The Science of Lance Armstrong
Teacher's Guide

Grade Level: 9–12 | **Curriculum Focus:** Technology | **Lesson Duration:** Two class periods

Program Description

After winning the Tour de France seven times, Lance Armstrong made the world aware of his athletic prowess. This program explores the scientific studies of Armstrong, including his unique skills and physical suitability to the sport of bicycle racing.

Onscreen Questions

Part 1, "Training to Win" and "Smarter, Stronger, Faster: The Masterminds of Cycling"

- Why is the support of a coach or family member important to an athlete?
- How does Lance Armstrong's F-One group rely on science to combat wind drag?

Part 2, "Conquering the Tour de France"

- How does Lance Armstrong's physiology give him an advantage over his competitors?
- How did carbon fiber revolutionize the construction of bicycle frames?

Lesson Plan

Student Objectives

- Learn that science is essential in athletic training, equipment, and competition.
- Research and summarize three examples of sports science that could be used by an athlete in a specific sport.
- Explain various ways that new technologies have changed sports.
- Discover the variety of careers in the field of sports science.

Materials

- *The Science of Lance Armstrong* video
- Computer with Internet access
- Print resources about sports science

Procedures

1. After watching the video, review some of the reasons behind Lance Armstrong's success in cycling. List students' answers in a chart with four categories: Physiology, Psychology, Equipment, Training/Strategy. (An interactive overview of some of Lance's physiology and high-tech equipment can be found online at http://science.discovery.com/convergence/lance/explore/explore.html.) The chart below lists possible answers:

Physiology	Equipment	Psychology	Training/Strategy
Heart: Heart can pump more blood per minute and beat more times than the average heart, making it a third more effective than an average man's.	Wind tunnel: Used to test aerodynamics of bikes, body position helmet, and even clothing.	Determination: Hunger to win, especially after comeback from cancer.	Body position: Entire body is carefully positioned to reduce aerodynamic drag.
Body weight: He was 20 pounds lighter after cancer, but with the same strength.	Clothing: "Dimpled" texture on parts of shirt and lower back seam reduce drag.	Pain: Ability to overcome pain.	Drafting: Technique in which teammates block the wind to reduce wind drag.
Lungs: Has very high lung efficiency and aerobic capacity. (He extracts more oxygen from every breath and uses it to generate more power than the average person.) At high altitudes, doesn't lose oxygen uptake capability as fast as other riders.	Bike frame: Strong, lightweight, stiff frame made of carbon fiber.	Focus: Getting "in the zone"	Echelon: Technique of riding in a wing formation when wind is coming from the side.
Muscles: Produce less lactic acid than most; body eliminates lactic acid more efficiently.	Use computers to create virtual prototypes and test bikes in a virtual wind tunnel.	Willpower: The dedication to train long and hard, especially in difficult conditions.	Early training: Started training hard and long in his early teens as a triathlete.
	Tires (tubulars): Aged several years in a cellar so they're soft	Confidence	Intense training: Trains long and hard, often riding 450 miles

	and supple.		a week.
	Time-trial bikes: Different shapes of frame, position, handlebar, and wheels to reduce drag.	Goal setting	Altitude training: Trains and recovers at higher altitudes to increase his oxygen-carrying capacity.
	Climbing bikes: As light as possible (100 grams lighter than regular tour bike).		Domestiques, people who pick up food, water, rain jackets, things Lance needs.
	Radio: Tiny, lightweight two-way radio used by riders and coaches to communicate during races.		

2. Explain that each example reflects different aspects of sports science. As students can see in the chart, sports science can touch on many different branches of science, such as technology, engineering, physics, biology, psychology, and medicine/health. Ask students to brainstorm their own examples of sports science. For example:
    - The physics of a curveball
    - New materials in tennis rackets
    - "Fast ice" in hockey
    - Swim suits that reduce drag
    - High-altitude training to increase lung capacity
    - Mentally visualizing a win before a competition
    - New "slapskates" used in speed skating (blade unhinges from boot)
    - The best diet for competitive athletes
    - The most effective weight lifting for specific sports
3. Tell students that they will choose one sport and research three examples of sports science that an athlete in that sport might use. Some examples may be specific to the sport, while others might be applicable to any competitive sport. For example, they might look at the technology behind new equipment, the physics behind a specific strategy or skill, the physiology involved in training, or the psychology of preparing for a game. At least one example should reflect the use and impact of new technologies on the sport. Tell students that their assignment it to summarize their findings in a fictional letter as a coach giving advice to an athlete. The following Web sites provide a wealth of information about different aspects of sports science:

- Sport Science (baseball, cycling, surfing, hockey, climbing)
  http://www.exploratorium.edu/sports/
- Popular Mechanics: Sports (tennis, baseball basketball, football, golf)
  http://www.popularmechanics.com/science/sports
- Physics of Sport (covers a variety of sports)
  http://physics-of-sport.net/
- On the Ball (basketball, attention/focus, diving, sports injuries)
  http://www.pbs.org/saf/1206/
- The Science of Sport (covers a variety of sports)
  http://discoverychannel.ca/science/science_of_sport/
- Sports Science (general information, some sports-specific articles)
  http://www.sportsci.org/
- Raquet Research (tennis)
  http://www.racquetresearch.com/
- The Physics of Baseball
  http://www.npl.uiuc.edu/~a-nathan/pob/

4. When students have completed their letters, have students exchange their letters with two or three other students. What were some of the most interesting examples of sports science they encountered? What were some of the ways that new technologies have changed sports?
5. To conclude the lesson, discuss examples of careers in sports science. What degrees or training do they think would be involved in these careers? You may want to ask students to choose one career that sounds most interesting them and investigate the necessary education and training involved, as well as different job opportunities available.

