

enduranceworks[®], LLC

HEART RATE TRAINING FOR ENDURANCE ATHLETES

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CERTIFIED COACH



USA CYCLING
COACH

Web: www.enduranceworks.net

Goals

- Better understand heart rate response to exercise
- Better understand energy zones and how they relate to intensity
- How to determine and use your heart rate training zones



"You wouldn't hunt without a weapon. So, why would you train without a heart rate monitor?"

- Lance Armstrong

My background and credentials

Personal and Athletic

- Former nuclear submariner
- Cancer survivor
- Background in running and PT
- Completed more than 100 triathlons since 1995
- 26 Ironman finishes since 1997
 - 8:51 PR (Quelle Challenge '07)
 - Qualified for Ironman Hawaii multiple times (competed 2002)
 - Won 5x Iron-distance races overall
 - 4th overall at Vineman in 2009

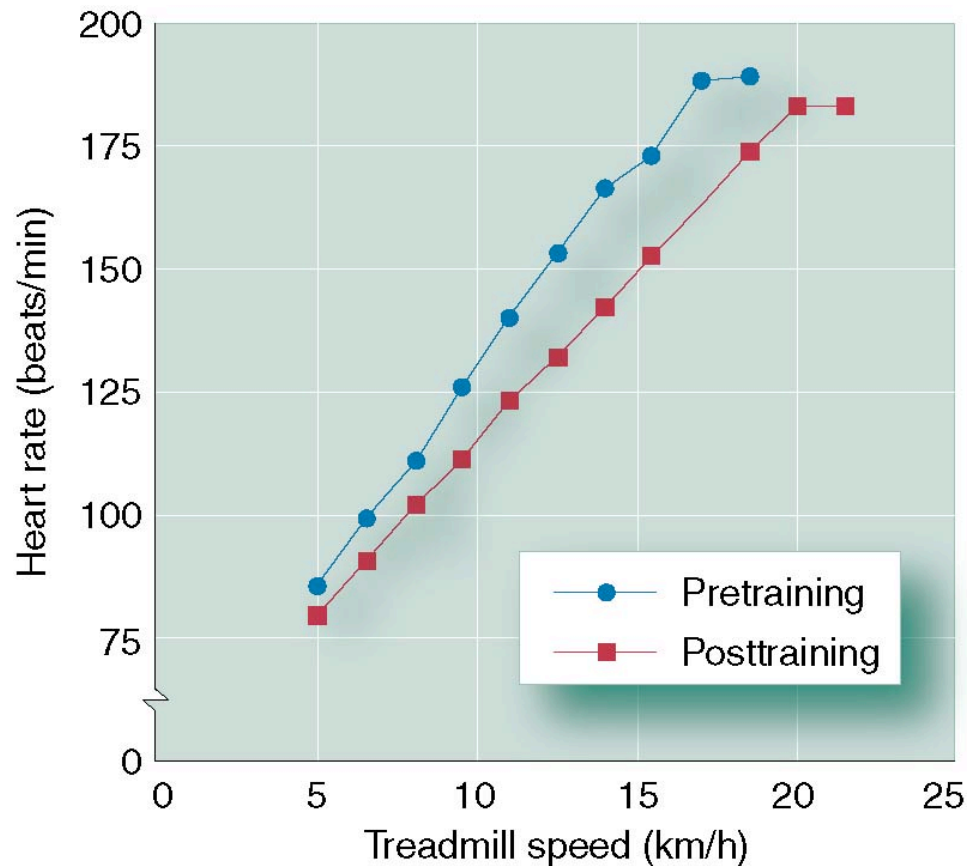
Professional

- Education:
 - BS, U.S. Naval Academy
 - MSE, Catholic University
 - MS (in progress), Applied Performance Physiology at Eastern Michigan University
- Certifications
 - USA Triathlon Level I
 - USA Cycling Level II
 - CSCS
- Triathlon coach
- Speaker
- Writer and author of *Full Time & Sub-Nine*

Agenda

- Why use heart rate as a tool?
- Overview of heart rate training zones
- The three energy systems
- Understanding heart rate changes with exercise
- Understanding lactate threshold
- Determining your heart rate training zones
- Additional considerations for using heart rate

Why use heart rate? Because heart rate increases with intensity, it's a convenient feedback tool for exercise.



