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Gene Doping: The Game Changing Technological Advancement of the Next Generation

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I. Introduction

To many Americans, sports enthusiasts, and cancer patients, Lance Armstrong's confession to Oprah Winfrey on January 17th, 2013 was both shocking and game changing [1]. Many lost their golden boy who had won seven Tours de France, some lost respect for the sport that had claimed to be clean time and again, and others lost hope that they too could survive cancer just like Lance and come back stronger than ever [2]. Lance's confession, however, is game changing on different levels (i.e. anti doping measures, professional sports' credibility, sponsorship fallout) now that sporting organizations and anti-doping agencies have been completely embarrassed by the fact that athletes like Lance have been able to beat their tests for so long [3]. In the cycling world alone, even long-time Dutch sponsor Rabobank (1996-2012) pulled out, leaving its team named

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[1] Oprah Winfrey, *Lance Armstrong Talks to Oprah*, OWN (last visited May 14, 2013), http://www.oprah.com/own_tv/onc/lance-armstrong-one.html.
[2] Steve Almasy, *Cycling, Facing An Uphill Climb, Hopes Next Hero Just Around Bend*, CNN, (last visited May 14, 2013), http://www.cnn.com/2013/01/18/sport/cycling-future/index.html?hpt=hp_c3.
[3] David Walsh, *UCI Embarrassed by Lance Armstrong Report,* RTE NEWS (last visited May 14, 2013), http://www.rte.ie/news/player/2012/1022/3420156-uci-embarrassed-by-lance-armstrong-report-the-sunday-times-chief-sports-writer-david-walsh/.

"Blanco" for lack of a title sponsor [4]. Further, the International Cycling Union (UCI) is taking extra precautions for this summer's Tour de France by cooperating with two independent agencies it has bumped heads with in the past; the Cycling Anti-Doping Foundation (CADF) and the French Anti-Doping Agency (AFLD) [5]. Whether the 2013 Tour de France is won clean will remain to be scene, and after cancelling the results from 1999-2005 (the Lance years) its credibility depends on it [6].

While cycling and other sports might go through a period of clean competition as a reaction to the Armstrong scandal, inevitably athletes seeking a competitive edge will find new methods of beating the tests. "Gene doping," or the use of gene therapy techniques to increase the production of performance-enhancing proteins, might just be the next big thing [7]! Also, given the financial incentives of winning a Tour de France, World Series, or Superbowl, the athletic field might just be the first place where genetic modification is implemented. As each new method of enhancing performance is released, the ever slow-to-catch-up anti-doping controls seem more and more a futile exercise.

Authorities such as the World Anti Doping Agency (WADA) and the U.S. Anti Doping Agency (USADA) will have to devise a way to regulate the future of gene doping. How they develop such a method will be interesting to see in coming years since there is neither a test, nor a human trial authorities can point to as a guinea pig. One such

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[4] *Rabobank Ends Sponsorship of Professional Cycling Team,* BBC (last visited May 14, 2013), *http*://www.bbc.co.uk/sport/0/cycling/20001685.
[5] Yuzuru Sunada, *UCI and AFLD to Cooperate at Tour,* PELOTON (last visited May 14, 2013), http://www.pelotonmagazine.com/Feedzone/content/6/2267/UCI-and-AFLD-to-Cooperate-at-Tour.
[6] Graham Dunbar, *Lance Armstrong Stripped of His 7 Tour de France Titles,* WLTV (last visited May 14, 2013), http://www.wwltv.com/sports/UCI-agrees-to-stripping-Armstrong-of-Tour-de-France-medals-175217311.html.
[7] MICHAEL J. SANDEL, THE CASE AGAINST PERFECTION: ETHICS IN THE AGE OF GENETIC ENGINEERING 45-62 (Belknap Press, 1st ed. 2009).

method would be to completely ban gene doping from competition such as performance-enhancing pharmaceutical substances, while another would be to treat it as a permissible technological innovation such as the prosthetic legs used by the "Blade Runner," Oscar Pistorius [8]. The mere fact that WADA has already labeled the practice "gene *doping*" is indicative of how they intend to treat it. Still, they have jumped the gun and failed to make an objective decision on a currently experimental procedure.

This paper will explore the world of gene doping and its intersection with law in athletics. First, I will provide an overview of gene doping before diving into the legal and moral framework of doping in athletics. Here, I will argue that gene doping does not fit within the present framework of prohibiting performance-enhancing drugs and techniques. The very nature of gene doping will require anti-doping agencies to take a fresh look and take a new approach to regulate gene doping's "gray" areas. Finally, I will propose that sporting bodies adopt a framework to allow genetically enhanced athletes to compete side-by-side with natural athletes, or alternatively, in a league of their own so that some level of fairness and safety is preserved while also letting all athletes compete, natural or genetically enhanced.

II. What Exactly is Gene Doping?

The basic premise behind gene doping is introducing a desired gene into the athlete's body, which will incorporate into his or her cells and be expressed as a natural

[8] *"Blade Runner's" Artificial Legs Controversial at Olympics*, CBS NEWS (last visited May 14, 2013), http://www.cbsnews.com/video/watch/?id=7416890n.

gene [9]. For example, if a person wanted to run faster and can pinpoint a number of genes that can make them do so, that person would incorporate those genes into their genome and genetically modify him or herself to run faster. Two potential forms of gene doping are: *somatic cell modification* in which genes are modified in a bodily cell like a muscle or lung, and *germline modification* in which a sperm, egg, or embryo is genetically modified, meaning the enhancements pass from one generation to another [10]. The focus of this paper is on somatic cell modification since athletes are more likely to gene dope themselves, though the possibility of parents breeding enhanced athletes certainly exists [11]. There are currently over a thousand gene therapy trials that are looking for ways to cure diseases, and it is thought that the same techniques employed in these trials would be used to introduce performance-enhancing genes into the athlete's body [12]. The three methods that could introduce artificial genes into an athlete's body are: loading those genes onto a virus that is introduced into the body, cultured cells that are modified and introduced into the body, and injecting foreign DNA into the athlete's muscle or bloodstream [13]. Each method is described more thoroughly below.

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[9] Susan L. Nasr, *How Gene Doping Works,* HOW STUFF WORKS (last visited May 14, 2013), http://science.howstuffworks.com/life/genetic/gene-doping.htm.
[10] Kathi E. Hanna, *Germline Gene Transfer,* NATIONAL HUMAN GENOME RESEARCH INSTITUTE (last visited May 14, 2013), http://www.genome.gov/10004764; Nasr *supra* note 9.
[11] Susannah Baruch, *Human Germline Genetic Modification: Issues and Options for Policymakers,* GENETICS AND PUBLIC POLICY CENTER, http://www.dnapolicy.org/images/reportpdfs/HumanGermlineGeneticMod.pdf; Hanna *supra* note *10.*
[12] ANGELA J. SCHNEIDER & THEODORE FRIEDMAN, GENE DOPING IN SPORTS: THE SCIENCE AND ETHICS OF GENETICALLY MODIFIED ATHLETES 30 (Academic Press, 1st ed. 2006).
[13] Mehmet Unal & Durisehvar Ozer Unal, *Gene Doping in Sports,* 34 SPORTS MED. 357, 358 (2004).

