

# The Chemical Games



**ANGUISHED CYCLIST:** A member of the Banesto team tries to hide from the press after his group withdrew from the 1998 Tour de France amid a sprawling scandal linked to the drug erythropoietin.

by Glenn Zorpette, *staff writer*

**A**t this year's Olympic Games, a decades-old tradition will play out between the lighting of the torch and the closing ceremonies. This will be the testing of the urine, in which scientists armed with millions of dollars' worth of state-of-the-art instruments will look for obscure molecules in incredibly small concentrations signaling the recent use of one or more banned performance-enhancing drugs.

Unless a superstar athlete is caught cheating, not many spectators will give more than a passing thought to this behind-the-scenes struggle. But as surely as athletes will pit themselves against one another, some will also match wits with doctors, technicians and sports

officials. A few athletes will probably be caught, triggering an appeal and arbitration process that will unfold well away from the public eye and under the aegis of officials with little or no formal education in physiology, pharmacology, or indeed any branch of science or medicine.

Even more dispiriting, it is a virtual certainty that a larger number of cheating athletes will beat the tests. Many of them will use a drug that cannot now be detected in urine. Others will carefully schedule and limit their use of banned substances so that their biochemical indicators will be below the thresholds that the International Olympic Committee (IOC) interprets

LAURENT REBOURS/AP Photo

## Biotechnical advances and administrative loopholes enable devious athletes to take performance-enhancing drugs without much risk of being caught or sanctioned

as a damning result. If the previous Olympics are a guide, some athletes will even take drugs, be caught and then have their sanctions overturned by an arbitration process that tends to exonerate all but the most poorly informed and reckless cheaters.

Given the variety of ways to circumvent drug tests, officials are at a loss to say even how widely abused some of the substances are. But scattered evidence suggests troubling pervasiveness, at least in some sports and among certain teams. "If this were a basketball game, we'd be behind about 98 to 2," says a former high-ranking official of the U.S. Olympic Committee (USOC), who asked not to be identified. Moreover, drug use by a small minority can fatally undermine the fundamental precept of athletic competition, in which victory goes to the contestant who best combines such attributes as strength, coordination, endurance, discipline and cunning.

"Sport is well aware it is losing the battle," says Don H. Catlin, director of the Olympic Analytical Laboratory at the University of California at Los Angeles. "Sports officials are terribly concerned about this matter. It tears at them."

The pall of drug use has grown darker in recent years as evidence has accrued that athletes in a variety of sports are increasingly turning to erythropoietin (EPO) and human growth hormone (hGH), both relatively recent arrivals in the world of sports. Like hundreds of other substances explicitly banned by the IOC, these two are effective and easy to obtain. They have surged in popularity because, unlike the other agents, EPO and hGH are undetectable with the technology that sports officials currently use to catch transgressors.

### A BRIEF HISTORY OF CHEATING

**E**PO and hGH are just the latest gambits in a cat-and-mouse game that is more than four decades old. By 1954 some Olympic weight lifters in the Soviet Union and elsewhere were using muscle-building anabolic steroids, according to sports historians. The chemical games had begun: the cheaters were in the lead, and their opponents have never caught up. As the pharmaceutical industry blossomed, new forms of steroids, stimulants, hormones and red blood cell growth hormones flowed into the market. Most of the substances

spur muscle growth; a few improve endurance; still others, known as beta blockers, slow the heartbeat, which lets sharpshooters or archers take steadier aim and helps a figure skater calm jangled nerves before a big performance.

Today the dishonest athlete can choose from an assortment of about 36 different anabolic steroids (among them a couple originally intended for veterinary use). Athletes get the drugs in different ways, and some observers maintain that it is not terribly difficult for an elite athlete to find a sports physician who is willing to break professional rules to assist an Olympian on a quest to glorify his or her country.

Cheating athletes have tapped biotechnological bounty with impressive swiftness and sophistication. Meanwhile the Olympic movement, along with all of international sport, has been turning to ever more advanced technologies in concerted if sporadic attempts to catch them. "It's almost like the cold war was," says David Joyner, chair of the USOC's sports medicine committee.