Increasing Intensity (i.e. Working Harder)

Source: Jack Wilmore, et al. *Physiology of Sport and Exercise*, 4th ed. (Champaign, IL: Human Kinetics 2008)

Training within a specific heart rate zone creates a desired training effect

Joe Friel's Heart Rate Training Zones (Most Widely Used)

Zone	Effort	Description and Purpose
Zone 1	Easy	Recovery. Easy pace. Aerobic endurance building.
Zone 2	Easy to moderate	Extensive endurance. Usually hold for a long time. Aerobic endurance building.
Zone 3	Medium	Intensive endurance/ muscular endurance. Tempo. Progress to threshold.
Zone 4	Medium Fast	Sub-threshold. Time trial. Improve and sustain around lactate threshold.
Zone 5a	Fast	Super threshold. Hard to maintain. Sustain lactate threshold.
Zone 5b	Very fast	Anaerobic endurance. Improve VO2 Max. Very difficult to maintain.
Zone 5c	Explosive	Power. All out sprint. Increase power.

Lactate Threshold

Adapted from: Joe Friel, *Training Bible Coaching* (www.trainingbible.com)

Examples of workouts in each training zone

Joe Friel's Heart Rate Training Zones (Most Widely Used)

Zone	Effort	Example Workouts
Zone 1	Easy	Easy spin on the trainer.
Zone 2	Easy to moderate	2 hour ride on rolling hills, moderate effort.
Zone 3	Medium	20 min Z2, 20 min Z3, 20 min Z2
Zone 4	Medium Fast	Z2 run with 2 x 10 min Z4 (5 min rest in between); 40km time trial on the bike
Lactate Threshold		
Zone 5a	Fast	5km to 10km running race
Zone 5b	Very fast	Warm up then 2 sets of 4 x (1 minute on, 3 minute off) with 15 min in between.
Zone 5c	Explosive	8 x 15s sprint as fast as you can with 2 min recovery in between

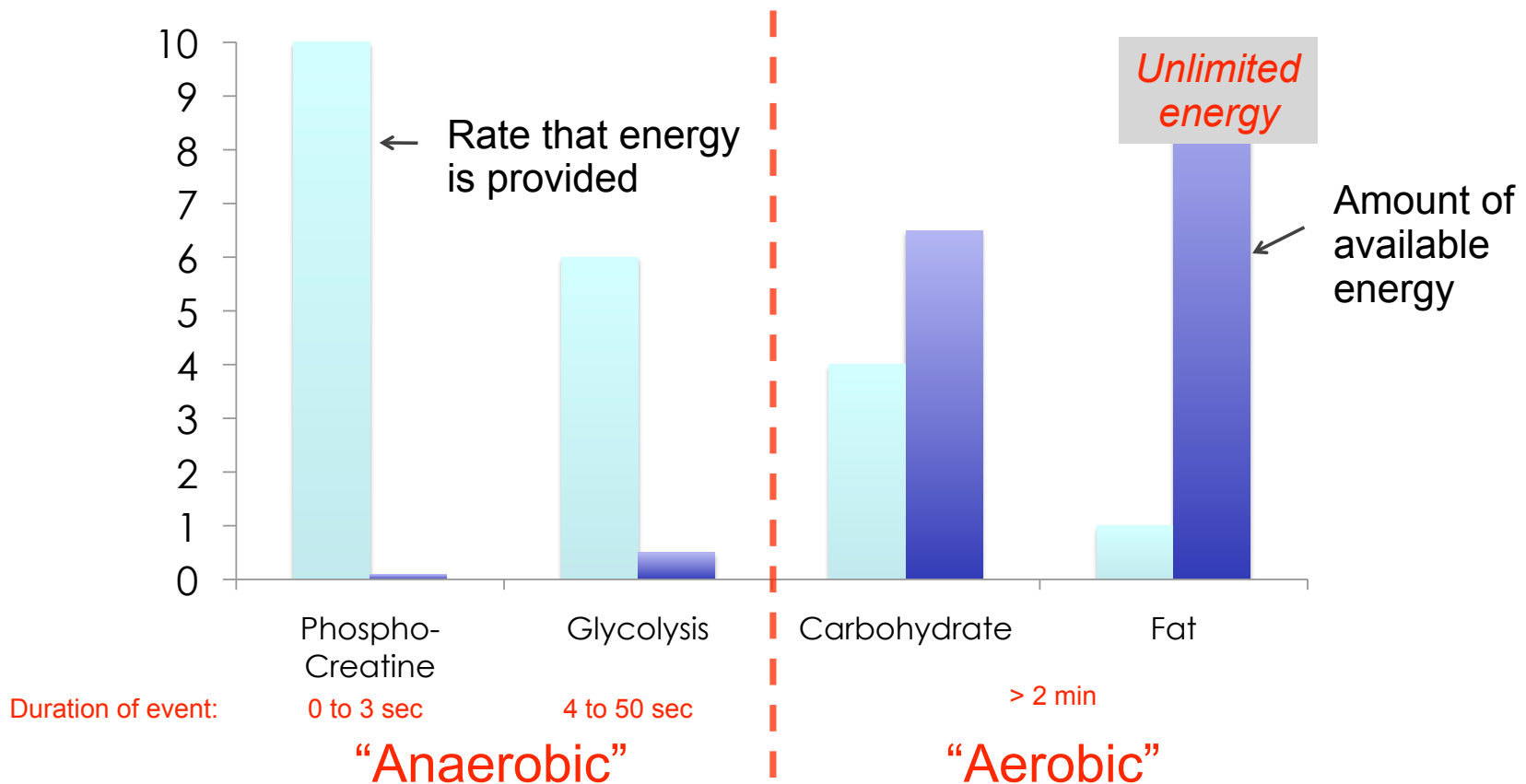
Adapted from: Joe Friel, *Training Bible Coaching* (www.trainingbible.com)

