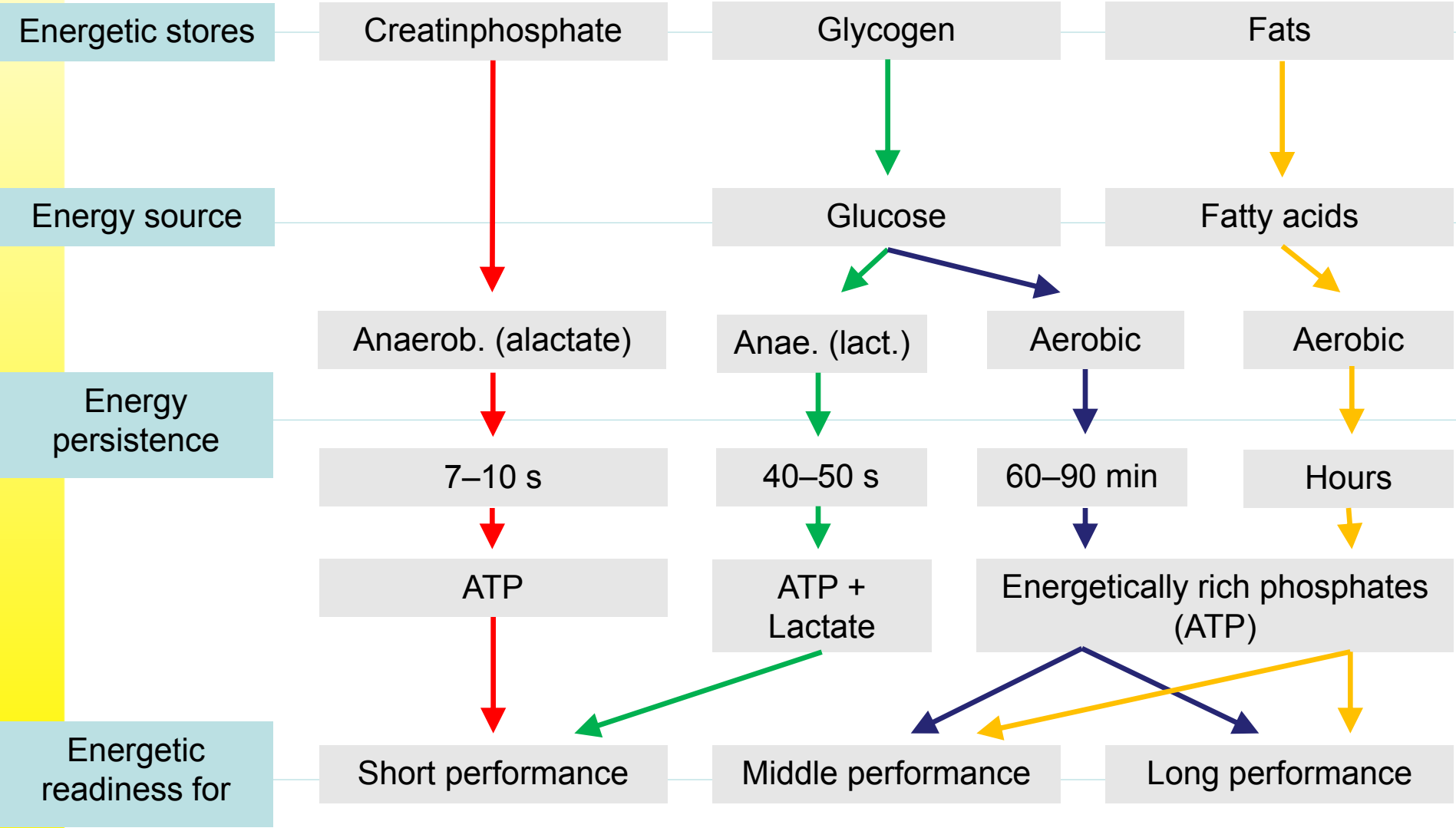
Anaerobic Threshold

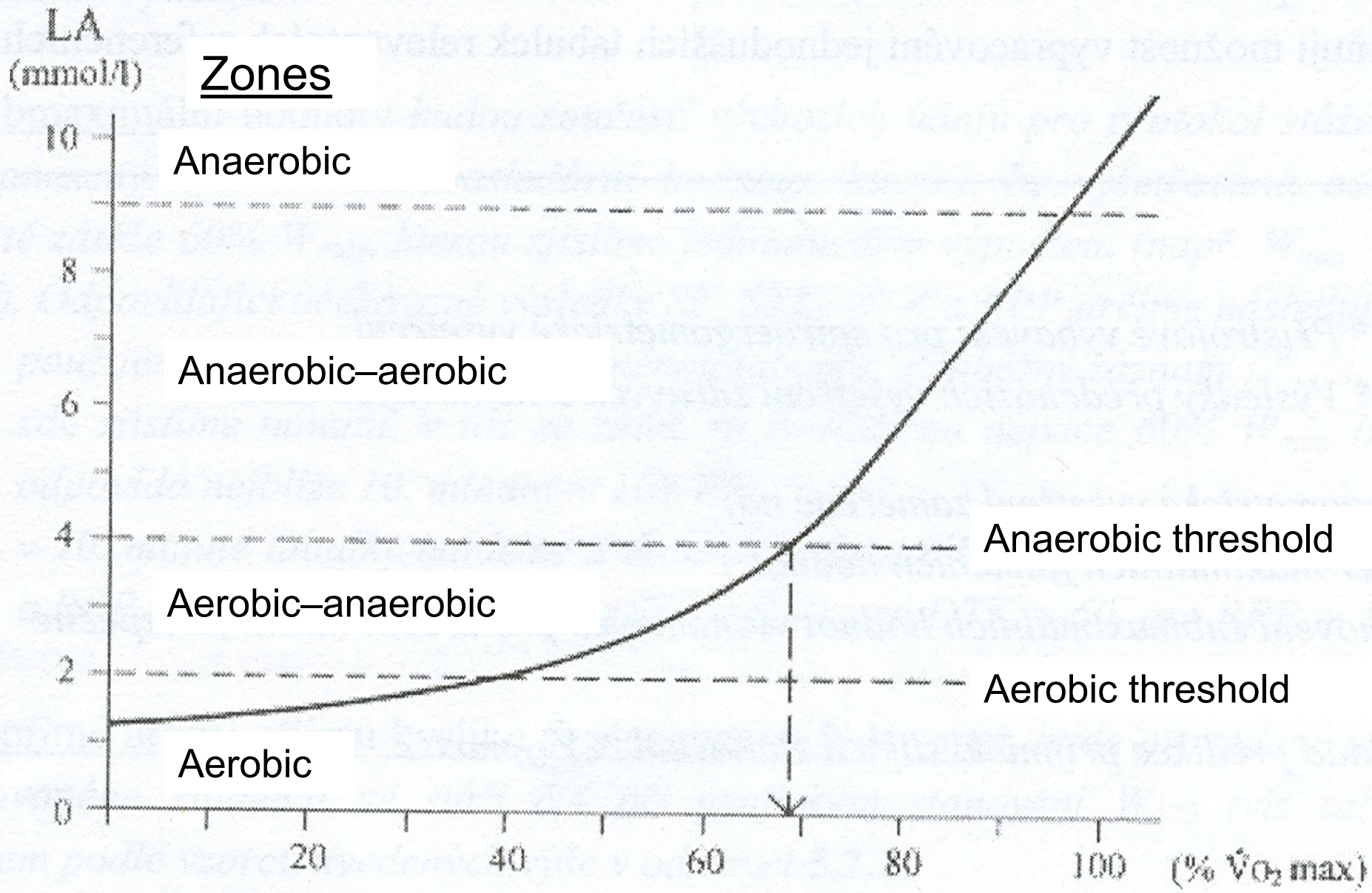

Energetic stores
Creatinphosphate
Glycogen
Fats
Energy source
Glucose
Fatty acids
Anaerob. (alactate)
Anae. (lact.)
Aerobic
Aerobic
Energy persistence
7–10 s
40–50 s
60–90 min
Hours
ATP
ATP + Lactate
Energetically rich phosphates (ATP)
Energetic readiness for
Short performance
Middle performance
Long performance

Anaerobic Threshold

- Point during intense exercise at which metabolism becomes increasingly more anaerobic
- Reflects the lactate threshold under most conditions, though the relationship is not always exact