A. Methods of Delivery

Virus Loading: T. Beiter of the University of Tubigen, Department of Sports Medicine, explained how a virus would first be needed to provide a means of delivering the genetic material in the body [14]. Before infecting the subject, the virus is modified or loaded with a "cassette" of DNA [15]. The virus, once in the body, delivers the cassette of genetic material into the cells, forming a blueprint of whatever proteins expression is desired [16]. Viruses have the most capacity to carry genetic material, and are thought to be the preferred method of gene doping [17].

Modified Cells: M.B. Rosenberg of the University of California School of Medicine, Department of Pediatrics explained how fibroblasts were genetically modified to secrete *nerve growth factor* (NGF) by infection with a retro virus before implanting the fibroblast into mice with surgical lesions [18]. The grafted cells were successful and produced enough NGF to stop degeneration of neurons, which would die if left untreated [19].

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[14] Thomas Beiter et al., *Establishing A Novel Single-Copy Primer-Internal Intron Spanning PCR (spiPCR) Procedure For The Direct Detection Of Gene Doping*, 14 EXERC IMMUNOL REV. 73-85 (2008).

[15] Alexis C. Madrigal, *By the Next Olympics, Athletes May Be Getting Routine Gene Doping Tests,* THE ATLANTIC (last visited May 14, 2013), http://www.theatlantic.com/technology/archive/2012/08/by-the-next-olympics-athletes-may-be-getting-routine-gene-doping-tests/260700/.

[16] *Id.*

[17] Christie Aschwaden, *Gene Cheats*, NEW SCIENTIST (last visited May 14, 2013), http://www.archway.ac.uk/Activities/Departments/SHHP/downloads/epo/Genecheats/genecheats.html.

[18] M.B. Rosenberg et al, *Grafting Genetically Modified Cells to the Damaged Brain: Restorative Effects of NGF Expression,* SCIENCE, http://www.sciencemag.org/content/242/4885/1575.full.pdf.

[19] *Id.*

Foreign DNA Injection: I. Danko of the University of Wisconsin-Madison, Department of Pediatrics explained his method of injecting foreign DNA in mice, dogs, and monkeys [20]. He injected DNA over a 1-minute period using a 1ml syringe and 27-gauge needle [21]. He explains that the animals' muscles were directly exposed to facilitate injection into specific muscle groups and the incisions were later closed [22]. The use of naked DNA plasmids yielded the highest expression two weeks after the procedure [23]. This procedure looks the most similar to pharmaceutical doping, and would likely be the least popular for its invasiveness.

B. Target Genes and Possibilities

There are several genes with different potential advantages for athletes interested in gene doping: Erythropoietin (EPO) for endurance, Insulin-like Growth Factor-1 (IGF-1) and Myostatin for strength, Vascular Endothelial Growth Factor (VEGF) for increased blood flow, and Leptin for weight loss [24]. Two of these are common in pharmaceutical doping and would be immensely popular in gene doping: the introduction of EPO in endurance athletes, and IGF-1 in power athletes [25]. The others would likely be supplementary, used to further enhance the effects of EPO and IGF-1.

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[20] I. Danko et al, *High Expression of Naked Plasmid DNA in Muscles of Young Rodents,* HUMAN MOLECULAR GENETICS, http://hmg.oxfordjournals.org/content/6/9/1435.full.pdf.
[21] *Id.*
[22] *Id.*
[23] *Id.*
[24] Unal & Unal, *supra* note 13, at 358.
[25] Edward H. Jurith & Mark W. Beddoes, *The United States' and International Response to the Problem of Doping in Sports,* 12 FORDHAM INTELLECTUAL PROPERTY, MEDIA, & ENTERTAINMENT L.J. 461, 470 (2002).

EPO has long been used in sports such as cycling and running because it is a hormone produced by the kidney that increases the number of red blood cells in the body, which help the athlete absorb more oxygen and thus, augment his or her aerobic capacity [26]. EPO's synthetic version, Epoetin Alfa, is commonly used to treat forms of cancer and kidney diseases, while also used illegally by athletes looking to increase their endurance in competition [27]. Ex vivo EPO gene transfers have already been successfully introduced into mice, triggering increased red blood cell counts [28]. If this method were one day introduced to humans, the results would be both positive and negative. On the one hand it would be another, perhaps, more effective method of treating diseases and cancers, while on the other hand it would be another way for athletes to cheat their competition. For athletes, EPO gene transfers mean they can stimulate the kidney to produce more "natural" (now that it has incorporated in the human genome) EPO, which increases red blood cells, raises hematocrit levels, and permanently boost their performance.

Likewise, IGF-1 has been successfully introduced into mice via in vivo gene transfers, which increased muscle growth [29]. This form of gene transfer would be popular among baseball, basketball, and football players as it could be injected directly into the muscles they wish to grow, producing localized results. Through this method, athletes could target what it is they need to improve, whether it is jumping higher, throwing

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[26] I. Casoni et al, *Hematological Indices of Erythropoietin Administration in Athletes*, INTERNATIONAL JOURNAL OF SPORTS MEDICINE, https://profile.thieme.de/HTML/sso/ejournals/login.htm?type=default&subsidiary=www.thieme-connect.com&hook_url=https%3A%2F%2Fwww.thieme-connect.com%2Fejournals%2Fpdf%2F10.1055%2Fs-2007-1021183.pdf.
[27] SCHNEIDER & FRIEDMANN, *supra* note 12, at 44.
[28] *Id.* at 44-45.
[29] Melinda Wenner, *How to Be Popular During the Olympics: Be H. Lee Sweeney, Gene Doping Expert*, SCIENTIFIC AMERICAN, (last visited May 14, 2013), http://www.scientificamerican.com/article.cfm?id=olympics-gene-doping-expert.

faster, or hitting harder without spending countless hours in the gym. Though IGF-1 is banned by anti-doping bodies, it is widely available on the Internet in various forms of "Deer Antler Spray" [30]. Several collegiate and professional football players have been linked to the substance in recent years, spurring cease-and-desist letters to break the line of communication between manufacturers and athletes [31]. The genetic introduction of IFG-1 into human athletes means they can produce more power and avoid current forms of detection since the procedure would only need to be done once instead of periodically.