To understand intensity and training zones, we first need to first understand where the body gets energy from

- The body breaks down ATP for energy
 - Three energy systems in the body create ATP:
 - Phosphocreatine: creatine phosphate
 - Glycolytic system: carbohydrate only
 - Oxidative system: fat, carbohydrate, protein
- “Anaerobic” without O₂
- “Aerobic” with O₂
- All 3 energy systems are always active
 - Analogy: 3 dimmer switches
 - Extent to which each one is used depends on intensity
 - Intensity dictates duration

The aerobic energy system can provide much more energy, but it's not as fast as the anaerobic systems

Comparison of the 3 Energy Systems



Adapted from: Jack Wilmore, et al. *Physiology of Sport and Exercise*, 4th ed. (Champaign, IL: Human Kinetics 2008)

Endurance events like triathlon rely primarily on the aerobic (oxidative) system – that’s what we need to train!

TABLE 8.4 Percentage of Emphasis on the Three Metabolic Energy Systems in Training for Various Running Events

Running event	Anaerobic—speed (ATP-PCr system)	Anaerobic—endurance (anaerobic glycolytic system)	Aerobic endurance (oxidative system) ✓
100 m (109 yd)	95	3	2
200 m (218 yd)	95	2	3
400 m (436 yd)	80	15	5
800 m (872 yd)	30	65	5
1,500 m (0.93 mi)	20	55	25
3,000 m (1.86 mi)	20	40	40
5,000 m (3.10 mi)	10	20	70
10,000 m (6.2 mi)	5	15	80
Marathon (42.2 km; 26.2 mi)	5	5	90

