Anaerobic Testing Methods
Methods of Anaerobic Measurement Overview

- Review of energy systems
- Anaerobic fitness classifications
  - Lactate
- Maximal accumulated oxygen deficit
  - Critical Power
  - Gross efficiency
- Anaerobic Power Testing Methods
Anaerobic Testing Methods

- Anaerobic Energy Systems
- Anaerobic Power Testing
Energy System Contribution

Anaerobic components

- Phosphagen
- Glycolytic
- Oxidative
Phosphagen System Review

- Immediate energy system
- Also called ATP-PCr system
- ~ 10 seconds
- Rephosphorylation of ADP by PCr
Glycolysis Review

- Breakdown of stored glucose to produce ATP

- Provides energy for short, high intensity bursts
  - Lasts from seconds to minutes
Anaerobic Energy System

Phosphagen + Glycolytic

Anaerobic Energy System
Quiz!

- What two energy systems comprise the anaerobic energy system?
- How long during intense exercise is the phosphagen system the greatest ATP contributor?
- What is another name for this energy system?
- How long during intense exercise is glycolysis the greatest ATP contributor?
How Anaerobic Fitness is Classified

Anaerobic Fitness Class

Intensity

Duration

ATP contribution
Anaerobic Fitness Classifications

- Strength/Power
- Power-endurance
- Mixed-endurance
Strength/Power Fitness

Short duration! (< 15 seconds)
- Phosphogenic – primary ATP producer
- Glycolytic – moderate
- Oxidative – minor

Power depends on:
- Storage capacity of CrP and ATP
- Rate of CrP and ATP use and re-synthesis
- Partially dependent on glycogen stores
Strength/Power Fitness Examples

1. Run - U. Bolt

2. Sports with explosive movement
Power-endurance

Duration: 15-60 seconds

Energy system contribution depends on duration:

• 15-30 sec
  • Phosphogenic and glycolytic – major
  • Oxidative – minor

• 30-60 sec
  • Glycolytic – major
  • Oxidative – minor
  • Phosphagen – minor

Power dependent on:

• Glycogen energy stores
• ATP/CrP use/re-synthesis
Power-Endurance Fitness

Most of the same sports as strength-power

800m Run U. Bolt 19 sec

300m Run U. Bolt 31 sec
Mixed-endurance

Duration: 1 – 2 minutes
Equal ATP contributions from glycolytic and oxidative pathways

- Relative contribution of each depends on intensity

Rudisha of Kenya
800m 1:41
Quiz!

What 3 factors determine anaerobic fitness type?
What is the dominant energy system and duration for each type of anaerobic fitness?
Give an example of an activity for each anaerobic fitness type.
Anaerobic Measurements

Anaerobic power: peak rate of ATP produced via anaerobic metabolism

Anaerobic capacity: maximal amount of ATP that can be generated through anaerobic metabolism
Methods used to evaluate energy release

**Aerobic Measurements:**

- Direct relationship between VO$_2$ and aerobic production of ATP
- *Indirect calorimetry* provides basis for aerobic energy measurements

**Anaerobic Measurements:**

- *No universally accepted method* to directly measure anaerobic energy production exists
How do we measure anaerobic capacity?

Most commonly used methods of measuring **anaerobic capacity**:

- Lactate
- Maximal accumulated oxygen deficit
- Critical Power
- Gross Efficiency
Quiz!

• Define anaerobic power and anaerobic capacity.
• What are the most commonly used methods to measure anaerobic capacity?
Origins of Lactate Measurements

Irzelius (1841)
First researcher to suggest measuring anaerobic energy

Hald (1932)
Alactacid or “lactacid anaerobic energy output” coined

Alactacid energy from splitting of ATP and creatine phosphate stored in muscle

Quantified via lactate formation in the blood

At the time known as “lactic acid”
Where do we get the term lactic acid?

• 1780 lactic acid is discovered in sour milk
• 1810 lactic acid is confirmed in organic tissue
  • Fermented ox meat and blood “not human”
• At the time, no way to measure proton dissociation
Lactate vs Lactic Acid
Pyruvate vs Lactate vs Lactic Acid

Lactate accepts H+ ions

Lactic acid dissociates H+ ions (strong acid – pH 3.67)
  • Muscle cell pH ranges from 6.1-7.05

NO lactic acid in the human body!!

Pyruvate

Lactate

Lactic Acid
Quiz!

• Why is it incorrect to use lactic acid and lactate interchangeably?
• Will you ever say we produce lactic acid again?
How is lactate measured?

Blood  OR  Muscle
Muscle biopsy is developed!

1937 Sacks and Sacks

- Blood lactate formation is not a direct measure of muscle lactate
- Developed the needle biopsy technique
- Now possible to measure muscle metabolites (lactate, ATP, CrP, pyruvate)
Are muscle biopsies the best method?

Limitations of muscle biopsy:

- Invasive
- Difficult to determine whole body response
- Blood lactate release not measured
Limitations of lactate measurements

Blood and muscle lactate are not always the same
Gives indication of extent of glycolysis
  • Phosphagen system?
Lactate measured in the blood peaks at varying times following exercise
Lactate in muscle declines rapidly
Quiz!

• Where do we typically measure lactate?
• What are the limitations to doing a muscle biopsy to measure lactate?
• What are some limitations of using lactate as a determinant of anaerobic capacity?