Formal drug testing for stimulants began at the Mexico City Olympic Games in 1968, a year after a British cyclist who had taken stimulants died of heart failure while competing in a televised stage of the Tour de France and eight years after several cyclists perished suddenly and similarly at the 1960 Olympics in Rome.

Not until 1975 did the IOC finally ban muscle-building anabolic steroids. Seven years later it added testosterone and caffeine to its list of forbidden substances. Testosterone, a key male hormone, plays an important role in muscle building. Anabolic steroids are just synthetic versions of testosterone, tweaked so they can be taken orally or so that they persist in the body.

A sensitive, reliable test for the anabolic agents did not debut until 1983, at the Pan American Games in Caracas, Venezuela. A German physician set up a lab in which the primary instruments were gas chromatographs married to mass spectrometers. The chromatograph in one of these combined units is basically an elaborate discriminator: it takes a sample that has been vaporized and separates it into its component substances. The spectrometer then weighs the fragments to identify the specific molecule they came from. The instrument, known as a GCMS, is the workhorse technology that testers rely on to this day.



**BUSTED:** Yuan Yuan, a Chinese swimmer, was escorted away by police on January 8, 1998, after she arrived at the Perth airport in Australia for a competition. Officials had found 13 vials of human growth hormone in a thermos she was carrying.

The use of the new technology in Caracas was not announced in advance to the competitors. As a result, 19 athletes tested positive for drugs at those games. More telling, many athletes—including a huge U.S. contingent—refused to be tested and left without competing. The next year, in 1984, GCMS was used for the first time in Olympic competition at the Los Angeles Games.

Sports officials, notably from East Germany and the Soviet Union (and subsequently Russia), were only mildly inconvenienced by the improved technology. Countries continued to operate elaborate programs that chemically enhanced hundreds or thousands of athletes and won hundreds of medals. At the 1988 Olympics in Seoul, for example, the Russian delegation reportedly operated a drug lab on board a ship docked in the harbor. The lab monitored Russian athletes to make sure they would not test positive for any banned substances. (Athletes on steroids simply stop taking them a few weeks prior to competition; continuing to exercise vigorously can retain for weeks the extra muscle mass.)

Members of the U.S. Olympic team, too, have been the subjects of disturbing allegations. Pat Connolly, a former U.S. Olympic women's track coach, told a Senate hearing in April 1989 that she believed that "at least 40 percent of the [U.S.] women's team in Seoul had probably used steroids at some time in their preparation for the games." It is worth noting that none of them tested positive in Seoul.

Although testers had a breakthrough at the 1984 Los Angeles Games with the GCMS, cheaters also made a major leap forward: blood doping. Weeks before the competition, eight of the 24 members of the U.S. cycling team had some of their blood removed and preserved. Their blood supply rebounded naturally over time. Shortly before competing they met in a southern California hotel and had their store of red blood cells transfused back into their system. Raising their red blood cell counts to abnormally high levels enabled their circulatory systems to carry more oxygen and thus improved their endurance considerably. The team went on to win a record nine medals before the doping was discovered, months later.

#### EPO: THE MODERN ERA BEGINS

**B**lood doping had begun years earlier, but the old transfusion method is no longer used. The practice became considerably more convenient when EPO became available in the late 1980s. A peptide hormone that stimulates the production of red blood cells in bone marrow, EPO is found naturally in the body. In 1985 the biotechnology firm Amgen introduced EPO produced by recombinant means to treat kidney dialysis patients and others.

Too much of a good thing, however, can be fatal. EPO has been blamed for the deaths of about 20 European cyclists since 1988. Although there is no hard proof that EPO caused the deaths, some doping experts believe the riders' blood may have thickened and clotted fatally after they took too much of the drug.

The full magnitude of the EPO problem, at least in cycling, became apparent for the first time during the 1998 Tour de France, cycling's premier event. During the race, police officers found cases of the drug in car trunks and in the hotel rooms of many cyclists. Seven teams were implicated; one withdrew, and another was expelled.