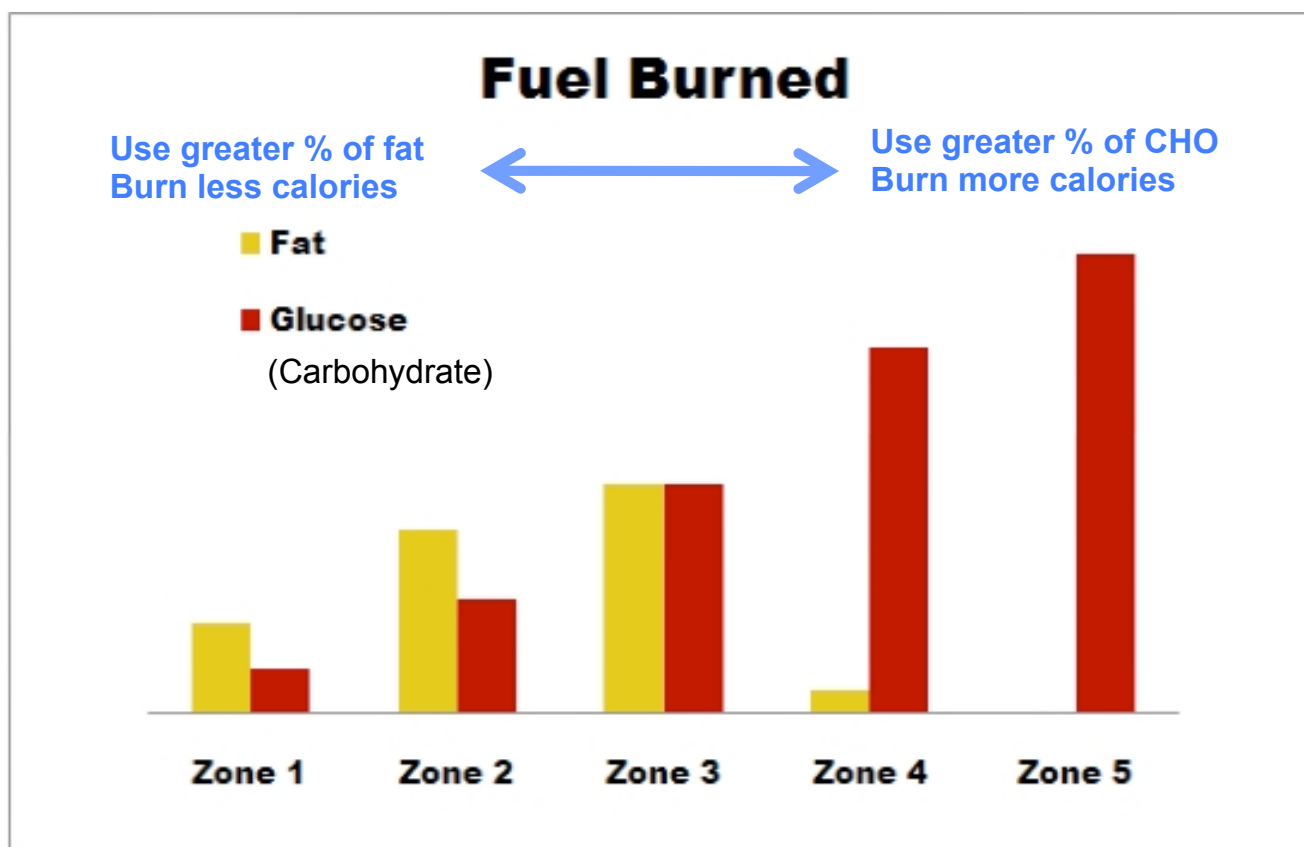
Sprint Triathlon
Ironman Triathlon

From an article published in *Exercise physiology*, F. Wilt, "Training for competitive running," edited by H.B. Falls. Copyright Elsevier 1968.

Source: Jack Wilmore, et al. *Physiology of Sport and Exercise*, 4th ed. (Champaign, IL: Human Kinetics 2008)

Fuel availability is an other consideration; we want to become more efficient at burning fat

As intensity increases, we burn less fat and more carbohydrate (CHO), but we only have a limited amount of CHO (i.e. bonking)



Source: <http://www.fitness-training-made-simple.com/heart-rate-training-zone.html>

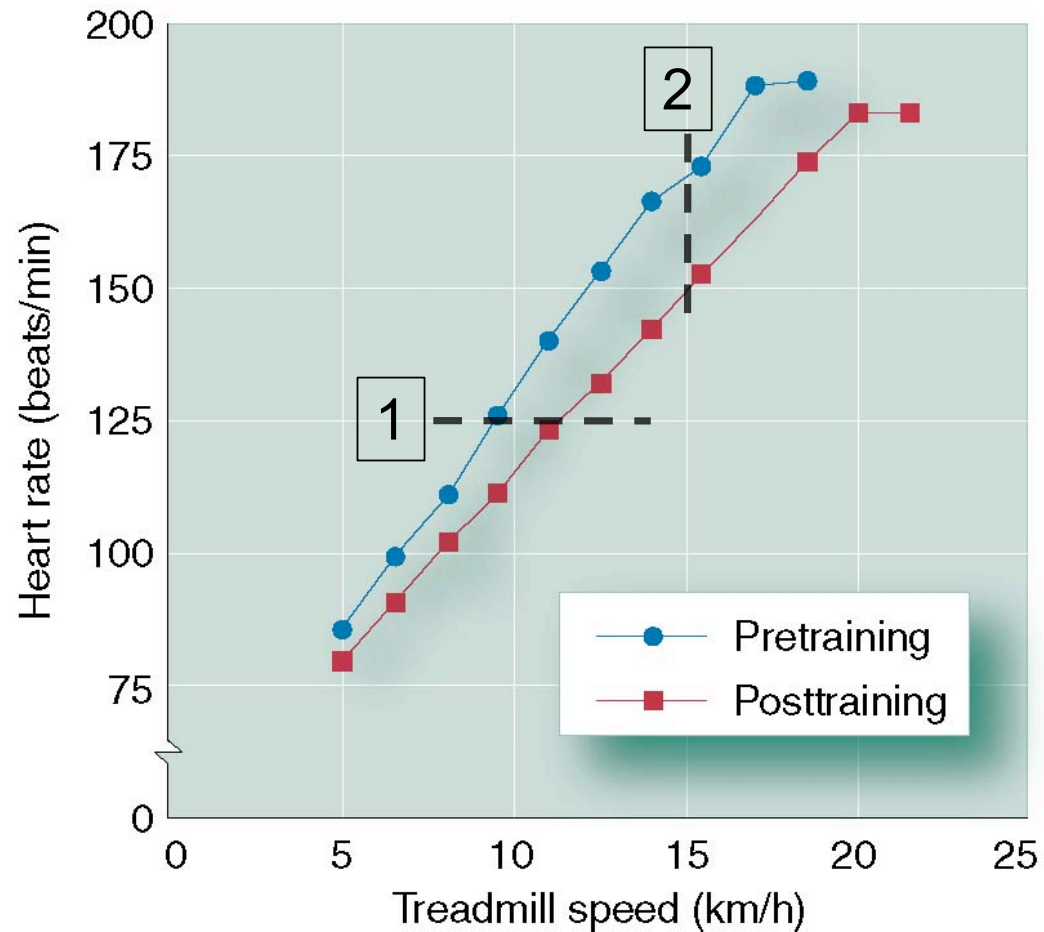
Your heart rate will change with endurance training

