

Escola de Educação Física e Esporte
Fisiologia da Atividade Motora I
EFB0105

Adaptações no músculo esquelético frente ao treinamento aeróbio

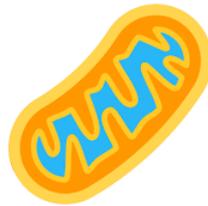
Valéria Leme Gonçalves Panissa

Bloco II - Objetivos da aula

- 1) Utilização de substratos (vídeo 1)**
- 2) Adaptações estruturais e funcionais (vídeo 2)**

Adaptações estruturais e funcionais

- Mitocôndria



- Tipos de fibras



- Área de secção transversa, síntese de proteínas, glicogênio e triacilglicerol no músculo esquelético
- Atividade enzimática

Mitocôndria



THE JOURNAL OF BIOLOGICAL CHEMISTRY
Vol. 242, No. 9, Issue of May 10, pp. 2278-2282, 1967
Printed in U.S.A.

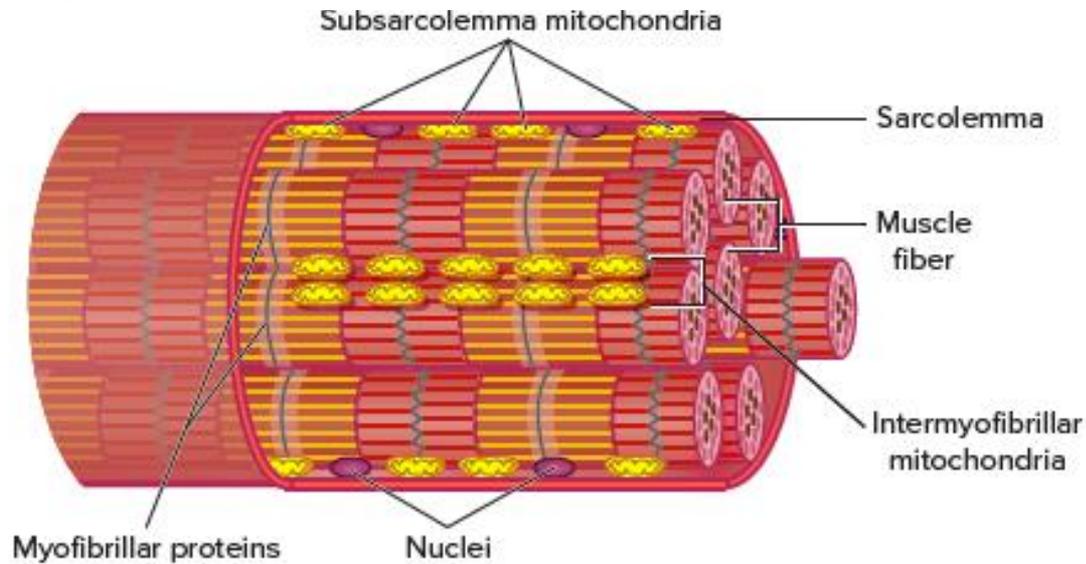
Biochemical Adaptations in Muscle

EFFECTS OF EXERCISE ON MITOCHONDRIAL OXYGEN UPTAKE AND RESPIRATORY ENZYME ACTIVITY IN SKELETAL MUSCLE*

(Received for publication, January 16, 1967)

JOHN O. HOLLOSZY

From the Department of Preventive Medicine, Washington University School of Medicine, St. Louis, Missouri 63110



- John Holloszy, 1967

Cross-talk - intensidade ou volume?

