Physiology of Endurance Running

By: Thomas Bambach

Goals

01

To provide a high level overview of what happens ‘under the hood’ when training

02

To help develop a common understanding and language

03

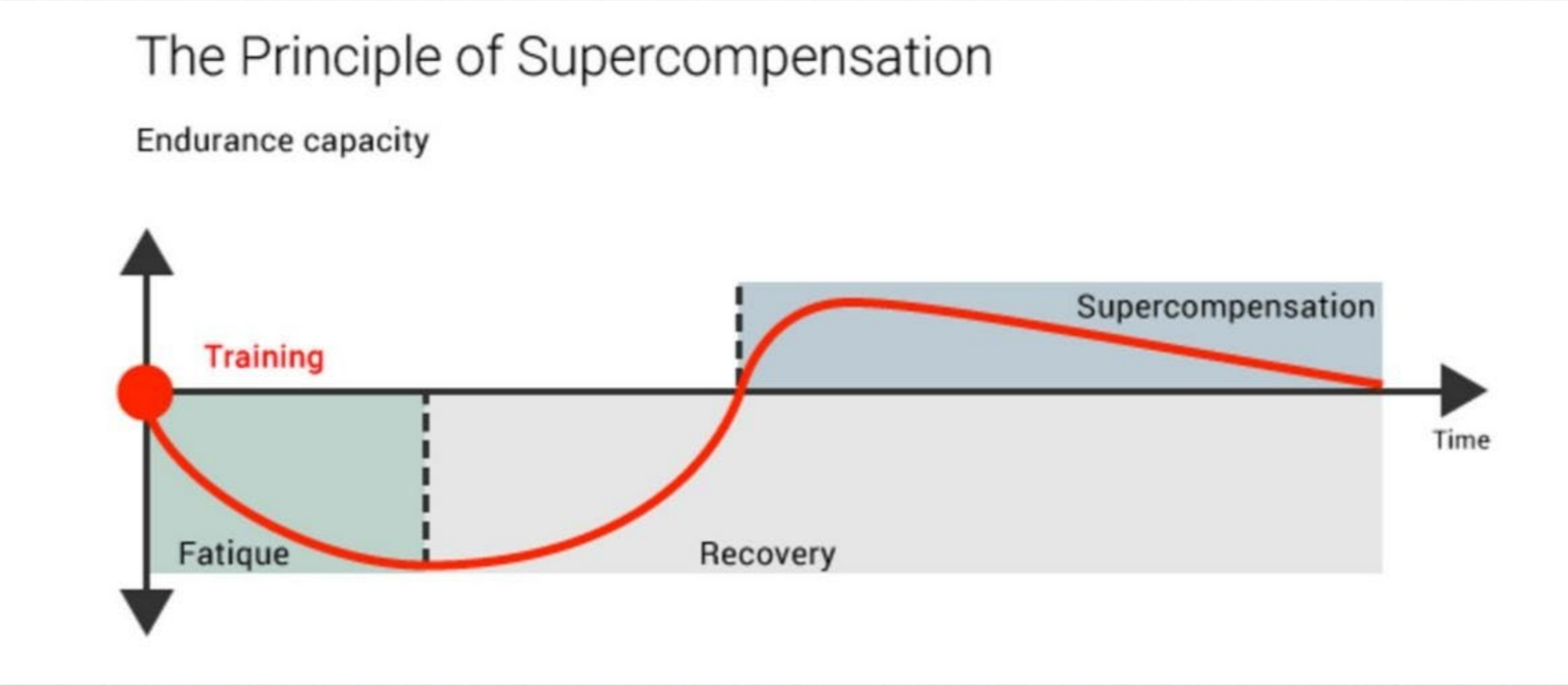
Establish a training ‘Tool kit’ - Which sessions do what?

