



For more on sports science visit [nature.com/collections/sports-science-outlook](https://www.nature.com/collections/sports-science-outlook)

**Editorial**

Herb Brody, Richard Hodson, Jenny Rooke, Joanna Beckett

**Art & Design**

Mohamed Ashour, Ffion Cleverley

**Production**

Nick Bruni, Karl Smart, Ian Pope, Kay Lewis

**Sponsorship**

Stephen Brown, Nada Nabil, Claudia Danci

**Marketing**

Nicole Jackson

**Project Manager**

Rebecca Jones

**Creative Director**

Wojtek Urbanek

**Publisher**

Richard Hughes

**VP, Editorial**

Stephen Pincock

**Managing Editor**

David Payne

**Magazine Editor**

Helen Pearson

**Editor-in-Chief**

Magdalena Skipper

**T**he competition to be crowned the fastest, strongest or most technically proficient sportsperson on the planet will once again reach its peak this summer when athletes descend on Tokyo for the Olympic Games. The global pandemic might rule out the throng of enthusiastic spectators that are typical of such an event, but millions will eagerly watch on television as the very best go toe-to-toe.

The cameras in Tokyo will be focused on the athletes. But behind each runner, swimmer or gymnast stands an interdisciplinary team of scientists tasked with keeping the competitors physically and mentally healthy, and able to perform to the absolute limit of their ability.

Some scientists are investigating how an athlete's physiology enables them to excel, and how these adaptations can be encouraged. In endurance events, such as the marathon, mitochondria hold the key to performance (see page S7). Researchers are also exploring the neuroscience behind striking a ball moving at incredible speed in sports such as baseball or cricket, with some coaches turning to virtual reality to give their players an edge (S4). And microbiologists are beginning to tease out the contribution that gut microbes make to athletic performance (S17).

Keeping athletes safe and healthy is also a priority. Refinements to training methods are improving athletes' abilities to cope with extreme heat (S2). And data scientists are using wearable sensors and machine-learning techniques to prevent avoidable injuries (S10).

Science also has a role in ensuring a fair contest. Performance-enhancing drugs garner most of the attention, but there are many ways to cheat, and calls to take these other threats to sporting integrity as seriously are growing louder (S16).

Who can compete in women's events has been an issue for many decades. Attempts to regulate this area have often attracted criticism from human-rights groups, demonstrating the complexity involved. Some people are now asking whether this is really a question for science at all (S12).

We are pleased to acknowledge the financial support of Lonza in producing this Outlook. As always, *Nature* retains sole responsibility for all editorial content.

**Richard Hodson**  
Supplements editor

**Contents****S2 CLIMATE****The heat is on**

How athletes are adapting to competing in warmer temperatures

**S4 VIRTUAL REALITY****Training for the impossible**

The technology helping players to strike a ball at lightning speed

**S7 MITOCHONDRIA****The key to endurance**

These cellular components are a target for long-distance athletes

**S10 ARTIFICIAL INTELLIGENCE****Could an algorithm predict an injury?**

Machine learning can help a player to avoid injuries

**S12 INTERSEX****The future of sex in elite sport**

Are the rules that determine who can compete in women's events fair?

**S16 OPINION****Clean sport is more than just drug-free**

Andrea Petróczi explains why all unethical behaviours must be dealt with in the same way

**S17 MICROBIOME****A winning gut**

Researchers are beginning to understand how microorganisms affect athletes

**On the cover**

Science helps athletes perform to the best of their ability  
Credit: Jonas Bergstrand

**About Nature Outlooks**

*Nature Outlooks* are supplements to *Nature* supported by external funding. They aim to stimulate interest and debate around a subject of particularly strong current interest to the scientific community, in a form that is also accessible to policymakers and the broader public. *Nature* has sole responsibility for all editorial content — sponsoring organizations are consulted on the topic of the supplement, but have no influence on reporting thereafter (see [go.nature.com/33m79fz](https://go.nature.com/33m79fz)). All *Nature Outlook* supplements are

available free online at [go.nature.com/outlook](https://go.nature.com/outlook)

**How to cite our supplements**

Articles should be cited as part of a supplement to *Nature*. For example: *Nature* Vol. XXX, No. XXXX Suppl., Sxx–Sxx (2021).

**Contact us**

[feedback@nature.com](mailto:feedback@nature.com)

For information about supporting a future *Nature Outlook* supplement, visit [go.nature.com/partner](https://go.nature.com/partner)

Copyright © 2021 Springer Nature Ltd. All rights reserved.