J Physiol 597.16 (2019) pp 4111–4113

CROSSTALK

CrossTalk proposal: Exercise training intensity is more important than volume to promote increases in human skeletal muscle mitochondrial content

Martin J. MacInnis¹ ,

Lauren E. Skelly² and Martin J. Gibala²

¹Faculty of Kinesiology, University of Calgary, Calgary, Alberta, Canada

²Department of Kinesiology, McMaster University, Hamilton, Ontario, Canada

Email: martin.macinnis@ucalgary.ca

Edited by: Francisco Sepúlveda & Paul Greenhaff

J Physiol 597.16 (2019) pp 4115–4118

CROSSTALK

CrossTalk opposing view: Exercise training volume is more important than training intensity to promote increases in mitochondrial content

David J. Bishop^{1,2} , Javier Botella¹ 
and Cesare Granata³

¹Institute for Health and Sport (iHeS), Victoria University, Melbourne, Australia

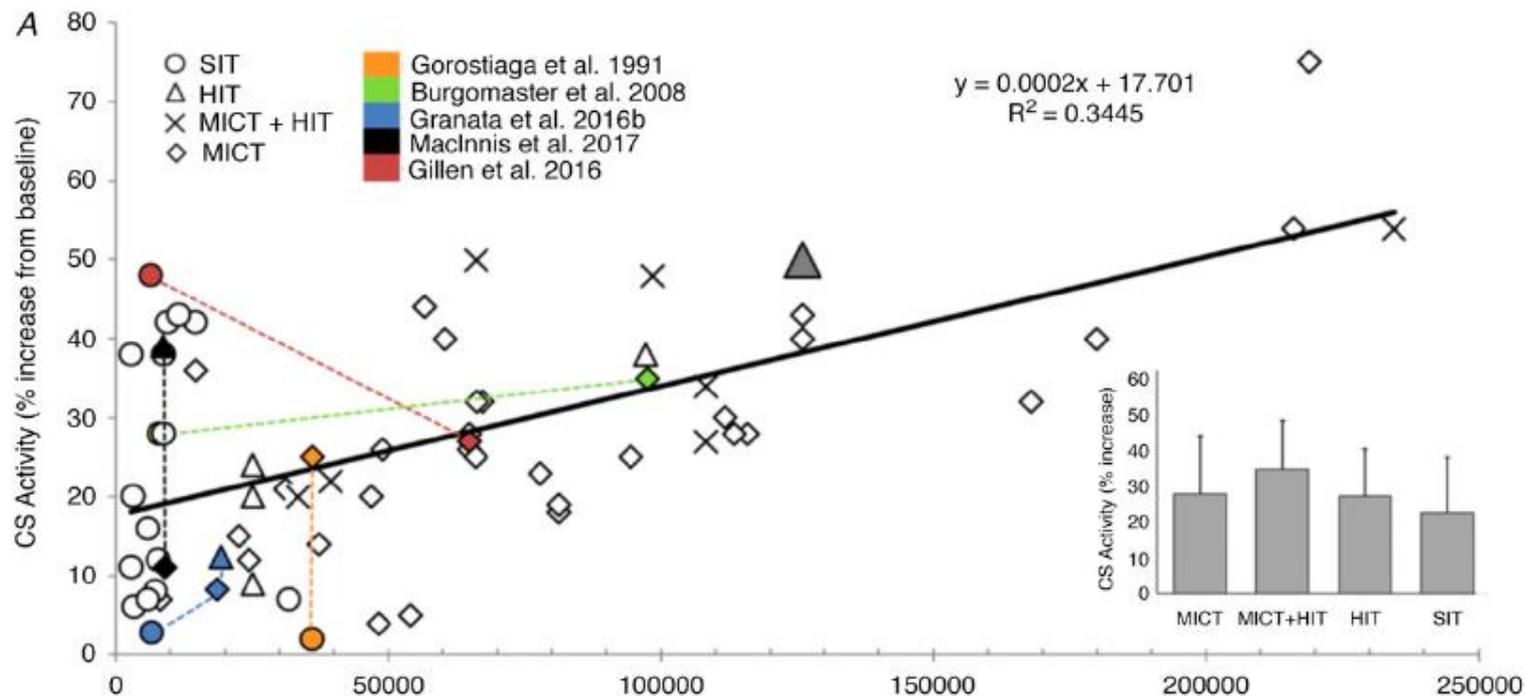
²School of Medical & Health Sciences, Edith Cowan University, Joondalup, Australia