$$Q = HR \times SV$$

Cardiac Output (L/min) Heart Rate (beats/min) Stroke Volume (L/beat)

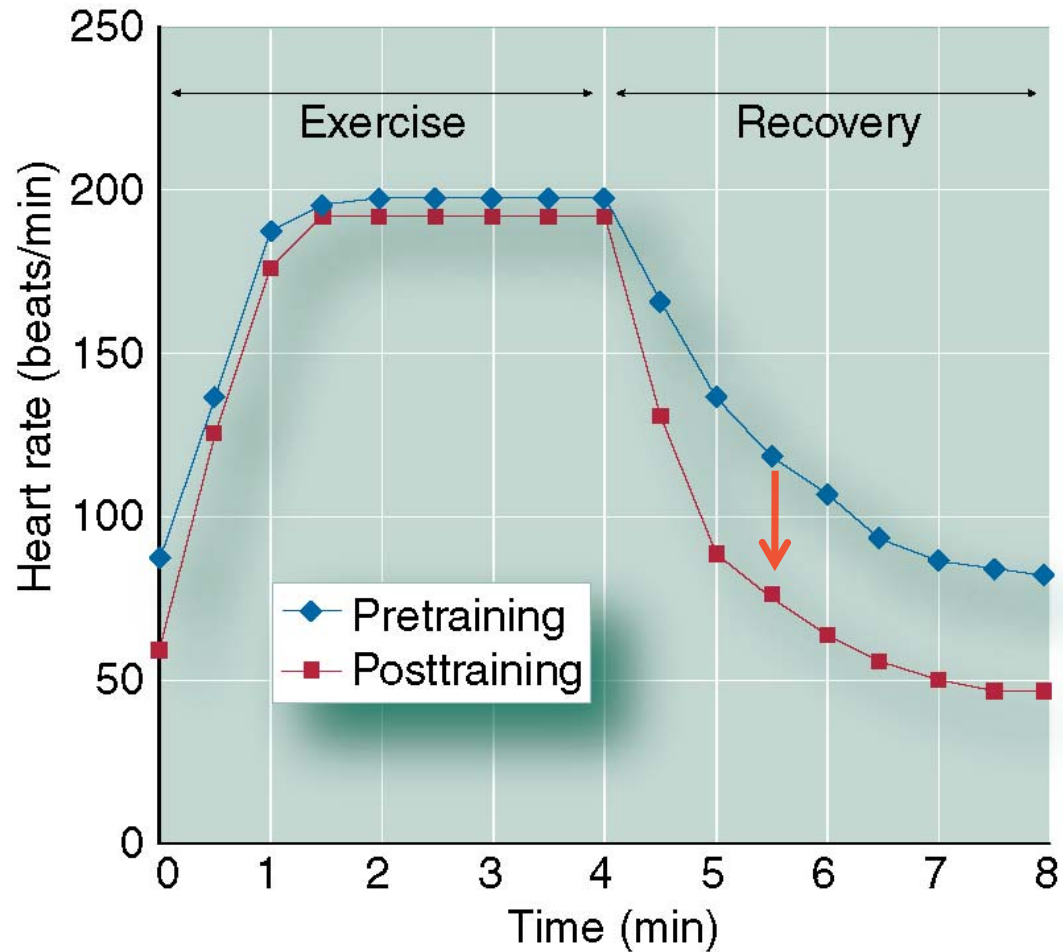
- Since the heart is a muscle, working your heart will make it bigger and allow it to pump more each beat (observe less HR for a given speed)
- In addition, resting heart rate decreases:
 - Resting heart rates in adults tend to be between 60 and 85 beats per min.
 - However, extended endurance training can lower resting heart rate to 35 beats or lower.

