Unpacking Interval Training

Lisa A. Workman

Sunday, September 24, 2017

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Overview

* History
* Exercise Physiology 101
* The Three Energy Systems
* Training Continuum
* Types of Intervals
* Benefits

History

Joe Binks
(1902)

History

Joe Binks
(1902)

F - 1x/wk

I - 'top speed' with rest in between

T - 30 minutes

T - Running

5-6 110-yard intervals

'Fast' 200-300 yard

Hannes Kolehmainen (1912) History

Hannes Kolehmainen (1912)

History

5-10 repetitions, 1000m or 3min 5sec, 19km/hr or 11.78mph

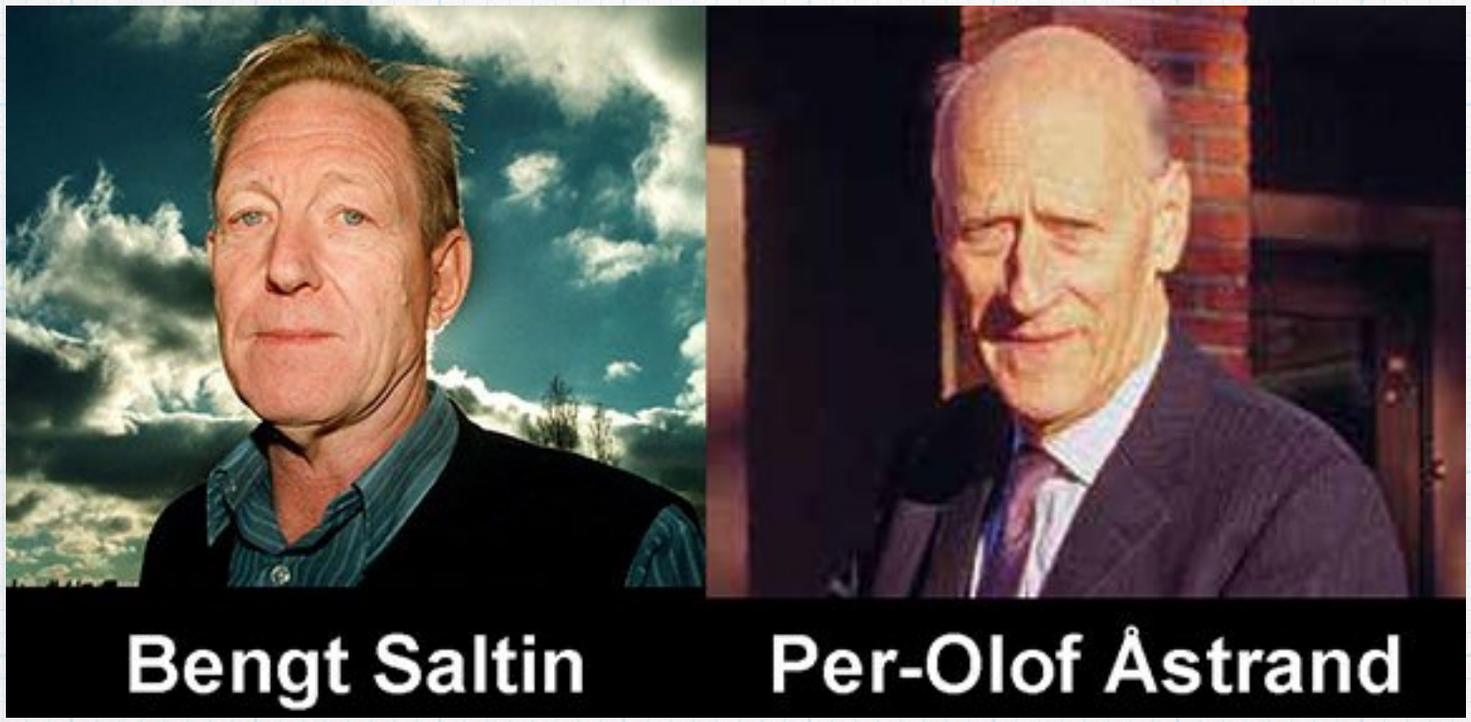
Recovery and frequency not known

History

Gosta Holmer
(1937)

* Fartlek - periods of fast running intermixed with periods of slower running
* Unstructured

History



(1960s)

* Introduced intervals as % of VO_{2max} and % speed of VO_{2max}
* 30min, 15sec runs, 15sec rest

Dr. Izumi Tabata (1996)

History

* Tabata - identified the health benefits of exhaustive 20 seconds work, 10 seconds recovery workout plan