³Department of Diabetes, Central Clinical School, Monash University, Melbourne, Australia

Email: David.Bishop@vu.edu.au

Edited by: Francisco Sepúlveda & Paul Greenhaff





Correlação significativa e positiva entre volume e aumento da mitocôndria



Não teve correlação significativa entre intensidade e aumento da mitocôndria

Cross-talk

- Segmentou para HIIT (extensivo e intensivo) (excluindo exercícios máximo - SIT)
- Exercício de moderada intensidade a 66 % (45 a 80%) $iVO_{2máx} = 28\%$ 
- HIIT 80% (65 a 90%) $iVO_{2máx} = 27\%$ 
- Volume 60% menor no HIIT

IMPORTANTE!

- Estudo da mitocôndria
 - Microscopia: volume da organela
 - Marcadores bioquímicos: enzimas localizadas na mitocôndria

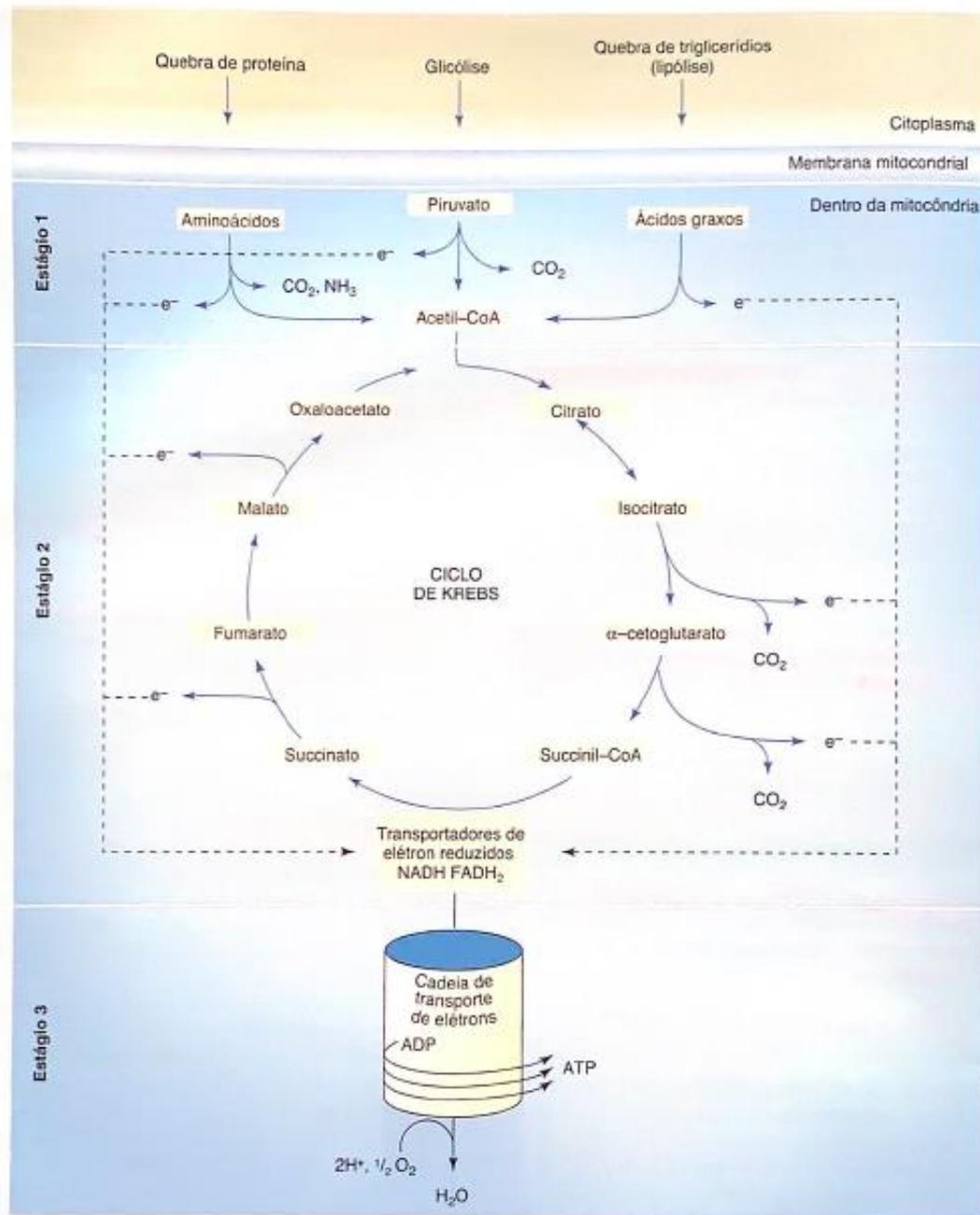
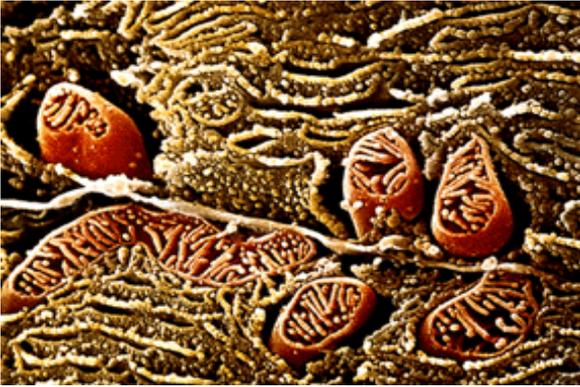