- Identified by noting an increase in $\dot{V}_E/\dot{V}O_2$ without an concomitant increase in the ventilatory equivalent for carbon dioxide ($\dot{V}_E/\dot{V}CO_2$)

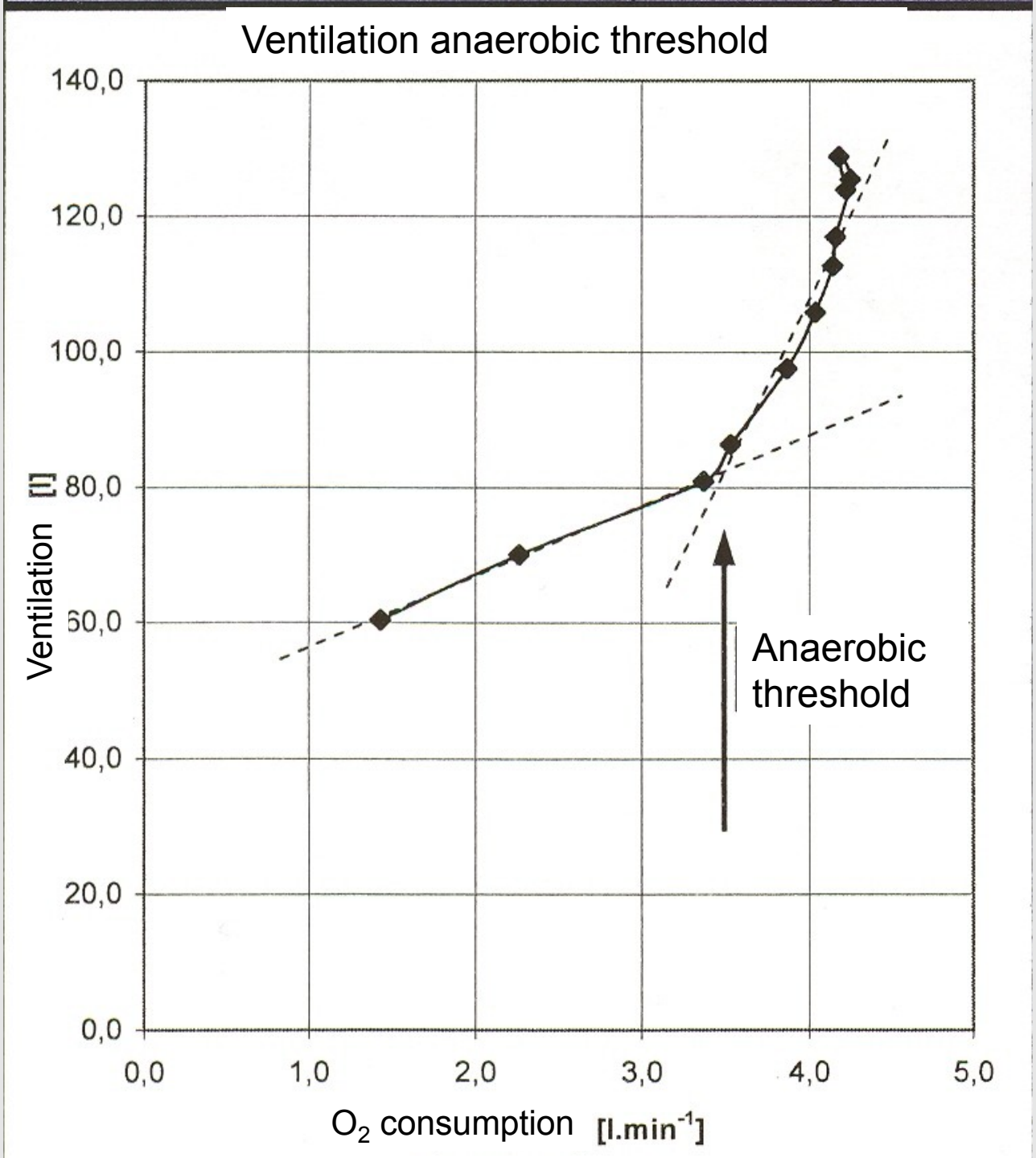
- Marker of aerobic abilities
- Demarks oxidative (aerobic) and non-oxidative (anaerobic) energetic coverage
- Occurrs at the moment of rapid increase of non-oxidative energetic coverage followed by blood lactate accumulation
- (Low intensity workout (steady-state) is covered with oxidative phosphorylation completely)