Today, despite more than a decade of sporadic research and development, several million dollars spent and intermittent promises by sports organizations, there is still no test that directly identifies the presence of EPO. Before major races, however, officials in cycling (and also in cross-country skiing) routinely test blood samples from all competitors. Those with a hematocrit, or red blood cell percentage, higher than 50 are banned from the race. A normal hematocrit is around 42. The policy has so far pre-

# BANNED PERFORMANCE ENHANCERS AND THEIR EFFECTS

The International Olympic Committee bans drugs in several categories. A few examples from each group, and their most common side effects, appear here.

Drug	Benefits	Side Effects	Notes
<b>Stimulants</b>			
Amphetamine, methamphetamine	Increases endurance; relieves fatigue; improves reaction times	Irregular heartbeat, false sense of well-being, irritability, nervousness, restlessness, trouble sleeping	Used to treat narcolepsy and Attention Deficit Hyperactivity Disorder
Caffeine	Increases alertness; reduces drowsiness; promotes endurance	Nervousness, irritability, sleeplessness, diarrhea, dizziness, fast heartbeat, nausea, tremors, vomiting	Brewed coffee per cup contains 40–180 milligrams; illegal urine levels are 12 micrograms per milliliter
Pseudoephedrine	In high doses, acts like amphetamines; narrows blood vessels	Increases blood pressure in patients who have high blood pressure	Decongestant (narrowing blood vessels decreases nasal congestion)
Salbutamol (albuterol)	Controls “bronchospasms” induced by exercise; opens up the lungs’ bronchial tubes	Fast heartbeat, headache, nervousness, trembling	Used to treat or prevent symptoms of asthma, chronic bronchitis, emphysema and other lung diseases
<b>Anabolic Steroids</b>			
Androstenediol, androstenedione, 19-norandrostenediol, 19-norandrostenedione, nandrolone, stanozolol, testosterone	Increases strength, muscle mass and aggressiveness	Acne or oily skin, enlarged clitoris/penis, deepened voice, unusual hair loss or growth, psychological disturbances; in sexually mature males, enlarged breasts	Androstenedione is available over the counter in the U.S. but is illegal in most other countries
Clenbuterol	Increases strength and muscle mass	Tremors and heart palpitations (tachycardia)	Decreases exercise capacity in rats, presumably due to changed cardiac muscle structure and function
<b>Diuretics</b>			
Acetazolamide	Increases urine flow and volume; prevents or lessens high-altitude effects	Unusual tiredness or weakness, diarrhea, general discomfort, loss of appetite or weight loss	Anticonvulsant (for epilepsy); used to treat glaucoma
Bumetanide, chlorthalidone, hydrochlorothiazide, triamterene	Increases urine flow and volume, diluting drugs or decreasing weight for sports with weight categories	Makes skin more sensitive to sunlight	Used to treat high blood pressure (hypertension) or to lower the amount of water in the body
<b>Masking Agents</b>			
Bromantan	Supposedly masks the use of other drugs, presumably steroids	Unknown	Russian-developed “immunostimulator”; unavailable in West
Probenecid	Stops excretion of steroids for a few hours, decreasing urine steroid concentration	Headache, joint pain, redness or swelling, loss of appetite, nausea or vomiting (mild)	Used to treat chronic gout or gouty arthritis; improves functioning of penicillins
<b>Peptide Hormones, Mimetics and Analogues</b>			
Chorionic gonadotropin (hCG)	Elevates testosterone production in men	Breast enlargement, headache, irritability; in women: bloating, stomach pain; in boys: acne, rapid increase in height, pubic hair growth, enlargement of testes and penis	Used by women to promote conception or in vitro fertilization and by men to produce testosterone
Human growth hormone (hGH)	Decreases fat mass; thought to improve human performance	Diabetes; abnormal growth of bones and internal organs such as the heart, liver and kidneys; atherosclerosis; high blood pressure (hypertension)	Used to treat growth disorders and prevent AIDS-related weight loss
Erythropoietin (EPO)	Increases circulating red blood cells, carrying more oxygen to muscles	Oily skin, acne and muscle tremors; thickens blood, increasing chances of stroke, myocardial infarction and heart failure	Used for treating anemia in patients with kidney disease, cancer and HIV
<b>Beta Blockers</b>			
Atenolol, bisoprolol, metoprolol, nadolol, propranolol	Slows heartbeat, enabling archers or shooters to increase their “interbeat interval”	Slows cardiac response time; makes running difficult; makes skin more sensitive to sun and temperature extremes	Used with a diuretic to treat high blood pressure