Exercise Physiology

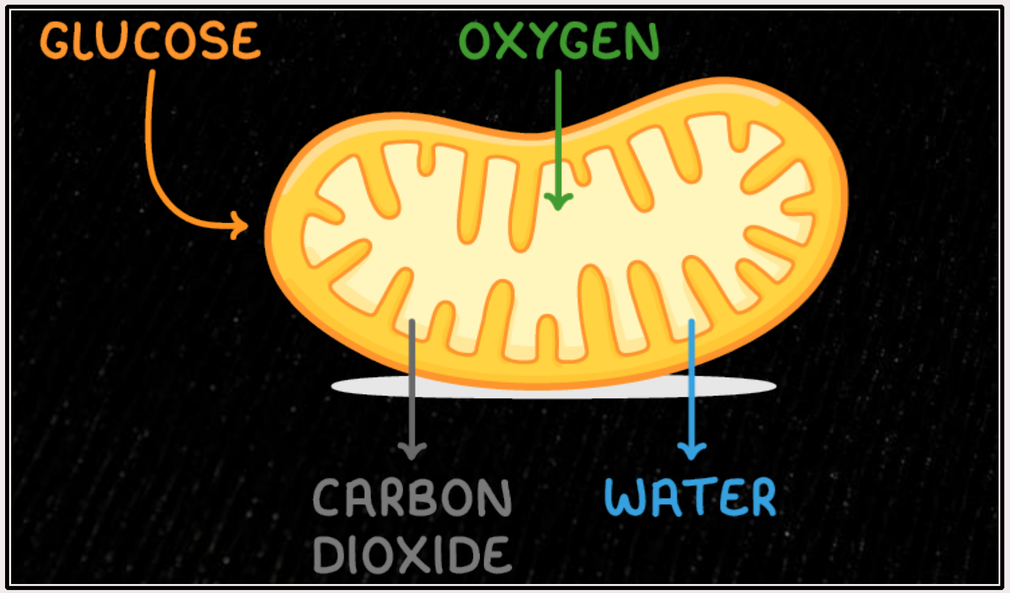
- How does the body work?
- How the body responds to exercise.
- How can exercise physiology help me?
  - Identify training zones
  - Link training sessions to specific adaptations
  - Design of the overall training plan.

- It’s going to speed up your development as a coach.
- Knowledge of how the body responds to stress both in the short and long term - allows us to pivot when things aren’t going how we planned.