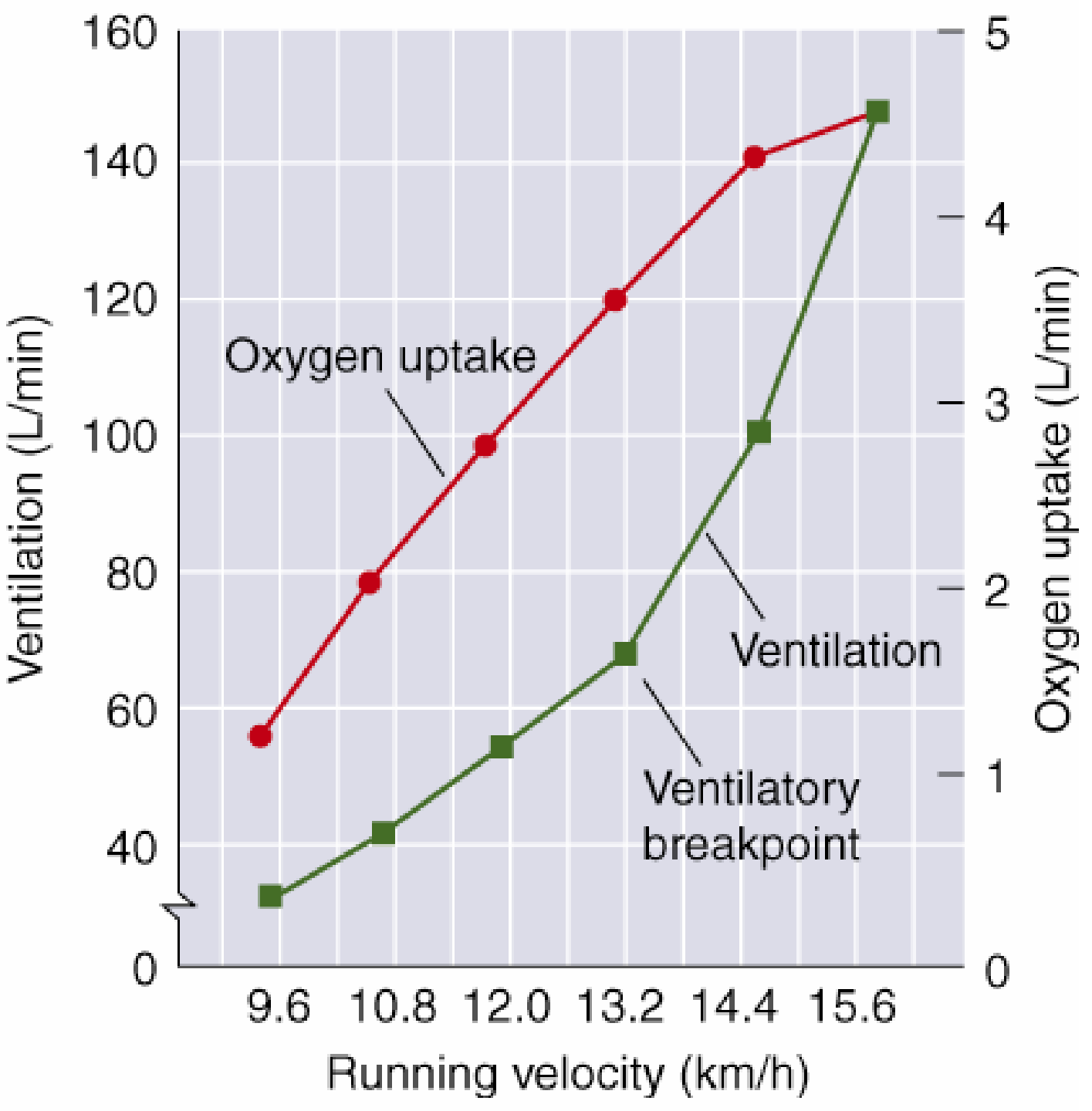
Zones

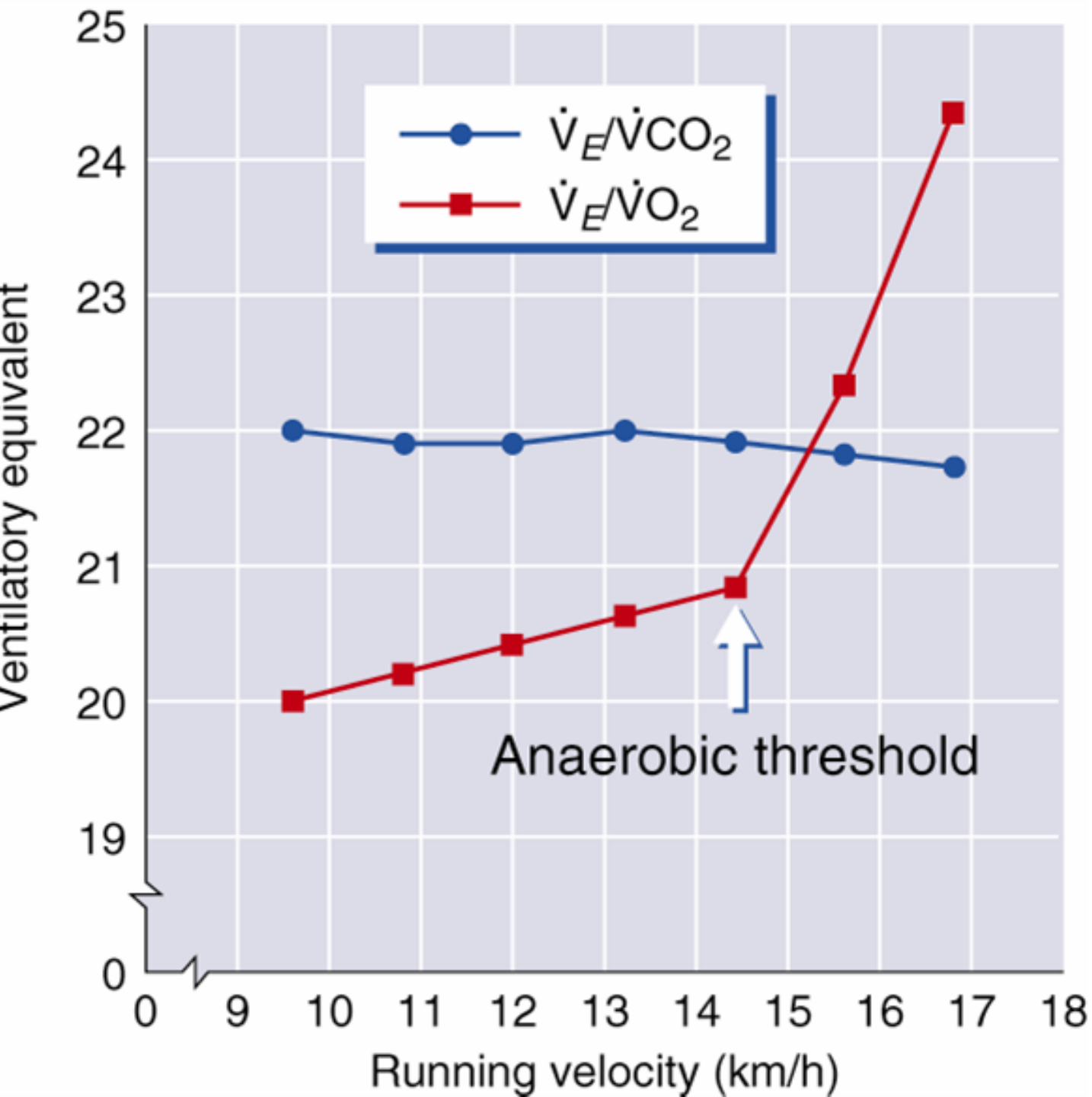

LA
(mmol/l)
10
8
6
4
2
0
Anaerobic
Anaerobic–aerobic
Aerobic–anaerobic
Aerobic
Anaerobic threshold
Aerobic threshold
20
40
60
80
100
(% $\dot{V}O_2$ max)