Compiled by Naomi Lubick. SOURCES: International Olympic Committee; Don H. Catlin, University of California at Los Angeles; Larry Bowers, University of Illinois; Mayo Clinic; National Institutes of Health

vented any more EPO-related fatalities during races, but it has done little to eliminate the drug from the cycling circuit. For example, the policy was in effect during the scandalous 1998 Tour de France, in which many dozens of riders are known to have used the drug.

Athletes in muscle sports such as weight lifting, sprinting, wrestling and short-distance swimming have their own options for obtaining an undetectable edge. Because hGH and testosterone are, like EPO, found naturally in the body, they can add muscle without leaving any incriminating molecules behind for the GCMS operators.

HGH is an astoundingly expensive steroid substitute. Yet its use was apparently rampant enough in Atlanta in 1996 to inspire some athletes to dub those Olympics the “hGH Games.” Around that time, a Latvian company was doing brisk business harvesting hGH from human cadavers and selling it for athletic use. And as recently as February, police in Oslo apprehended two Lithuanians with 3,000 ampoules of black-market hGH, according to Gunnar Hermansson, chief inspector of the drugs unit of Sweden’s National Criminal Intelligence Service. The cache was enough to supply about 100 athletes for a month.

Esters of testosterone are another essentially undetectable muscle builder. As their name implies, they consist of testosterone linked to an ester, both organic molecules. The ester acts to delay the loss from the body of the hormone, which would otherwise be metabolized in hours. In the body, neither the testosterone nor the ester arouses suspicion, because both are found there naturally.

Sports officials can, however, detect gross abuse of esters of testosterone. As part of a standard drug test, they examine the relative amounts in the athlete’s urine of testosterone and epitestosterone, a hormone of uncertain function. In a normal Caucasian male, the ratio is about one to one. If the ratio is found to be six to one or greater, the IOC and other sports organizations declare the test positive and the athlete is sanctioned, unless he can prove that he is the rare (one in 2,000) male who has such a high ratio naturally.

The situation is far from ideal. Doping experts say that some athletes use transdermal patches and other controlled delivery methods to boost the level of testosterone in their blood significantly while staying below the six-to-one ratio. Another problem is that the current practice does not treat different races equally: on average, Asians have lower

levels of testosterone than blacks or Caucasians do, so it is considerably more difficult for an Asian athlete to dope himself beyond the six-to-one limit.

### THE CHEATER’S LAST LOOPHOLE

Even if sports officials decide to sanction an athlete based on an elevated testosterone ratio or some other test result, they are often stymied by a recourse that increasingly seems like the abusing athlete’s ace in the hole: the adjudication process. Suppose an athlete wins an Olympic medal but then tests positive for a banned substance. If the IOC decides to strip the athlete of his medal, she can appeal to the Court of Arbitration for Sport. The court must then decide within 24 hours whether to uphold or overturn the sanction.

The court, set up in the mid-1980s, comprises representatives from the IOC, the National Olympic Committees (NOCs), the International Federations (IFs) and representatives of the athletes. The NOCs are the agencies that govern and coordinate a coun-

**DRUG CZAR:** Manfred Ewald, the former East German sports director, went on trial in May for his involvement in a state-sanctioned program that drugged hundreds if not thousands of athletes, most without their knowledge or consent.



try’s Olympic representation and help train its athletes (the USOC is an example). The IFs organize and oversee amateur competition in a specific sport. The one group of people the court has never seen fit to include are those with formal expertise or credentials in the pharmacology or physiology of performance-enhancing drugs.

