Will genetic cyber-athletes come to dominate sports?

It is sport's doomsday scenario: a new generation of bioengineered performance-enhancing agents that can transform also-rans into gold medalists. Imagine athletes injecting artificial genes right into their muscles—a virtually undetectable act that would give them the sinewy muscles of a cougar, or endurance like that of an antelope.

But this is not the science fiction of Hollywood, the movie "Gattaca" or a long-lost chapter of H.G. Well's 1904 pharmacological fantasy "The Food of the Gods," about a superhuman race of young giants grown on drugs. This is the coming reality in sports, and it is calling into question cherished beliefs about what is "natural" and "unnatural," fair and unfair, in the world of elite athletics.

"Genetic engineering is accelerating and it's damaging sports," former Norwegian speed skating champion Johann Olav Koss has warned. He's now an assistant coach of Norway's speed skating team, and once served as an athletes' representative to the International Olympic Committee's World Anti-Doping Agency (WADA).

"We can't be naive. We have to be realistic. This is not only an issue for sport, it's a broad ethical issue for human beings." Koss, who is also a physician, has been deeply involved in various athletic performance summits addressing ways to ensure the sport does not cross invisible lines of ethics and safety.

Former WADA president Dick Pound, a staunch advocate of drug testing for athletes, has warned that genetic doping could "end sport as we know it." "We will look back on Ben Johnson with his Stanoloxol [steroid scandal in 1988 for which he was stripped of the 100-meter gold medal], and say that's like an ancient rock painting in a cave compared to what we face now with genetic engineering."

Genetic doping worries sport officials because they see it as further undermining sports' bedrock ethical principle, fairness—and doing so in a way that's infinitely harder to regulate than traditional performance-enhancing drugs. That concern is legitimate, but it runs up against three difficult realities.

First, in the elite world of performance sports like track and field, cycling, power lifting and perhaps swimming, the use of performance-enhancing drugs is already so widespread as to make a mockery of the ideal of the pure, untainted athlete.

Second, in the coming age of the cyber-athlete, detection of genetic enhancement is all but impossible.

And third, the advent of genetic interventions raises ethical dilemmas for which there are no easy solutions. There is no double yellow line separating genetic therapy, which conference participants by and large said was acceptable, from genetic enhancement, which is universally condemned.

Sports gene enhancement on the horizon?

Is it ethical, for example, for an athlete who has injured herself after super-aggressive training to use genetic therapy to repair her body—and gain an advantage over a competitor who was more judicious in

her training program? What about athletes who use genetic editing to avoid a debilitating disease — and also realize a side benefit of improved performance? Should they be banned from competition? Or only some kinds of competition?

And beyond victory and defeat, of course, looms the larger issue of an athlete's health. The use of genetic enhancement may pose health hazards, many of them still unknown and some of which may never be known.

To be sure, some concerns about genetic enhancement in sports are overblown and, despite dramatic innovations such as CRISPR gene editing, still futuristic. So-called designer babies, for example, are science fiction, although recent developments suggest the future may be closer than we think. Although some start-up companies have tinkered with the idea, it may be a decade or more before scientists can remove embryonic fluid or swab your genes and generate a readout of the predicted sporting accomplishments of our prodigies in waiting.

Less distant are gene therapies and gene editing, already proven on animals, that if transferable to humans might be able to regulate energy metabolism, alter blood flow to the tissues, modify pain perception, or even postpone sexual development to keep preadolescent females—perhaps gymnasts and figure skaters of the future — in their performance prime. There are hundreds of active studies involving human clinical trials, with numerous therapies seeking federal approval. Scientists and athlete guinea pigs are also busy trying out gene enhancements to regenerate the body after cartilage damage, tears and fractures.

Synthetic drugs to boost endurance or increase strength and speed are already widely available. Confined to international cycling and weightlifting only a few years ago, gene doping invaded winter sports, track and field, the NFL and even World Cup soccer. And despite new screening measures that has curtailed the practice, many people suspect that problems remain. World sporting organizations, the Olympic movement and world cycling in particular, have proved hapless over the years in screening for dopers.

The genetic revolution presents even more difficult challenges. Unlike classic drugs such as steroids, bioengineered substances or body tweaks are chemically identical to the body's natural hormones, making detection difficult at best. The problems will increase exponentially in the next wave of genetic enhancement, the direct injection of viruses or other delivery agents that carry DNA that can turn genes into energy factories or activate dormant muscles.