Building Blocks

Benefits

Types of Intervals

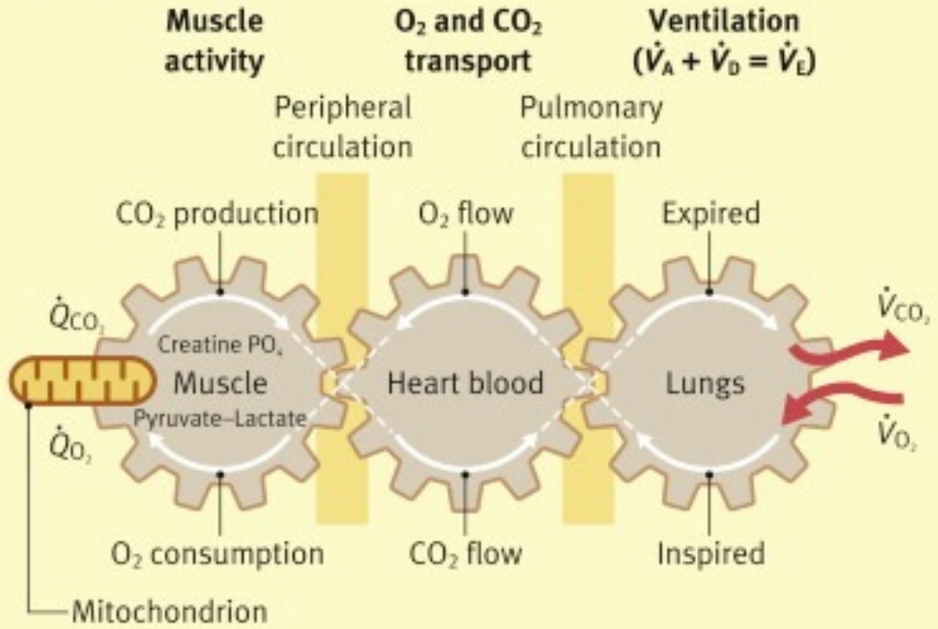
Training Continuum

Energy Systems

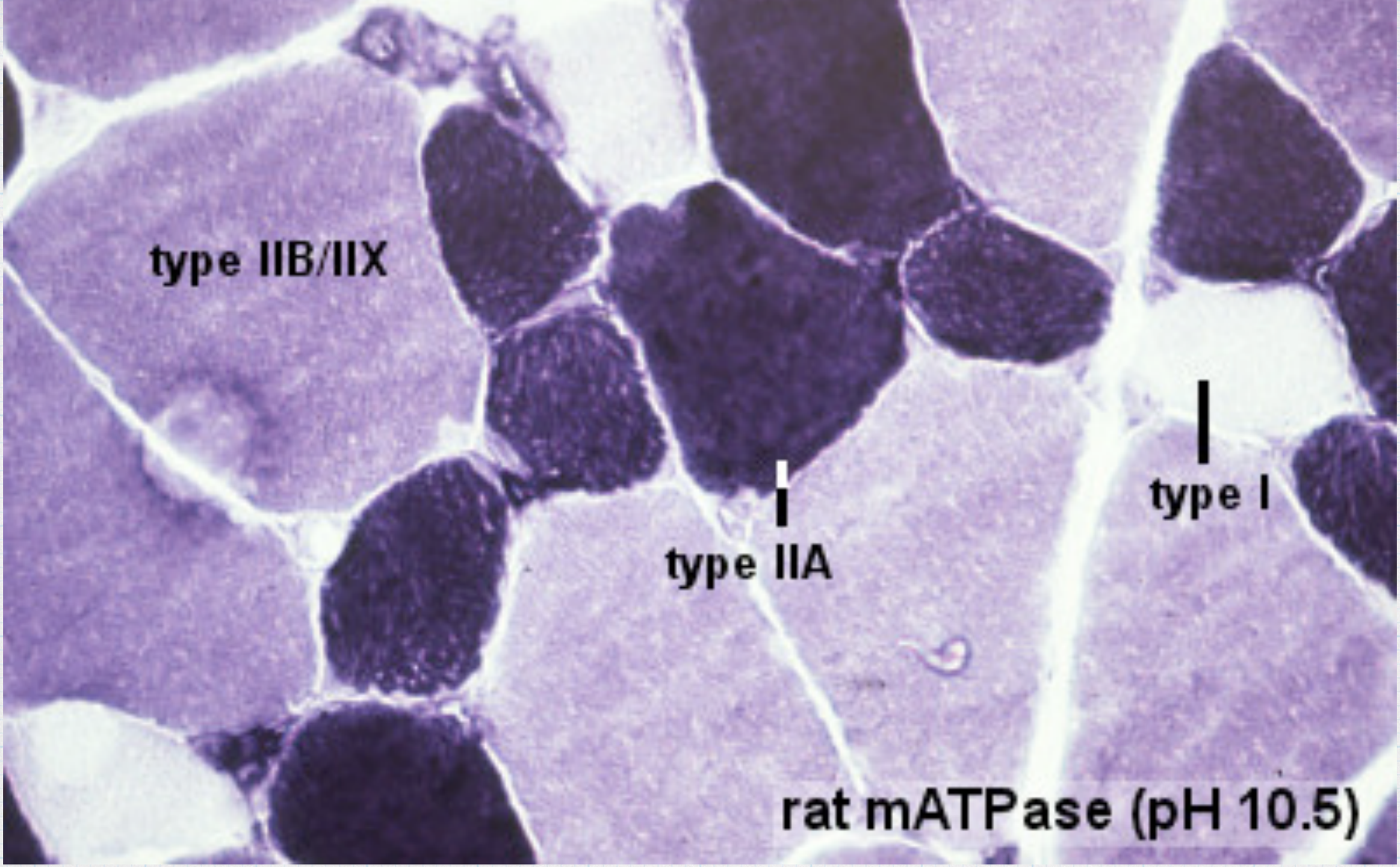
Exercise Physiology

Exercise Physiology 101

The interaction among the pulmonary, cardiovascular and skeletal muscle systems during exercise



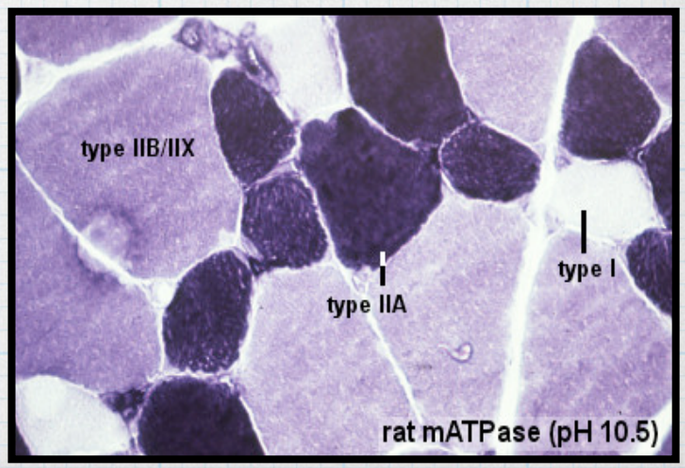
V_A, ideal alveolar ventilation/time; V_D, physiologic dead space ventilation/time; V_t, total ventilation during expiration/time; Q_{O_2}, O_2 consumption; Q_{CO_2}, CO_2 production; V_{O_2}, O_2 uptake; V_{CO_2}, CO_2 output; creatine PO_4, creatine phosphate. Courtesy of Wasserman



Muscle: The First Cog in the System

Muscle: The First Cog in the System

* Three types of muscle fibres:
    * Slow Twitch (Type I) Muscle Fibres
    * Fast Twitch (Type IIa) Muscle Fibres
    * Fast Twitch (Type IIb) Muscle Fibres
    * Others?

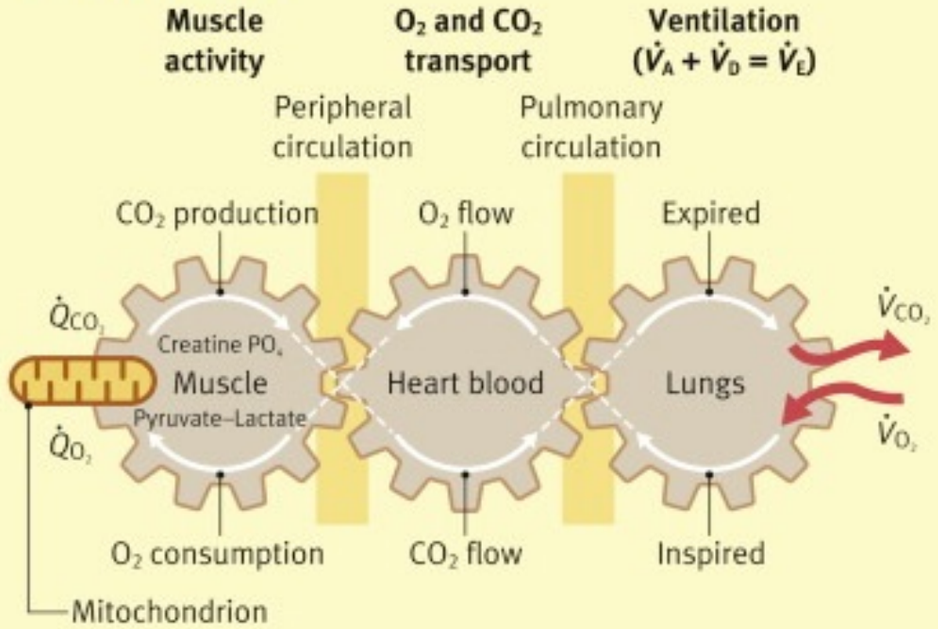


Characteristics of the Three Muscle Types

	Slow Twitch	Fast Twitch	Fast Twitch
Contraction Time	Slow	Fast	Very Fast
Size of Motor Neuron	Small	Large	Very Large
Resistance to Fatigue	High	Intermediate	Low
Activity	Aerobic	Long-term Anaerobic	Short-term Anaerobic
Force Production	Low	High	Very High
Mitochondrial Density	High	High	Low
Capillary Density	High	Intermediate	Low
Oxidative Capacity	High	High	Low
Glycolytic Capacity	Low	High	High
Major Storage Fuel	Triglycerides	Creatine Phosphate, Glycogen	Creatine Phosphate, Glycogen