Similarly, proteins such as Myostatin would take the place of clenbuterol, which has been used to treat asthma as well as help athletes cut fat and increase muscle [32]. Schneider and Friedmann have commented that by adjusting the metabolism of particular muscles in mice they were able to increase “slow-twitch” muscle fibers via the peroxisome proliferator-activated receptor (PPAR) delta gene allowing those mice to increase their endurance by reducing fat and functioning more efficiently [33]. What this means for human athletes is that they can tailor their muscle fibers to better meet the demands of their sport. The two extremes are endurance (i.e. marathon runner) and power (i.e. 100 meter sprinter) and modifying one's fast or slow twitch fibers can make one run longer or sprint faster.

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[30] Jerry Hinnen, *S.W.A.T.S. Salesman Says He Watched Tide Players Use Deer Spray,* CBS SPORTS, (last visited May 14, 2013), http://www.cbssports.com/collegefootball/blog/eye-on-college-football/21623944/swats-salesman-says-he-watched-tide-players-use-deer-spray.
[31] *Id.*
[32] Wenner, *supra* note 29, at 12.
[33] SCHNEIDER & FRIEDMANN, *supra* note 12, at 46.

C. Advantages of Gene Doping: Permanence and Lack of Detectability

There are at least two reasons why gene doping would be preferable to pharmaceutical doping to the athlete seeking an edge. Genetic modification is permanent, thus, once the foreign genes are introduced into the athlete, they become his or her own genetic material [34]. By making doping a one-shot process, the cheating athlete would likely save money over the long-term, but more importantly eliminate the chance of getting caught by not having to periodically reintroduce a pharmaceutical drug [35]. Just think how much more discrete a doper would be if every time he raised his arms in victory at the finish line or the podium, there would be no signs of needle injections on his arms (*See* https://securecdn.disqus.com/uploads/mediaembed/images/437/1408/original.jpg*)*.

Similar to the reason above, gene doping is virtually undetectable because engineered genes produce proteins that look identical to naturally-occurring ones [36]. Further, certain gene doping methods would not be detectable by blood tests, as they would be entirely contained in the muscle and not circulate in the blood at all [37]. Extremely invasive muscle biopsies would be the only means of detection, however, few athletes would submit to slicing their muscles for such a test [38]. Though tests are developing, there are no official gene doping tests as of now, making the practice invisible.

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[34] Kristen Jo Custer, *From Mice to Men: Genetic Doping in International Sports*. 30 HASTINGS INTERNATIONAL & COMPARATIVE L. REV. 181, 188 (2007).
[35] *Id.*
[36] Aschwaden, *supra* note 17.
[37] Wenner, *supra* note 29, at 13.
[38] Custer, *supra* note 24, at 203.

Less invasive methods would be monitoring the athlete's deoxyribonucleic acid (DNA) to detect changes and foreign DNA based on an initial base line DNA test, looking for the presence of virus vectors, and using imaging to detect artificial genes [39]. These methods, however, are currently impractical and not reliable enough to use for competition [40]. Likely alternatives would be to monitor for indirect evidence of gene doping such as changing focus to the proteins such genes would produce. While this method would not catch instances where muscles have been genetically enhanced and produce no byproduct in the bloodstream, it could be effective at detecting EPO since abnormal levels of hematocrit would be present in the bloodstream [41].

The current method for detecting EPO in athletes involves a "biological passport" which keeps track of the athletes hematocrit levels overtime after an initial baseline test [42]. If a suspicious spike is detected, then sporting organizations have grounds to ban an athlete based on indirect evidence of hematocrit levels [43]. This method's effectiveness would be limited in the context of gene doping because an athlete who has gene doped before his or her baseline test would continue to have an artificially high hematocrit level due to the procedure's permanency. Similarly, athletes with a natural genetic mutation, such as Finnish cross-country skier Eero Mantyranta, would be labeled cheats for naturally producing hematocrit levels beyond the normal threshold [44]. Further, athletes

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[39] Wenner, *supra* note 29, at 13.
[40] *Id.*
[41] Jurith & Beddoes, *supra* note 25, at 470.
[42] Unal & Unal, *supra* note 13, at 360.
[43] *The Future of Cheating: EPO Gene Doping*, CYCLING TIPS, (last visited May 14, 2013), http://www.cyclingtips.com.au/2013/02/the-future-of-blood-doping-epo-gene-doping/.
[44] David T. Martin et al, *Blood Testing for Professional Cyclists: What's a Fair Hematocrit Limit?*, SPORTSCIENCE NEWS (last visited May 14, 2013),

with a legitimate baseline test might opt to elevate their hematocrit levels over time, by modifying their EPO expression incrementally, as to not produce sudden spikes that are indicative of doping prior to competition. Still, this method is potentially dangerous since it is purely based on indirect evidence and would vilify athletes such as Eero Mantyranta, who was born with unusually high hematocrit levels as a result of a natural genetic mutation [45].

D. Risks, Uncertainties, and Other Considerations

As of now, it is hard to tell what exactly the risks of gene doping are since there are no known cases of gene doping that have surfaced, and genetic modification has only been used in a clinical context [46]. In 1999, Jesse Gelsinger died shortly after a gene therapy clinical trial [47]. Even though his rare liver disease was not life threatening, the immune response his body had proved the procedure to be fatal and halted gene therapy trials in the U.S. for some time after [48].

It is thought that EPO gene doping would carry the same risks as pharmaceutical EPO, such as circulatory abnormalities that can cause internal bleeding and death [49]. Vascular Endothelial Growth Factor (VEGF) is thought to influence the expression of more than 200 genes, many of which are not well understood yet and have the potential

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http://www.sportsci.org/news/news9703/AISblood.html; *Eero Mantyranta,* SPORTS REFERENCE (last visited May 14, 2013), http://www.sports-reference.com/olympics/athletes/ma/eero-mantyranta-1.html.

[45] Aschwanden, *supra* note 17, at 29.

[46] *Challenges in Gene Therapy*, GENETIC SCIENCE LEARNING CENTER (last visited May 14, 2013), http://learn.genetics.utah.edu/content/tech/genetherapy/gtchallenges/.

[47] *Id.*

[48] *Id.*

[49] CYCLING TIPS, *supra* note 43.

for serious complications [50]. Since the rate of expression varies from one individual to another, genetic modification is still far from a precise science [51]. There is a high probability that if the bloodstream is oversaturated with red blood cells, it would become too thick for the heart to pump [52].