"If direct injection is used, the DNA will only be present in that specific muscle," noted Peter Schjerling of the Copenhagen University Institute for Sports Medicine. "A positive test would require coring out actual muscle tissue. Not many athletes would allow that. And the sample would have to be at the exact spot of the injection." Certainly genetic engineering is becoming an ever more attractive option for those inclined to cheat.

"Why would anyone use stimulants and steroids when they can use genetically engineered drugs or therapies, which are virtually undetectable?" said Charles Yesalis, a Penn State University sports scientist and world expert on performance enhancing drugs. "If things spin out of control, it could be a freak show

in athletics.”

Genetic engineering is an issue, whether in stem cell research or GMOs, that stirs an immediate and powerful gut reaction. In recent years, biomedical researchers have made small but measurable strides in developing bio-engineered drugs. Many look forward, perhaps unrealistically, to an age when many diseases will have been wiped out and hospitals will be obsolete except to treat trauma. But such a revolution, if it should occur, invariably would result in collateral damage.

Challenging human limits

The genetics revolution has certainly changed how we view sports and the desire to challenge human performance limits. Since the dawn of the original Olympics in ancient Greece, it had been assumed that training and discipline were the heroic qualities most critical to athletic success. But recent research into population genetics and physiology has battered the myth that sports is a level playing field where athletes who work the hardest go on to glory.

The fact is that humans are not equally endowed. The new axiom in sports, especially performance sports like track where skill and technique are comparatively less important than in ones like tennis, is that choosing one’s parents is far more important than choosing a coach. The belief in the power of the environment has been superseded by the reality that much of human nature, and certainly a great deal of the performance potential of elite athletes, is hard-wired and measurable.

For scientists who struggle to measure the real-world relationship of genetics to human behavior, sports offers the refreshing possibility of quantifying differences. Genes matter, and performance sports offer a great way to figure out just how much.

Consider the mystery that still surrounds the cross-country skiing exploits of Eero Mdentyranta. For decades after the Finn won two gold medals in the 1964 Winter Games at Innsbruck, and seven medals over three Olympics, he was dogged by rumors of deceit. Mdentyranta was not noted for his dedicated training habits, which prompted many of his competitors to accuse him of blood doping—adding red blood cells before the race to increase his oxygen and stamina, a not-uncommon practice of cheats of his era. He was tested and shown to have 15 percent more blood cells than normal. But with no evidence of doping, the controversy morphed into one of sports’ most intriguing long-running mysteries.

Although Mdentyranta never failed a drug test, the rumors that he had an advantage turned out to be true. Whether the advantage was unfair depends on what you think of the gifts of fate. By 1993, Finnish researchers were able to conclude that Mdentyranta and his family carry a rare genetic mutation that produced the EPO hormone and loaded his blood cells with 50 percent more red cells than the average man’s.

Certainly many elite athletes, especially those in the performance sports, are freaks of nature, but Mdentyranta’s genetic advantage was huge and unique. His body was a natural energy factory. Unlike most people, he had no shutdown valve, so his red blood cell count continuously soared and his endurance never flagged. The extra cells bathed his laboring muscles in energy-producing oxygen,

providing the boost to glide past competitors.

Mdentyranta's case may seem extreme, but only by degree: Many superstar athletes in highly competitive sports are outliers on the distribution of human possibility, the product of accumulating genetic mutations as rare as those that produce a 150-IQ chess champion or a violin-playing toddler.

"Very many in sports physiology would like to believe that it is training, the environment, what you eat that plays the most important role," Bengt Saltin, former director of the Copenhagen Research Center and a pioneer in the study of the relationship between genes and muscles, told me before he passed away last year. "But we argue based on the data that it is 'in your genes' whether or not you are talented or whether you will become talented. The extent of the environment can always be discussed but it's less than 20, 25 percent."

"You can't change human nature" may be one of the wisest of adages, but today, even a merely good athlete can be turned into a superstar by engineering "genetic defects"—creating future Eero Mdentyrantas. We are confronted with the reality that we can harness random acts of nature. Athletes often are willing guinea pigs, eager to gamble their health and maybe even their lives for the glory and riches of victory—and the genetic revolution will doubtless prove irresistible. And why not? From aging offensive linemen to Kenyan-chasing distance runners, athletes will know that their prospects might be brighter with an injection from the right DNA-filled test tube.

Future of sports and gene manipulation

Should athletes be allowed to use genetic techniques to improve performance? Most physiologists, ethicists and sport authorities say no. According to Saltin, messing around with genes is playing God—and only God should play God. "Biological variation is fundamental to sport," Saltin asserted. "You could say it's what gives a person their talent. This can now be radically affected with bioengineering, and this must be wrong."

