Gymnasts put extreme strain on their bodies for moves such as the Maltese cross (left).

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A breed apart

Olympic athletes are on the edge of normal physiology, finds Alison Abbott.

"The physiology, biomechanics and psychology of the élite athlete is something else," says John Hawley, sports scientist from the RMIT University in Melbourne, Australia. "Compared with the merely fit, that athlete is an entirely different animal."

Like all sports scientists, Hawley would like to understand why — but he knows he has chosen a difficult test species. Getting biological data out of élite athletes is almost impossible. By definition, they are in perpetual, intense training programmes that they do not wish to interrupt — either to take part in experiments or to donate blood or muscle samples. "It's not so easy to get an Australian cyclist who earns over a million dollars a year to stick a thermometer in his butt while training — you have to be able to sell your idea very convincingly," says Hawley.

And despite the number of dedicated institutes that have sprung up in many countries to support top athletes, sports scientists also know that they will have limited input into training strategies designed to hone individual performance. Coaches — usually former athletes themselves — tend to stick with training programmes that have been well tested in the field. More experimental ideas usually take a long time to be accepted by the sporting community.

The exceptions to this rule are advanced technologies — such as video feedback — that can help athletes focus their more traditional training. "Being able to track performance in real time has had a major impact on technique training in events such as high-jump and diving," says Peter Davis, director of coaching and sports sciences at the US Olympic Training Center in Colorado Springs. Electromyography (EMG), which measures electrical activity in working muscles, is another technique that has proven popular. One trainer, recalls Davis, brought a gymnast to the Colorado Springs centre for EMG analysis and was stunned to find that the muscle groups he had been focusing on for the 'Maltese cross' — a challenging move on the rings where a gymnast holds his body up in a horizontal position — were not the ones that the gymnast was actually using for the trick.

Sporting chance

Such quick, definitive feedback is easy for trainers to work with. But more long-term, subtle studies are much harder. "We usually use recreational athletes to confirm that a particular training technique that has been used in the field actually works in the lab," says Hawley. But such studies are often inconclusive. Australian and US research teams have studied the effects of high-altitude training, for example — a technique long thought by trainers to improve performance. But the mechanism by which it works remains unclear. Some studies have shown an increase in the level of the oxygen-carrying protein haemoglobin found in red blood cells[1], whereas others have found no change in blood markers at all[2]. And not everyone studied has actually benefited from the technique.

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Electromyography allows athletes to identify which muscles are active.

To work out who benefits, and why, scientists need to look at genes and their responses to environmental triggers. "I'm convinced that if we could look at all the genes that are induced by low oxygen levels in a big enough pool of athletes, we would learn how to predict which ones would benefit from altitude training," says Hawley. For the moment, that kind of study seems out of the question.

Even if the genes that control responses to everything from oxygen levels to different nutrients could be pinned down, and every athlete provided with an ideal training schedule and diet, it wouldn't level the playing field.

Only those whose genes are preset for maximal athletic performance will ever join the élite band of Olympic athletes. Eero Mäntyranta, the 1964 Finnish cross-country skiing gold medallist, for example, had a mutation in the gene encoding for erythropoietin, a protein that regulates the production of red blood cells, which sports scientists believe accounted for his extraordinary stamina. There are hundreds of other genes — from those determining body proportions to those optimizing oxygen and nutrient utilization by muscles — that help tip the balance towards élitism.

Although the élite athlete — packed with performance-enhancing genes and aided by the best technology available — is indeed a different kind of creature, in at least one way they are just like the rest of us: to improve, they need to work hard. As physiologists freely admit, the biggest impact on performance is still down to good-old-fashioned sweat. "What science can bring to the athlete is perhaps 0.1%," says Davis. "99.9% is still down to the athletes themselves."

The standards for hard work in sport have increased dramatically over the years. Roger Bannister — who in 1954 became the first person to run a mile in under 4 minutes — trained for only 35 minutes per day. That's barely considered a warm-up today, when the mile record stands at 3 minutes 43.13 seconds. To bring that down any further is going to take an awe-inspiring combination of extreme physiology and hard work. ■

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