In its short history the court has leaned toward exoneration, unless the case is simple and compelling in the extreme. In Atlanta, tests of seven ath-

JAN BAUER/AP Photo

letes—among them two Russians who had won bronze medals—indicated that they had used a drug called Bromantan. The IOC, which now regards the drug as both a stimulant and a masking agent, decided to disqualify the athletes. The case went to the Court of Arbitration, where the athletes' attorneys contended that the Bromantan merely strengthened the athletes' immune systems and helped them deal with the heat of summer in Atlanta. The argument swayed the court enough for it to overturn the disqualification.

The case was important because it suggested to many observers that the burden would fall on the prosecution to prove each case beyond a reasonable doubt. "A lot of people seem to have decided that the criminal standard is the one that should apply," says Larry D. Bowers, head of the drug-testing laboratory at the Indiana University School of Medicine. Unfortunately for prosecutors, the complexity of the biochemical evidence often leaves defense attorneys enough room to generate at least a trace of doubt in adjudicators' minds.

### GETTING THROUGH THE NETS

**A**lthough it is undoubtedly nice to know it is there, an athlete-friendly adjudication process is something that most clever drug users will not need. Various administrative and logistical factors conspire to create holes in the nets set up to snare cheaters.

Because of its position at the pinnacle of amateur athletics, the IOC is often regarded as the central figure in high-stakes drug testing. In reality, the situation is far more complicated. The IOC is responsible for drug testing during the Olympic Games, but that is only a small fraction of the testing performed on elite amateur athletes. At each Olympics, the medal winners at every event submit urine samples at doping-control stations immediately following their events. One or two nonmedalists are also generally tested at random. Athletes are selected arbitrarily, too, at preliminary events and from teams in final and semifinal rounds. In all, just under 20 percent of all athletes are tested during an Olympiad.

Officially, over the past 30 years only 52 athletes have been caught and sanctioned for using drugs in Olympic competition. Not even the staunchest Olympic booster thinks that only 52 athletes have cheated in the past three decades; it is now well known that far more than 52 competitors from the former East Germany alone took drugs and eluded detection. Even today the low rate of detection is thought to reflect the fact that the games are the one time when an athlete can be sure of being tested if he or she does well. "These days you have to be a total idiot to test positive at an event," says Bob Condron, a spokesman for the USOC.

This and other factors shift attention to the role of the IFs and the NOCs in drug testing. The IFs oversee drug tests at major non-Olympic competitions in the specific sports they administer. But it is the NOCs that arguably have the most crucial drug-testing role in all of amateur sports. They are re-

sponsible for testing athletes throughout their training—the period when almost all performance-enhancing substances, other than stimulants, are taken. The NOCs also test at national championships and at international competitions in their respective countries. Yet the world's many NOCs approach their drug-testing duties with varying degrees of rigor and vigilance.

Whereas tests by the IOC during Olympic Games are anticipated by athletes, the NOCs have the power to test athletes with little advance notice—or, ideally, no notice at all. Until recently, most NOCs have taken advantage of this opportunity relatively infrequently, if at all. And when they did, they often performed short-notice tests, in which the athlete was given 48 hours' warning that he or she would be tested. The tip-off would often enable a cheating athlete to take steps to expunge or mask the telltale chemicals. "A lot of athletes can clear their systems in 24 hours," explains Baaron Pittenger, head of the USOC's antidoping committee.

According to Catlin, athletes can try at least 13 different diuretics, which stimulate urination that dilutes incriminating chemicals and speeds them out of the body. A drug called probenecid has been used to interfere with the excretion of steroids. A few athletes, Catlin adds, have even endured the excruciatingly painful process of using a long needle to put untainted urine into their own bladder. Diuretics and probenecid are no longer as effective as they once were, because testers now routinely check for them.