With endurance training, your heart rate will be lower for a given speed (more stroke volume!)



Source: Jack Wilmore, et al. *Physiology of Sport and Exercise*, 4th ed. (Champaign, IL: Human Kinetics 2008)

With more endurance training, you'll also recover faster

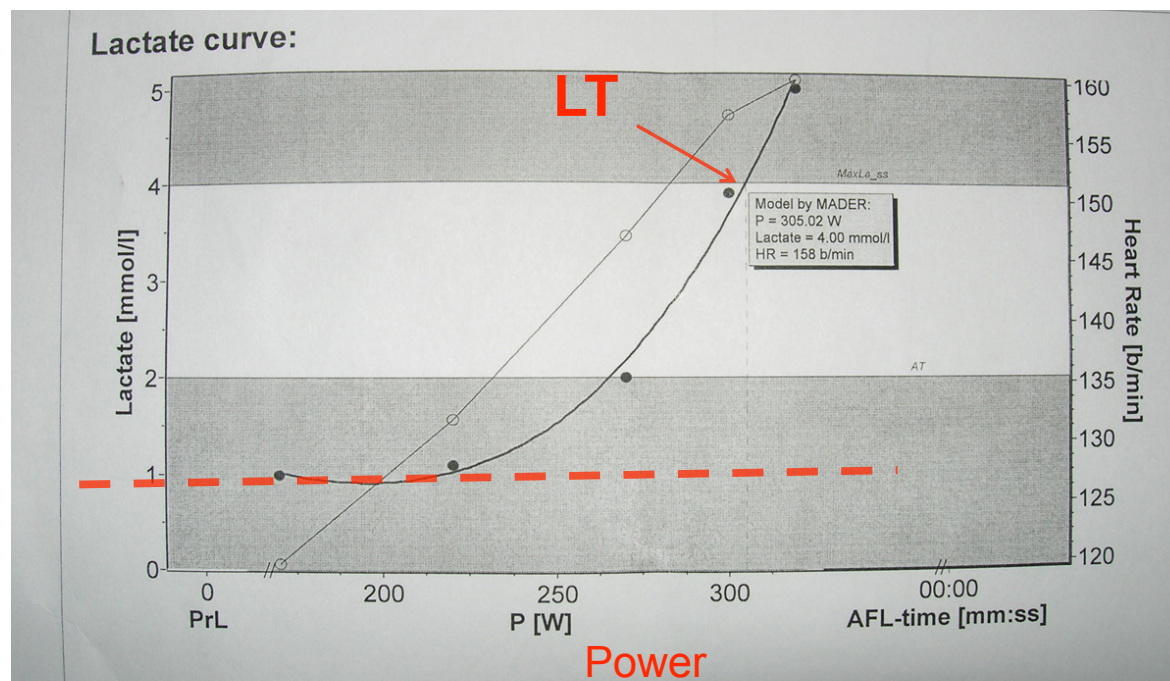


Source: Jack Wilmore, et al. *Physiology of Sport and Exercise*, 4th ed. (Champaign, IL: Human Kinetics 2008)