Exercise Physiology 101

The interaction among the pulmonary, cardiovascular and skeletal muscle systems during exercise



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Heart: The Second Cog in the System

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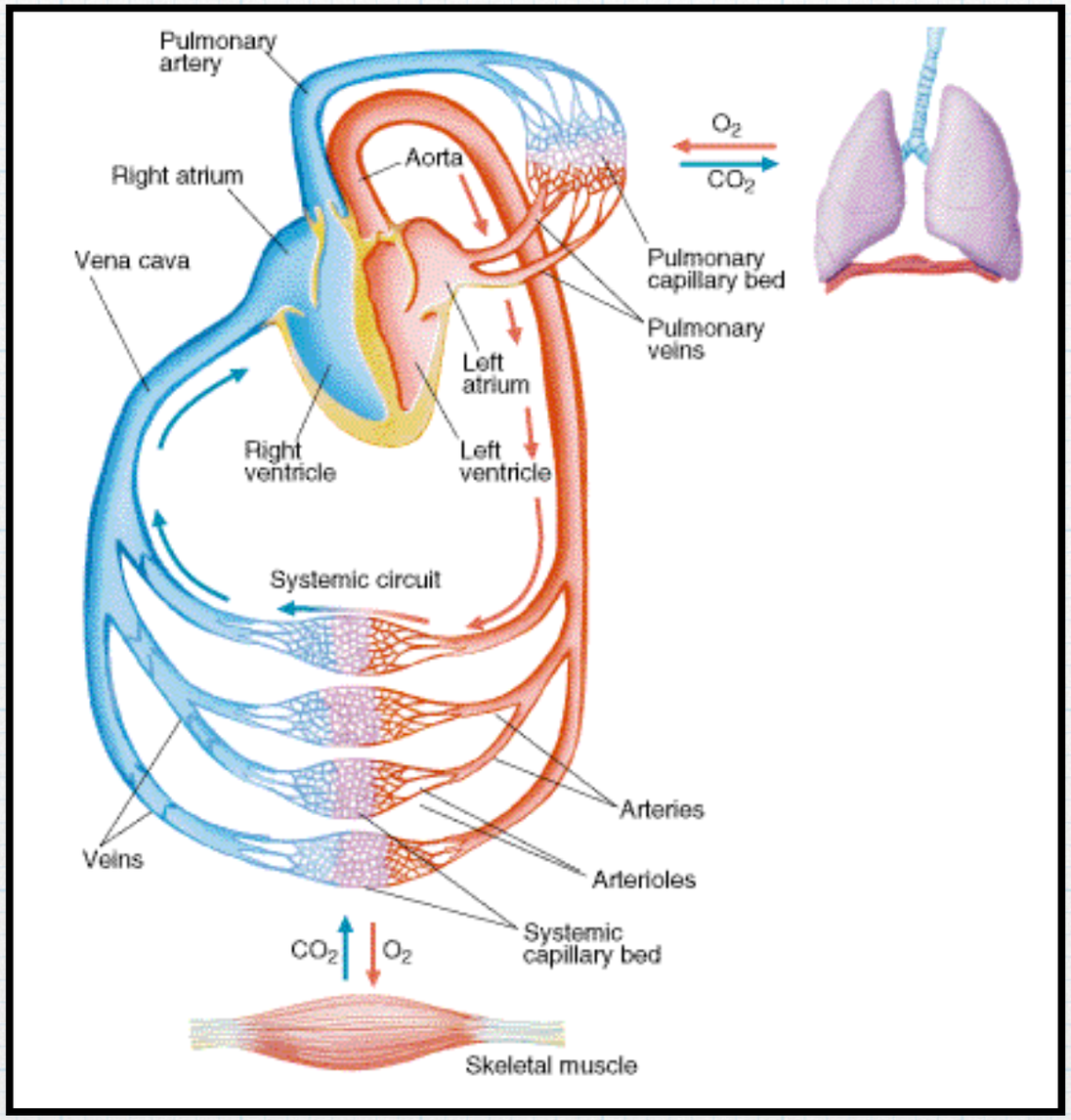
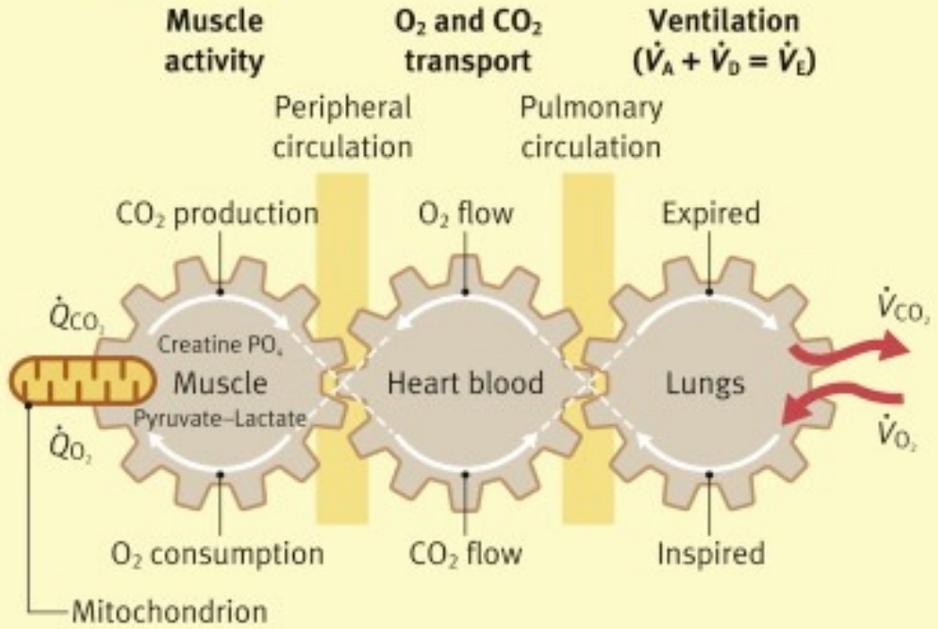


Exercise Physiology 101

The interaction among the pulmonary, cardiovascular and skeletal muscle systems during exercise



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Lungs: The Third Cog in the System

