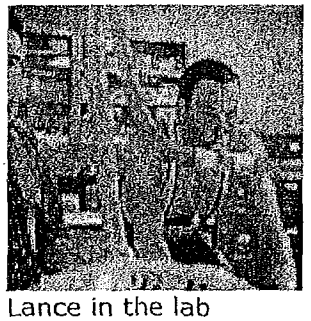
Edward F. Coyle, Ph.D.; Professor
Director, Human Performance Laboratory

Resume & Honors
Publications
Review Articles
Presentations
Graduate Students

Univ of Texas at Austin
Human Performance Lab
Environmental Lab
Sports Science/Nutrition
Dept. of Kinesiology

Courses Taught
Adv Exercise Physiology
Conditioning for Athletes
Sports Nutrition (Grad)
Lab Techniques
Sports Nutrition (UG)



Lance in the lab

Lance Armstrong's Physiological Maturation

Muscle Efficiency Helps Lance Armstrong Improve Over Years of Training

Increase of 8% in muscle power in 7 years
show benefits of long-term training;
Fat loss boosts power gain to 18%: better for Tour de France climbs

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Winning combo: high maximum capacity, efficient sub-maximal capacity

Lance Armstrong, the six-time Grand Champion of the Tour de France is now preparing for his last race. D Coyle (director of the Human Performance Lab at UT) has measured the physiological changes in Lance s he was 20 years old and in June 2005 published a scientific paper about this man, who arguably is the bes endurance athlete on the planet. This research paper focuses upon discoveries made on Lance during a 7·

year period spanning age 21 to 28 y. Both Lance and us sport scientists have learned much in the process An 8% improvement in mechanical efficiency and thus submaximal power when cycling appears to be a m factor in Lance's improvement from age 21 to 28 years. This was determined in the lab by the amount of cycling power Lance generates when consuming a given amount of oxygen. Thus, Lance's maturation as a cyclist has been marked by a steady and progressive increase in the cycling power or muscle efficiency, amounting to a remarkable 8% improvement over 7 years! This increase directly translates into power and velocity when racing. Given that only a 1-3% difference separates the winner from the middle of the pack in most Olympic finals, an 8% improvement in efficiency is astounding. The physiological factors contributing Lance's improved efficiency are the subject of further study.

An additional factor in Lance's improvement over the years is that he has learned how to reduce his body weight and body fat by 10 pounds (5 kg) prior to each of his victories in the Tour de France. Therefore, ove his power per kg of body weight has increased a 18% while climbing-up the steep mountains in France. La is indeed a phenomenon.

The fact that Lance was diagnosed with cancer and received chemotherapy at age 25 years did not seem t hurt or help his long-term progression. Furthermore, physiological evaluation performed 8 months after completing chemotherapy revealed no abnormalities after taking his reduced level of training into consideration.

Here are some of the questions and possible answers

Is Lance a 'genetic freak' ?

Lance is arguably the best endurance athlete on the planet. Dr. Coyle is often asked if Lance is a 'genetic freak' ! The implication is that Lance was born with some body part, important to cycling, that is bigger or better than almost any other person on earth. In other words, he was given a head start at birth, through genetic endowment. One might joke that he 'chose his parents well'.

Yet, Dr. Coyle does not view Lance as a 'genetic freak'. This term seems to apply to a person born with an abnormal genetic mutation that gives the individual a physical ability that few if any other individuals on ear possess. Height is important to being a basketball center and it can't be increased by physical training and thus the genetic head start is paramount.. A 10 foot tall basketball player who is coordinated might be 'freaky' ? The 7 foot 6 inch Yao Ming, who plays basketball for the Houston Rockets seems to be a genetic anomaly, due to the low probability of finding such a person the population. What probability must be achie to be considered a 'freak' ? If much of the physical advantage is developed through training and not simply endowed at birth in a persons DNA, can accomplishments still be ascribed to a freak occurrence at the ger levels ? Furthermore, genes and physical training interact. For example, the genes that allow muscle to gr to their biggest potential can be fully activated by heavy weight lifting. The individuals who develop very bi muscle do indeed have a genetic head start, but they must also train very hard. There are thousands of the people in the US alone, some who have never lifted weight and who don't look unusually buff. I don't think can be classified as genetic freaks no mote than the high school student who scores in the top 2% on the S exam.

Success in sport usually requires numerous abilities derived from more than one gene and which respond training, like the example of muscle hypertrophy. Bicycling endurance requires that a number of body parts exceptional and each of these parts are controlled by separate genes. Some examples are the size of the heart and its pumping ability, or the number of blood vessels that deliver oxygen to the leg muscles or the biochemical proteins in muscle that generate power or efficiency and resist fatigue. Furthermore all of thes body parts can increase their size and function by 30-100% with years of intense training.

What is unique about Lance's Heart and Blood Vessels and His Maximal Oxygen Uptake ?