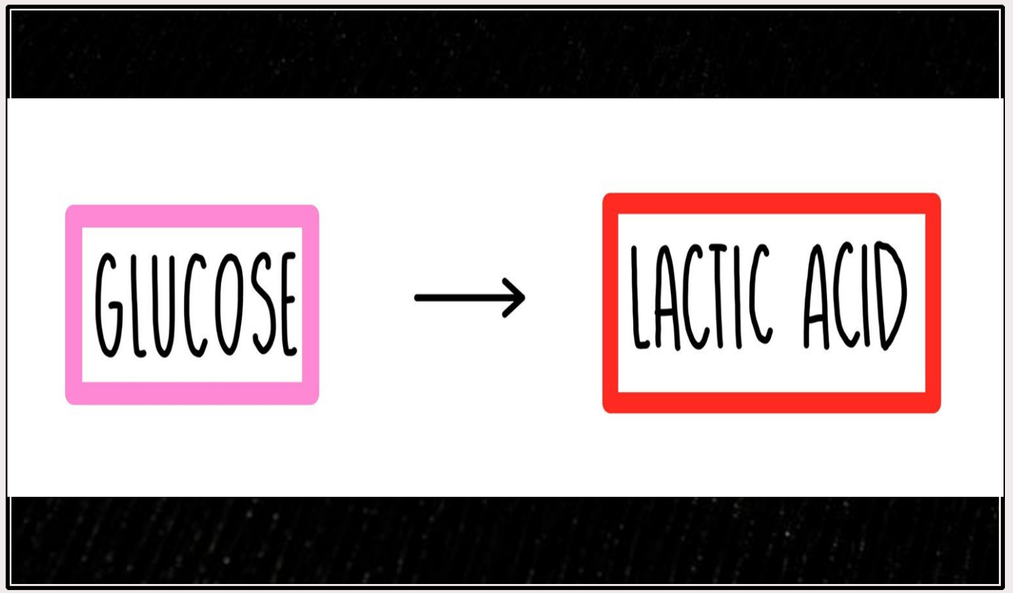
Adaptations



The Energy Systems

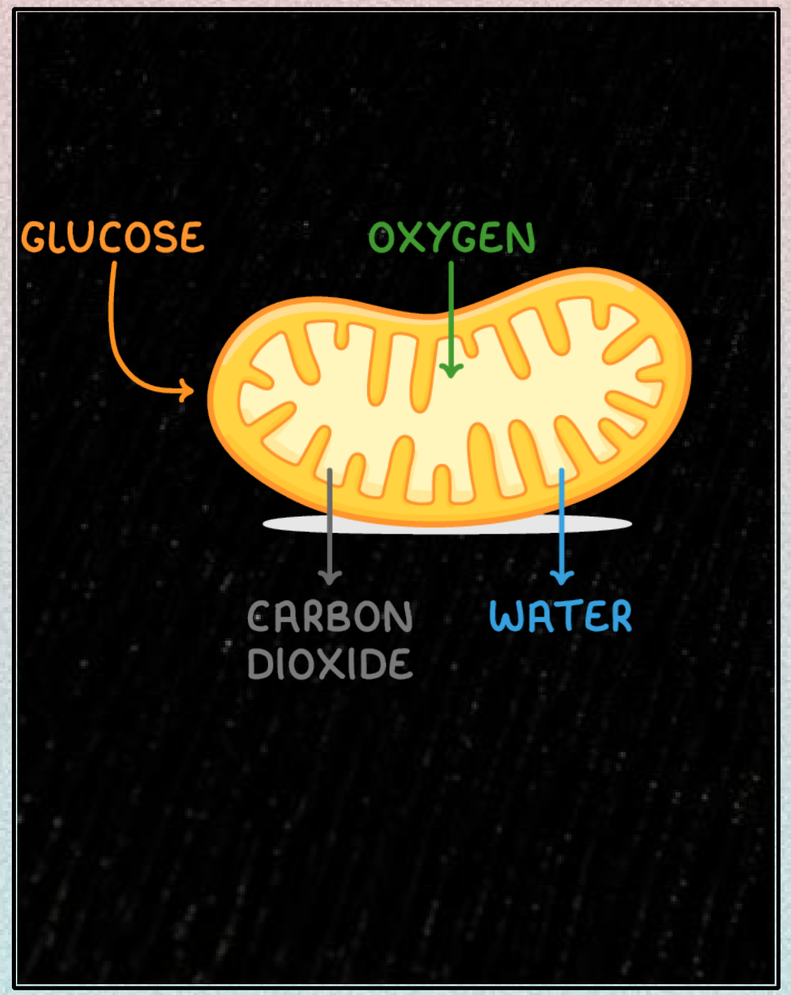


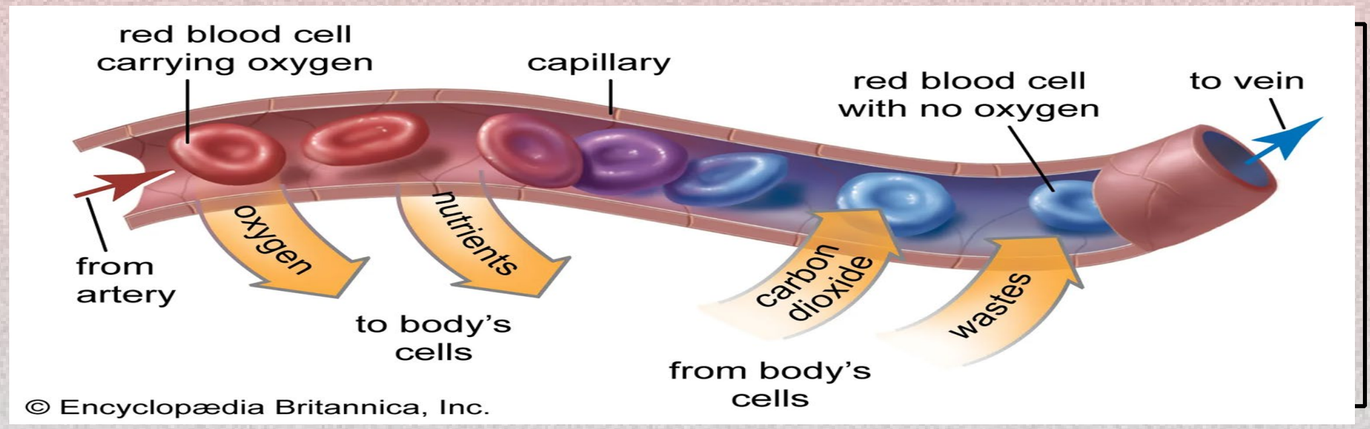
Aerobic System
(With Oxygen)



Anaerobic System
(Without Oxygen)