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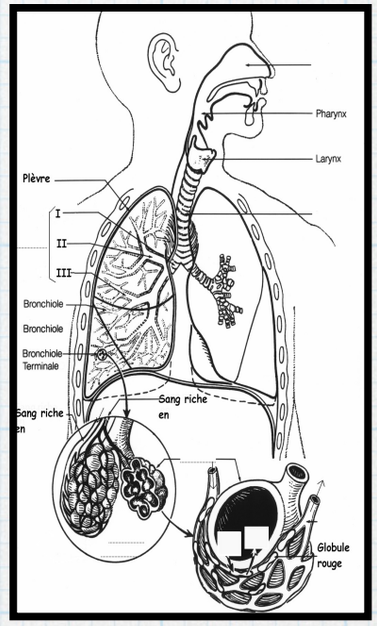
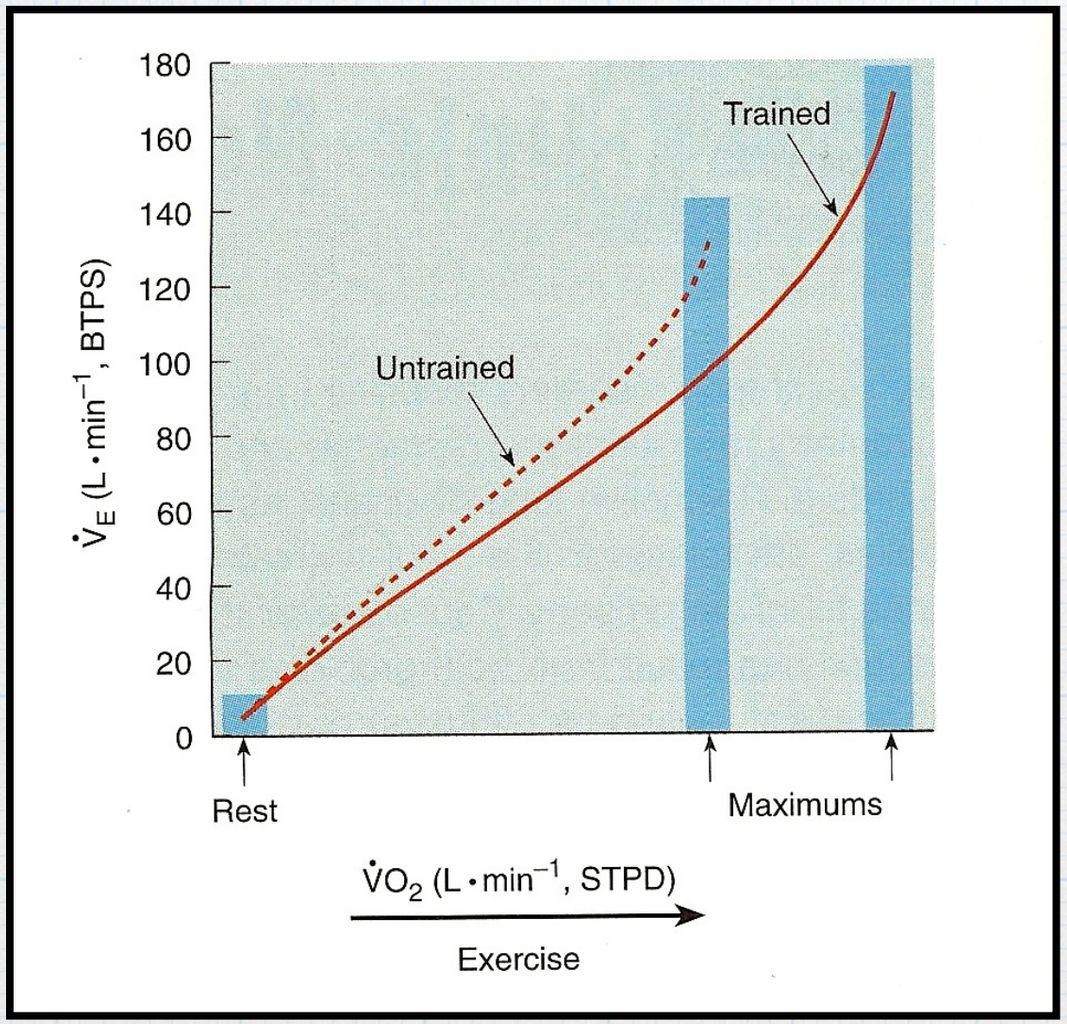
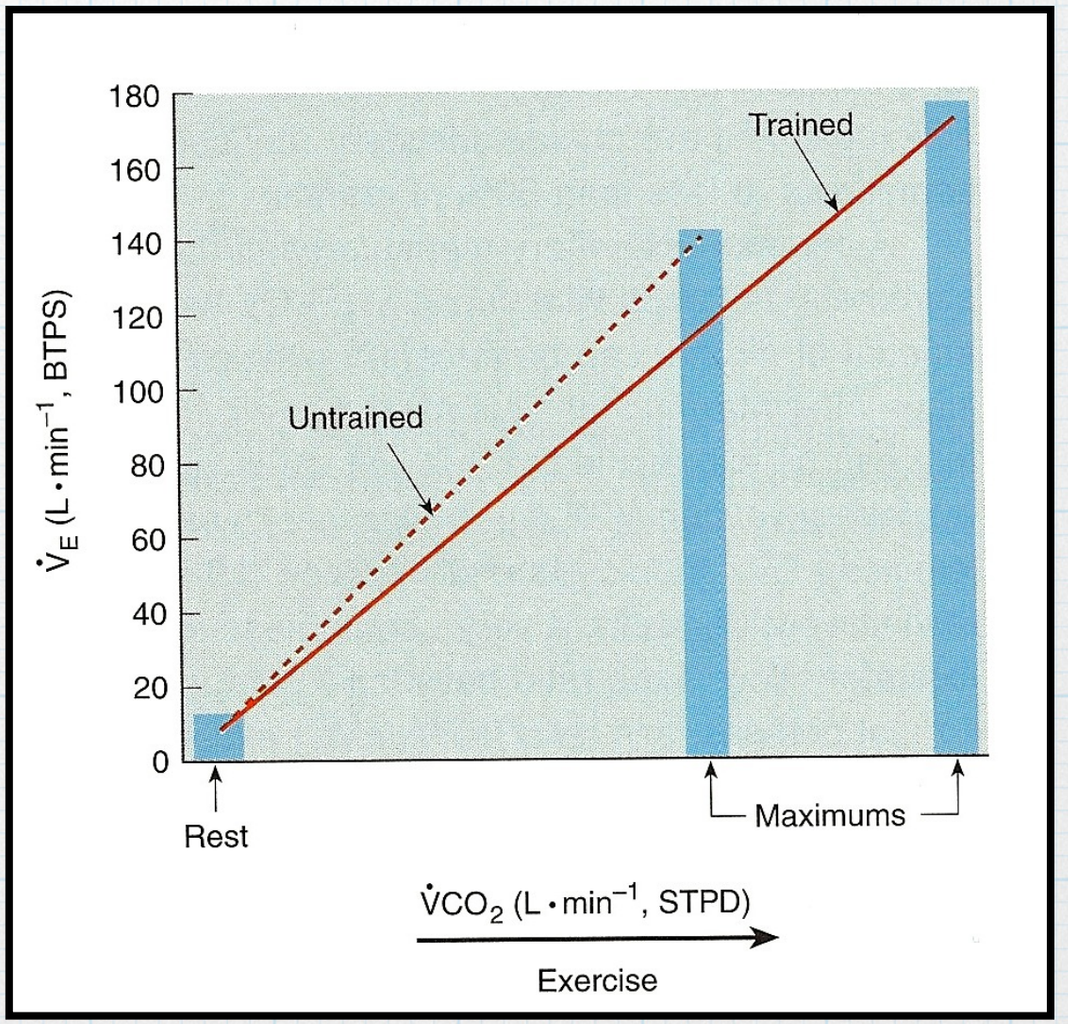