Just recently, WADA announced that it would hold a meeting in China to review the progress of developing tests for gene doping, with hopes that they will be available by the next Olympics [53]. Under review are two tests that WADA described as major breakthroughs: a blood test detecting gene doping as far back as 56 days, and another test for detecting gene doping in muscles [54]. WADA says it has the scientific basis to detect gene doping, but that the methods would have to be developed in order to make the tests effective in real-world scenarios [55]. This method is crucial as WADA was embarrassed that Lance Armstrong was able to beat over 500 doping tests in his career [56]. The pressure is also on for WADA because scientists working on potential genetics cures have been contacted about genetic techniques to enhance performance [57]. Without the proper

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[50] *Id.*
[51] Hanna, *supra* note 10.
[52] Leslie Johns, *5 Things You Need To Know About Having Too Many Red Blood Cells*, LIVESTRONG (last visited May 14, 2013), http://www.livestrong.com/article/5987-need-having-many-red-blood/.
[53] Stephen Wilson, *WADA to Hold Meeting in China on Gene Doping*, ABC NEWS (last visited May 14, 2013), http://abcnews.go.com/Sports/wireStory/wada-hold-meeting-china-gene-doping-19098995#.UZJvXZUo1zs.
[54] *Id.*
[55] *Id.*
[56] Brendan Gallagher, *Lance Armstrong was Tipped Off 20 Minutes Before he was Tested, Claims French Anti-Doping Official*, THE TELEGRAPH (last visited May 14, 2013), http://www.telegraph.co.uk/sport/othersports/cycling/lancearmstrong/9499744/Lance-Armstrong-was-tipped-off-20-minutes-before-he-was-tested-claims-French-anti-doping-official.html.
[57] Wilson, *supra* note 53.

methods of administering potential doping tests, athletes will all too easily think of ways to beat them.

As mentioned above, somatic gene transfer only affects the athlete's body, yet germline transfer would affect the human genome, meaning the changes would be passed on to the offspring [58]. Currently, there are no (known) germline clinical trials as its ethical value and desirability are being debated, however, somatic transfers can inadvertently lead to germline transfers since the methods of delivery can be hit-or-miss [59]. Thus, genetic therapy is at such an early stage that there are many uncertainties, and the potential to unbalance genetic expression, alter or mutate the genome, and affect offspring is very real [60]. Perhaps the only certainty is that unscrupulous athletes will forgo these risks to gain a competitive edge [61].

III. Legal and Moral Framework of Doping in Athletics

In the past two decades a number of doping scandals have pressured international doping agencies to become more harmonized and effective at combating performance-enhancing drugs [62]. In 1999 the International Olympic Committee (IOC) called on the International Sports Federations and National Olympic Committees to meet in Lausanne,

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[58] Hanna, *supra* note 10.
[59] *Id.*
[60] John Naish, *Genetically Modified Athletes: Forget Drugs. There are Even Suggestions Some Chinese Athletes' Genes are Altered to Make Them Stronger*, MAIL ONLINE (last visited May 14, 2013), http://www.dailymail.co.uk/news/article-2181873/Genetically-modified-athletes-Forget-drugs-There-suggestions-Chinese-athletes-genes-altered-make-stronger.html.
[61] *Id.*
[62] ANDY MIAH, GENETICALLY MODIFIED ATHLETES: BIOMEDICAL ETHICS, GENE DOPING AND SPORT 33 (Routledge, 1st ed. 2004).

Switzerland for the World Conference on Doping in Sport [63]. The result was the establishment of the World Anti Doping Agency (WADA), which was created with two overriding principles: promoting fair play and protecting athletes' health [64]. As part of its mission WADA continually updates the World Anti-Doping Code, which lists all banned PEDs (anabolic steroids, amphetamine, EPO) and methods (blood doping and gene doping) that athletes are required to abide by [65]. Likewise, individual countries have their own anti-doping bodies, such as the U.S. Anti Doping Agency (USADA), to help implement and administer WADA's goals [66].

Within these anti-doping bodies, a discussion over gene doping has ensued for the past decade, recognizing that it will be confronted in the future [67]. While WADA and others have often been criticized for responding slowly, they took full advantage of this opportunity to put in place a policy prior to the development of gene-doped athletes [68]. As early as 2001 the IOC formed a group to address the future of gene doping in which they found that genetic modification could be medically sound, yet should be kept out of sports [69]. The IOC Gene Therapy Working Group concluded,

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[63] Custer, *supra* note 34, at 191.
[64] *WADA History*, WORLD ANTI-DOPING AGENCY (last visited May 14, 2013), http://www.wada-ama.org/en/About-WADA/History/WADA-History/.
[65] *World Anti-Doping Code*, WORLD ANTI-DOPING AGENCY (last visited May 14, 2013), http://www.wada-ama.org/en/World-Anti-Doping-Program/Sports-and-Anti-Doping-Organizations/The-Code/.
[66] *About USADA*, US ANTI-DOPING AGENCY (last visited May 14, 2013), http://www.usada.org/about.
[67] WADA, *Special Feature: Gene Doping*, 1 PLAY TRUE at 12, http://www.wada-ama.org/Documents/Resources/Publications/PlayTrue_Magazine/PlayTrue_2005_1_Gene_Doping_EN.pdf.
[68] MIAH, *supra* note 62, at 38.
[69] *Id.* at 12.

> "we are aware there is potential for abuse of gene therapy medicines and we shall begin to establish procedures and state-of-the-art testing methods for identifying athletes who might misuse such technology" [70].

Since then doping investigations have shown how urgent this issue is, revealing evidence of running coach Thomas Springstein referencing Repoxygen in an email [71]. Repoxygen is a form of EPO used in conjunction with gene therapy for anemic patients and would increase red blood cell production in enhanced athletes [72].

The next step taken against gene doping was WADA's Banbury Conference in which its President, Richard Pound, explained that gene doping would make the realm of pharmaceutical doping look like the dark ages [73]. In his push to speed the development of an anti gene-doping framework, two ideas emerged. The conference called for a gene doping detection program backed with numerous grants in the areas of genomics, proteomics, metabolomics, bioinformatics, and viral detection oriented at researching detection methods, as well as including gene doping within the World Anti-Doping Code [74]. The addition of an anti gene-doping clause in the Code reflects the majority stance of anti-doping organizations that genetic modification is to be strictly banned from sports [75]. WADA's Pound has said that gene doping is a "slippery slope we do not ever want to go

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[70] International Olympic Committee, *Gene Therapy Working Group - Conclusions*, IOC (last visited May 14, 2013), http://www.olympic.org/content/news/media-resources/manual-news/1999-2009/2001/06/06/ioc-gene-therapy-working-group---conclusions/.
[71] Custer, *supra* note 34, at 20.
[72] *Id.*
[73] SCHNEIDER & FRIEDMANN, *supra* note 12, at 71.
[74] Oliver Rabin, *WADA Research Program on Gene Doping*, WADA, http://www.wada-ama.org/rtecontent/document/2008_Stpetersburg_declaration_Dr.rabin.pdf; *The World Anti-Doping Code*, *supra* note 65, at M3.
[75] MIAH, *supra* note 62, at 178.

down" [76]. The labeling of genetic modification as a form of "doping" was a significant step in banning it, as it makes clear the negative connotation associated with it [77]. Pound has stated that WADA will fight gene doping just as vigorously as pharmaceutical doping since he and his colleges believe sports will not benefit from gene doped athletes, and it is critical to prevent such practices before they become widespread [78].

