LACTATE THRESHOLD TESTING AND TRAINING ZONES

Endurance United Lecture Series

OVERVIEW

- Aerobic vs Anaerobic
  - What is lactate?
- Lactate Threshold-so what?
- Test protocol
- Setting training zones
- What are the 5 training zones and why are they important

AEROBIC VS ANAEROBIC

- Aerobic: "With Oxygen"
  - Long, steady state exercise
  - Oxygen demand is met by oxygen consumption
- Anaerobic: "Without Oxygen"
  - Short, high intensity efforts
  - Oxygen demand exceeds oxygen supply
  - Results in the byproduct: **lactate**

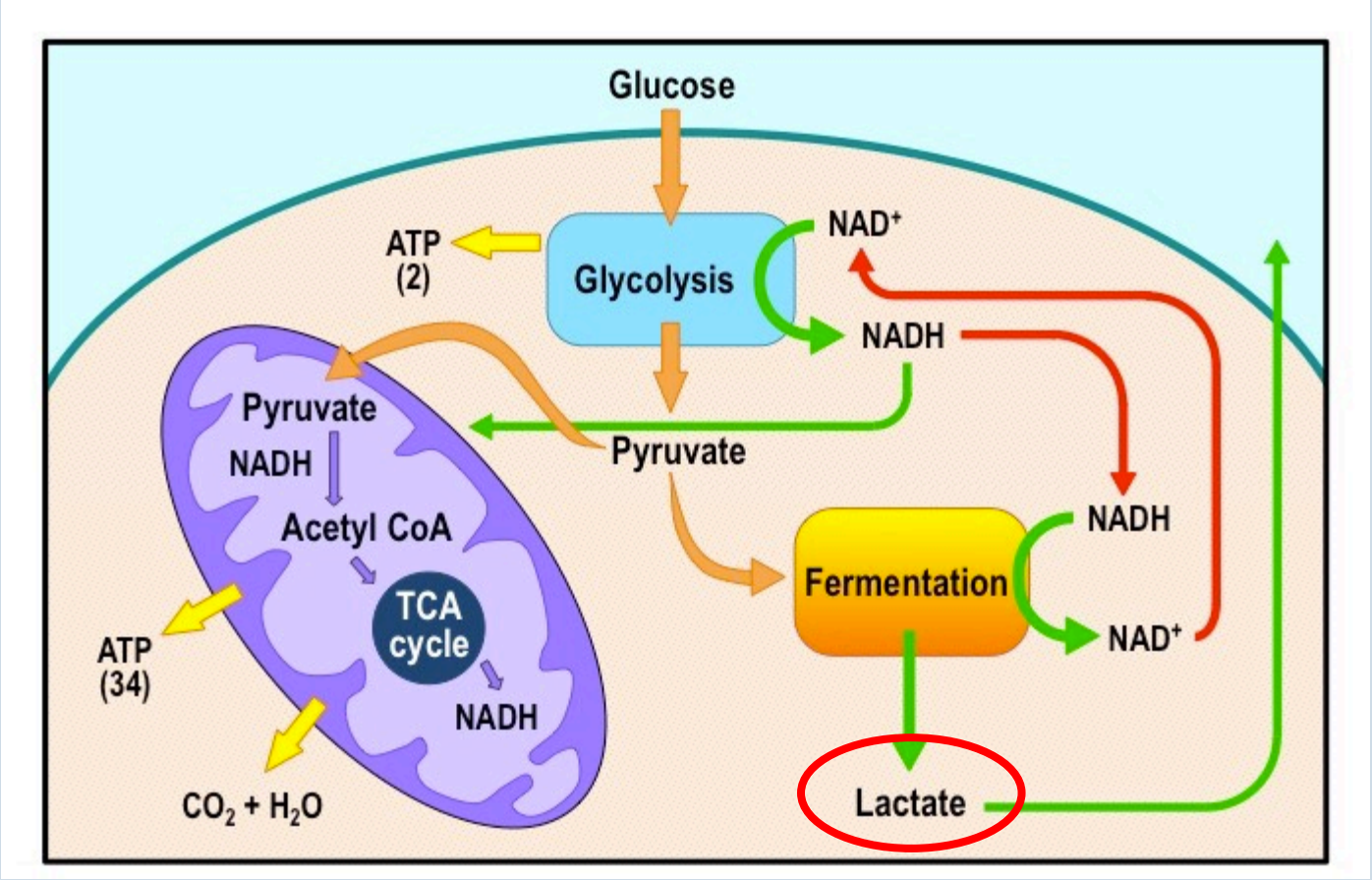
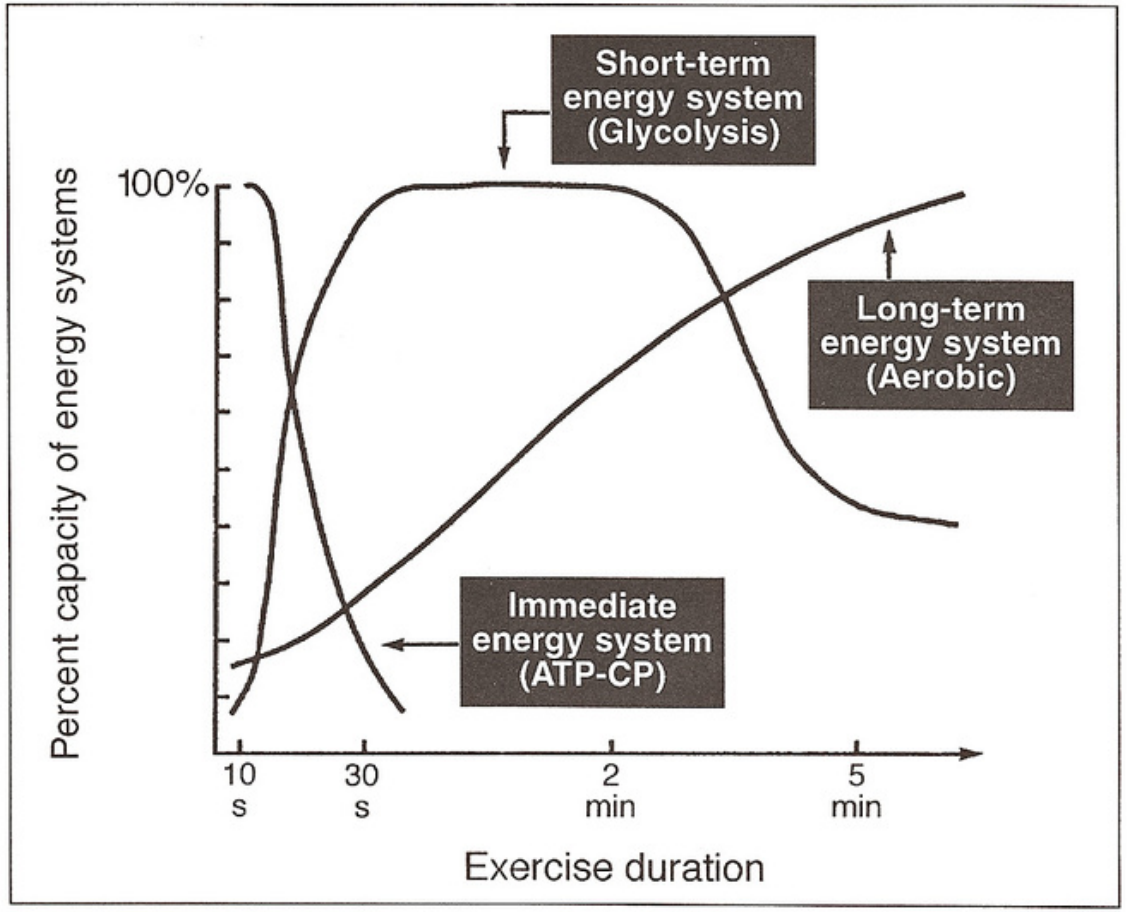


Figure 3-1: ***The three systems of energy transfer and their percentage contribution to total energy output during all-out exercise of different durations.***