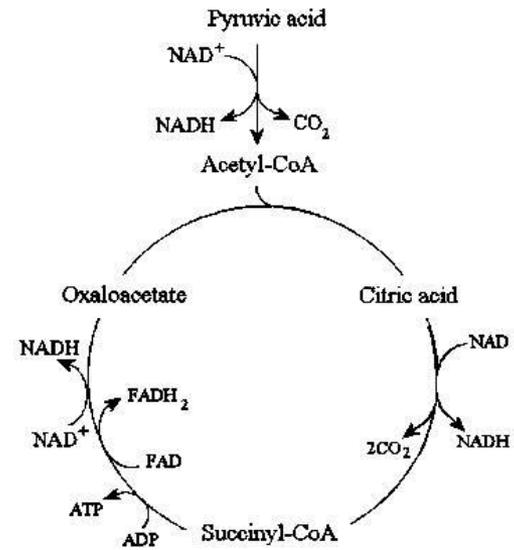
Figura 3.17 Os três estágios da fosforilação oxidativa. De Mathews e van Holde, *Biochemistry*, Diane Bowen, Ed. Copyright © 1990 Benjamin/Cummings, Menlo Park, CA. Reproduzido com permissão.

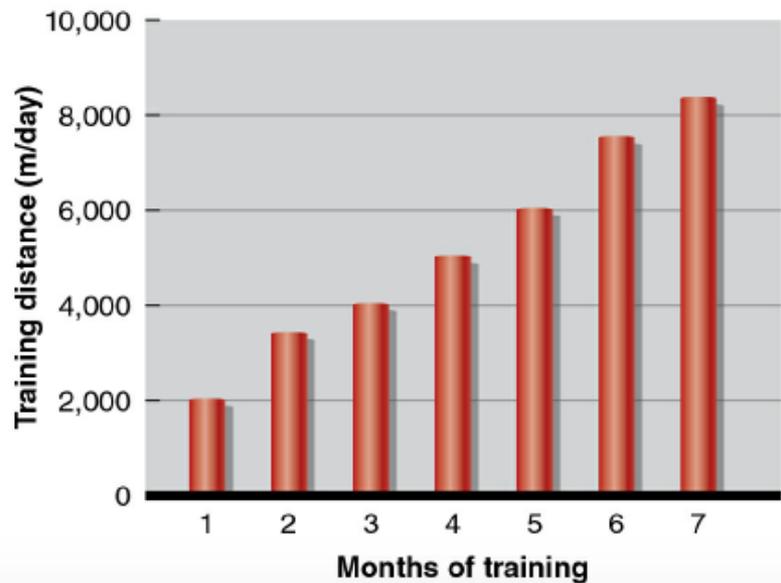
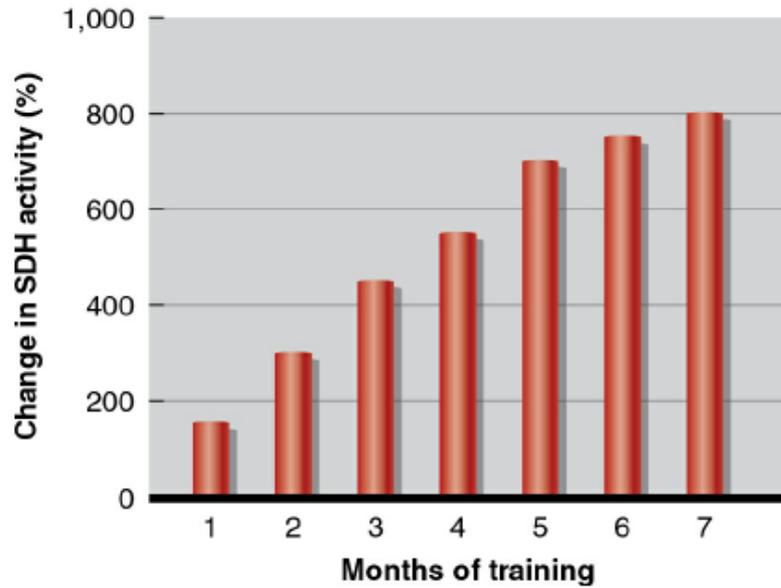