Anaerobic threshold assessment based on ventilation

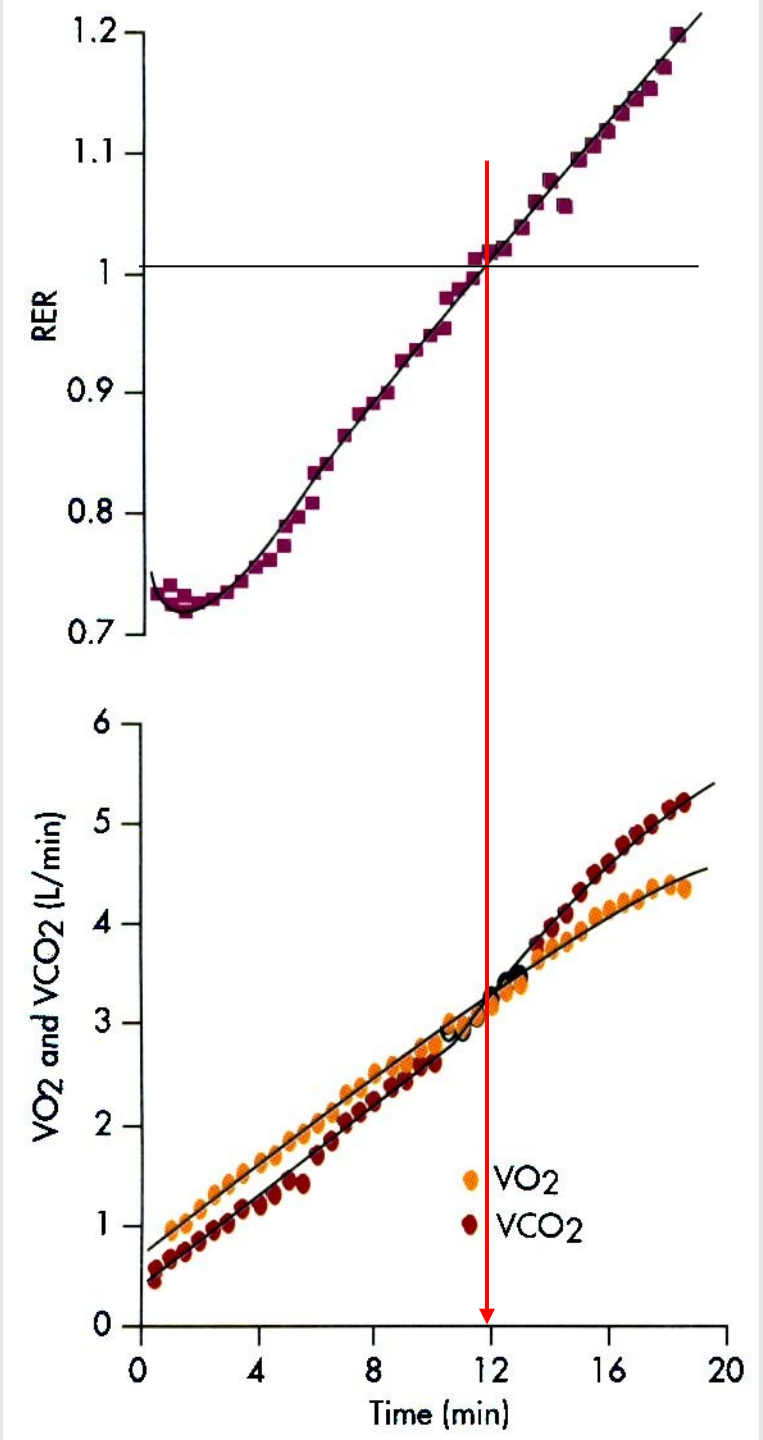
- Well trained athlete bears VO_2max intensity 10–15 minutes
- For longer loads the intensity has to decrease
- Intensity over 50 % VO_2max the fast-twitch fibres activate
- The fast-twitch fibres work on anaerobic basis
- The threshold lies approximately at the point of higher intensity ventilation, CO_2 exhalation and O_2 culmination

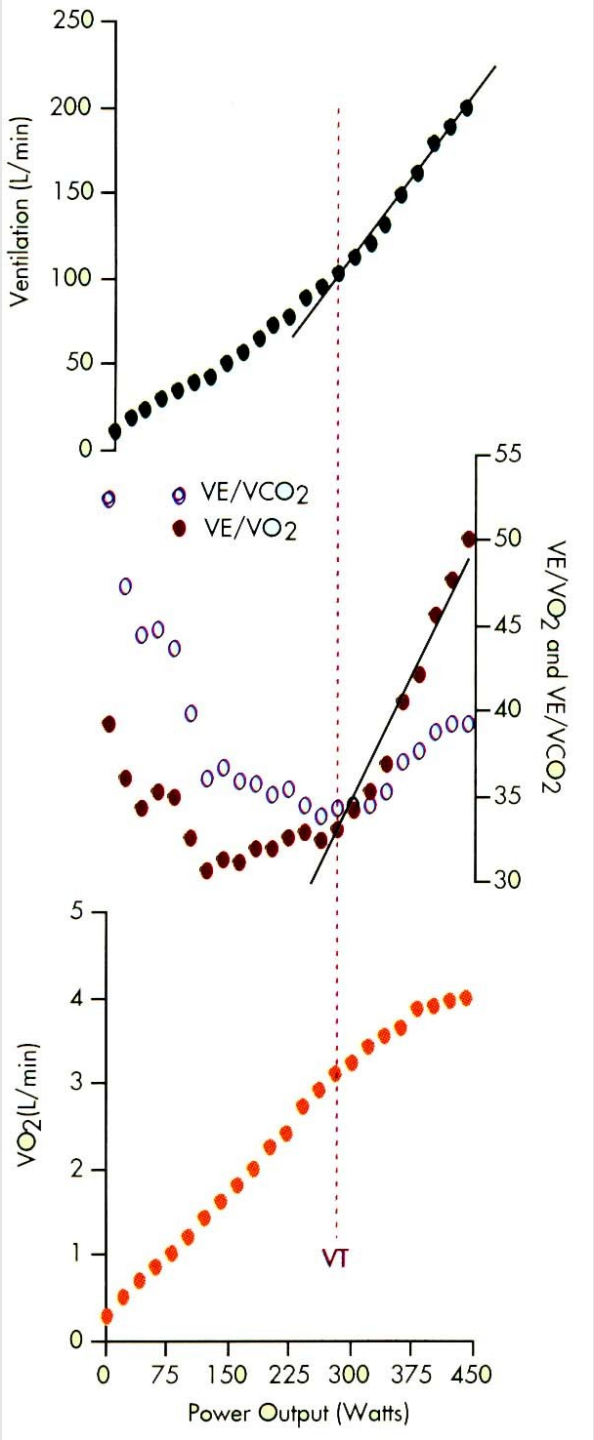

Ventilation anaerobic threshold
140,0
120,0
100,0
80,0
60,0
40,0
20,0
0,0
Ventilation [l]
0,0
1,0
2,0
3,0
4,0
5,0
O2 consumption [l.min-1]
Anaerobic threshold