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

LACTATE THRESHOLD

- Lactate Threshold (LT): point at which lactate accumulates faster than it can be cleared and begins to accumulate in the muscles.
  - Shift from predominately aerobic energy systems to anaerobic energy systems
  - Non-linear increase in Blood lactate
- When you have exceeded LT:
  - Lactate not the cause of fatigue
  - Build up of metabolic byproducts
  - Acidosis (H+ ions)
  - Inadequate muscle contractions
  - "Heavy legs"
  - Pace slows

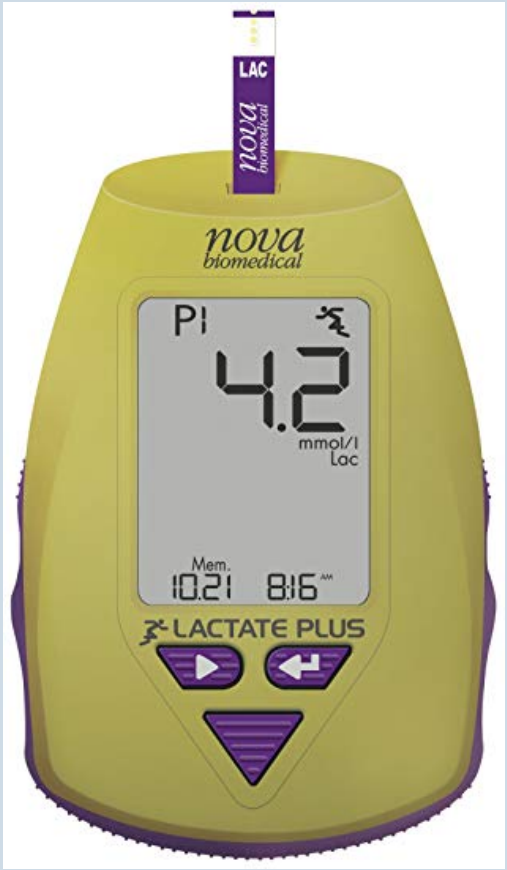
WHY DO WE TRAIN AT THRESHOLD PACE (L3)?

- Increase our EFFICIENCY
  - Improving our body's ability to clear out lactate
- If the pace you can hold at your LT is faster than the pace your competitor can hold at their LT: you will WIN
- Athlete able to work at a higher percentage of VO_2 (maximal oxygen uptake) before lactate accumulation will perform better
- Race pace is closely tied to onset of blood lactate accumulation
  - Average Onset of Blood Lactate Accumulation (OBLA) of junior female Norwegian Nordic skiers: 93% running VO_{2max}
  - Average intensity of 6 km Nordic race: 88% of running VO_{2max} (95% of the VO_2 at OBLA)
  - 5 km races are completed at or above the OBLA, and therefore at or above the lactate threshold.

Welde B, Evertsen F, Von Heimburg E, Ingulf Medbø J. Energy cost of free technique and classical cross-country skiing at racing speeds. *Med Sci Sports Exerc.* 2003;35(5):818–25.
Kumagai S, Tanaka K, Matsuura Y, Matsuzaka A, Hirakoba K, Asano K. Relationships of the anaerobic threshold with the 5 km, 10 km, and 10 mile races. *Eur J Appl Physiol Occup Physiol.* 1982;49(1):13–23.