WADA's justifications for banning genetic modification from sports are currently legitimate, as clinical studies have shown to have deadly side effects [79]. Further, since genetic doping is a permanent modification of the body there is a danger that if the foreign gene produces too much of its protein product, there is no way to reduce or stop it [80]. Another concern is that the interaction of the foreign gene with the native genes might have an unbalancing effect on the body resulting in a condition called pleiotropy, in which the foreign gene that was intended to boost EPO might accidently effect a completely unrelated gene and cause damage to the body [81]. Finally, gene doping that targets specific muscles, such as IGF-1, would only strengthen the targeted muscles without strengthening their adjoining tendons and ligaments, putting the athlete at risk of injury every time he or she uses that muscle and puts strain on its connective tissue [82].

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[76] WADA, *supra* note 67, at 1.
[77] Custer, *supra* note 34, at 197.
[78] MIAH, *supra* note 62, at 54.
[79] SCHNEIDER & FRIEDMANN, *supra* note 12, at 29-30.
[80] Aschwaden, *supra* note 17.
[81] Randall Mayes, *The Modern Olympics & Post-Modern Athletics: A Clash in Values*, THE JOURNAL OF PHILOSOPHY, SCIENCE & LAW (last visited May 14, 2013), http://www6.miami.edu/ethics/jpsl/archives/all/Olympics%20and%20Athletics.html.
[82] PRESIDENT'S COUNCIL ON BIOETHICS, BEYOND THERAPY: BIOTECHNOLOGY AND THE PURSUIT OF HAPPINESS 112 (2003), *available at* http://changethis.com/manifesto/9.BeyondTherapy/pdf/9.BeyondTherapy.pdf.

Due to the concern of the side effects above many associations in the U.S. such as the Recombinant DNA Advisory Committee (RAC) will not approve genetic modification aimed at anything but treatment [83]. Countries around the world, such as the United States, have enacted strict requirements for genetic clinical studies, requiring approval from the U.S. Food and Drug Administration (FDA), National Institutes of Health (NIH), and the RAC before any federal funds are allocated [84].

These steps, however, might not be enough, as athletes would seek laboratories operating illegally in and outside of the US [85]. The possibility that athletes would turn to the black market if gene doping were banned is a very real one as history has shown this to be the case with other illicit substances such as drugs and alcohol [86]. The counterargument would be to legalize genetic modification so that it is regulated, leaving the athlete to decide whether the pros outweigh the cons [87].

While athletes engage in risk analysis every time they compete, perhaps the consequences of gene doping are currently too unknown for the athlete to make a reasoned decision. Likewise, WADA's national affiliates such as the United Kingdom Anti-Doping Authority (UKAD) and USADA have echoed WADA's stance and introduced campaigns such as "100% me" backed by multi-gold medalist Sir Chris Hoy,

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[83] SCHNEIDER & FRIEDMANN, *supra* note 12, at 61.
[84] *Id.*
[85] Custer, *supra* note 34, at 202-203.
[86] Shane Stokes, *WADA Issues Urgent Warning About Black Market Substance GW501515,* VELONATION (last visited May 14, 2013), http://www.velonation.com/News/ID/14196/WADA-issues-urgent-warning-about-black-market-substance-GW501516.aspx.
[87] PRESIDENT'S COUNCIL ON BIOETHICS, *supra* note 82.

and have relentlessly taken down doping "king pins" such as Lance Armstrong in the last year [88].

An additional concern over gene doping would be that its unknown risk/benefit analysis would make it impossible for athletes to give informed consent, undermining the most basic tenet of medical practice [89]. Athletes would likely not appreciate the unknown risks when weighed against the money and pride associated with winning. This concept is known as the Goldman Dilemma, in which elite athletes were asked on a biannual basis since the 1980s whether they would take a drug guarantying them Olympic gold if it would also kill them within five years [90]. Over half of the athletes said yes each time the survey was conducted [91]. Similarly, other athletes would feel pressured to make the jump and gene dope, as not doing so would put their livelihood at risk [92]. Many elite athletes, particularly from underdeveloped countries, would be faced with the decision to dope and remain competitive or work in the mines back home. They justify doping as a way to

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[88] Lucy Battery, *Gene Doping: Olympic Genes for Olympic Dreams,* JOURNAL OF THE ROYAL SOCIETY OF MEDICINE (last visited May 14, 2013), http://jrs.sagepub.com/content/104/12/494.short?rss=1; Shannon J. Owens, *Lance Armstrong has New Title: Doping Kingpin,* ORLANDO SENTINEL (last visited May 14, 2013), http://articles.orlandosentinel.com/2012-10-22/sports/os-shannon-owens-lance-armstrong-1023-20121022_1_usada-charges-betsy-andreu-armstrong-teammate-frankie-andreu.

[89] National Institute for Health, *The Belmont Report* at C1, US DEPARTMENT OF HEALTH AND HUMAN SERVICES (last visited May 14, 2013), http://www.hhs.gov/ohrp/humansubjects/guidance/belmont.html#xinform.

[90] Gretchen Reynolds, *Phys Ed: Will Olympic Athletes Dope if They Know it Might Kill Them?,* THE NEW YORK TIMES (last visited May 14, 2013), http://well.blogs.nytimes.com/2010/01/20/phys-ed-will-olympic-athletes-dope-if-they-know-it-might-kill-them/.

[91] *Id.*

[92] Nicole Cooke, *Full Retirement Statement,* NICOLECOOK.COM (last visited May 14, 2013), http://www.nicolecooke.com/index.php?option=com_content&view=section&layout=blog&id=1&Itemid=18.

even the playing field, and that they are not necessarily cheating since they do not have an advantage over their competition [93].

WADA has taken it upon itself to educate athletes, trainers and physicians of the dangers of gene doping, specifically in its St. Petersburg Declaration [94]. One of their conclusions was that athletes, trainers, and physicians should be educated so that they can critically assess claims on the Internet or elsewhere about the benefits (and detriments) of gene doping [95]. Their stance reflects the current unknown consequences of gene doping and the impossibility of obtaining informed consent without better knowing the associated risks [96]. Yet, there is a possibility that after adequate testing gene doping could be safe and/or the risk would be quantifiable. Arguably, this would undermine WADA's primary justification of the athlete's safety and shift the argument to fair play [97].