Some scientists and ethicists look to a precarious future—perhaps before next year's Brazil games, in which an ambitious sprinter tired of running in Usain Bolt's tailwind turns to a renegade geneticist for help. This scientist would be familiar with new research that has pinpointed genes that can activate dormant human muscle fibers—fibers that resemble muscle from breathtakingly fast animals like cheetahs, and that fire far more quickly than human fast-twitch muscles. Humans only lack a genetic trigger to activate them—and those genes can be turned on.

Just a few injections of the right DNA into the quadriceps, hamstring and gluteus, and the muscle fibers could start cranking out Velociphin, activating the fast myosin gene. Within weeks, the muscles would bulge and burst with energy.

The tale deepens. This desperate athlete faces his long-awaited race into Olympic immortality. BANG! The genetically doped athlete dashes into the lead, extending it with every stride. Then at 65 meters, far out in front of the field, a sudden twinge tickles his thigh.

Bengt Saltin mused to me about what could happen next:

“At 80 meters,” he said, “the twinge explodes into an overwhelming pain as he pulls his hamstring. A tenth of a second later the patella tendon gives in — because it is no match for the massive forces generated by his quadriceps muscle. The tendon pulls out part of the tibia bone, which then snaps, and the entire quadriceps shoots up along the femur bone. The athlete crumples to the ground, his running career over.”

I gulp as he concluded his tale. “This is not the scenario that generally comes to mind in connection with the words ‘genetically engineered super athlete,’” he aded, “but it is very much a part of the reality.”

Without question, there is a high potential cost to playing god, even if genetic spigots can be developed to turn on and off at a whim, and therapies perfected. The issue is homeostasis. While many of us naively view the human body as an invincible machine, it is an integrated combination of tendons, cartilage, bones, nerves, muscle and fat. All living creatures are in delicate balance. One small change can have extraordinary and unanticipated consequences.

Olympic authorities have traditionally taken a hard line: Genetic engineering to improve performance is wrong. As former U.S. Olympic scientist Tim Conrad said a decade ago, “Anything you did not get from God is illegal.”

“We’re not trying to see what country has the best engineers.” According to former IOC president Jacques Rogge, who is also a physician and retains close ties to the Olympic movement as a sports administrator in Belgium. “Genetic manipulation is there to treat people who have ailments, not to treat a healthy person. I am very clear on this.”

While the issue of genetic performance enhancement is troubling, both because of health concerns and because allowing its use would unfairly benefit the privileged, the issue is not nearly so black and white. First, there’s the question of what is “natural” and “normal”—and why those who benefited at birth by a lucky throw of the genetic dice should not have to face equal genetic competition.

Many newly developed drugs and therapies are identical to natural chemicals made by the body. What should be considered “normal” levels of such naturally occurring hormones? Because many great athletes are in effect an accumulation of favorable (for that sport) genetic mutations, at what point do we disallow certain athletes as being too far from the “genetic mainstream”? Should we deny the sons of daughters of Eero Mdentyranta to pursue their dreams of becoming Olympic cross-country skiing champions because they have a huge advantage that is “natural” but no less decisive than an athlete who takes a synthesized version of natural EPO?

The most powerful argument for allowing genetic interventions, however, is that there is a hazy and debatable line between “health restoration” and “performance enhancement.” Genetic enhancement offers promising health benefits—as do any number of treatments that are the result of medical breakthroughs. Imagine an athlete using gene modification to overcome congenital asthma or another genetic abnormality. What about aiding someone who is destined to be short, say below 5 feet? Should they be disallowed from playing competitive sports if genetic manipulation will allow them to lead richer lives by

making them 5 feet 10 inches? How about 6 feet 10 inches? Should people be punished because the roulette wheel of genetics did not land on their number?

Former world and Olympic champion sprinter Maurice Greene believes that the anti-genetic engineering orthodoxy is fueled by hysteria, and raises an intriguing point about personal responsibility.

“What if you’re born with something having been done to you?” he asks. Should manipulation of an embryo be considered cheating? Is it fair to disqualify an athlete if the genetic changes were made before she was even born, perhaps even to save her life?

Finally, there is the pragmatic point. It seems overwhelmingly likely that, whether we like it or not, many world-class athletes in the future will have “had their genes done” the way they now get their knees scoped—and no one will know. What can or should we do about that?

There are no easy answers to these questions. The debate over genetic engineering is just beginning. The Pandora’s box is open. There are cyborg athletes among us.

Jon Entine is the author of the best selling book *Taboo: Why Black Athletes Dominate Sports and Why We Are Afraid to Talk About It*. Follow @JonEntine on Twitter.