Some NOCs are finally making more use of no-advance-notice tests. Joan Price, senior manager of drug testing for the USOC, says the organization performed 1,345 no-advance-notice tests in 1999, up from about 800 the previous year. It carried out 4,024 additional tests during competitions. For both the no-advance-notice tests and the ones performed during competitions, the rate of positive results was between 3 and 4 percent, she says.

The main reason why NOCs have been slow to pursue no-advance-notice testing more rigorously is that it is a relatively expensive, travel-intensive process. In some cases, it requires paying for a tester to travel hundreds or thousands of miles to meet an individual athlete.

### DOES THE IOC MEAN BUSINESS?

**A**lthough the NOCs have the power to be the main bulwark against the use of performance-enhancing drugs, the IOC remains firmly entrenched at the center of the antidrug movement. Some reasons are practical: the organization plays a key role in formulating drug-testing policy, sets the standards for drug-testing laboratories worldwide and is also the largest single source of funding for drug-testing research. Other reasons have more to do with perceptions. Because the IOC is the highest Olympic governing body, its moves in the fight against performance enhancement greatly influence how the broader Olympic movement regards the effort.



**BLOOD-DOPING BREAKTHROUGH?** Finnish long-distance runner Lasse Viren, reportedly among the first to boost his red blood cell count by artificial means, was victorious in the 5,000- and 10,000-meter races at the 1976 Olympics in Montreal.

Unfortunately, the IOC's actions over the past two or three decades have repeatedly left observers questioning the organization's commitment. At Los Angeles in 1984, papers describing between five and nine positive drug tests were taken from a safe and shredded shortly after the end of the games. The athletes involved could therefore not even be identified, much less sanctioned. The records had been secured in a hotel room used by Prince Alexandre de Merode of Belgium, chair of the IOC's Medical Commission, which oversees antidrug activities. De Merode later said he believed the papers were taken mistakenly and destroyed by members of the Los Angeles Olympic Organizing Committee. (He declined repeated invitations from SCIENTIFIC AMERICAN PRESENTS to be interviewed for this article.)

Months after the 1996 Atlanta Games, it came to light that four test results indicating use of the steroid methandienone were never acted on. The results were obtained with an extremely sophisticated high-resolution mass spectrometer (HRMS), which

was being used for the first time during Olympic competition in Atlanta. The HRMS, which costs a cool \$860,000, has about 10 times the resolution of a conventional GCMS. The greater sensitivity means that the high-resolution unit can often detect steroid metabolites in a urine sample more than a month after the athlete has stopped taking the drugs, as opposed to perhaps two or three weeks later with a conventional GCMS.

After the drug testers reported the four positive results to the IOC toward the end of the games, the IOC decided not to take action on them. Having been stung by the Bromantan experience just a few days before, the organization apparently decided it could not win a case based on evidence from a machine that some regarded as experimental.

Why would the IOC not want to vigorously root out and prosecute drug use at every opportunity? Some critics, including former athletes, have speculated that a large number of drug busts at an Olympics would undermine public support and enthusi-

TONY DUFFY/Allsport

asm for the games by tarnishing the sheen of fair competition. It is increasingly hard to accept that notion, though, given that the Tour de France has hardly suffered despite a scandal only two years ago that was about as bad as can be imagined.

### WHAT'S DIFFERENT NOW?

As the Sydney Olympics get under way, a comparison between the current state of Olympic drug testing with what it was on the eve of the 1996 Atlanta Games is revealing—and perhaps a little depressing. The tests, technology and administrative procedures available to sports officials are essentially unchanged. And few antidrug officials were satisfied with the way things turned out in Atlanta. After all, these were the Olympics known as the hGH Games, in which 11 athletes are known to have tested positive for banned substances and suffered no consequences.

There may be one small but potentially significant technological advance for the antidrug forces. Officials may make more use of a technique known as carbon isotope ratio detection to determine whether competitors have taken synthetic testosterone. The test would be a vast improvement over the current method—the dubious search for a testosterone-to-epitestosterone ratio greater than six to one.