* Ventilation (V_E)
  * the amount of air we expire in one minute
* VO_2
  * the volume of oxygen consumed in one minute
* VCO_2
  * the volume of carbon dioxide produced in one minute

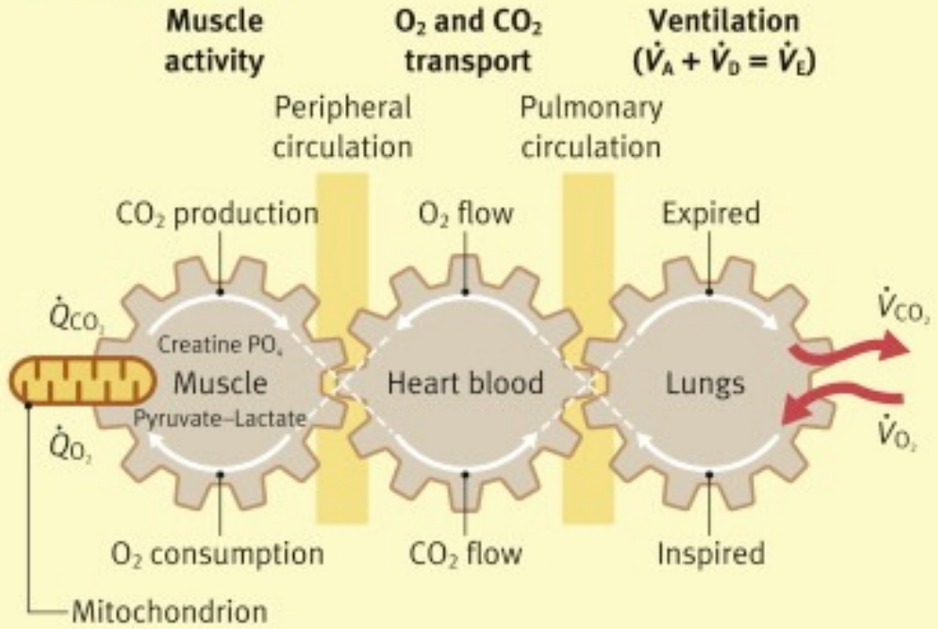
Lungs: The Third Cog in the System





Exercise Physiology 101

The interaction among the pulmonary, cardiovascular and skeletal muscle systems during exercise



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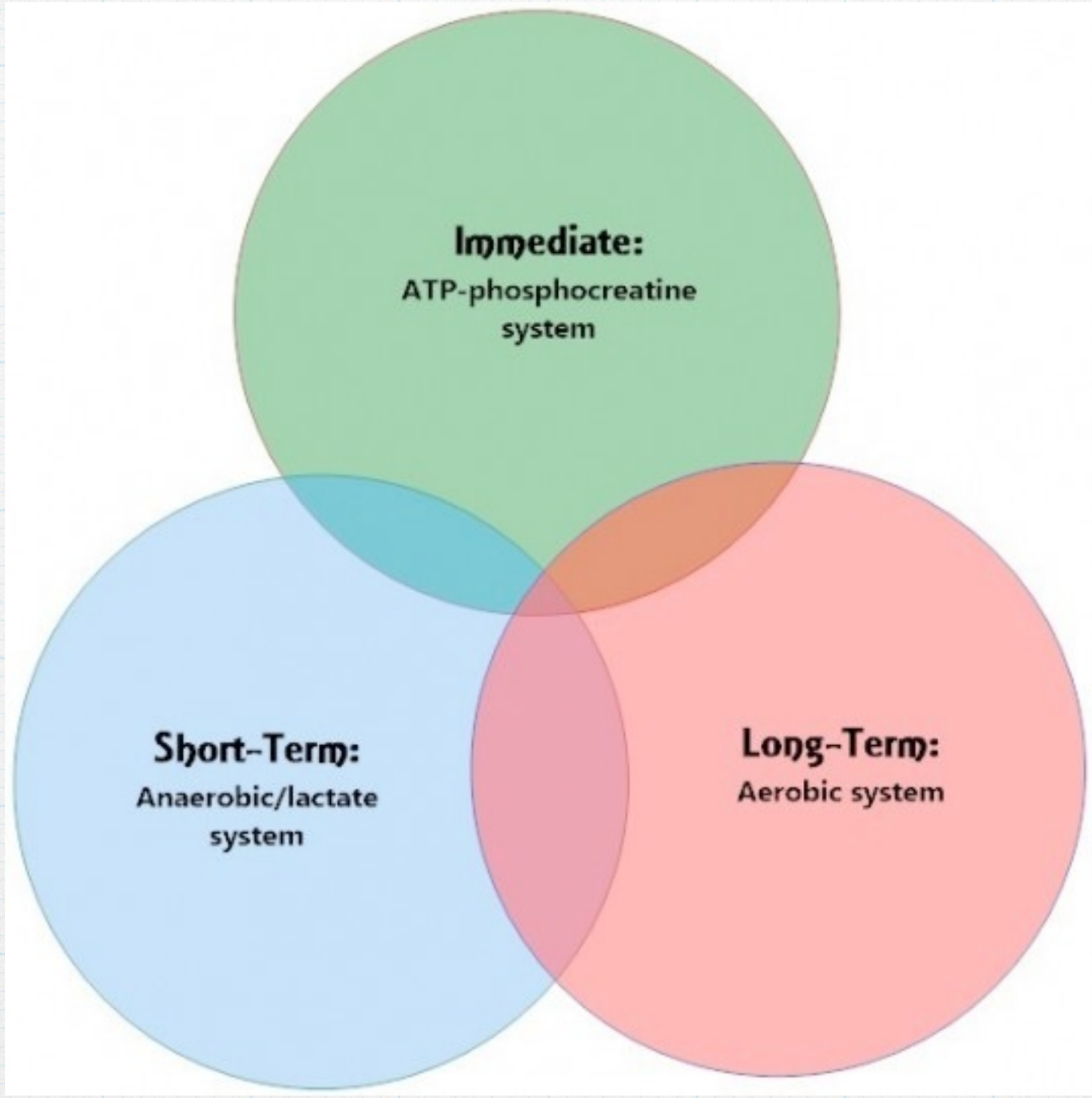
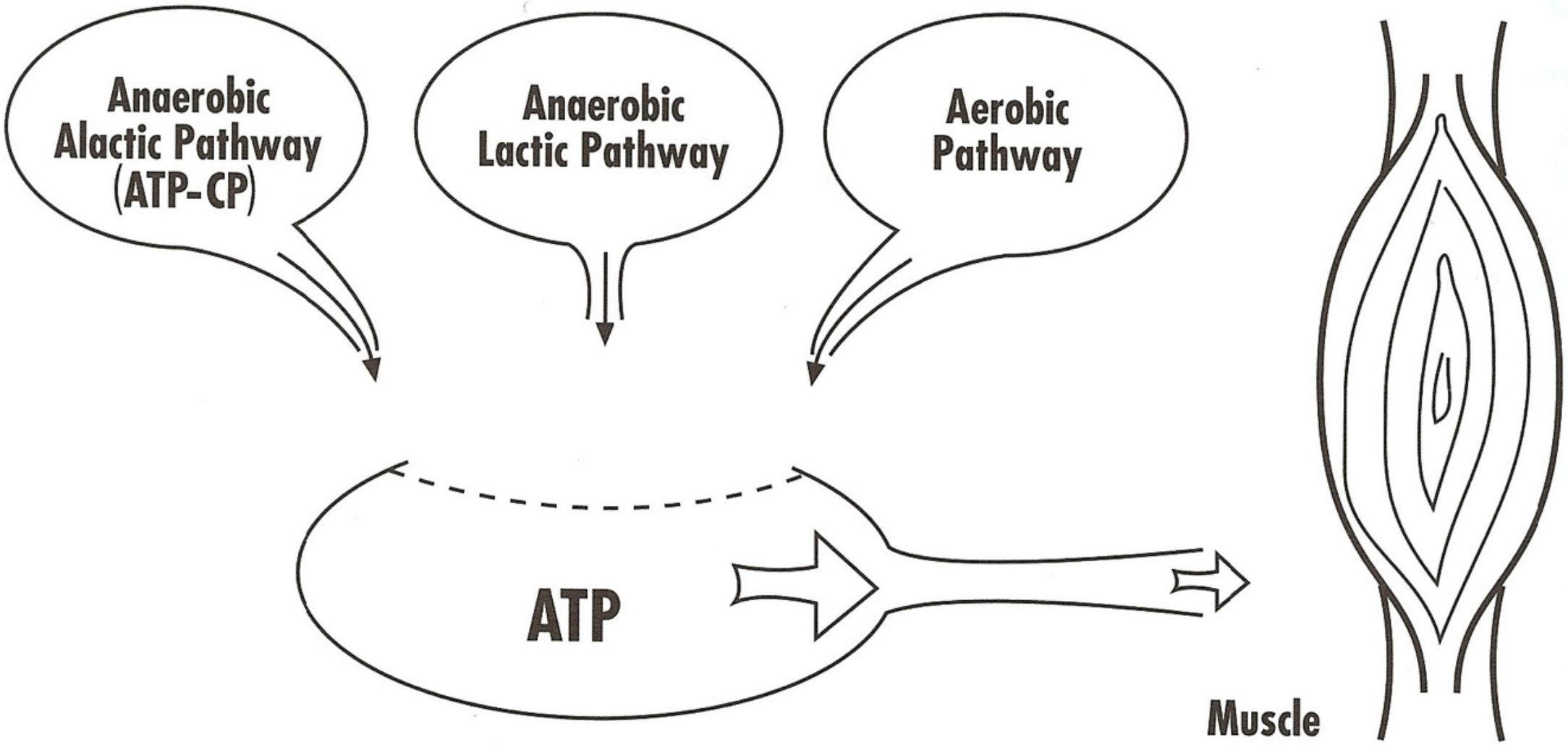


