, most of the countermeasures deal with loading bone and muscle via exercise or elastic garments in an attempt to slow or reverse disuse atrophy. Other countermeasures, such as fluid loading before reentry into the Earth’s 1-G environment, were introduced due to the observation that circulating blood volume is reduced. These countermeasures also have clinical implications with regard to fitness, prolonged bed rest, and the treatment of shock. Hence, the discoveries that are made from physiological research in a microgravity environment will have important implications not only on future space exploration but also on health-related issues on Earth.

A key component of future space exploration must include a comprehensive evaluation of the physiological effects of microgravity. Once completed, the International Space Station will provide a unique opportunity for microgravity research and a better understanding of the impact of microgravity on basic physiological properties. A few examples include the impact of gravity on cells, the effect of gravity on embryonic development, and the cellular responses to mechanical stress. The list of possibilities is endless. We now have the opportunity and methodologies to investigate the role of gravity in the regulation and modulation of fundamental physiological processes; therefore, we are at the threshold of a new era of scientific investigation, in which the microgravity of space can be used as an investigative tool.

The mini-reviews in this series will focus on some of the more important aspects of microgravity research as it pertains to the physiology of the lung, skeletal muscle, bone, cardiovascular, and neuromotor responses to microgravity. In this issue, Dr. G. Kim Prisk explores the effects of microgravity on the lung. The lung, by virtue of its structure as a network of air spaces and blood vessels, is very sensitive to gravity because of its compliant nature, which can cause it to be markedly deformed by even its own weight. Although, overall, gas exchange is little affected by microgravity, there are nonetheless significant implications for the lung and its function in a low-gravity environment, as gravity has a dominant effect on the distribution of blood flow and on regional expansion of the lung.

In the August issue, Dr. Robert Fitts will focus on the effects of microgravity on skeletal muscle. A microgravity environment will often result in a reduction of muscle mass, reduced muscle force, and increased muscle fatigue, as well as cause impairment of motor coordination and metabolic alterations. Also in August, Dr. Russell Turner will examine the effects of micro-
gravity on bone density. Like skeletal muscle, bone density also suffers from a microgravity environment. Microgravity can cause bone demineralization and general bone loss and may be the single most important factor with regard to the feasibility of long-term spaceflight.

The September issue will feature a mini-review from Dr. Benjamin Levine on microgravity and the cardiovascular system. The effects of microgravity on the cardiovascular system largely involve fluid balance and postflight orthostatic intolerance. With the removal of normal gravity, a fluid shift occurs from the lower extremities to the upper body. Lower body negative pressure can simulate a normal gravity environment and may be used in conjunction with fluid loading before reentry as a countermeasure to orthostatic intolerance and the shift in fluid balance. In the final mini-review of this series, Dr. V. Reggie Edgerton presents the next era of research in gravitational biology and neuromotor systems. Specifically, in addition to knowledge of normal mechanisms of neural control, microgravity can lead to a clearer understanding of neuromotor disorders. This is of particular importance, as technologies developed as a result of current microgravity research will shape the course of future research on motor dysfunction and may have an impact on the effects of spinal cord injury and stroke.

As we further define and expand the scope of the Journal of Applied Physiology, we will continue to emphasize research that employs cutting-edge methods and techniques ranging from molecular genetics to biomedical engineering to systemic physiology. Such sophisticated integrative approaches will become increasingly important and relevant as we near the successful completion of the Human Genome Project and realize that many of the implications of this project can only be advanced by applied physiology.

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