Assessment

Use the following three-point rubric to evaluate students' work during this lesson.

- 3 points: Students shared several examples of the science behind Lance Armstrong's physiology, equipment, psychology, and training; provided more than one example of sports science in a different sport; clearly and accurately described three examples of sports science that could be used by an athlete in a specific sport; explained how new technologies have changed a sport; shared at least one example of a career in sports science.
- 2 points: Students shared a few examples of the science behind Lance Armstrong's physiology, equipment, psychology, and training; provided one example of sports science in a different sport; clearly described three examples of sports science that could be used by an athlete in a specific sport; explained how new technologies have changed a sport; shared one example of a career in sports science.
- 1 point: Students shared few or no examples of the science behind Lance Armstrong's physiology, equipment, psychology, and training; did not provide any examples of sports

science in a different sport; provided an unclear or inaccurate descriptions of three examples of sports science that could be used by an athlete in a specific sport; did not explain how new technologies have changed a sport; did not share any examples of a career in sports science.

Vocabulary

aerodynamic

Definition: Designed to reduce air resistance

Context: In the wind tunnel, the team attempts to tweak the cyclist's aerodynamic positions by measuring their drag.

carbon fiber

Definition: A very strong, lightweight synthetic thread made by burning acrylic fibers; used to reinforce materials such as metal

Context: The most significant revolution in bicycle construction came with the use of carbon fiber in frames and wheels, which was borrowed from the aerospace industry.

drafting

Definition: A technique in which cycling teammates block the wind, especially for the team leader

Context: When you consider that wind tunnel tests have shown that 80 percent of a rider's energy is spent cutting through the air, you can see just how crucial drafting is.

drag

Definition: A force acting on a body that slows motion

Context: Even what might seem like minor position changes, like an extended thumb or elbow or a slightly higher stance in the saddle, contribute significantly to wind drag.

lactic acid

Definition: An organic substance produced in muscle tissue as a result of the breakdown of carbohydrates

Context: At increasing levels of intensity, muscles create lactic acid, which accounts for the punishing burn associated with great levels of exertion.

physiology

Definition: The study of the internal workings and processes of living things, such as how an organism breathes, gets energy, or reproduces

Context: Lance began to pay particular attention to his own physiology, using a battery of very specific tests to improve his performance.

triathlete

Definition: Someone who competes in a triathlon, a long distance race of three events, usually swimming, biking, and running

Context: A professional at the age of 15, Lance Armstrong started as a triathlete.

Academic Standards

Mid-continent Research for Education and Learning (McREL)
McREL's Content Knowledge: A Compendium of Standards and Benchmarks for K–12 Education addresses 14 content areas. To view the standards and benchmarks, visit http://www.mcrel.org/compendium/browse.asp.

This lesson plan addresses the following national standards:

- Science—Physical Sciences: Understands the structure and properties of matter; Understands forces and motion
- Science —Life Sciences: Understands the structure and function of cells and organisms
- Science—Nature of Science: Understands the scientific enterprise
- Technology: Understands the nature of technological design

National Academy of Sciences

The National Academy of Sciences provides guidelines for teaching science in grades K–12 to promote scientific literacy. To view the standards, visit this Web site: http://books.nap.edu/html/nses/html/overview.html#content.

This lesson plan addresses the following science standards:

- Life Science
- Physical Science
- Science in Technology
- History and Nature of Science

Support Materials

Develop custom worksheets, educational puzzles, online quizzes, and more with the free teaching tools offered on the Discoveryschool.com Web site. Create and print support materials, or save them to a Custom Classroom account for future use. To learn more, visit

- http://school.discovery.com/teachingtools/teachingtools.html

DVD Content

This program is available in an interactive DVD format. The following information and activities are specific to the DVD version.

How To Use the DVD

The DVD starting screen has the following options:

Play Video—This plays the video from start to finish. There are no programmed stops, except by using a remote control. With a computer, depending on the particular software player, a pause button is included with the other video controls.

Video Index—Here the video is divided into sections indicated by video thumbnail icons; brief descriptions are noted for each one. Watching all parts in sequence is similar to watching the video from start to finish. Brief descriptions and total running times are noted for each part. To play a particular segment, press Enter on the remote for TV playback; on a computer, click once to highlight a thumbnail and read the accompanying text description and click again to start the video.

Curriculum Units—These are specially edited video segments pulled from different sections of the video (see below). These nonlinear segments align with key ideas in the unit of instruction. They include onscreen pre- and post-viewing questions, reproduced below in this Teacher's Guide. Total running times for these segments are noted. To play a particular segment, press Enter on the TV remote or click once on the Curriculum Unit title on a computer.