In all, the IOC, WADA, USADA, UKAD, and other organizations under this umbrella share the same policy stance about genetics; that gene therapy is a promising technology that can be abused by athletes as a form of doping [98]. While there are no gene doping tests currently in practice, the mentioned organizations have been working steadfastly to come up with one by the next Olympics [99]. That being said, there has been speculation over certain Chinese swimmers who performed way beyond their previous

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[93] Celestine Chua, *Case Study: Lance Armstrong's Elaborate Doping Scandal*, PERSONAL EXCELLENCE (last visited May 14, 2013), http://personalexcellence.co/blog/lance-armstrong/.
[94] WADA, *St. Petersburg Declaration*, WORLD ANTI-DOPING AGENCY, http://www.wada-ama.org/Documents/Science_Medicine/Scientific%20Events/WADA_StPetersburg_Declaration_2008.pdf.
[95] *Id.*
[96] *Id.*
[97] MIAH, *supra* note 62, at 138.
[98] WADA, *supra* note 94.
[99] Wilson, *supra* note 53.

results at London 2012, as well as reports of Chinese hospitals offering gene therapies to anyone willing to pay their price, but until a test is developed this can only be speculation [100]. Still, the increase in media coverage on the topic has shown just how imminent gene doping is.

IV. How Should WADA Regulate Gene Doping?

As mentioned in the introduction, it is unclear whether gene doping should be treated like pharmaceutical doping or as a technological innovation. Even if gene doping is treated like anabolic steroid use and is completely banned, there would be problems in applying the black and white approach of doping sanctions in the gray area of gene modification. For one, the permanency of gene modification would impose a lifelong ban on an athlete, running at odds with WADA's constitutional approach of granting second chances [101]. While there are many similarities between traditional pharmaceutical doping and gene doping, there are just as many similarities between gene doping and non-genetic technological innovation in sport. Cyclists benefit from the latest aerodynamic equipment to help them reduce drag, ski-jumpers benefit from the latest skin suits to help them hold flight in the air, swimmers benefitted from slippery swimsuits, and disabled runners benefit from the latest prosthetic legs so much so that their competitors claim the prosthetics are faster than real legs [102].

The primary difference between pharmaceutical doping and gene doping is that in gene doping genetic material is introduced and assimilated into the body where as in

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[100] Naish, *supra* note 60; *German TV Report on Gene Doping in China Stuns Experts*, ESPN (last visited May 14, 2013), http://sports.espn.go.com/oly/news/story?id=3501414.
[101] *The World Anti-Doping Code*, *supra* note 65, at Art. 2.
[102] CBS NEWS, *supra* note 8.

traditional forms of doping, the substance stimulates growth in the body and the development of new cells temporarily. The distinction is that pharmaceutical doping actively stimulates change in the body that is excreted for a limited time, where as genetic material has to be assimilated by the body, which then expresses the desired changes, based on the new genetic code going forward. While this may seem to be a very narrow distinction, it might make all the difference when one compares gene doping to high altitude training.

In altitude training the lack of oxygen in the air forces the body to adapt and produce more red blood cells so that it becomes more efficient at absorbing the scarce oxygen [103]. Further, there are altitude chambers readily available for purchase that allow athletes to reduce the density of air while they sleep at night, without ever having to step foot on a mountain [104]. In 2006, WADA decided not to ban altitude chambers because their biological response came only as a result of informational input (i.e. lower oxygen content) instead of a pharmaceutical reaction [105]. Thus, the similarity between gene doping and altitude training is that the input forces the body to adapt and modify its output, which is distinguishable from pharmaceutical doping, which artificially trumps the DNA and stimulates the body to produce more output without a biological response [106].

Commentators such as Coleman have pointed out that while steroids push the body to grow more and produce more tissue, genetic material "cannot cause the body to

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[103] MIAH, *supra* note 62, at 36.
[104] Hypoxico Altitude Training Systems, (last visited May 14, 2013), http://www.hypoxico.com/home-products.shtml.
[105] Doriane Lambelet Coleman & James Coleman, Jr., *The Problem of Doping*, 57 DUKE L.J. 1743, 1756 (2008).
[106] *Id.* at 1771.

be more and perform differently that its genes would otherwise allow" [107]. In essence, the performance benefits of gene doping are the products of the athlete's own body, albeit enhanced. Yet, Coleman's conclusions raise questions on what constitutes a person's DNA, particularly when a genetic transfer becomes the athletes own permanent DNA. Does a person who undergoes gene therapy ever get to claim ownership of their DNA, or do they forever carry the stigma (i.e. plastic surgery, Botox, silicone implants) of being genetically enhanced? In the context of genetic transfer, perhaps sporting bodies would debate whether only the athlete's DNA at birth is his or her own DNA, despite the permanency genetic transfer would have on the athlete's actual DNA. This debate could go either way, indicating that current anti-doping measures would be inadequate at dealing with genetic doping since it raises too many questions and too closely resembles natural adaptations.

If and when gene doping becomes widespread, doping authorities will be faced with many challenges such as the difficulty of detection through blood work or the overly expensive and intrusive nature of muscle biopsy. Yet, if authorities develop an inexpensive, unobtrusive, and effective means of catching gene dopers, they would still run into difficulty distinguishing between cheaters and those like Finnish skier Eero Mantyranta who was born with a genetic mutation [108].

Once genetic material is introduced to the body, there is no way of removing or muting that material, meaning that the change is permanent. The dilemma is that such a genetically modified athlete would have to be banned for life since they would always be

[107] *Id.* at 1772.
[108] Aschwaden, *supra* note 17.

genetically enhanced [109]. While the risk of a lifetime ban is the athlete's, this one-and-done ban runs against WADA's policies, which allow for athletes to come clean and have a second chance [110]. WADA's policy explicitly mandates a two-year suspension for first time offenders, yet under their current zero-tolerance policy, the two-year suspension would last indefinitely since genetic change is permanent [111].

WADA's constitutional conflict would mean that even an athlete who admits to having done wrong by gene doping could not be given a second chance since that athlete will forever be genetic enhanced! Currently, a number of reformed cyclists are serving as anti-doping ambassadors in the sport; a fair tradeoff for athletes deserving a second chance [112]. Yet, without having such an opportunity, gene dopers would be quickly forgotten and their competitors would just as quickly forget about the consequences of gene doping. This disparate treatment would be even more pronounced if two athletes were caught for using EPO, one pharmaceutical and the other genetic. After two years, the pharmaceutical doper would be cleared to compete, but the genetic doper cannot since it is known that his condition is permanent. Perhaps the only way for the gene doper to compete again would be to undergo a reversing treatment (if one were possible) and then be tested for reinstatement.