Adaptação enzimática pós TF aeróbico



Sir Hans Krebs





Sucinato desidrogenase

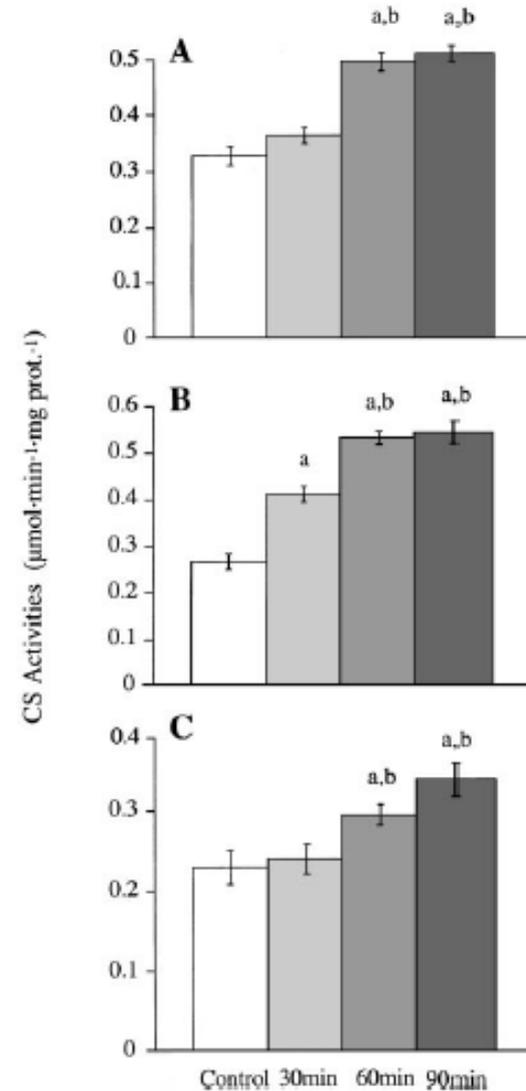
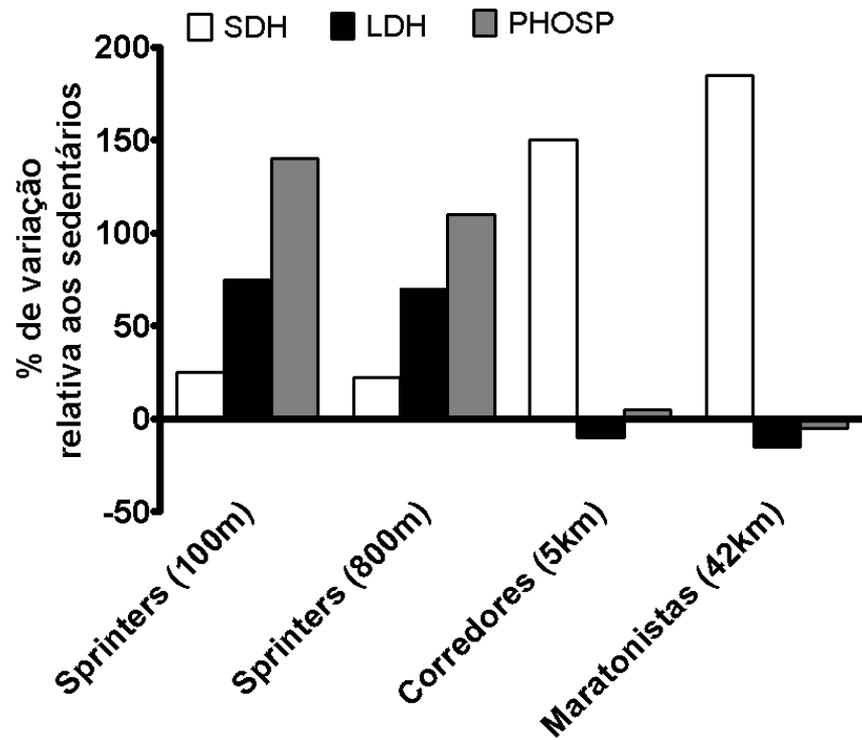


Fig. 1. Citrate synthase (CS) activity of soleus (A), plantaris (B), and extensor digitorum longus (C) muscles. Values are means \pm SE expressed as micromoles of substrate converted per minute per milligram of muscle protein (prot.). Significant difference ($P < 0.05$): from ^acontrol group; from ^b30-min group.

Citrato sintase

Variações na atividade enzimática

Tipo de modalidade praticada
(Vastus lateralis)