Energy Systems: The Cogs Working Together as a Team

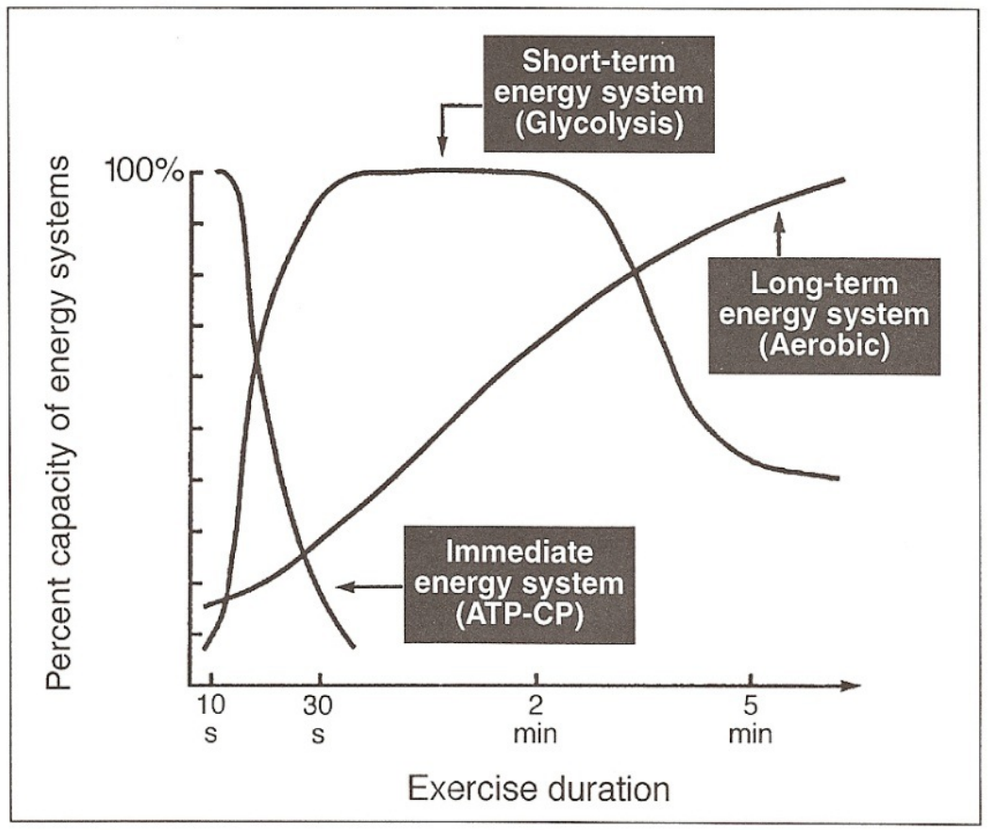
The Three Energy Systems

Figure 10-1: Sources of production of ATP for muscle contraction



The Three Energy Systems

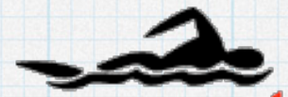
Figure 3-1: The three systems of energy transfer and their percentage contribution to total energy output during all-out exercise of different durations.



Reference: McArdle, Katch and Katch. (1996). Exercise Physiology. Energy, Nutrition and Human Performance. Williams & Wilkins, Maryland. p. 190.

Phosphagen system

Sprinter — **8-10 seconds** (100 m)



Glycogen-lactic acid system

Swimmer — **1.3–1.6 minutes** (400 m)

Aerobic respiration

Marathon runner — **Unlimited time** (15 Km)

System	Rate of ATP Production	Energy Source	Capacity of System	Major Limitation	Major Use
Anaerobic Alactic Pathway (ATP-CP)	Very rapid rate	stored creatine phosphate (CP), stored ATP in the muscle	Very limited ATP production	Very limited supply of CP	Very high intensity, short duration sprint activities. During high intensity activities of 1-10 seconds.
Anaerobic Lactic Pathway	Rapid rate	Blood glucose, glycogen	Limited ATP production	Lactic acid by product causes rapid fatigue	High intensity, short duration activities. During high intensity activities of 1-3 minutes
Aerobic System	Slow rate	Blood glucose, glycogen, fatty acids	Unlimited ATP production	Relatively slow rate of oxygen delivery to cells	Moderate intensity, longer duration. During moderate to high intensity activities longer than 3 minutes. Fatty acid oxidation dominates after ~20 minutes of exercise.