Aerobic Energy Production



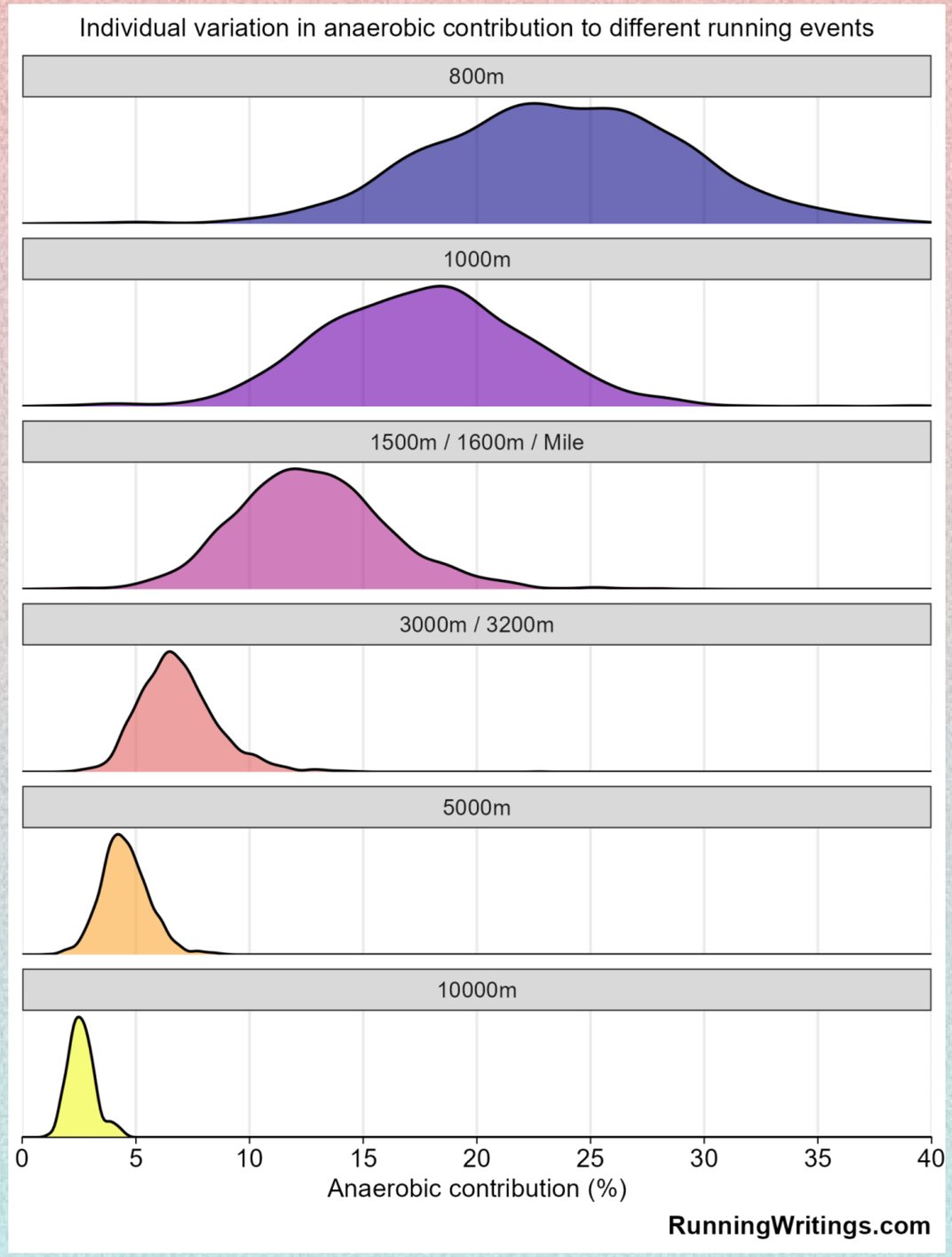


Total Energy Contribution

70% + of total energy production in races 1600m+ comes from the aerobic system.

Slow to adapt

The Aerobic System takes time and consistent pressure to make adaptations, but can be trained constantly for long periods of time.


Individual variation in anaerobic contribution to different running events
800m
1000m
1500m / 1600m / Mile
3000m / 3200m
5000m
10000m
0
5
10
15
20
25
30
35
40
Anaerobic contribution (%)
RunningWritings.com