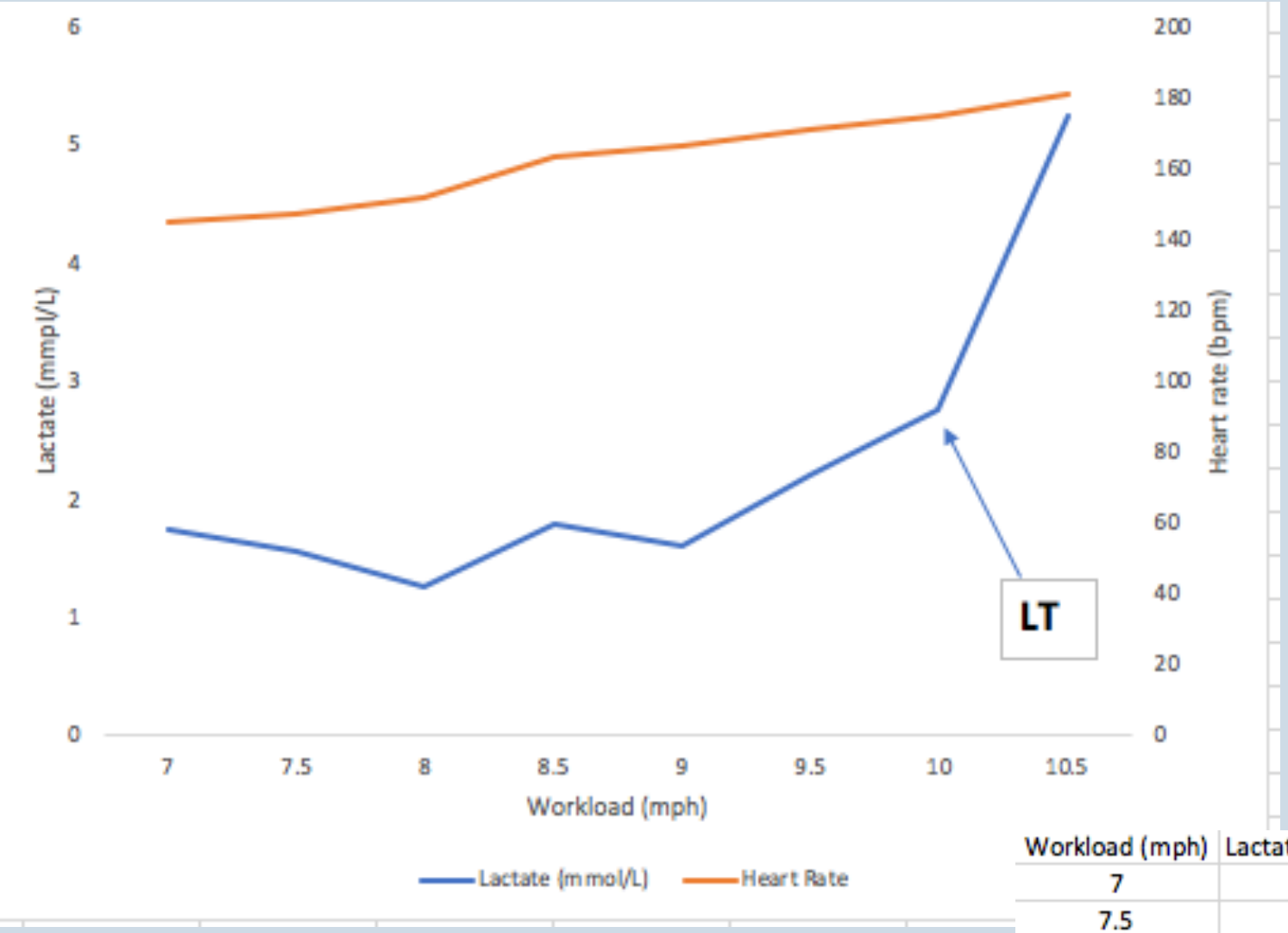
LACTATE TESTING

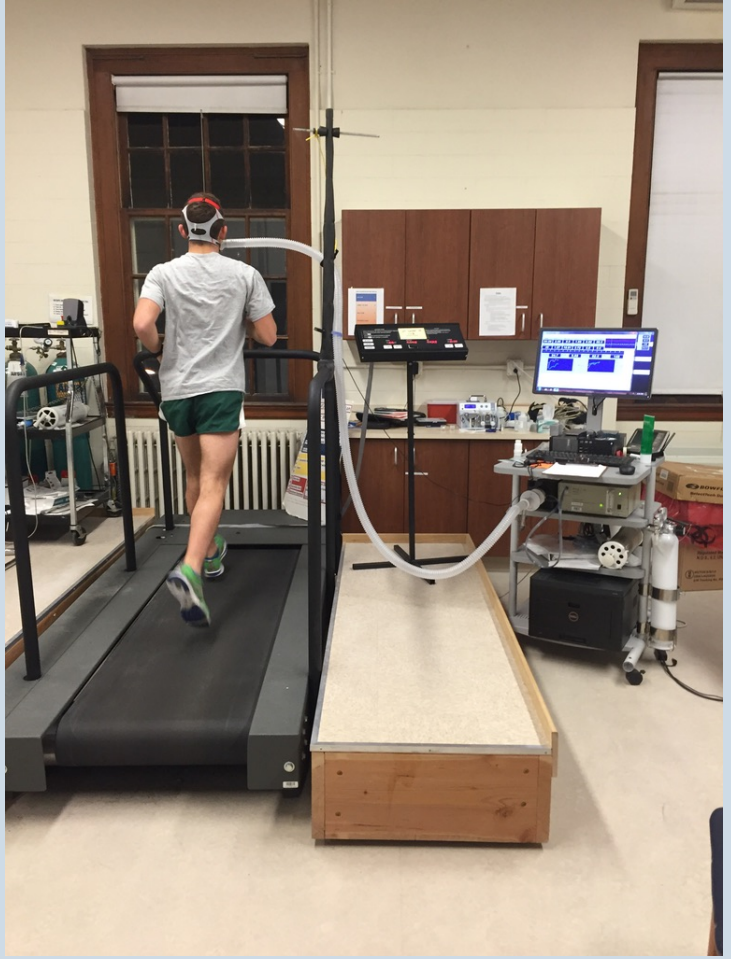
- Equipment:
  - Treadmill (bike, rollerski treadmill)
  - Heart rate monitor (preferably a chest strap)
  - Lactate analyzer
- For Best Results:
  - Refrain from exercise 12 hrs prior to test
  - Refrain from food, alcohol, caffeine, tobacco for at least 3 hrs prior to the test



PROTOCOL

- Short warm-up on treadmill
  - Easy walking/jogging for <10 min
- Adult Protocol:
  - 3 minute stages
    - Stage 1-2 mph @ 3% grade
    - Stage 2- 3 mph @ 3% grade
    - Stage 3- 4 mph @ 3% grade
    - Stage 4- 5 mph @ 3% grade
    - Stage 5- 6 mph @ 3% grade
    - Stage 6- 6 mph @ 5% grade
    - Stage 7- 6 mph @ 7% grade
  - 60 seconds of recovery between each stage to collect blood sample and determine HR at end of stage and beginning of subsequent stage.
- Test will continue until peak lactate has been reached
- Lactate Threshold will be determined:
  - Sharp, non-linear increase in lactate
  - 4 mmol/L blood lactate
  - 1+1 mmol/L method
- Lactate Threshold (L3) Training Zone: 3-5 mmol/L
- HR zones will be determined
- Note: Protocol can be adapted to suit the individual athlete
  - Stage intensities
  - Exercise modality