160
140
120
100
80
60
40
0
Ventilation (L/min)
5
4
3
2
1
0
Oxygen uptake (L/min)
Oxygen uptake
Ventilation
Ventilatory
breakpoint
9.6
10.8
12.0
13.2
14.4
15.6
Running velocity (km/h)



- Faster ventilation, same O_2 consumption
- Faster ventilation, slightly higher CO_2 expulsion

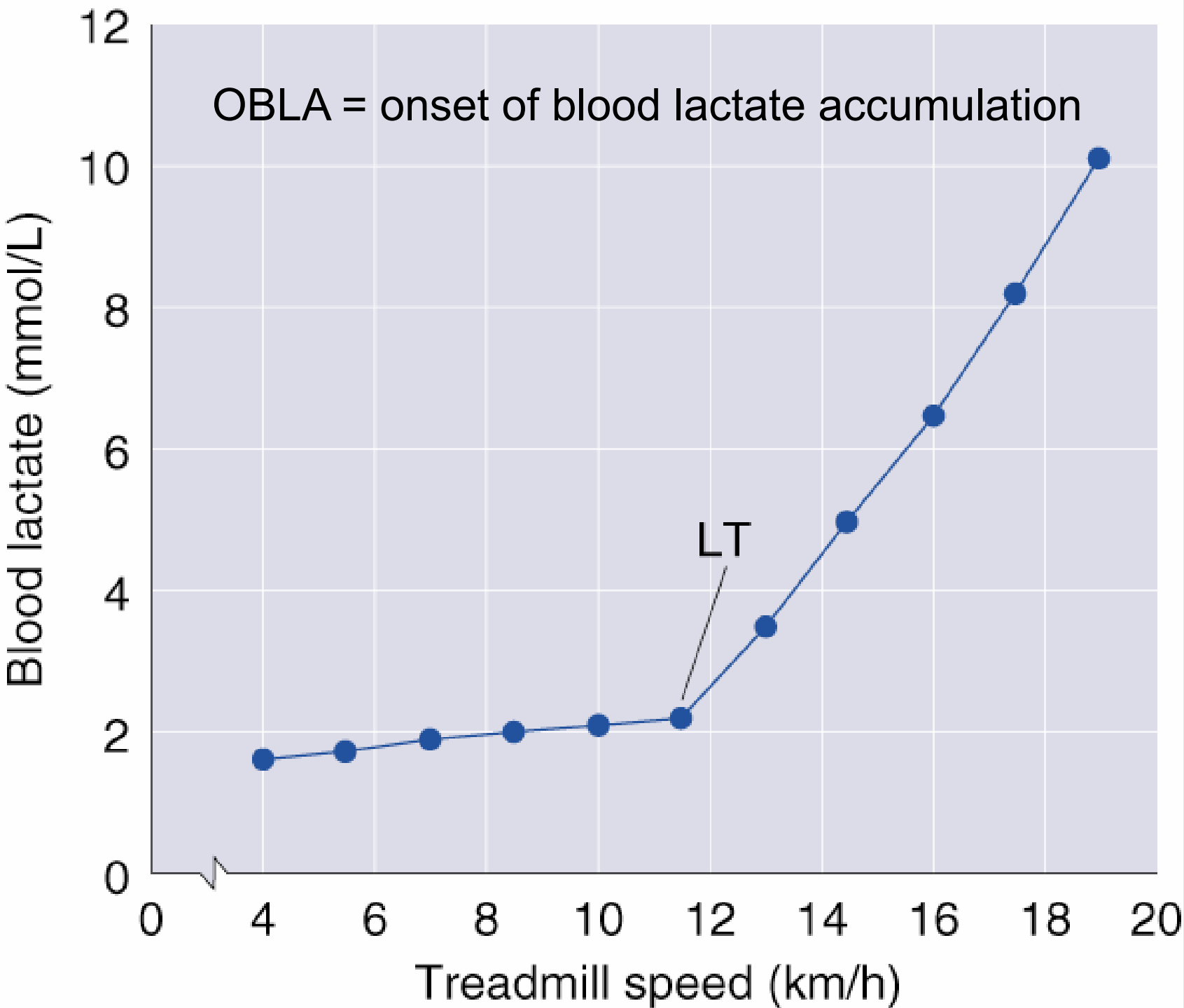

RER
1.2
1.1
1
0.9
0.8
0.7
VO2 and VCO2 (L/min)
6
5
4
3
2
1
0
VO2
VCO2
0
4
8
12
16
20
Time (min)