Taylor et al., 1985

Tipos de Fibras

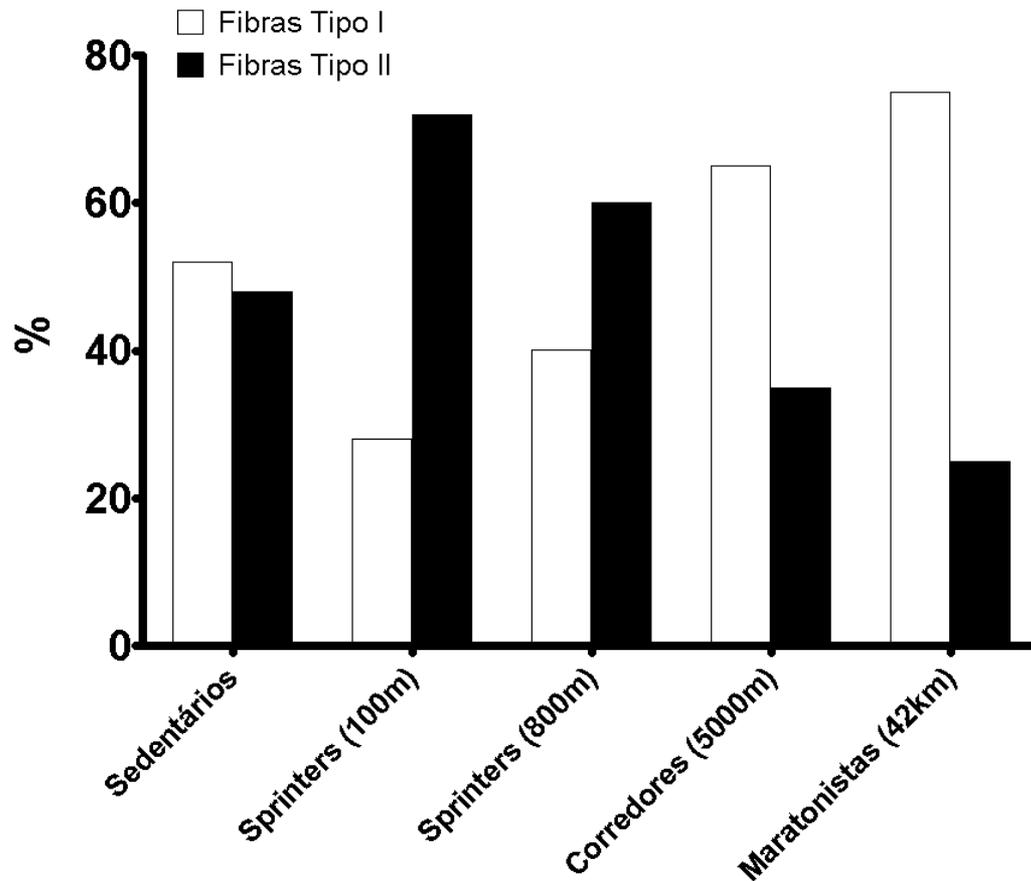
TABLE 1.1 Percentages and Cross-Sectional Areas of Type I and Type II Fibers in Selected Muscles of Male and Female Athletes

Athlete	Sex	Muscle	% type I	% type II
Sprint runners	M	Gastrocnemius	24	76
	F	Gastrocnemius	27	73
Distance runners	M	Gastrocnemius	79	21
	F	Gastrocnemius	69	31
Cyclists	M	Vastus lateralis	57	43
	F	Vastus lateralis	51	49
Swimmers	M	Posterior deltoid	67	33