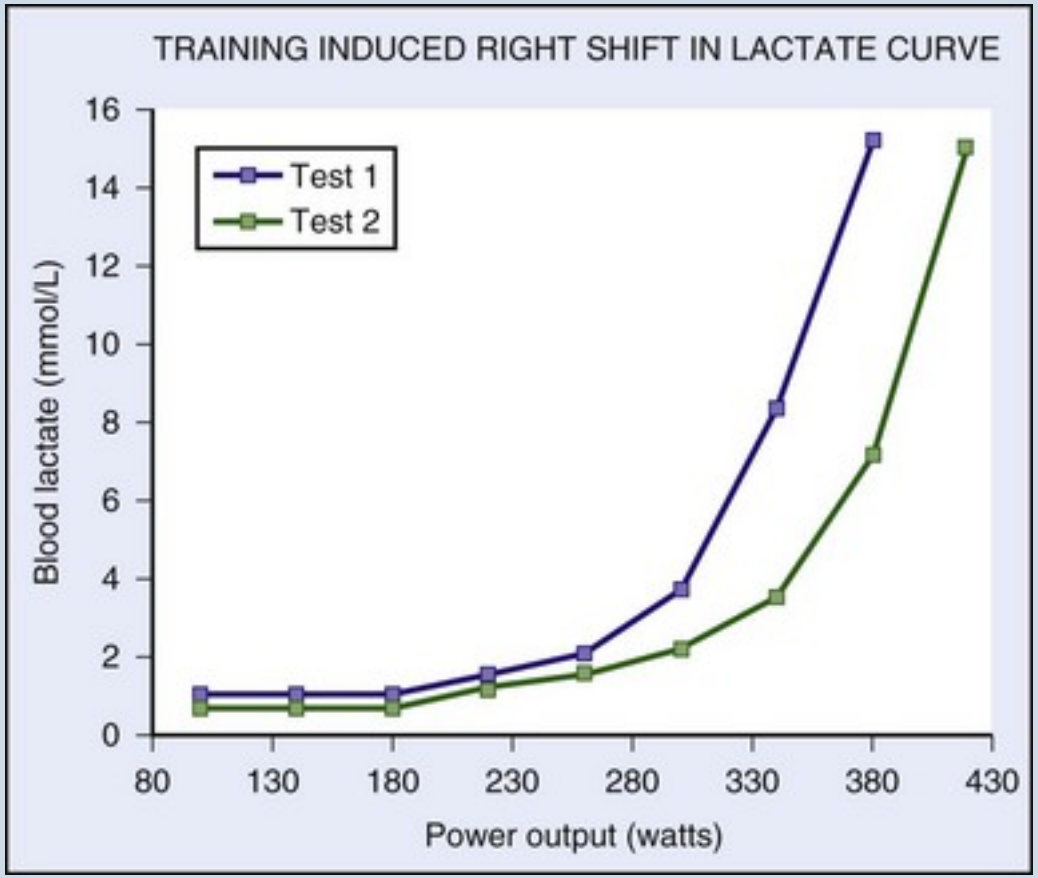




Workload (mph)	Lactate (mmol/L)	Heart Rate	HR % of Max	VO2 (ml/kg/min)	% of VO2 max
7	1.75	145	79	39	59
7.5	1.55	147	80	42.5	64
8	1.25	152	83	46.9	71
8.5	1.8	163	89	52.3	79
9	1.6	166	91	55	83
9.5	2.2	171	93	58.8	89
10	2.75	175	96	60.5	91
10.5	5.25	181	99	64.1	97
VO2 Max	5.55	183	100	66.2	100

WHAT DO WE LEARN FROM THE RESULTS?

- Determine proper HR training zones
- Assess fitness
- With repeat test can determine how training has affected your fitness
  - Continue to move threshold closer to maximal output
- When to test:
  - Elite Athletes: spring/summer, end of fall training, yearly
  - Juniors: beginning of summer, yearly
  - Birkie Skiers: Every few years