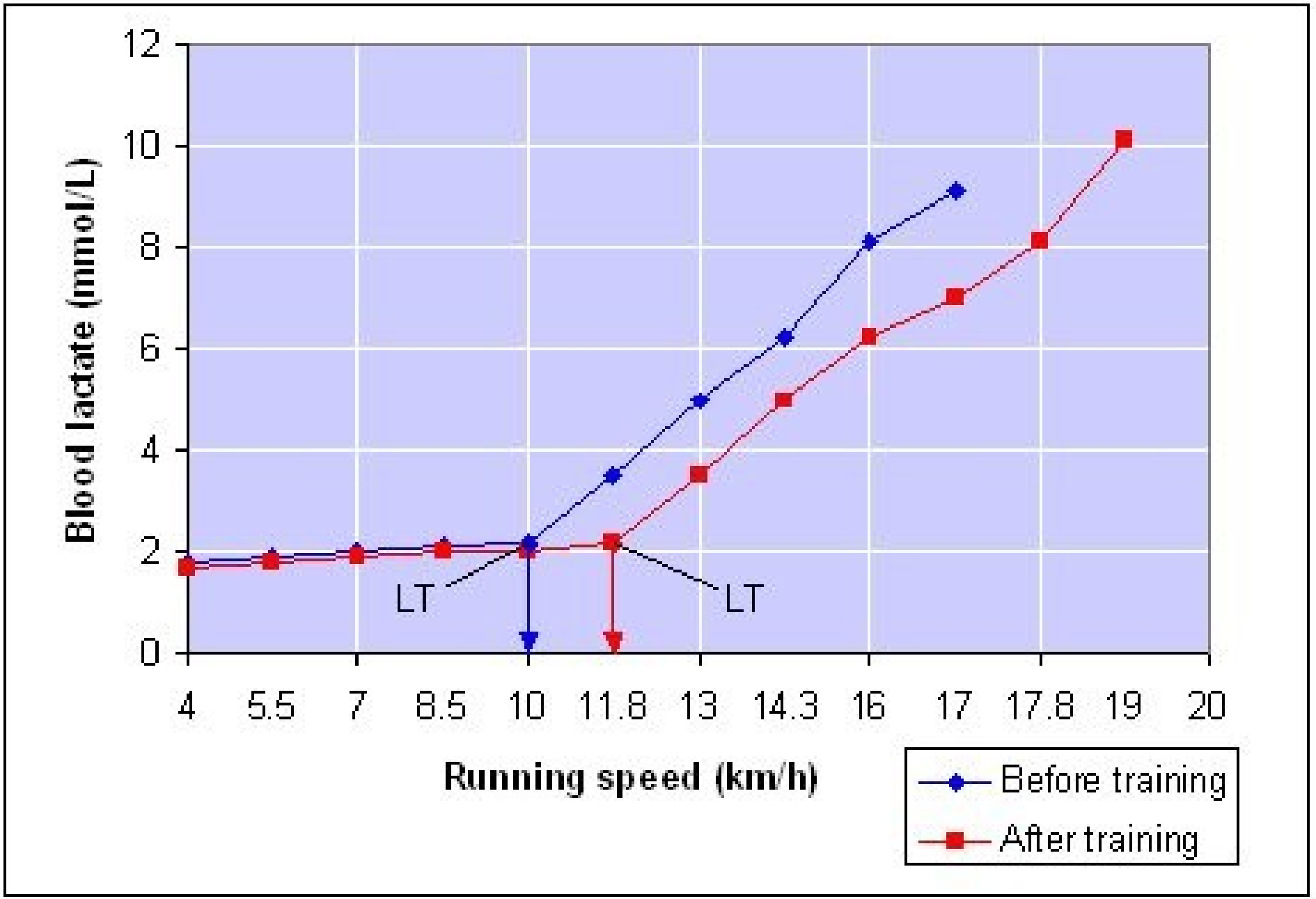

Ventilation (L/min)
250
200
150
100
50
0
VE/VCO2
VE/VO2
55
50
45
40
35
30
VE/VO2 and VE/VCO2
VO2(L/min)
5
4
3
2
1
0
VT
0
75
150
225
300
375
450
Power Output (Watts)

Lactate curve

- A product of anaerobic glycolysis is lactate
- Lactate outflow from muscles occurs through blood
- Lactate rest levels are below 2 mmol/l
- Lactate produced is metabolised by muscles (working and resting), heart and liver
- At low intensity exercise, the lactate metabolism doesn‘t allow to build it up (dynamic balance)

- Build-up lactate leads to acidosis causing fatigue – lowering load intensity, eventually stopping it
- Break of lactate dynamic balance occurs approximately at anaerobic threshold (4 mmol/l)
- By training, lactate threshold can be shifted towards higher intensity workout (metabolic efficacy)


OBLA = onset of blood lactate accumulation
LT
Blood lactate (mmol/L)
Treadmill speed (km/h)
0
2
4
6
8
10
12
0
4
6
8
10
12
14
16
18
20


Blood lactate (mmol/L)
12
10
8
6
4
2
0
LT
LT
4
5.5
7
8.5
10
11.8
13
14.3
16
17
17.8
19
20
Running speed (km/h)
Before training
After training

Test du parler – Croteau et al.