The carbon isotope ratio technique is telling because drug companies use plant sterols from soybeans to produce synthetic testosterone. Natural testosterone in the body comes from cholesterol. Compared with carbon atoms in natural testosterone, the carbon atoms in a sample of synthetic testosterone have a slightly lower ratio of the carbon 13 isotope to carbon 12. By measuring this ratio, researchers can determine if some of the carbon in a testosterone sample originated outside the body.

Researchers did have a carbon isotope ratio detection system in Atlanta and also at the 1998 Winter Games in Nagano, Japan, but the machines were used only experimentally. At press time, the IOC was evaluating whether it would incorporate the machine into its routine tests.

### WHITHER WADA?

Even if there is a test for testosterone in Sydney, there will be none for the two other natural hormones, EPO and hGH. The reasons why are complex [see “All Doped Up—and Going for the Gold,” News and Analysis; SCIENTIFIC AMERICAN, May]. The short, simplified answer is that the IOC, unwilling to put its full support behind experimental tests that might not withstand legal challenge in the Court of Arbitration, opted to plow its resources into a new antidrug bureaucracy, the World Anti-Doping Agency (WADA).

WADA was formed to bring together, for the purpose of fighting the spread of performance-enhancing drugs, representatives of the IOC, the IFs, the NOCs, Olympic athletes, 12 national governments, and bodies from various international organizations, such as the United Nations. Perhaps not

coincidentally, its formation was announced to great fanfare in February 1999 as the reverberations from the Salt Lake City Olympics bribery scandal were reaching a crescendo at the IOC. WADA's director is Richard W. Pound, an attorney, a former Canadian Olympic swimmer and a longtime IOC vice president who is often mentioned as the favorite to succeed Juan Antonio Samaranch as IOC president.

According to Pound, the IOC has pledged to spend \$25 million over two years to get WADA up and running. It hopes that by then ongoing contributions will be coming from additional sources, such as national governments and international organizations. In explaining the need for WADA, Pound notes that the fight against performance-enhancing drugs is now a sprawling effort, heavily dependent on the work of the NOCs, IFs and, in some cases, customs agents and national police forces. WADA will be a single place where all those parties can plot strategy and find common ground among their agendas. But getting so many agencies to cooperate will probably be more challenging than it might initially seem. Although antidrug efforts are decades-old, the Olympic movement, including the NOCs and the often recalcitrant IFs, agreed on a single, uniform antidoping code only this past January. Pound also expects that with its diverse membership base, WADA will be able to assume a role as a larger, more effective platform for directing and funding research and development on drug tests.

It is possible, however, that drug-testing research as it is practiced today is nearing a twilight of sorts. In the near future dopers will take their perennial, escalating struggle with their keepers to a new level. Within a decade, perhaps, athletes will be able to inject themselves with genetic vaccines that will induce their body's own protein-making apparatus to add muscle mass or increase EPO (or both). In fact, in an overlooked experiment reported in 1997, Eric C. Svensson and others at the University of Chicago successfully used a genetic technique to boost the levels of EPO in the blood of some adult cynomolgus monkeys. The researchers subsequently measured hematocrits as high as 70 in the monkeys. (To keep the monkeys alive, the researchers diluted their blood.) When such genetic vaccines become available to athletes, the chemical games will be pretty much over. It will be difficult, if not impossible, for testers to distinguish inserted fragments of DNA from the DNA that was already there.

“When you come to a method where you are increasing proteins in the cells genetically and directly, you'll have to have much more sophisticated detection techniques,” says Mats Garle, scientific director of the IOC-affiliated Doping Control Laboratory at Huddinge University Hospital in Sweden. After a moment's reflection, he admits, “Maybe we'll never get a solution to that problem.”

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### FURTHER INFORMATION

ANABOLIC STEROIDS IN SPORT AND EXERCISE. Edited by Charles Yesalis. Human Kinetics Publishing (in press).