Weightlifters	M	Gastrocnemius	44	56
	M	Deltoid	53	47
Triathletes	M	Posterior deltoid	60	40
	M	Vastus lateralis	63	37
	M	Gastrocnemius	59	41
Canoeists	M	Posterior deltoid	71	29
Shot-putters	M	Gastrocnemius	38	62
Nonathletes	M	Vastus lateralis	47	53
	F	Gastrocnemius	52	48

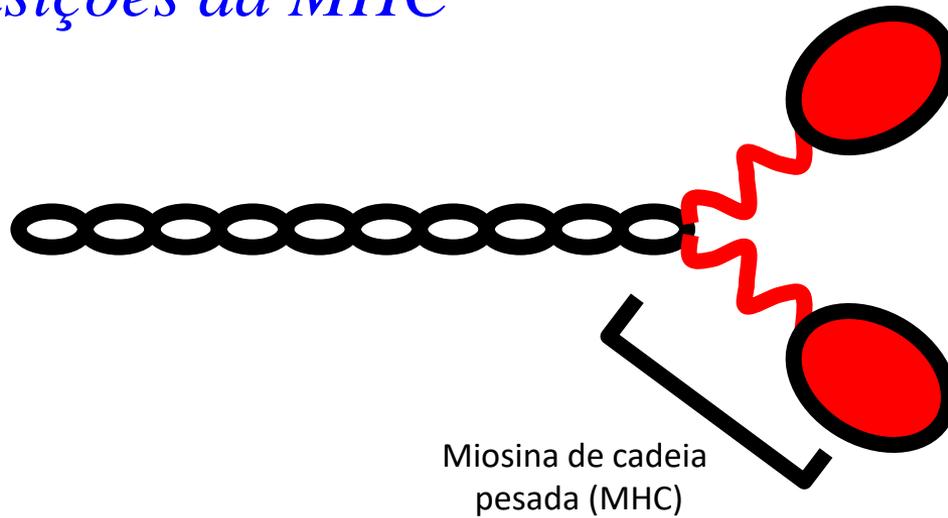
Adapted, by permission, from W.L. Kenney, J.H. Wilmore, and D.L. Costill, 2015, *Physiology of sport and exercise*, 6th ed. (Champaign, IL: Human Kinetics), 45.