- „Speech threshold“
- Estimates anaerobic threshold
- Increased ventilation disables continuous speech

Rating of perceived exertion (RPE)

6 – No exertion at all

7 – Extremely light

8

9 – Very light

10

11 – Light

12

13 – Somewhat hard

14

15 – Hard

16

17 – Very hard

18

19 – Extremely hard

20 – Maximal exertion

Max Heart Rate	VO_2 max	Lactate	RPE Classification of Threshold	Intensity
< 35 %	< 30 %	< 40 %	< 10	Very light
35–59 %	30–49 %	40–65 %	10–11	Light
60–79 %	50–74 %	65–83 %	12–13	Moderate
80–89 %	75–84 %	83–99 %	14–16	Heavy
≥ 90%	≤ 85 %	100 %	> 16	Very heavy

Runner	HRmax	VO_2max/kg	Speed at VO_2max	VO_2/kg at anaerobic threshold	% of VO_2max/kg at anaerobic threshold	RERmax CO_2/O_2
	(BPM)	$(ml \cdot kg^{-1} \cdot m^{-1})$	$(km \cdot h^{-1})$	$(ml \cdot kg^{-1} \cdot m^{-1})$		
1	198	64.0	23	51.9	81	1.33
2	177	61.8	22	54.2	88	1.13
3	193	70.4	23	56.8	81	1.12
4	202	75.2	23	60.4	80	1.12
5	197	56.7	19	45.9	81	–

- RER (RQ) over 1.00 means exclusive glycogen supplies consumption

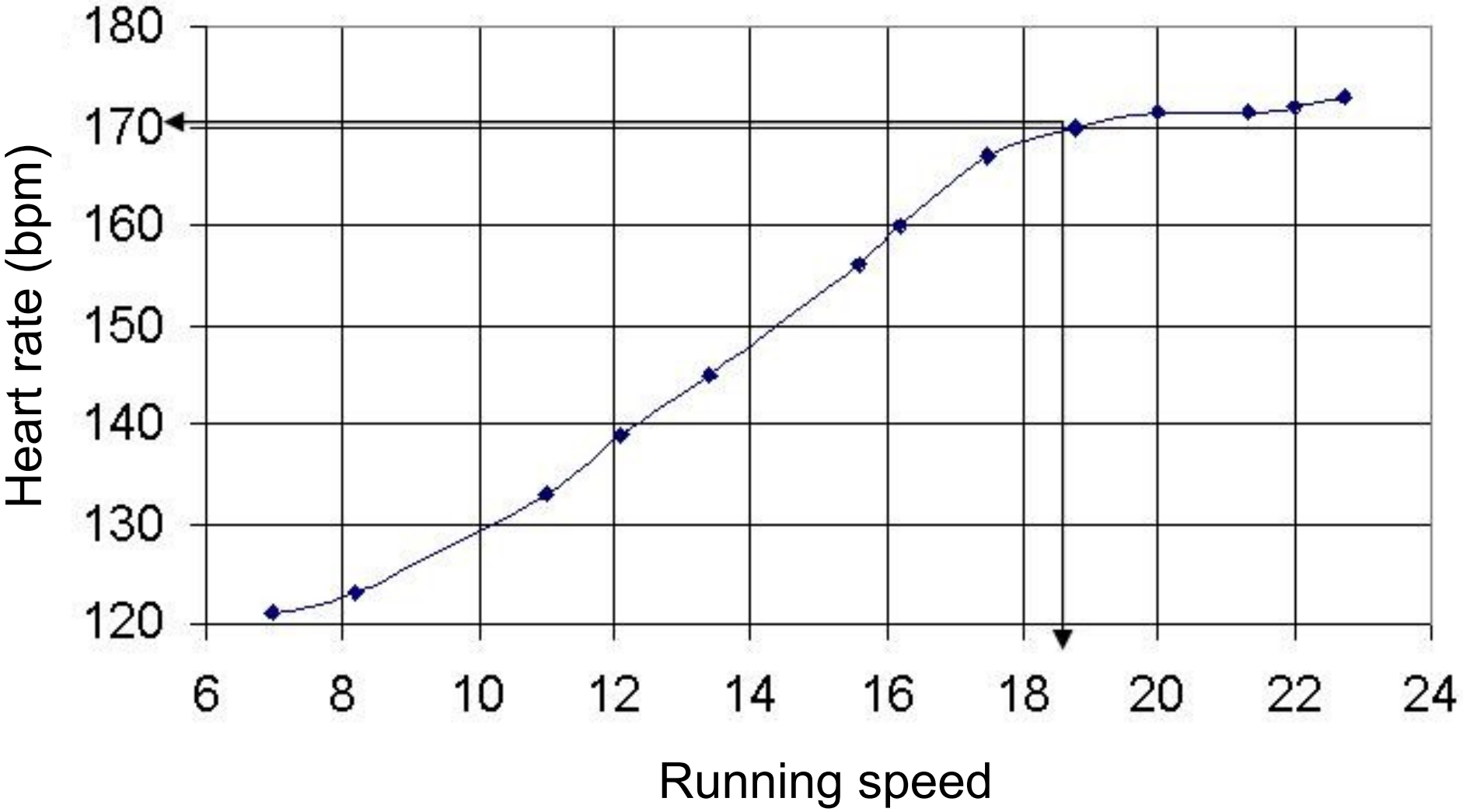
Conconi test

- Anaerobic threshold assessment test
- Heart rate is dependent on load intensity
- During increasing load, from 120 bpm increase linearly
- At anaerobic threshold intensity, the linearity of the HR curve is deflected
- In acid environment of working muscles the oxygen extraction from blood improves

- Test aims to assess load intensity of deflection point

- Speed increse after 200 m of 0.5–1 km/h

Anaerobic threshold (Conconi)



Runner's endurance

		Threshold speed
Recreational runner	Very low	below 9 km/h
	Low	9–12 km/h
	Good	12–14 km/h
	Very good	above 14 km/h
	Endurance runner	16 km/h and above
	Professional endurance runner	above 20 km/h