Adaptations to the Aerobic System

01

Higher Blood Volume

More Blood = More oxygen

02

Capillarization

03

Larger / More Mitochondria

04

Larger Heart Muscle

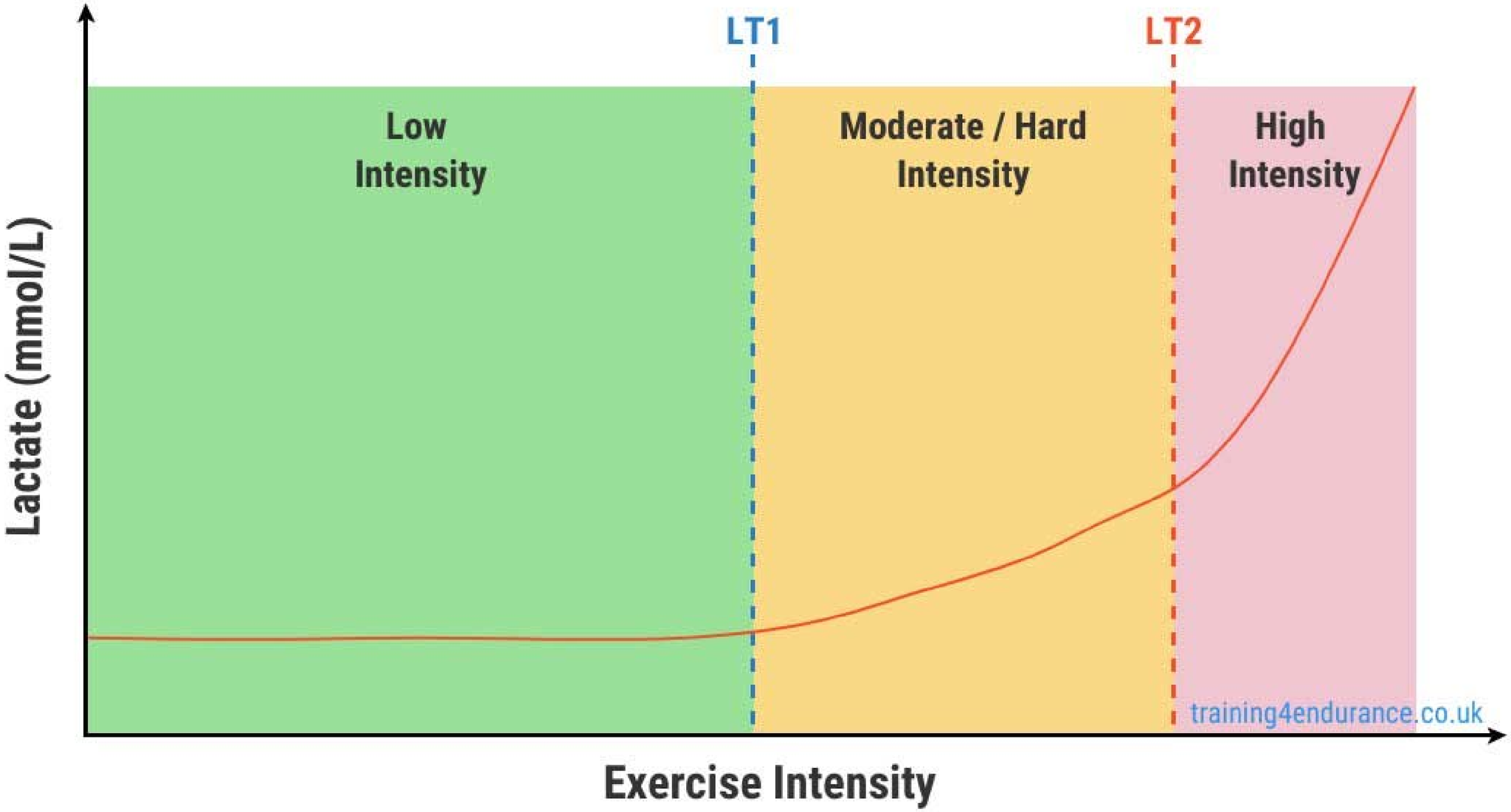
05

Fatigue Resistance

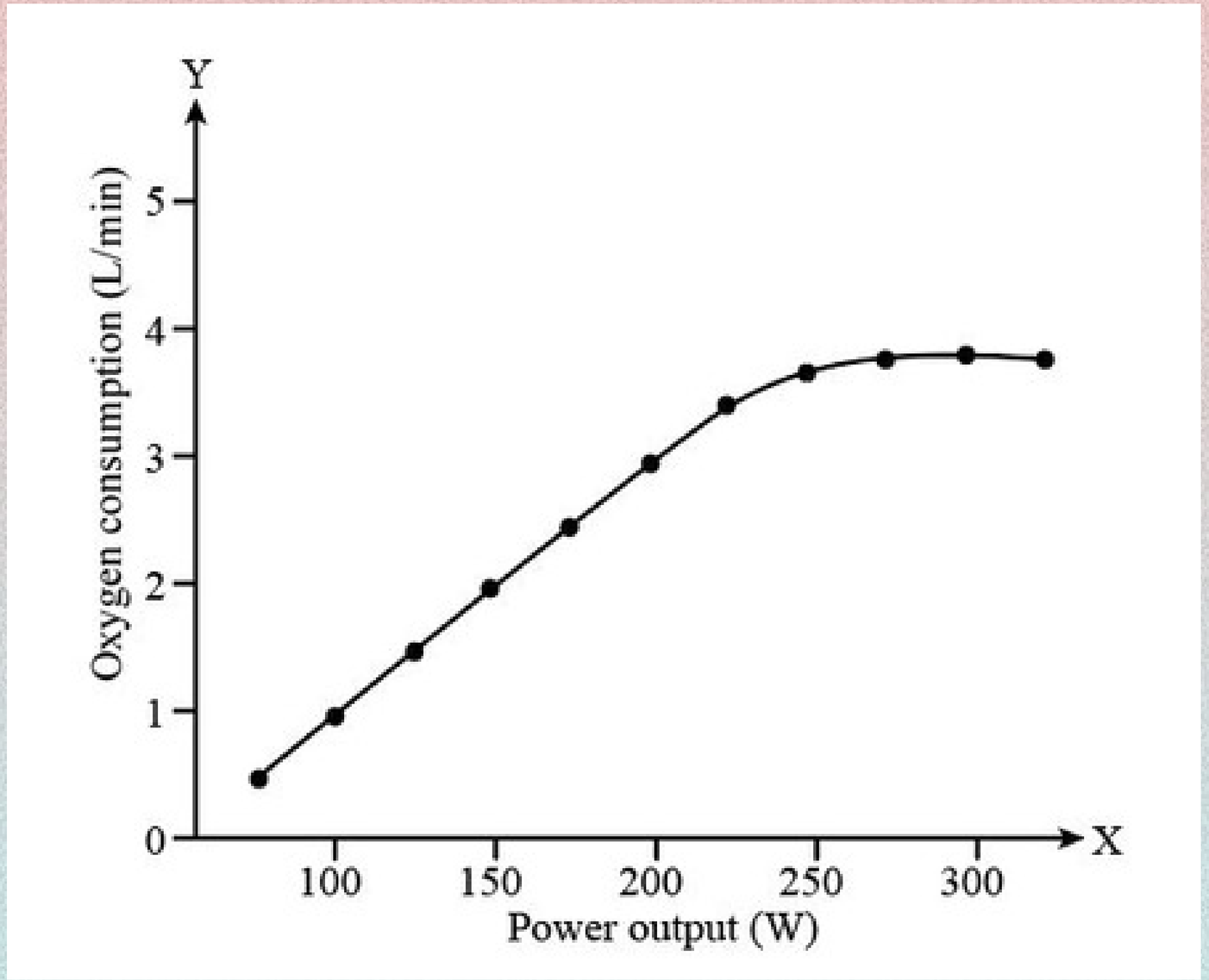
06

Running Faster

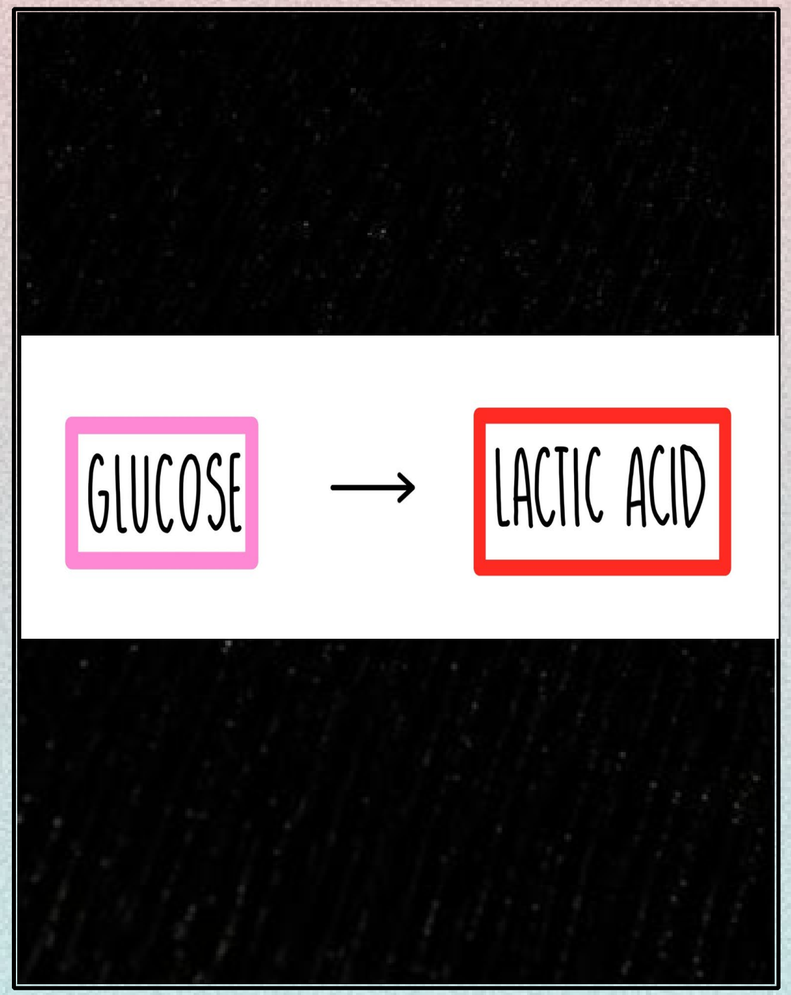
Threshold(s)

