Part I: Introduction

Competitive sports are very aggressive and only the best athletes attain fame and fortune. In an effort to succeed, some athletes may try to gain unfair advantages. Athletes who are on the margins of success may be tempted to boost their performance with the use of drugs and new, untested genetic therapies. Sex also plays a role in determining what a fair competition is. Males are typically bigger and stronger than females, and in some athletic competitions, males have an advantage over females.

In an effort to maintain fair competition, many sports committees define what practices are allowed or banned. Many sports ban the use of drugs and gene therapy to enhance performance, by testing athletes to ensure they do not have an unfair advantage over others. A majority of sports are also gender segregated, meaning men only compete against men and women only compete against women. Some athletes, particularly women, have been scrutinized when it is believed that they could be a male. Thus, this athlete would have an unfair advantage over the other women competitors.

How can an equal playing field be maintained? Some people suggest that genetically manipulated individuals should be banned from competing, but gene therapy is still experimental for humans. There is no conclusive test to determine if a person has manipulated their genes. Some people also suggest that males should only compete against males, but determining the boundaries of who is male and who is female can be complicated, even by using genetic information.

In this module, you will explore the ethical complications and implications of using genetic knowledge in determining fairness of an athletic competition. Genetic knowledge in athletic competitions is used to determine whether an athlete has undergone genetic manipulation or to determine the sex of an athlete. You will explore the ways that athletes can gain an unfair advantage in competition by increasing red blood cell production through blood doping and gene doping. You will also explore the practice of using genetic tests to determine the sex of athletes, which will confirm whether some athletes have an unfair advantage.
Part II: Vocabulary

1. **Androgen**: Any group of hormones that primarily influence the growth and development of the male reproductive system.

2. **Blood doping**: A practice banned in most sports, but used by some athletes to improve performance. Hormones are injected into the body to increase red blood cell production.

3. **Gender**: The roles, behaviors, and attributes that a society considers appropriate for men and women.

4. **Gene**: A DNA sequence that is transcribed to produce a functional product (proteins).

5. **Gene doping**: The practice of using genetic engineering to enhance athletic performance. It is banned by the International Olympic Committee.

6. **Gene therapy**: Adding genes to cells or altering genes in cells in the body using introduced genetic material. Not yet approved for human use.

7. **Sex**: The biological characteristics that define males and females. Males have XY sex chromosomes and females have XX sex chromosomes.
Part III: Activities

Activity 1: Enhancing athletic performance

A natural advantage

Red blood cells transport oxygen to muscle cells and remove carbon dioxide (CO₂) waste during exercise. An increased red blood cell count leads to more oxygen being transported to the muscles and less buildup of CO₂ waste, increasing athletic performance. Some athletes have an advantage because of a natural mutation in their genes that makes their body produce more red blood cells than a person without the mutation. The mutation for increased red blood cell production gives athletes an advantage over competitors, since they are able to transport more oxygen to their cells and remove CO₂ waste more effectively. Athletes with the natural gene mutation are not banned from competition.

There are three different methods that an athlete without the gene mutation could use to increase red blood cell production, including high altitude training, blood doping, and gene doping.

Three Ways to Produce more Red Blood Cells

1. High Altitude Training
2. Blood Doping (Hormone EPO Injections)
3. Gene Doping (Gene Therapy)

An environmental advantage

Athletes without the gene mutation can naturally increase red blood cell count in their body by training at high altitudes. At high altitudes, there is less oxygen in the air, therefore, the body has to work harder to provide cells with the required oxygen. To compensate, the body produces more red blood cells. Thus, an athlete could spend most of his or her training period at a higher altitude and would have the benefit of increased performance during competitions, especially at lower altitudes. For example, many of the best cycling teams practice in mountainous regions, both for the rigor of the steep terrain and also for the benefits of increasing the production of red blood cells in the body. Even the USA Olympic Team has training facilities in Denver, Colorado. Some athletes also naturally live at high altitudes. For example, some of the world’s elite marathon runners are from high altitude areas in east Africa. Athletes are not banned from training in high altitude settings.

