

SP.235 - Chemistry of Sports Sports Scandals

Wednesday April 25, 2007

Scandals we are going to look at

- EPO/blood doping
- Anabolic Steroids/Androstenedione
- THG
- Modafinil
- Human Growth Hormone

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Papers that will help our discussion

Birkeland, Kåre I., and Peter Hemmersbach. "The future of doping control in athletes: issues related to blood sampling." *Sports Medicine* 28, no. 1 (1999): 25-33.

Saugy, M., N. Robinson, C. Saudan, N. Baume, L. Avois, P. Mangin. "Human growth hormone doping in sport." *British Journal of Sports Medicine* 40, suppl. 1 (2006): i35-i39.

Juhn, Mark S. "Popular sports supplements and ergogenic aids." *Sports Medicine* 33, no. 12 (2003): 921-939.

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EPO/Blood doping

- EPO (Erythropoetin) is naturally produced in the kidneys to regulate red blood cell production.
- The FDA has approved it for medical use in chronic renal failure and certain types of anaemia

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EPO/Blood doping

The following is from the website: <http://www.aranesp.com>

- Aranesp® is a man-made form of the protein human erythropoietin. Aranesp® works by stimulating your bone marrow to make red blood cells. After two to six weeks of treatment, your red blood cell counts may increase and if so, you may be able to avoid the need for red blood cell transfusion.
- Aranesp® is used to treat anemia (a lower than normal number of red blood cells).
- Aranesp® may be used to treat your anemia if it is caused by:
 - * chronic kidney disease (you may or may not be on dialysis)
 - * chemotherapy used to treat cancer
- While you are being treated with Aranesp®, you will be having blood tests (called hemoglobin and/or hematocrit) to check the number of red blood cells your body is producing. The amount of time it takes to reach the red blood cell level that is right for you, and the dose of Aranesp® needed to make the red blood cell level rise, is different for each person. You may need Aranesp® dose adjustments before you reach your correct dose of Aranesp® and the correct dose may change over time.

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EPO/Blood doping

The following is from the website: <http://www.aranesp.com>

- **CLINICAL PHARMACOLOGY: Mechanism of Action**
- "Aranesp® stimulates erythropoiesis by the same mechanism as endogenous erythropoietin. A primary growth factor for erythroid development, erythropoietin is produced in the kidney and released into the bloodstream in response to hypoxia. In responding to hypoxia, erythropoietin interacts with progenitor stem cells to increase red blood cell (RBC) production. Production of endogenous erythropoietin is impaired in patients with chronic renal failure (CRF), and erythropoietin deficiency is the primary cause of their anemia. Increased hemoglobin levels are not generally observed until 2 to 6 weeks after initiating treatment with Aranesp®"

Why would you want to boost your red blood cells?

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Blood doping

- From the Tour de France 2006: ([Washington post](#))
- The drug scandal revolves around a sports doctor, Eufemiano Fuentes, the head of hematology at a Madrid hospital who had worked with several cycling teams. Fuentes allegedly helped riders and athletes from other unidentified sports engage in different kinds of drug use and blood doping to enhance their performance.
- The blood doping reportedly involved drawing oxygen-rich blood at high altitudes to obtain a concentrate of red blood cells, then injecting them back into riders before a race to boost endurance.

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Blood doping

- The best way to get around the tests is to take your own blood purify the red blood cells (by centrifugation) and transfuse it back into you
- So basically you are giving yourself a blood transfusion using your own blood

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Please see Juhn, Mark S. "Popular sports supplements and ergogenic aids." *Sports Medicine* 33, no. 12 (2003): 921-939.

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How can you naturally boost your red blood cell count?

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How can you naturally boost your red blood cell count?

- Work out at low O₂ levels (I.e. in the mountains) and then race at high O₂ levels (I.e. sea level)

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EPO Test

- The adopted by WADA (World Anti-Doping Agency) urine test for EPO is based on a combination of isoelectric focusing on a gel (a semi-analytical separation of proteins according to the molecules' net electric charge), the transfer of proteins from gel to a special paper and protein detection by a double immunoblotting, not well established complicated and operator-dependent procedure to immunologically detect proteins of interest with an antibody color reaction.

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EPO test

Beullens, M., J. R. Delanghe, and M. Bollen. "False-positive detection of recombinant human erythropoietin in urine following strenuous physical exercise." *Blood* 107, no. 12 (June 2006): 4711-4713.

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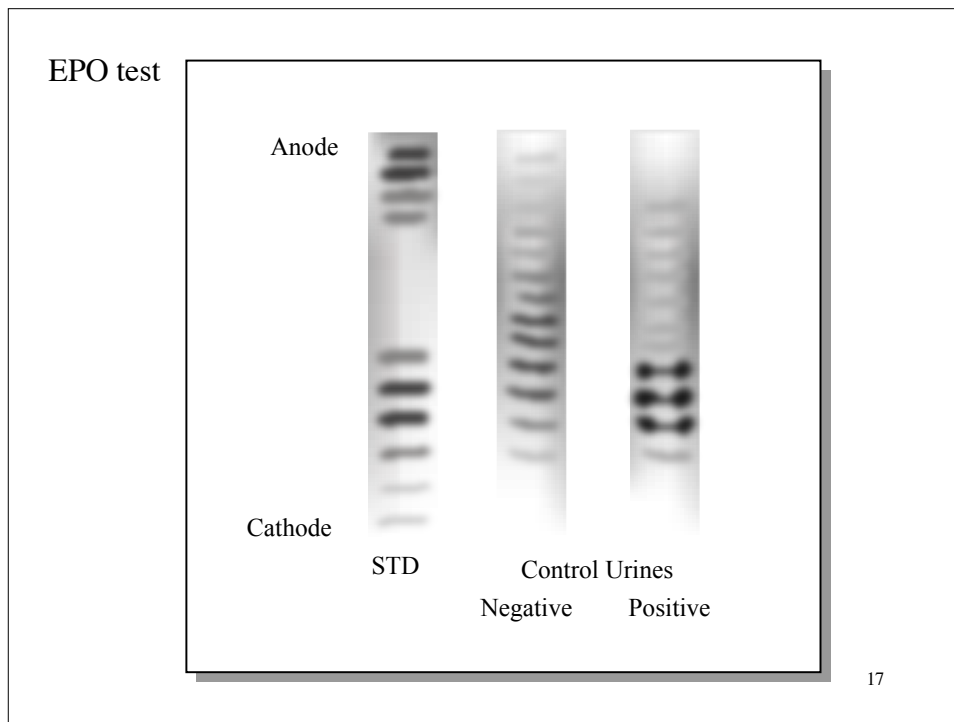