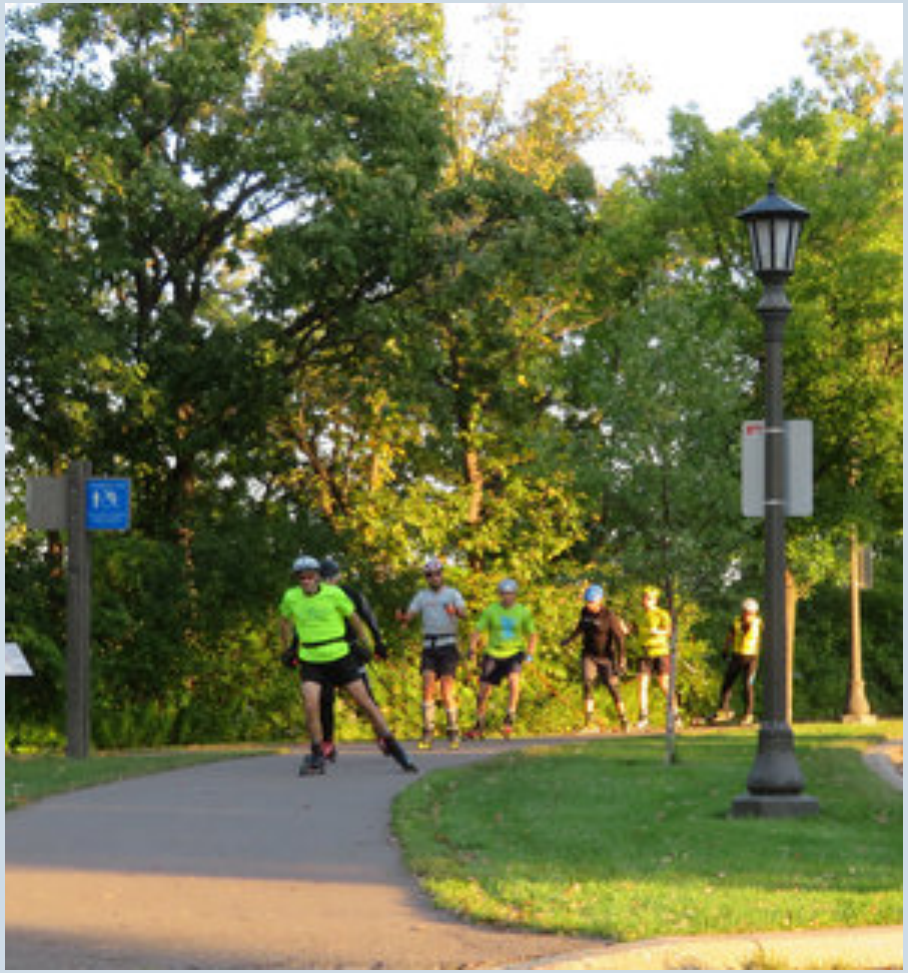


5 TRAINING ZONES

ZONE	% of Max HR	Lactate (mmol/L)	Energy	Purpose	Duration in Zone (Approximate)
1	60-70%	2 or less	Aerobic	Recovery and Over Distance	1-6 hours
2	70-80%	2- 3	Aerobic	"No training Zone"	
3	80-90%	3.5-5	Aerobic/ anaerobic	Threshold and Endurance Speed (Lactate Threshold Training)	30 min to 1 hour
4	90-95%	5-10	Anaerobic	Endurance race pace and max VO2	2 to 6 min, 6 to 10 min
5	95-100%	8+	Anaerobic	Max Speed	5-15 sec

ZONE 1

- Easy Aerobic Endurance and Over distance training
- 60-70% of max HR
- Lactate 2 mmol or lower
- 70-90% of total training
- 100% aerobic energy sources
- Burning Fat > CHO
- Easy distance and recovery sessions
- “Building a base”
- Comfortably hold a conversation