Unpacking Interval Training

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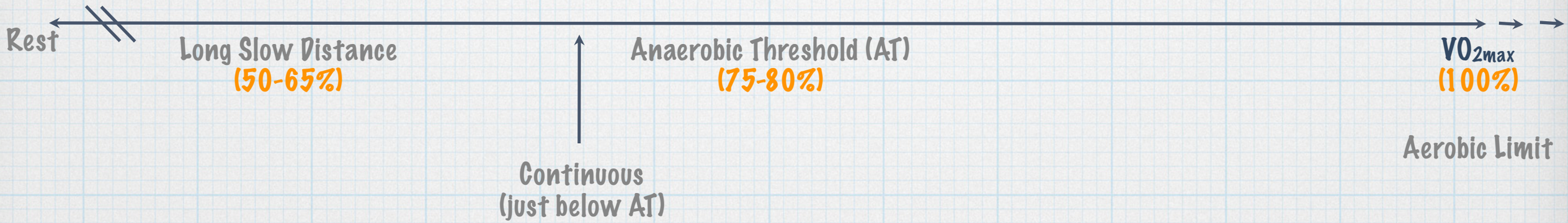
Sunday, September 24, 2017

Training Continuum

Training Continuum



Terms

* Long Slow Distance (LSD)
* Anaerobic/Lactic Threshold
    * exercise intensity at which lactic acid starts to accumulate in the blood stream and CO_2 production begins to increase non-linearly
    * lactate removal fails to keep up with the rate of lactate production causing increased in CO_2 production
* VO_{2max}
    * the maximum volume of oxygen consumed in one minute

Training Continuum

Rest

Long Slow Distance
(50-65%)

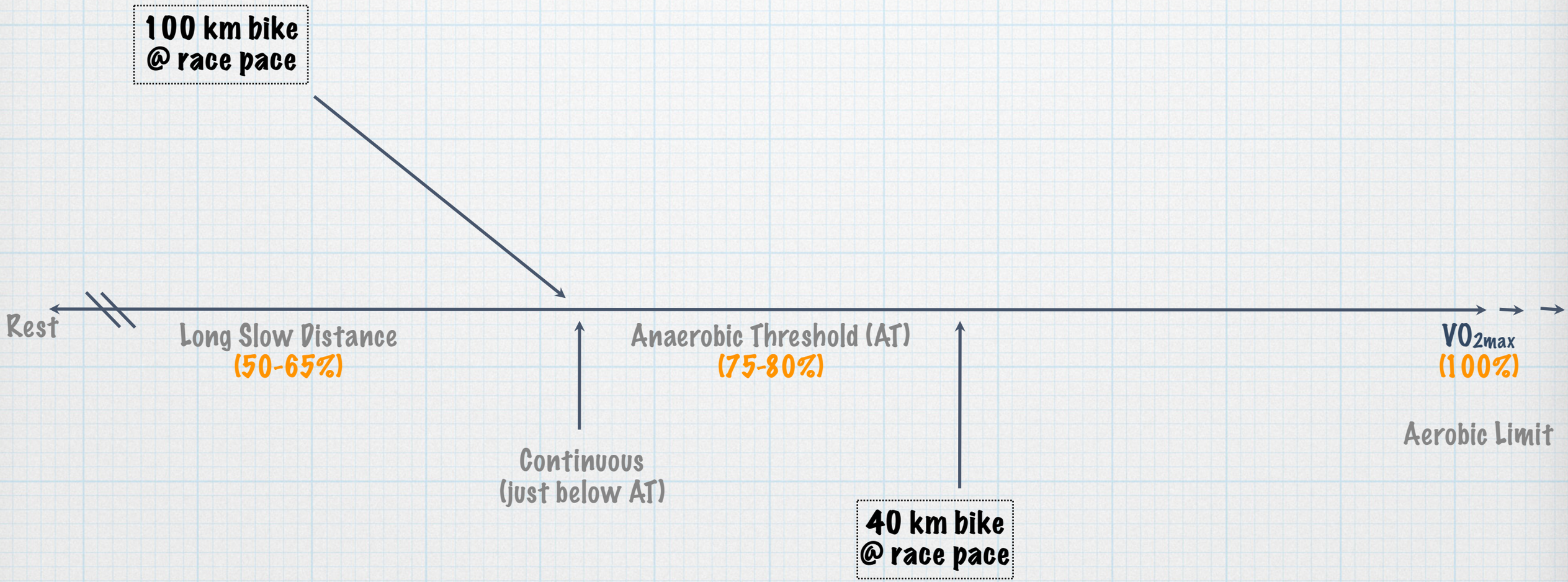
Anaerobic Threshold (AT)
(75-80%)

Aerobic Limit
VO_{2max}
(100%)

Aerobic Energy System ⟷ **Anaerobic Lactic Energy System**

Anaerobic Alactic Energy System

Training Continuum



Training Continuum

100 km bike
@ race pace

Rest

Long Slow Distance
(50-65%)

Continuous
(just below AT)

Anaerobic Threshold (AT)
(75-80%)

40 km bike
@ race pace

VO_{2max}
(100%)

Aerobic Limit

Aerobic Intervals
Work: below race pace
(training pace)
Rest: short

Aerobic System: LongTerm

* Aerobic Intervals
    * Aerobic energy system
    * Blood Glucose, Glycogen, Fatty Acids
    * 1:1 Work-to-Rest Ratio
    * 1:0.5 Work-to-Rest Ratio
    * *Example:* 3 min flat time trial with 1.5 min spin-out recovery

Training Continuum

100 km bike @ race pace

Aerobic-Anaerobic
Work: race pace
Rest: variable

Rest

Long Slow Distance
(50-65%)

Continuous
(just below AT)

Anaerobic Threshold (AT)
(75-80%)

40 km bike @ race pace

VO_{2max}
(100%)

Aerobic Limit

Aerobic + Anaerobic Systems

* Combination of Aerobic and Anaerobic Capacity/Lactic Systems
    * Moving from aerobic to anaerobic back to aerobic
    * 1:2 Work-to-Rest Ratio
    * *Example:* 1 minute time trial with 30s sprint; return back to time trial with each sprint interval

Training Continuum

Fartlek
Work: variable
Rest: variable

100 km bike
@ race pace

Rest

Long Slow Distance
(50-65%)

Continuous
(just below AT)

Anaerobic Threshold (AT)
(75-80%)

40 km bike
@ race pace

VO_{2max}
(100%)

Aerobic Limit

Fartlek

* Combination of the three energy systems
    * Alternating and variable speed and durations
    * No prescriptive Work to Rest Ratio
    * *Example:* Lamp post runs (increase speed for 3 lamp posts, decrease speed for 1 lamp post)

Training Continuum

100 km bike
@ race pace

AT intervals
Continuous
Work: +/- 10%
Rest: medium

Rest

Long Slow Distance
(50-65%)

Continuous
(just below AT)

Anaerobic Threshold (AT)
(75-80%)

40 km bike
@ race pace

VO_{2max}
(100%)

Aerobic Limit

Anaerobic System: ShortTerm

* Anaerobic Threshold Intervals
    * Anaerobic Capacity; Anaerobic Lactic
        * Glycolysis/Glycogenolysis
        * 1:2 Work-to-Rest Ratio
        * *Example:* 30s Seated Power with 1 min spin-out recovery