A chemical advantage

Athletes without the gene mutation, who want to experience the increased athletic performance through increased red blood cell count, but do not want to train at high altitudes, may use hormones injections to increase the production of red blood cells in their bodies. The hormone erythropoietin (EPO) triggers red blood cell production and is often used by athletes. The practice of injecting hormones into the body to increase athletic performance is called blood doping. This practice is banned in most athletic competitions. Many sports test athletes for performance-enhancing drugs and ban competitors who test positive for the banned substances.
An altered-gene advantage

New technology has introduced a third possibility for athletes, who want to mimic the natural benefits experienced by persons with the mutation that causes their body to produce more red blood cells. The new technology is called gene therapy. In gene therapy, genes are added to human cells to genetically change a person’s DNA. Gene therapy is not approved for human use, but studies in animals make the technology very promising. The practice is so problematic to sports associations, that they have already banned gene doping, the practice of using genetic engineering to enhance athletic performance. In 2003, the International Olympic Committee officially banned gene doping. Despite the ban and lack of approval for use in humans, athletes may attempt to add the gene for increased red blood cell production to their cells. There are no tests to conclusively establish whether an athlete has altered his or her genetic makeup, but scientists expect to have a test available by the 2012 Summer Olympic Games in London.

Think about the information you just read, and discuss the following questions as a group. Write the comments of the group, as well as your thoughts in the space provided below.

1. Athletes who train at high altitudes to increase the level of red blood cells in their body are allowed entry into any competition. Not all athletes in a competition live in high altitudes, have access to high altitude environments, or can afford to train at high altitude training centers. Do you think it is fair to allow athletes, who train at high altitudes, to compete with those who cannot? Why or why not?

2. Injecting EPO creates the same effect as training at high altitudes. Do you think that injecting EPO should be banned? Why or why not?

3. Do you think that genetically enhancing athletic performance through gene doping is something the international athletic associations should allow? Why or why not?
Activity 2: The Story of Santhi Soudarajan

1. Is it fair for boys and girls to compete in the same races?

What is your first reaction to this question? Discuss with your group. Write the comments of the group, as well as your thoughts in the space provided below.

Everyone knows what a boy is, right? Anyone can tell a girl is a girl just by looking, right? Sometimes telling whether someone is a boy or a girl is more complicated. Consider the following story about an athlete named Santhi Soudarajan.

Santhi Soundarajan, who appears to be female, grew up in a small town in India. While in school, she competed in field hockey, javelin, and middle distance running. Santhi was recruited by an engineering college and soon became a collegiate women’s track star. She won the women’s 800 meter, 1,500 meter, and 3,000 meter events at a national meet in Bangladesh in 2005. Santhi also won a silver medal in the women’s 800 meter event at the Asian games two years in a row.

In 2006, after a meet in Doha, Qatar, Santhi was asked to undergo genetic testing to determine if she was male or female. The chromosome results showed that Santhi has an X and Y chromosome. This means Santhi is genetically male. Human females are female by definition because they have two X chromosomes. Human males are male by definition because they have one X chromosome and one Y chromosome. About 1 in 1000 babies is born with an “intersex” condition, meaning they have chromosomal abnormalities related to the determination of sex, like Santhi. Some babies with an intersex condition are born with ambiguous reproductive organs, but others with intersex conditions may go their entire lives unaware of any abnormalities.

Santhi’s case is complicated. Although she has an X and Y chromosome, she also has a disorder called androgen insensitivity syndrome (AIS). This means that while Santhi produces testosterone at normal male levels, her cells do not respond to the testosterone or other male hormones, therefore, she does not have the strength associated with males or physical male attributes. Even though Santhi had no advantage by having an X and a Y chromosome because of AIS, the Asian games officials stripped Santhi of the silver medal she won.

Outwardly, Santhi looks like a woman. She grew up as a woman and it was not until her chromosomes were tested that she learned she had an X and Y chromosome. After the genetic testing, and being stripped of her silver medal, Santhi never ran again. The state government of Tamil Nadu in India awarded Santhi a cash prize as a show of support after the loss of her silver medal. Santhi used the prize to start a sports academy in Pudukkottai, India, where about 68 students now attend. Santhi says, “I am living my dream through them.”

In 1999, the International Olympic Committee stopped genetic testing, since the results can be confusing and controversial, especially in cases such as Santhi’s. So how can an equal playing field be maintained? Should males only compete against males, and females only compete against females? How do you determine the boundaries of who is male or female?
Think about the information you just read, and discuss the following questions as a group. Write the comments of the group, as well as your thoughts in the space provided below.

2. Do you think Santhi is a boy or a girl? (Review the definition of gender and sex).

3. Do you think Santhi was treated fairly? Consider the loss of her silver medal, emotional trauma, and the cash prize from the government.

4. The International Olympics Committee allows persons, who have undergone a sex change surgery from male to female, to compete in women’s events in the Olympics two years after surgery. Do you think this practice is fair?

Part IV: Conclusion questions

Once the groups have discussed the responses to the scenarios, spend some time thinking about today’s lesson.

1. Write three key concepts from today’s module. Think about what you learned from the discussions. Also, consider how you feel about sex testing, gene therapy, and gene doping.

Part V: Notes
X, Y, and Athletes

Module 8