Moreover, athletes, just like all other people should have access to therapeutic gene uses (as opposed to enhancements) when they become medically available [113].

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[109] Custer, *supra* note 34, at 208.
[110] *Id.*
[111] *The World Anti-Doping Code*, *supra* note 65.
[112] Justin Davis, *Proud Ex-Doper David Millar Shines at Tour de France Again,* BICYCLENET (last visited May 14, 2013), http://www.bicycle.net/2012/proud-ex-doper-david-millar-shines-at-tour-de-france-again.
[113] SCHNEIDER & FRIEDMANN, *supra* note 12, at 49.

WADA's Code provides for "therapeutic use exemptions" when treatment requires the legitimate use of drugs not permitted in competition [114]. Under traditional therapeutic treatment, athletes can return to competition free of any sanctions once the procedure is completed [115]. The moral dilemma comes up when at an early age a child undergoes therapeutic gene modification and later wishes to compete at the elite level [116]. Does WADA then ban the athlete for having a necessary procedure, or recognize its legitimacy and allow the athlete to compete with a distinct advantage [117]? Further, what if a famous athlete is diagnosed with cancer and the only means of treatment is genetic modification using EPO. Would sporting bodies make an exception to allow the athlete to compete, and would competitors feel such an exception was fair?

Bans on genetic modification could run opposed to human rights standards under the Universal Declaration on the Human Genome and Human Rights [118]. Article 2 states that "everyone has a right to respect for their dignity and for their rights regardless of their genetic characteristics," and Article 6 states "no one shall be subjected to discrimination based on genetic characteristics that are intended to infringe or have the effect of infringing human rights" [119]. Indeed, this would be a difficult decision for WADA to make because neither of the two outcomes, banning the athlete or letting the athlete complete, would be fair. Hence, the anti-doping authorities need to rethink their policies and provide for an alternative means of dealing with genetically modified

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[114] *The World Anti-Doping Code*, *supra* note 65, at Art. 4.4.
[115] *Id.*
[116] Custer, *supra* note 34, at 205-206.
[117] *Id.*
[118] U.N. Educ., Sci. & Cultural Org. (UNESCO), Universal Declaration on the Human Genome and Human Rights at Arts. 2, 6, (1997).
[119] *Id.*

athletes, particularly when such athletes had no malicious intent to cheat. I suggest, that WADA regulate enhanced athletes by enforcing a measurable handicap appropriate for their sport, or putting enhanced athletes in a separate, enhanced category of competition.

Obviously, WADA has already passed judgment on genetic modification by labeling it "gene doping" and tried to take a stance on the practice before it becomes prevalent [120]. Yet, genetic modification shows promise in the many legitimate benefits it could provide to society [121]. If the medical field and society at large perceive genetic modification in the eyes of WADA, perhaps the technology would never realize its full potential [122].

The first step WADA should take is relabeling "gene doping" into a more neutral title to remove the negative connotation it receives by being called "doping." The Code can continue to disallow it for now, since the point would be to allow society to make up their minds on whether genetic modification is good or bad, without being told by WADA and USADA that genetic modification is the equivalent of pharmaceutical doping. WADA itself recognized the impact it has on social perceptions in its St. Petersburg Declaration, noting that sport is likely one of the first places where genetic treatment and enhancement will be debated [123].

Under the current regime, steroid use is the equivalent to illicit drug use and by and large society has taken the stance that illicit drug use is unacceptable [124]. Entire campaigns are focused around dissuading people from taking drugs, not leaving it up to

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[120] *The World Anti-Doping Code*, *supra* note 65, at M3.
[121] MIAH, *supra* note 62, at 165.
[122] Custer, *supra* note 34, at 197.
[123] *The World Anti-Doping Code*, *supra* note 65, at Art. 2.
[124] J. Ahern et al, *Stigma, Discrimination and the Health of Illicit Drug Users*, PUBMED (last visited May 14, 2013), http://www.ncbi.nlm.nih.gov/pubmed/17118578.

the individual to decide whether or not drugs are good or bad [125]. If genetic modification were also grouped into this category as a result of WADA's policies, perhaps society would dismiss the potential benefits of gene therapy as a deviant practice without even giving it a chance [126]. If genetic modification is given a chance and is found to be beneficial to society, WADA's dismissive stance on the subject would pigeonhole it from what society has decided is acceptable [127].

If and when society decides that genetic modification is acceptable, authorities need to decide where to redraw the line. Allowing all forms of genetic modification cannot be the solution as the financial and social benefits association with winning a competition would pressure all athletes to genetically enhance just to remain competitive. WADA and other sporting authorities would have to maintain some level of fairness in order to keep both natural and enhanced athletes content. If athletes were completely free to gene dope, sport would turn into an arms race of who can purchase better genes, making the cost of competition prohibitive to less established athletes.

One option would be to disregard how an athlete with abnormal levels of hematocrit obtained them (whether it be through pharmaceutical EPO, genetic EPO, or genetic mutation) and say that cyclist, runners, and other endurance athletes with more than "x" amount of "y" cannot participate in the same category deemed to be natural. This could then go in anyone of two ways: either such athletes would have no category to compete in, or such athletes would compete in an enhanced category. The name of the

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[125] *About*, D.A.R.E. (last visited May 14, 2013), http://www.dare.com/home/about_dare.asp.
[126] MIAH, *supra* note 62, at 159.
[127] *Id.* at 175.

enhanced category can be strategic in order to dissuade athletes from the "gene doped" category and incentivize remaining clean for the natural category.

Another option would be to single out the athletes with abnormal levels of EPO or IGF-1 and conduct an investigation on whether such elevated levels are products of legitimate therapeutic uses or illegitimate attempts at cheating. At that point athletes without a legitimate therapeutic use (i.e. they were dying of cancer) would be banned from competition so long as such levels remain abnormally high. This, however, would inevitably come to the question of which therapeutic uses are legitimate. Cancer certainly would be one, but perhaps other procedures would be mere charades for dopers. While this investigatory method would be harsh to athletes like Eero Mantyranta, perhaps the level playing field for all others would make up for it. On that note, if the Mantyrantas of the world wanted to compete, they might (emphasis on might) be able to genetically diminish their EPO levels.