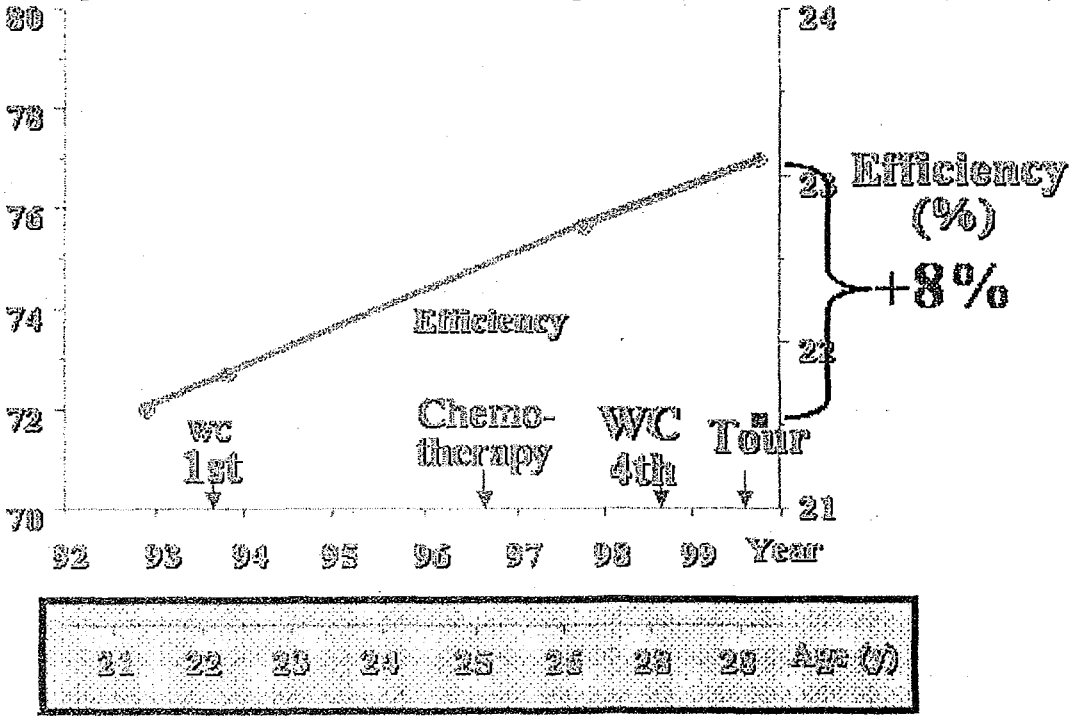
There is no doubt that Lance now possesses a big and strong heart that can beat over 200 times a minute maximum and thus pump a exceptionally large volume of blood and oxygen to his legs. There are probably

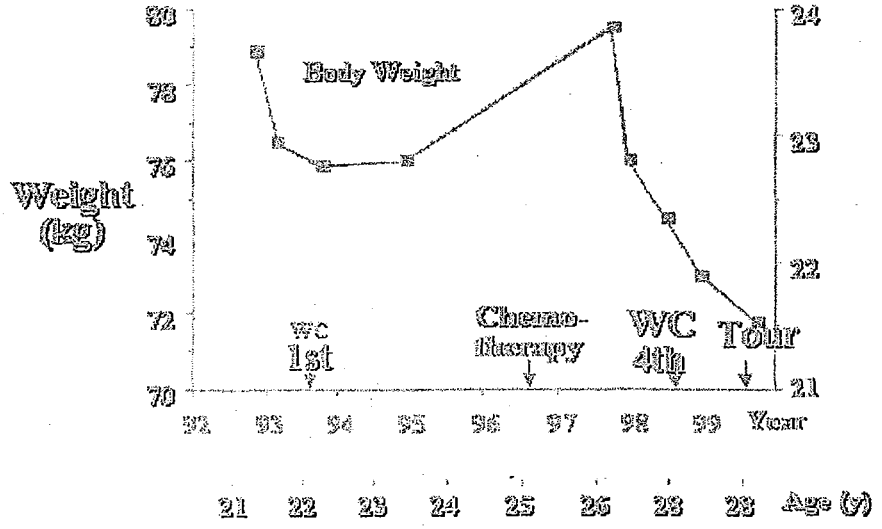
100 other men on earth who have comparable abilities while each assumedly must have performed intense endurance training for at least 3 years and are now between the ages of 18-40 y. In testing hundreds of competitive cyclists over 20 years at UT, Dr. Coyle has found two other individuals with the physiological potential of Lance. Each possessed a maximal oxygen uptake of approximately 6 liter/min or when expres per unit of body weight it is 75-85 ml/kg/min. As discussed later, also they had a high lactate threshold and good cycling efficiency. Lance's maximal heart rate of over 200 bt/min was at least 5% higher than the othe who reached typical values of 180-190 bts/min. Yet this relatively high maximal heart rate is certainly not 'freakish'. It might be freakish if a person who never performed endurance training possessed a maximal oxygen uptake above 70 ml/kg/min as this might indicate that when trained their values could be approximately 100 ml/kg/min. No human has been measured (reliably and by two sources) at above 90 ml/kg/min.