Standards Link—Selecting this option displays a single screen that lists the national academic standards the video addresses.

Teacher Resources—This screen gives the technical support number and Web site address.

Video Index

I. Training to Win
Elite athletes must be in top physical and mental condition. Listen to Lance Armstrong and cycling coach Charlie Walsh as they describe what it takes to be an elite cyclist.

II. Smarter, Stronger, Faster
Lance Armstrong may be the world's best cyclist, but his victories are not entirely his own. Examine the roles and functions of Lance's coaches and team members.

III. Conquering the Tour de France, I
Lance Armstrong was sidelined in his cycling career when he was diagnosed with testicular cancer. See how Lance's fight against the disease made him a stronger person and a better athlete.

IV. Conquering the Tour de France, II
Retiring after his seventh Tour de France victory, Lance Armstrong has changed the face of cycling. Discover what sets him apart from all others.

Curriculum Units

1. Armstrong's Career Beginnings
Pre-viewing question
Q: Who has been supportive to you in your life?
A: Answers will vary.

Post-viewing question
Q: What goals would you like to accomplish in your lifetime?
A: Answers will vary.

2. Coaching Elite Cyclists
Pre-viewing question
Q: What characteristics would you expect a good athlete to possess?
A: Answers will vary.

Post-viewing question
Q: What does coach Charlie Walsh look for in a cyclist?
A: Charlie Walsh looks for endurance, a good production of lactic acid in the muscles, and a high-powered temperament. An elite athlete must be able to tolerate pain and have more drive and focus than a regular person.

3. The F-One Group
Pre-viewing question
Q: Have you ever accomplished something with a group that you could not have done alone?
A: Answers will vary.

Post-viewing question
Q: How is the technology of Lance's F-One group necessary to his success?
A: Answers will vary.

4. Inside the Wind Tunnel
Pre-viewing question
Q: Describe a time you have experienced high winds.
A: Answers will vary.

Post-viewing question
Q: How would a dimpled texture on Lance's shirtsleeve affect wind drag?

A: Applying a dimpled texture to the sleeve's surface reduces aerodynamic drag, allowing greater speed. A smooth sleeve would form a low-pressure zone directly behind the arm, creating drag.

5. Working as a Team
Pre-viewing question
Q: Have you ever trained for a big event?
A: Answers will vary.

Post-viewing question
Q: What are the functions and job assignments of the members of a cycling team?
A: The main function of a cycling team is to block the wind from the leader. The riders behind the leader rest until those in front tire; they switch positions to protect the leader and share the work.
A Tour de France cycling team consists of a leader, lieutenants, and domestiques. Lieutenants to give a leader some shelter in a wind draft until the last moment, when the final race for victory begins. The domestiques provide food, water bottles, raincoats, and other supplies throughout the day.

6. Coaching Lance to Victory
Pre-viewing question
Q: What is a coach's most important function?
A: Answers will vary.

Post-viewing question
Q: What is unique about Lance's heart that makes him such a good athlete?
A: Lance's heart can pump nine gallons of blood per minute at its maximum output; an average heart pumps five. Lance's heart would beat more than 200 times a minute, making it one-third more effective than average.

7. Cancer Diagnosis
Pre-viewing question
Q: What do you know about cancer?
A: Answers will vary.

Post-viewing question
Q: How did cancer and cancer treatments affect Lance's short-term physical health?
A: Lance's disease and the treatments were debilitating and nutritionally depleting. He lost his hair and experienced muscle weakness.

8. Lance the Cancer Survivor
Pre-viewing question
Q: What motivates you to do well?
A: Answers will vary.

Post-viewing question
Q: What did Lance's experience with cancer teach him?

A: Lance says his bout with cancer was a turning point that gave him an opportunity to change his life and career for the better, including working even harder as an athlete.

9. Monitoring Metabolic Capability
Pre-viewing question
Q: What physical activities can be tiring?
A: Answers will vary.

Post-viewing question
Q: How does Lance's oxygen uptake differ from an average person's?
A: Lance's lung capacity is the same as average person's, but he can extract far more oxygen with each breath, meaning that he can breathe air twice as efficiently.

10. Physiological Advantages
Pre-viewing question
Q: What might be the most difficult aspect of competing in an event like the Tour de France?
A: Answers will vary.

Post-viewing question
Q: How does a human body respond to high altitudes?
A: Because air at high altitudes has less oxygen, the human body creates more red blood cells to increase its ability to use any available oxygen.

11. Technology and Products
Pre-viewing question
Q: What equipment do you need for a favorite activity?
A: Answers will vary.

Post-viewing question
Q: How do weight and flexibility affect a bicycle frame?
A: A lightweight frame makes a bicycle lighter and easier to haul up mountains. A stiff frame allows more pedal power to be transferred to the road.

12. The Final Tour de France
Pre-viewing question
Q: Do you have the will to compete in an arduous competition?
A: Answers will vary.

Post-viewing question
Q: How has Lance Armstrong changed the sport of cycling?
A: Answers will vary.

Credit

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