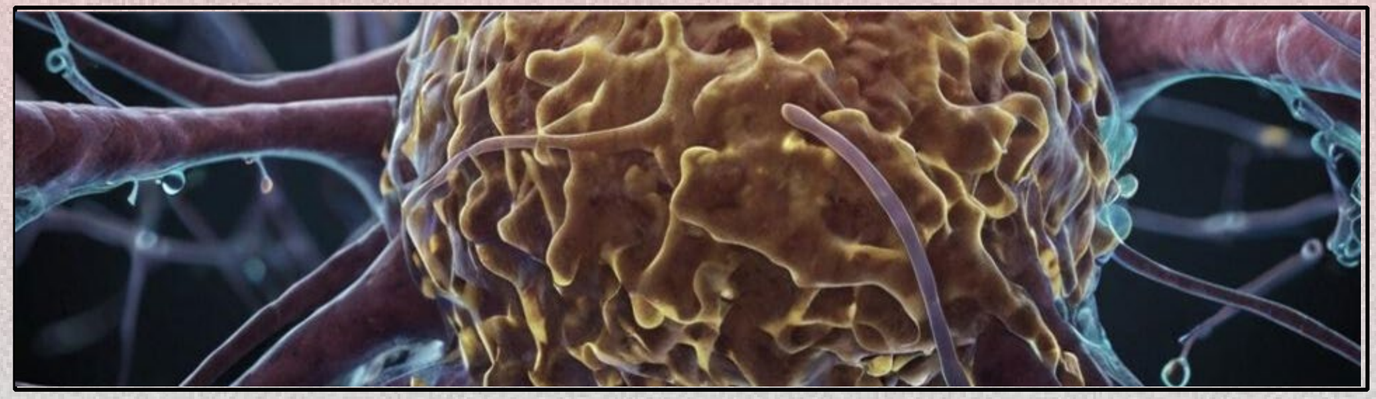

LT1
LT2
Low Intensity
Moderate / Hard Intensity
High Intensity
Lactate (mmol/L)
Exercise Intensity
training4endurance.co.uk

Vo2 Max


Y
Oxygen consumption (L/min)
5
4
3
2
1
0
X
100
150
200
250
300
Power output (W)

Anerobic Energy Production





“Fast energy”

Lots of energy, but it comes at a cost.