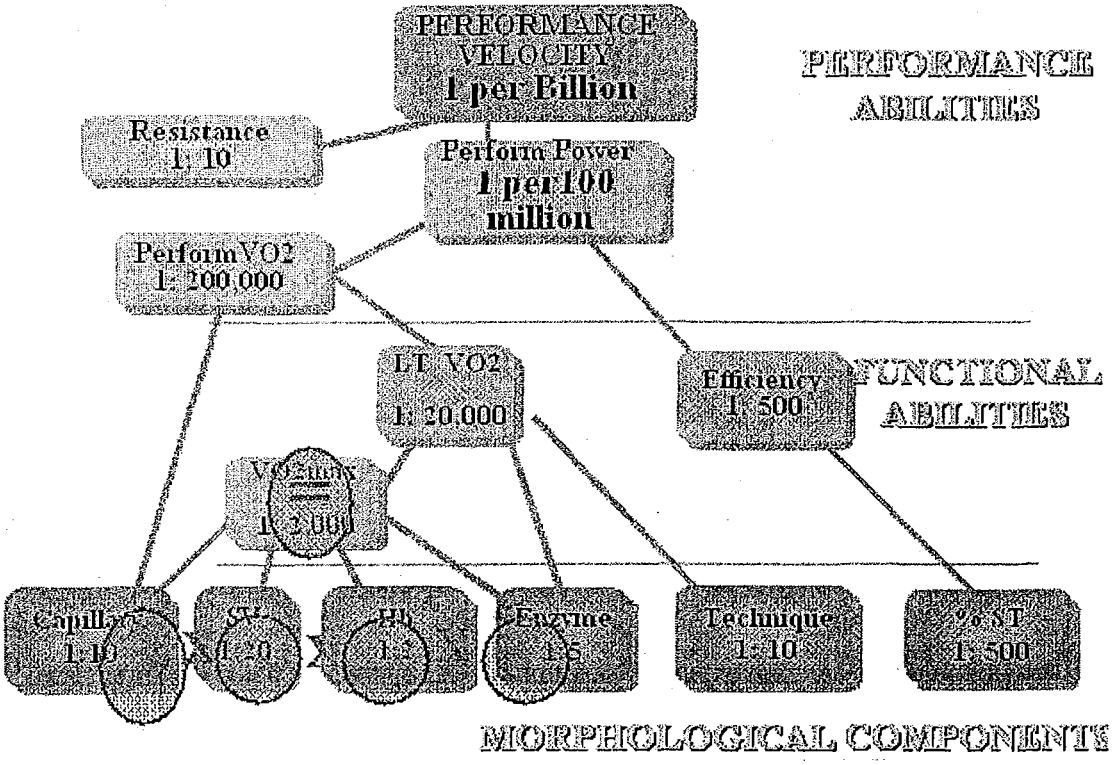
To put this in perspective, a recreationally active and lean male in college typically possesses a maximal oxygen uptake of 40-50 ml/kg/min and if they became couch potatoes for a few months, they would be 30- ml/kg/min. We estimate that if Lance were to become a couch potato, his VO2max would not decline below ml/kg/min. assuming he did not become over-weight. Furthermore, if the normal college student were to tra intensely for two or more years, his VO2max would not increase above 60 ml/kg/min. In other words, if Lan were to become sedentary, his cardiovascular fitness would remain at the highest level possible for a norm person. In other words, Lance would not have to train in order to be able to ride with a person with average genetic potential, even if this person trained as hard as possible for a few years.

However, Lance does not race in the Tour de France against people possessing average cardiovascular systems. Like him, most have probably been in the top 1% of the population regarding heart size and maxi oxygen consumption, since even before becoming athletes.

Lance also possesses is the 'drive' and 'mental toughness' needed to train very, very hard. Furthermore, h intelligent and semi-scientific in his training making sure to focus on 'specificity', especially for France in Ju




Body Weight
Weight (kg)
80
78
76
74
72
70
24
23
22
21
WC 1st
Chemo-therapy
WC 4th
Tour
92
93
94
95
96
97
98
99
Year
21
22
23
24
25
26
27
28
Age (y)


PERFORMANCE VELOCITY
1 per Billion
PERFORMANCE ABILITIES
Resistance
1: 10
Perform Power
1 per100 million
PerformVO2
1: 200,000
LT VO2
1: 20,000
Efficiency
1: 500
FUNCTIONAL ABILITIES
VO2max
1: 2,000
Capillary
1: 10
SV
1: 10
HR
1: 5
Enzyme
1: 5
Technique
1: 10
% ST
1: 500
MORPHOLOGICAL COMPONENTS