A final option would be allow those athletes to compete side by side natural athletes, but to attach some quantifiable “handicap” to their performance such as having them run 27 mile marathons (instead of 26.2) or having them sprint 110 meters (instead of 100). The difficulty here would be coming up with what handicap would exactly compensate for a gene doper's genetic advantage. Racer are won or lost by hundredths of a second, and thus, every inch would matter.

While quantifiable handicaps might not translate well in all sports, it is at least another available option to deal with genetic modification. In fact, many amateur level cycling races make use of racing handicaps to deal with varying levels of skill and experience. For example, in order for a race promoter to break even, the promoter might

allow Cat.3 (low category) cyclist to compete with Pro, Cat.1 (high), and Cat.2 (intermediate) cyclist. While the Cat.3's would be at a distinct disadvantage, the promoter might attempt to level the playing field by starting the Cat.3's with a two-minute advantage [128]. Similarly, other sports such as boxing, wrestling, and rowing have weight categories to accommodate athletes that cannot compete against competition with a distinct (but natural) size advantage [129]. Finally, athletic competition is already divided among lines of gender because it is believed that intermingling competition would be unfair to one or both genders [130]. Yet, there are instances where female athletes that outperform their competition are allowed to compete against males [131]. In rowing, female coxswains are free to compete in both male and female events since it is their nonphysical skills (motivating rowers and steering the boat) that set them apart. Still, instances of males competing in female sports are nearly unheard of, save a few transgender cases [132].

These alternative methods do of course have some limitations. For example, creating distinct categories for enhanced athletes might not be as easy as it sounds since it would require sporting bodies to handle the logistics of another race, game, league and so

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[128] Charlie Issendorf, *2011 Kings County Kermesse*, CYCLINGREPORTER (last visited May 14, 2013), http://cyclingreporter.com/2011/04/16/2011-kings-county-kermesse/.
[129] *Rowing Classifications*, US ROWING (last visited May 14, 2013), http://www.usrowing.org/About/Rowing101/RowingClassifications.aspx; MIAH, *supra* note 62, at 155.
[130] Chris Stankovich, *Boys Competing Against Girls in Sports May Not Be Such A Great Idea*, EXAMINER (last visited May 14, 2013), http://www.examiner.com/article/boys-competing-against-girls-sports-may-not-be-such-a-great-idea.
[131] *See* Amy Cutler, *Branchbrook Park Spring Series*, USA CYCLING (last visited May 14, 2013), https://www.usacycling.org/results/?year=2013&id=478&info_id=60533.
[132] Noah Berger, *Gabrielle Ludwig, First Transgender Basketball Player to Play College Ball as Both Man and Woman, Keeps Head High Despite Threats*, DAILY NEWS (last visited May 14, 2013), http://www.nydailynews.com/news/national/transgender-college-hoops-player-head-high-article-1.1220117.

on. Creating a separate category might be a financial nightmare particularly if it consumes a lot of the promoter's time for only a few athletes that compete at the enhanced level. Further, if athletes find the enhanced level to be more lucrative than their present level, this might unnecessarily pressure them into genetic enhancement. The other side of this argument is that if there is no league for enhanced athletes, they have nowhere to compete and could be faced with the decision to forgo necessary genetic treatment in order to compete.

Another limitation would be how to effectively categorize the athletes. To say that the only relevant trait in cycling is your hematocrit level would be to severely undermine all other factors such as training, motivation, and skill. Similarly, to say that IGF-1 is the only relevant factor in weightlifting would be to eliminate all other means that athletes could use to cheat. If sporting bodies only tested EPO or IGF-1 then athletes would look for other means to avoid the enhanced category. Ultimately, if sporting bodies were concerned for their athletes' health, they would find a way to allow for genetic modification in a controlled manner because its outright ban simply forces people to the black market.

On the other hand, sports could play a vital role in developing genetic therapies, as the medical field might race to catch a portion of the market share. For example, Dr. Dello Russo is one of a handful of doctors that pioneered lasik surgery in the 1990s, and has local professional teams such as the NY Giants and Brooklyn Nets endorse his procedure [133]. The public, at large, recognizes that a football and basketball player's vision is crucial to his or her success and would think that if such athlete used the

[133] DELLO RUSSO LASER VISION, (last visited May 14, 2013), http://www.dellorussolaservision.com/html/doctors.html.

procedure then they would try it too. As a result, Dr. Dello Russo is known as the leading lasik surgeon in the area, if not the country, and has captured a large portion of the market for lasik [134].

Traditionalists would likely argue that allowing any form of genetic modification in sports would defeat the romantic ideal of sport as the spirit's triumph over body and result in competition that is so unreal that sports would become a spectacle [135]. Friedmann explains,

> "what are the endpoints of manipulation?.. How fully can we engineer the human body… something that looks like a human, but is so engineered, that it's no longer going to do what the body is designed to do" [136]?

Others would argue that the very nature of sport is incrementally getting stronger, better, faster. Currently, it's clear what field WADA stands in, yet, this traditionalist approach does not necessarily reflect society's stance since it has not yet had a chance to judge [137]. Ideally, WADA will find a way to balance its priorities of fair play and athletes' health with the game changing reality that genetic modification will be.

V. Conclusion

At this point in the debate, it is hard to say which method of dealing with gene doping is best, or that certain options are superior to others as all have their own pros and

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[134] *Id.*
[135] MIAH, *supra* note 62, at 178.
[136] SCHNEIDER & FRIEDMANN, *supra* note 12, at 56-57.
[137] *The World Anti-Doping Code*, *supra* note 65, at M3.

cons. The point is simply to open the discussion and have athletes, sporting bodies, and society at large take a clean look at “gene doping” and decide how they want to proceed.

Personally, I believe that if genetic modification develops into a legitimate practice, then sporting bodies should not interfere by smudging it as "doping" for the sake of maintaining their integrity. WADA has the opportunity to play an instrumental role in the development of genetic modification by neutralizing its stance on “gene doping” and collaborating with the scientific and medical communities to monitor the development of genetic therapies. By labeling genetic modification "gene doping" it has already burnt bridges in a potential enterprise to enrich both everyday people and elite athletes.

Further, I feel strongly against prohibiting athletes from competing for whatever reason, whether they doped or were treated for disease via genetic transfer. Thus, I feel that sporting organization should accommodate all athletes by finding a fair way for them to compete either in separate enhanced leagues, or natural leagues with a handicap. I believe strongly in dissuading athletes from cheating, yet I feel equally as strong about giving repentant athletes a second chance.

Finally, WADA’s role will inevitably shape the public’s view of how such gene therapies are perceived, and so they will have to be particularly careful of where to draw the line in order to not discourage the development of genetic therapies while also preserving the integrity of their organization and sport as a whole. The future leaves us with many Superbowls, Tours de France, and Olympics ahead, and one can only wait to see how genetic modification is received.