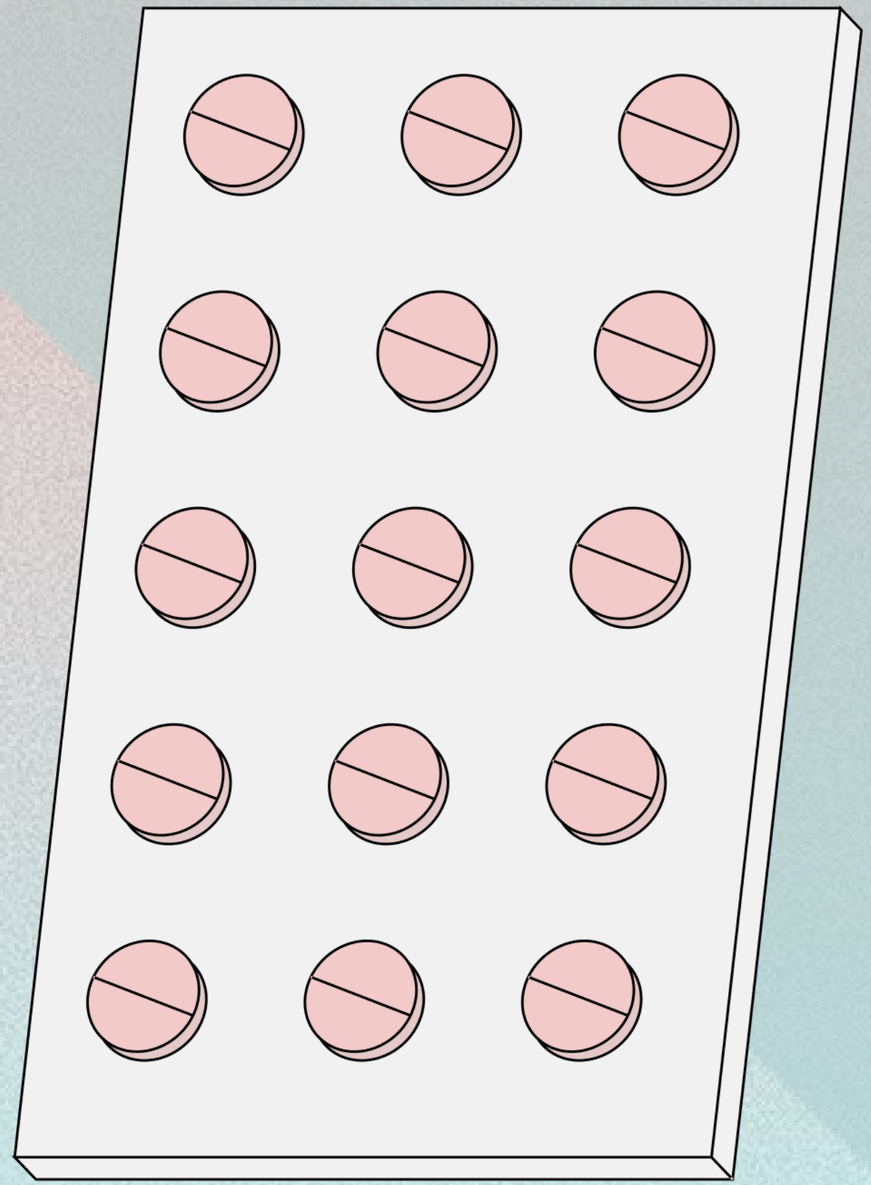
Highly Trainable

We can see anaerobic adaptations in as little as 48 hours. However, total capacity is limited. Further research is needed.

System	Adaptation Speed	Adaptation Ceiling	Recovery Cost
Aerobic System	Slow	High / Unknown	Generally Lower
Anaerobic System	Fast	Relatively Low	Generally Higher

HOW?

All the science is great - HOW do we improve the Aerobic system?



Examples

Easy Running

Easy running / Low Intensity Training is the most cost effective way to improve the aerobic system

High(er) volume

Volume is the primary driver of aerobic gains. Volume is individual in nature.

Consistency

Adaptations come slowly - Perfect for offseason focus

Duration / Intensity

Using certain intensities (Threshold) we can jumpstart the adaptation process.

Examples

Activity	Stimulus	Recovery Cost
Easy Running	*	*
Moderate Running	**	**
Long Run	***	***
Threshold Training	***	**
V02 Max Training	*****	*****

6:10 1600m girl who runs 25-35 miles per week

Activity	Sample
Easy Running	4-6 mile easy run (8:20+ per mile)
Moderate Running	2-3 miles @ 7:40-7:55 per mile
Long Run	6-8 miles at an easy pace
Threshold Training	3 x 1 mile @ 7:20-7:30 per mile w/ 1’ recovery
V02 Max Training	6 x 800 @ 3:20-25 w/ 2:00-3:00 recovery

10:20 3200m boy who runs 35-45 miles per week

Activity	Sample
Easy Running	4-7 mile easy run (7:30+ per mile)
Moderate Running	4-5 miles @ 6:10-6:25 per mile
Long Run	8-10 miles at an easy pace
Threshold Training	6-7 x 1000m @ 3:35-3:45 (5:48-6:00) w/ 1’ recovery
V02 Max Training	6 x 800 @ 2:35-45 w/ 2:00-3:00 recovery

Anaerobic Training

Increased Fatigue Resistance
Fatigue resistance to paces around race pace.

Low(er) volume
Intensity is the primary driver of adaptations for anaerobic training. High volumes can be dangerous

Scalpel not a Sledgehammer
Adaptations come quickly, can carefully dose workouts to achieve results.

Racing is Training
Racing is Anaerobic Training. We can replace a good anaerobic workout with an 400/800/1600m race.

Anaerobic Training

- Anaerobic Training should be connected to the **SPEED** of the event.
  2:00 for 800m is :15 per 100m. Does not matter if you are short or tall, skinny or muscular. The SPEED of the event is constant.

- Anaerobic Training should be used to ENHANCE, not to REPLACE foundational training.

- “Aerobic Capacity determines anaerobic potential” - Al Carius

- Anaerobic training is typically where we can see athletes getting “overcooked”

Anaerobic Training

Example - for 2:20 800m girl.
4 x 200 in 36-37 (recovery :45) - Rest 3’
4 x 200 in 35 (recovery 2’) - Rest 4’
4 x 200 in 33.5 (recovery 3’)

Example - for 2:00 800m boy.
4 x 200 in 31-32 (recovery :45) - Rest 3’
4 x 200 in 30 (recovery 2’) - Rest 4’
4 x 200 in 28.5 (recovery 3’)

For 800m -
- **3 sets of 300’s -> Increasing rest, decreasing pace each set.**

Example - for 2:20 800m girl.
3 x 300 in 54-55 (recovery 1’) - Rest 3’
3 x 300 in 52-53 (recovery 2’) - Rest 4’
2 x 300 in 50-51 (recovery 3’)

Example - for 2:00 800m boy.
3 x 300 in 47-48 (recovery 1’) - Rest 3’
3 x 300 in 46-47 (recovery 2’) - rest 4’
2 x 300 in 44-45 (recovery 3’)

Volume Guidelines

Race Distance	Total Volume
800m	1000m - 2500m
1600m	1800-3200m
3200m	2500-5000m

Thank You

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