Training Continuum

100 km bike
@ race pace

Rest

Long Slow Distance
(50-65%)

Continuous
(just below AT)

Anaerobic Threshold (AT)
(75-80%)

40 km bike
@ race pace

VO_{2max}
(100%)

Aerobic Limit

Anaerobic intervals
Work: ~120% of race pace
Rest: variable

Anaerobic System: Immediate

* Anaerobic Intervals
    * Anaerobic Power; Anaerobic Alactic
    * ATP-CP
    * 1:3 Work-to-Rest Ratio
    * *Example:* 15s Sprint with 45s spin-out recovery

Training Continuum

100 km bike
@ race pace

VO_{2max} Intervals
Work: 90-100%
Rest: 30-40%

Rest

Long Slow Distance
(50-65%)

Continuous
(just below AT)

Anaerobic Threshold (AT)
(75-80%)

40 km bike
@ race pace

VO_{2max}
(100%)

Aerobic Limit

Anaerobic System: Immediate

* *VO_{2max} Intervals*
  * Anaerobic Power; Anaerobic Alactic
  * ATP-CP
  * 1:2 Work-to-Rest Ratio
  * 1:3 Work-to-Rest Ratio
  * *Example:* 30s at predetermined VO_{2max} with 60s recovery

Training Continuum

100 km bike
@ race pace

Rest

Long Slow Distance
(50-65%)

Continuous
(just below AT)

Anaerobic Threshold (AT)
(75-80%)

40 km bike
@ race pace

VO_{2max}
(100%)

Aerobic Limit

Tabata
Work: 100%
Rest: 20%

Tabata

* Anaerobic Power; Anaerobic Alactic
    * ATP-CP
    * 1:0.5 Work-to-Rest Ratio
    * *Example:* 20s at maximal effort with 10s passive recovery, repeat 8 times (4 minute set)

Circuit Training

* "Aerobic Weight Training"
* Stations with a variety of exercises that work the entire body
* Including a weight that can be lifted without going to failure
* May include cardiovascular exercise such as running, skipping, cycling etc.
* Continuous time interval (consider the energy systems!)
* *Example:* 1 minute at each station; complete cycle 1 to 3 times.

High Intensity Interval Training (HIIT)

* Where does HIIT belong?

* A title to various forms of intervals including VO_{2max}, Tabata, some circuit training

High Intensity Interval Training (HIIT)

Lifestyle › Health and Fitness › Body

HIIT: is the fitness scene's biggest fad doing more harm than good?

share

http://bit.ly/2geOD9j

There are a whole range of health risks associated with excessive exercise CREDIT: GETTY IMAGES

Training Continuum

Fartlek
Work: variable
Rest: variable

AT intervals Continuous
Work: +/- 10%
Rest: medium

Aerobic-Anaerobic
Work: race pace
Rest: variable

VO_{2max} Intervals
Work: 90-100%
Rest: 30-40%

100 km bike @ race pace

Rest

Long Slow Distance (50-65%)

Continuous (just below AT)

Anaerobic Threshold (AT) (75-80%)

40 km bike @ race pace

VO_{2max} (100%)

Aerobic Limit

Aerobic Intervals
Work: below race pace (training pace)
Rest: short

Tabata
Work: 100%
Rest: 20%

Anaerobic intervals
Work: ~120% of race pace
Rest: variable

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Toe Tap Mania

* Aerobic Interval (80 bpm)
    * Under the Bridge - Red Hot Chilli Peppers
* Anaerobic Capacity Interval (120 bpm)
    * Staying Alive - Bee Gees
* Anaerobic Power Interval (160 bpm)
    * Shake It Off - Taylor Swift

Interval Considerations

Intensity of work	Number of sets or series
Duration of work	Between sets recovery duration
Intensity of rest	Between sets recovery intensity
Duration of rest	Exercise modality
Number of intervals	Others?

Buchheit & Laursen (2013)

Benefits

Benefits

* most effective stimulus to improve VO_{2max}
* allows for large motor unit recruitment (Type II muscle fibres) and attainment of near maximal cardiac output
* signals for oxidative muscle fibre adaptation (increase mitochondrial mass) and myocardium enlargement

Buchheit & Laursen (2013)

Benefits

Cancer. 2007 Aug 1;110(3):590-8.

Effects of presurgical exercise training on cardiorespiratory fitness among patients undergoing thoracic surgery for malignant lung lesions.

Jones LW[1], Peddle CJ, Eves ND, Haykowsky MJ, Courneya KS, Mackey JR, Joy AA, Kumar V, Winton TW, Reiman T.

⊕ Author information

Abstract

BACKGROUND: To determine the effects of preoperative exercise training on cardiorespiratory fitness in patients undergoing thoracic surgery for malignant lung lesions.

Benefits

* variety in workout
* time efficient workout
* increase energy expenditure during and after workout (EPOC)

What's Next for Interval Training?

Cochrane Library

Cochrane Database of Systematic Reviews

Interval training exercise for hypertension (Protocol)

Oliveros MJ, Gaete-Mahn MC, Lanas F, Martinez-Zapata MJ, Seron P

http://bit.ly/2uxL0Qq

Oliveros MJ, Gaete-Mahn MC, Lanas F, Martinez-Zapata MJ, Seron P.
Interval training exercise for hypertension.
Cochrane Database of Systematic Reviews 2017, Issue 1. Art. No.: CD012511.
DOI: 10.1002/14651858.CD012511.

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References

* A brief history of interval training
    * http://bit.ly/2yfPAle
    * http://bit.ly/2xUrMHs
    * http://bit.ly/2yg3XWK
    * http://bit.ly/2ygf4z5
    * http://bit.ly/2xkJ1 1S

References

* Alberta fitness leadership certification association. (2001). Group exercise leader manual.
* Buchheit, M. & Laursen, P.B. (2013). High-intensity interval training, solutions to the programming puzzle. Part I. Sports Med. DOI 10.1007/s40279-013-0029-x
* Buchheit, M. & Laursen, P.B. (2013). High-intensity interval training, solutions to the programming puzzle. Part II. Sports Med. DOI 10.1007/s40279-013-0066-5
* Burke, E. (2002). Serious cycling. Champaign, IL: Human Kinetics Publishing Inc.
* Doyle-Baker, P. (2017). SIT, HIT, FIT: The science behind interval training. AFLCA Professional Development KT Article.
* Foss, M.L. & Keteyian, S.J. (1998). Fox's physiological basis for exercise and sport. (6th Ed.). Boston, Massachusetts: WCB/McGraw-Hill.
* Hoolihan, C. (2016). Enduring Intensity. IDEA Fitness Journal, Volume 13, Number 8.
* Karp, J.R. (2010). A primer on muscles. IDEA Fitness Journal, Volume 7, Number 5.
* Kennedy, C.A. & Yoke, M.M. (2009). Methods of group exercise instruction. 2nd Ed. Champaign, IL: Human Kinetics Publishing Inc.
* Kory, K. & Seabourne, T. (1999). Power pacing for indoor cycling. Champaign, IL: Human Kinetics Publishing Inc.
* Peterson, S. (2003). Peds 511 academic course notes.

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