Understanding lactate threshold (LT) is the key to determining training zones

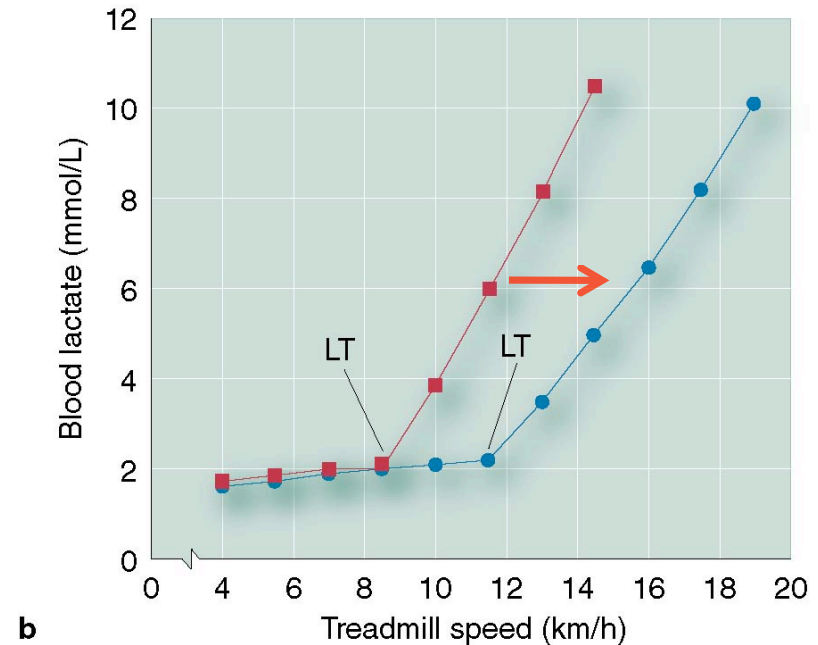
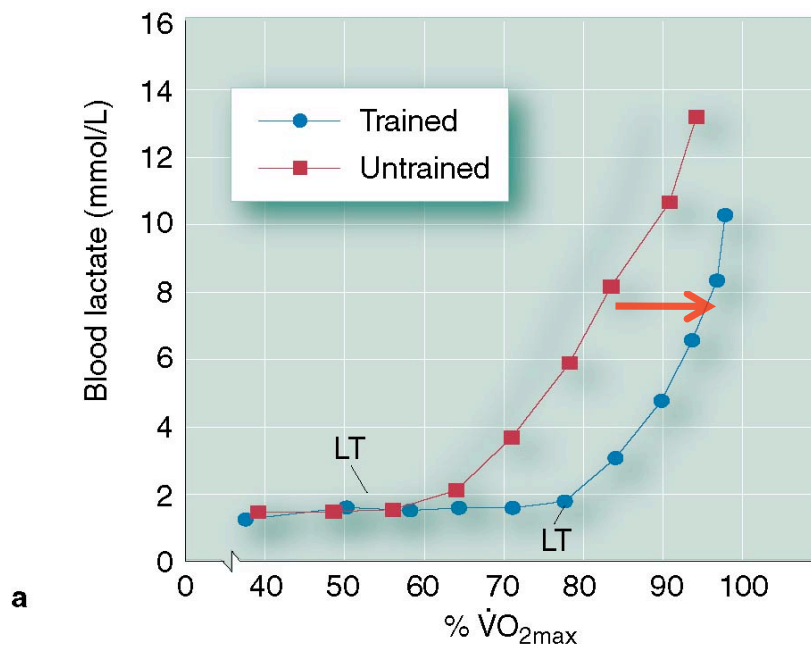
- Lactate is always being produced by the muscles but is also being cleared
- Above LT, lactic acid begins to rapidly accumulate in your working muscles – your muscles will feel heavy with a burning sensation and breathing increases
- It's unsustainable!

David's Blood Lactate Test on the Bike



Improving LT is very trainable

Training around LT (Z4, Z5a), improves your speed and sustain a higher a speed for a longer period of time



Source: Jack Wilmore, et al. *Physiology of Sport and Exercise*, 4th ed. (Champaign, IL: Human Kinetics 2008)

There are multiple ways to determine your training zones

Formulas

RPE
(Rate of Perceived
Exertion)

Field Tests

Lab Tests

Determining training zones: Formulas

- Examples:
 - Max Heart Rate (MHR) = $220 - \text{Age}$
 - Karvonen formula using MHR and Resting Heart Rate
- Pro: Easy, no equipment needed
- Con: Inaccurate for most people – like picking your shoe size based on age

Determining training zones: RPE

- Examples:
 - What's my heart rate?
 - How hard am I breathing?
 - Are my legs burning?
- Pro: Real-time feedback; always available
- Con: Subjective; better with experience

Borg Rate of Perceived Exertion / HR Zones

RPE	Zone	Description
6	1	
7	1	Very, very light
8	1	
9	2	Very light
10	2	
11	2	Fairly light
12	3	
13	3	Somewhat hard
14	3	
15	4	Hard
16	5a	
17	5b	Very hard
18	5b	
19	5c	Very, very hard
20	5c	