ZONE 2

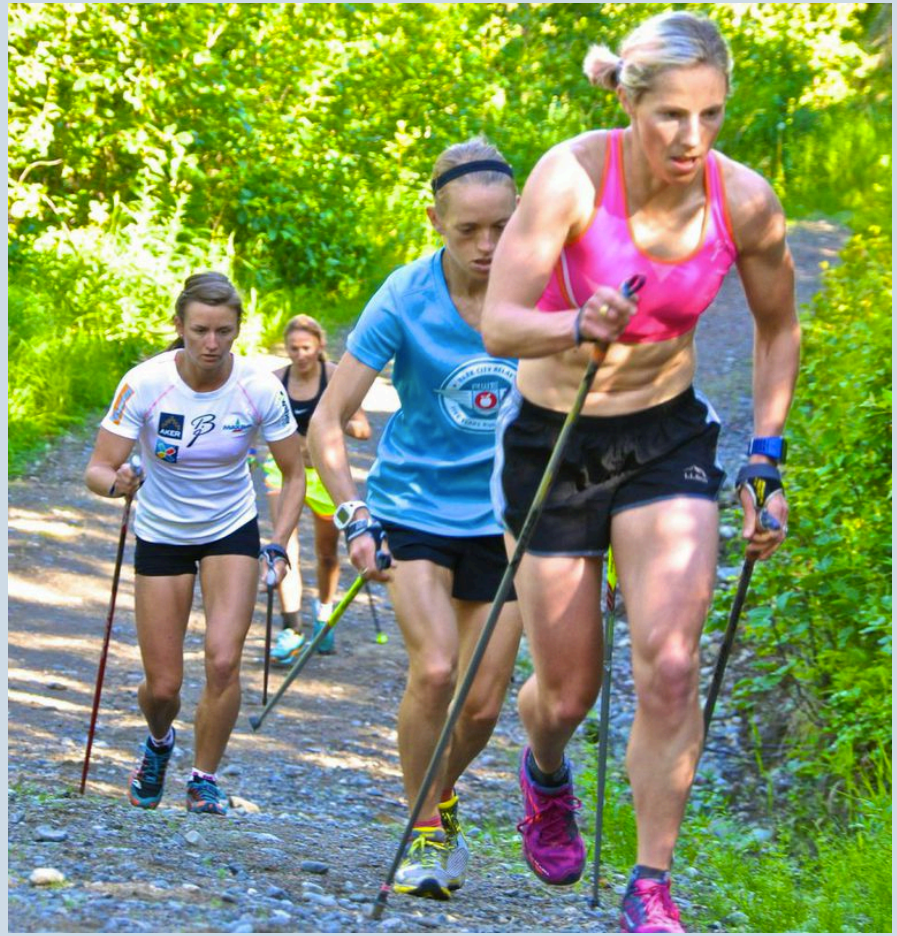
- General endurance
- 70-80% max HR
- Lactate 2-3 mmol
- Increase the anaerobic contribution to energy supply.
- “No-training” zone
  - Working too hard for easy training/recovery
  - Not hard enough for speed benefits
  - Okay for general health benefits
- Hold a conversation with heavy breaths between sentences

ZONE 3

- Threshold (LT) and endurance speed
- 80-90% max HR
- Lactate 3.5-5mmol
- Pace you can maintain for 1 hr
  - Fast but controlled
  - Training for short events-train at high end of threshold to improve LT
  - Marathons-train at low end
- Talk in bursts between breaths

ZONE 4

- Endurance Race Pace and max VO2
- 90-95% max HR
- Lactate 5-10 mmol
- Rely heavily on anaerobic energy sources
- Unable to maintain for long periods of time
  - O2 demand > O2 consumption
- 6-15km race pace at low end of zone (6-10 min)
- 1-5km race pace at upper end (2-6 min)
- Able to say a word or 2, breathing heavy



ZONE 5

- SPEED
- 95-100% max HR
- Lactate 8mmol+
- Short and fast to improve max power and speed
- 5-15 sec with long rest periods
- Unable to talk

FIELD TESTS

- **Determine Max HR**
  - Warm-up
  - Long hill (2+ min to climb)
  1. Build up to pace you could maintain for 20 min
     - Recovery
  2. Build up to 3km pace
     - Recovery
  3. Run pace you could maintain for 1 min (run half the hill)-check for max HR
     - Cooldown
- **Calculate HR zones based on Max HR**

- **Determining Lactate Threshold:**
- 30 min time trial (solo):
  - After first 10 minutes, hit "lap" on watch and record Heart Rate for the final 20 minutes
  - Average HR over the last 20 min will be approximately HR of Lactate Threshold (L3)
    - Determine zones based on this HR

- 200m repeats on track:
  - Gradually increase speed and monitor HR every 200m
  - When HR begins to level off: Lactate Threshold

TAKE AWAY

- Incorporate threshold training (summer/fall) to increase LT and therefore improve fitness and race pace
  - Higher LT= Greater Fitness = faster race pace = VICTORY
- Know your Zones and stick to them!
  - Train with a HR monitor
  - Smart purposeful training

- Look for an email for the next EU Lecture in July!
  - Periodization, training plan breakdown, proper endurance training
    - Volume, Intensity, Strength, Agility + Speed