Figure by MIT OCW. Adapted from Figure 1 in Catlin, Don, Gary Green, Michael Sekera, Paul Scott, and Borislav Starcevic. "False-positive Epo test concerns unfounded." *Blood* 108, no. 5 (September 2006): 1778.

EPO tests

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Anabolic Steroids/Androstenedione

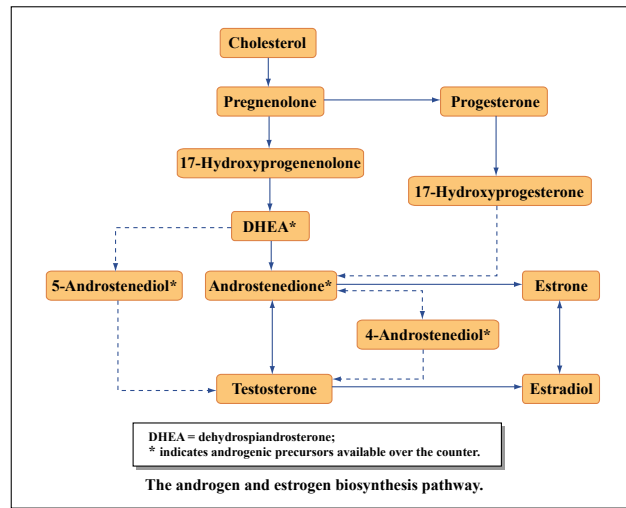


Figure by MIT OCW.

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Anabolic Steroids/Androstenedione

- Used because it increases muscle mass and strength
- Either take testosterone or one of its precursors, dehydroepiandrosterone (DHEA), androstenedione or dihydrotestosterone (DHT)

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Cycling and illegal drugs

Floyd Landis won the Tour de France in 2006

"Landis allegedly tested positive for a skewed testosterone-epitestosterone ratio following his remarkable come-from-behind performance in the 17th stage of the 2006 Tour." (VeloNews.com)

Read the entire article here:

<http://www.velonews.com/news/fea/12047.0.html>

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The test

Ritter, Steve. "The Dope On Testosterone Tests."

Chemical and Engineering News 84, no. 35 (August 2006): 43-45.

Read the entire article here:

<http://pubs.acs.org/cen/science/84/8435sci4.html>

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Baseball investigation

- How it all got started
- George Mitchell's investigation
- List of the baseball performance enhancing drugs
- List of steroid users in baseball

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Mark McGwire

- McGwire, the former Oakland A's and St. Louis Cardinals slugger, broke the single-season home run record in 1998. He and Sammy Sosa brought baseball back from the edge of obscurity after the sport had been rocked by labor strife and fan indifference. Their pursuit of Roger Maris' all-time record of 61 home runs was gripping and made for one of the best summers of baseball in history.
- Did McGwire hit 70 home runs because he was pumped up with steroids? No one knows for sure.
- "McGwire's use of a body-building drug, androstenedione, was much discussed during his record-breaking season; though legal in professional baseball, "andro" was banned by many other professional sports leagues. McGwire later stopped taking the supplement, saying he didn't want others to emulate him" (<http://www.answers.com/topic/mark-mcgwire>)

Barry Bonds

Fainaru-Wada, Mark, and Lance Williams. *Game of Shadows: Barry Bonds, BALCO, and the Steroids Scandal that Rocked Professional Sports*. New York, NY: Gotham, 2007. ISBN: 9781592402687.

Barry Bonds + steroids

"Bonds exposed: Shadows details superstar slugger's steroid use." SI.com. March 7, 2006.

Read the entire article here:

<http://sportsillustrated.cnn.com/2006/baseball/mlb/03/06/news.excerpt/index.html>

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THG-tetrahydrogestrinone

- [FDA comment](#)
- [BBC newstory](#)
- [USA times story](#)

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Tools for the athlete

- [US antidoping agency](#)
- From the website:
 - List of latest samples tested -pdf
 - List of banned substances -pdf

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Modafinil

- Let's look at the website
- NIH version
- Why do athletes take it

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Birkeland, Kåre I., and Peter Hemmersbach. "The future of doping control in athletes: issues related to blood sampling." *Sports Medicine* 28, no. 1 (1999): 25-33.

General information about cheating in life

Callahan, David. *The Cheating Culture: Why more Americans are doing wrong to get ahead*. New York, NY: Harvest Books, 2004. ISBN: 9780156030052.

- Cheating culture in sports
- Nice summary of all the drugs we talked about