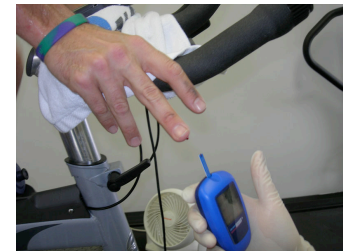
Determining training zones: Field Tests

- Examples:
 - Graded treadmill, track or stationary bike test
 - Gradually speed (run) or resistance (bike) every minute after 10 minute warm up
 - Look for signs of change (e.g. heavier breathing, leg burn) to indicate LT
 - 30 minute test taking average HR at end of 10, 20, 30 min
- Pro: Minimal equipment needed
- Con:
 - May be difficult to measure accurately
 - Subject to course conditions (e.g. wind on bike)
 - Taking “average” heart during 30 minute test may pick above or below true LT

Determining training zones: Lab Tests

- Examples:
 - VO₂ Max test (measure O₂ consumption vs. CO₂ production)
 - Blood lactate test (measures lactate via blood sample from finger tip prick)

- Pro: Measures actual work output; can be very accurate
- Con:
 - Costs money
 - All equipment not created equal
 - Parvo Medics (as used in Olympic Training Center)
 - New Leaf, Cardio Coach (cheap components; not accurate)
 - All testers not equal - look for a degree in exercise science / physiology



Once you have your lactate threshold heart rate (LTHR), you can calculate your zones

Joe Friel's Bike Zones

	HEART RATE RANGE	
ZONE	FROM:	TO:
Z1		< 81% * LTHR
Z2	81% * LTHR	89% * LTHR
Z3	90% * LTHR	93% * LTHR
Z4	94% * LTHR	99% * LTHR
Z5a	100% * LTHR	102% * LTHR
Z5b	103% * LTHR	106% * LTHR
Z5c	>106% * LTHR	

Joe Friel's Run Zones

	HEART RATE RANGE	
ZONE	FROM:	TO:
Z1		< 85% * LTHR
Z2	85% * LTHR	89% * LTHR
Z3	90% * LTHR	94% * LTHR
Z4	95% * LTHR	99% * LTHR
Z5a	100% * LTHR	103% * LTHR
Z5b	103% * LTHR	106% * LTHR
Z5c	>106% * LTHR	

Joe Friel's Zones are the most widely used

Helpful hint: Simplify by just using 5 zones

Source: Joe Friel, *Training Bible Coaching* (www.trainingbible.com)

Once you know your zones, you can use your heart rate monitor as a tool to obtain the desired training effects

Joe Friel's Heart Rate Training Zones (Most Widely Used)

Zone	Effort	Description and Purpose
Zone 1	Easy	Recovery. Easy pace. Aerobic endurance building.
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Zone 5c	Very, very fast	Power. All out sprint. Increase power.

Lactate
Threshold

Adapted from: Joe Friel, *Training Bible Coaching* (www.trainingbible.com)

But remember, heart rate training zones are just a tool

- Never be a slave to your monitor. Batteries may die.
- Always use perceived effort.
- Heart rate can fluctuate due to a number of factors:
 - Fitness level
 - Air / water temperature
 - Sitting (bike) vs. Standing (run)
 - Anxiety
 - Caffeine
 - Fatigue
 - Hydration status
 - Over time (cardiac drift)
- Other tools are available: RPE, power (wattage), pace, speed

Thank you for your time today!

- Be sure to check out our triathlon resources at: www.enduranceworks.net and my blog articles at: www.davidglover.net.

- For testing services using the same equipment used at the Olympic Training Center, contact:

Krista Schultz, MEd, CSCS

Email: krista@totalperformanceinc.net

Web: www.totalperformanceinc.net.



- Please contact me with any questions or feedback regarding this webinar.

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- Tricia

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The logo for 'TRIATHLON IN A BOX' features the word 'TRIATHLON' in large, grey, sans-serif capital letters at the top. Below it is a dark blue horizontal bar containing three white silhouettes: a swimmer on the left, a cyclist in the middle, and a runner on the right. At the bottom, the words 'IN A BOX' are written in the same grey, sans-serif capital letters as 'TRIATHLON'.

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 - Comprehensive and detailed training guide
 - 15-week sprint and international-distance training schedules
 - Guidelines for schedule customization
 - And more!
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