Introduction

- Who am I?
- My Background
- My Conditioning Story
Overview

- Lecture I: Conditioning Essentials
- Lecture II: Methods of Conditioning
- Lecture III: How to Write Effective Conditioning Programs
Conditioning Essentials
What is Conditioning?

- Everything comes down to ENERGY
- Every cell in the body requires constant supply of energy
- Conditioning is directly related to energy production and expenditure
Muscular Work & Cellular Function

Aerobic Processes

Anaerobic Processes

ATP

Metabolic Energy

Muscular Work & Cellular Function
Homeostasis

The maintenance of the body’s interval environment within the required physiological ranges in the face of varying internal and external stressors

...All for one specific purpose: Energy production
Energy Production

- Each sport challenges energy production in different ways

- Every adaptive response in the body is essentially about maintaining homeostasis so that energy production can be maintained in the specific environment
Components of Energy Production

- Each environment can be broken down into three different components
  - Rate of energy production
  - Duration of energy production
  - Work to rest ratio

- These variables define the unique environment the body faces
Rate of Energy Production

- Defined by how rapidly ATP is regenerated during the work period. High rate = high power output
  - Weightlifting
  - Track & Field – Jumps/Throws/Sprints
  - Powerlifting

- High Rate = Anaerobic dominant
Duration of Energy Production

- Defined by how long energy must be produced for. Duration = economy/efficient
  - Triathletes
  - Cycling
  - Marathon

- Long durations = Aerobic dominant
Work to Rest Ratio

- Defined by variance between length of work and periods
  - Higher peak power - longer rest = more anaerobic contribution
  - Shorter rest periods or longer work periods = greater aerobic contribution
Force-Fatigability

Maximum Rate of Energy Production

- Weightlifting, Powerlifting
- Track & Field – Shot, Discus, Jumps

- Short sprints, 100m, 200m, 400m

- Team Sports – Football, Rugby, Soccer, Hockey

- Combat Sports

Maximum Duration of Energy Production

- Marathon, Triathlon, Cycling
Energy Systems
Energy Systems

The graph illustrates the percent contribution of aerobic and anaerobic energy systems as a function of distance. As distance increases, the percent contribution of aerobic energy increases, while the percent contribution of anaerobic energy decreases. This indicates a shift from anaerobic to aerobic energy systems as the distance increases.
The Bottom Line

- The rate of ATP regeneration dictates the level of power output
- There is always a trade off between the amount of power generated and the ability to repeat it over time

...but why?
Substrate Power

- Mitochondrial fat
- Mitochondrial CHO
- Glycolytic
- Phosphagen

ATP turnover rate (mmol/kg/s)
Anaerobic Power Reserve

- Anaerobic speed reserve
- Aerobic speed range

Speed (m·s⁻¹)

Subject

Anaerobic Power Reserve

- Max power out in 6s or 3s sprint - Anaerobic
- Max power at VO2 - Aerobic
- Able to predict rate of performance decline – remained constant based on fractional energy contribution
- APR inversely proportional to fatigability in repeat sprint performances
Anaerobic Power Reserve

“...These results suggest that the performance of the musculoskeletal system may undergo duration-dependent performance decrements dictated by the relative reliance on anaerobic metabolism to provide mechanical function”

“The main finding was that subjects with higher anaerobic power reserves, implying a greater reliance on anaerobic processes to supply energy, recorded larger power decrements across the ten sprints.”
Anaerobic Power Reserve

600 watts

Athlete A

Athlete B
What is Fatigue?

- Fatigue is a decrease in muscular work and power output despite maximal voluntary efforts to maintain it.

- ...but what causes it?

- ...why is directly related to anaerobic contributions?
Causes of Fatigue

Who the hell knows

A few things we do know...

- Not caused by “lactic acid”
- Usually has both central and peripheral factors
- Is a protective to maintain homeostasis
- Is multifactorial depending on activity
- Muscles never run out of ATP – fibers can get low
Potential Causes of Fatigue

- Increase in inorganic phosphate
- Changes in Ca2+ handling
- Muscle temperature
- pH – overstated
- Substrate availability
- ROS production
- Central factors
Potential Causes of Fatigue

Fatigue results from a change in the cellular environment – i.e. homeostasis is challenged.

- The larger the change, the greater the amount of fatigue.

- AN energy production = faster ATP turnover = greater cellular change = more fatigue.
Fatigue & Conditioning

- Conditioning is a **measure of maximum sustainable power output** over a given duration – i.e. how much power can you generate without fatiguing?

- Can be evaluated based on constant or repetitive power output based sports
Cyclical Sports

- Constant power output across duration with little to moderate variation
Acyclic Sports (RSA)

- Constant variation of high power output and lower power or rest

Power Output

Maximum Repeatable Power
Conditioning correlates inversely to the anaerobic power reserve

Performance comes down to both conditioning and energy expenditure

The athlete with the highest level of conditioning does not always maintain power output the longest
Fatigue & Conditioning

Power Output

Athlete A

Athlete B

Duration
Improving Conditioning

- Increase % of power output coming from aerobic side
- Become more efficient in energy expenditure – technique
- Have a better strategy – i.e. pacing
- Nutritional considerations
Improving Conditioning

Cardiovascular Adapations

- ↑LV chamber size
- ↑Ventricular Compliance
- ↑LV wall thickness
- ↑Venous Return
- ↑RBC Mass
- ↑PV
- ↑Myocardial Contractility?
- ↓TPR

- ↑Mito #
- ↑# Capillaries
- ↑Oxidative enzymes
- ↑[Mb]?
- Fibre Type Transition
- ↑Q/VO₂ matching

Skeletal Muscle Adapations

Increased Blood Flow, O₂ delivery and Extraction
Energy System Papers


Energy System Papers