Variações na % de distribuição de fibras

Tipo de fibra de acordo com modalidade praticada
(Vastus lateralis)



Transições da MHC



O TF de endurance leva a mudança na expressão da miosina de cadeia pesada de fibra do tipo I

Demirel HA et al. J Appl. Physiol. 1999, 86:1002-8

Treinamento aeróbio e área de secção transversa



Estudo com humanos – mulheres idosas

- Treinamento aeróbio durante 12 semanas
- 60-80% da FC de reserva
- 3/4 sessões por semana (30-45 minutos cada)

	Pre	Post	% Change
Aerobic capacity, L·min ⁻¹	1.1±0.1	1.4±0.1*	29±6
ml·kg ⁻¹ ·min ⁻¹	15.9±1.0	20.5±0.9*	30±6
Maximum heart rate, bpm	154±7	157±6	N/A
Body weight, kg	68.0±4.8	67.2±4.5	N/A
BMI, kg·m ⁻²	25.2±1.8	25.1±1.8	N/A
Body fat, %	40.7±3.4	39.8±3.5†	-2.4±1.0
Fat mass, kg	27.6±4.3	26.4±4.1†	-3.9±1.6
Fat-free mass, kg	39.2±1.4	39.6±1.4†	0.9±0.4
Quadriceps muscle volume, cm ³	587±55	654±60*	12±2
Knee extensor power, w	241±42	290±43*	21±7
Normalized power, W·cm ²	5.8±0.8	6.5±0.8*	14±4
Knee extensor peak isometric force, Nm	199±25	261±27*	35±7
Normalized force, Nm·cm ²	4.9±0.4	5.9±0.5*	22±7

Aerobic Exercise Training Increases Muscle Water Content in Obese Middle-Age Men

0195-9131/16/4805-0822/0

MEDICINE & SCIENCE IN SPORTS & EXERCISE®

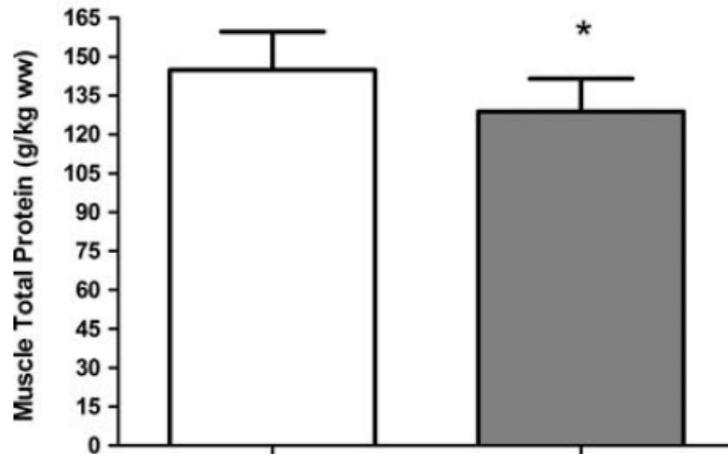
RICARDO MORA-RODRÍGUEZ¹, ALICIA SANCHEZ-RONCERO¹, VALENTIN EMILIO FERNÁNDEZ-ELÍAS¹,
AMELIA GUADALUPE-GRAU¹, JUAN FERNANDO ORTEGA¹, FLEMING DELA², and JORN WULFF HELGE²

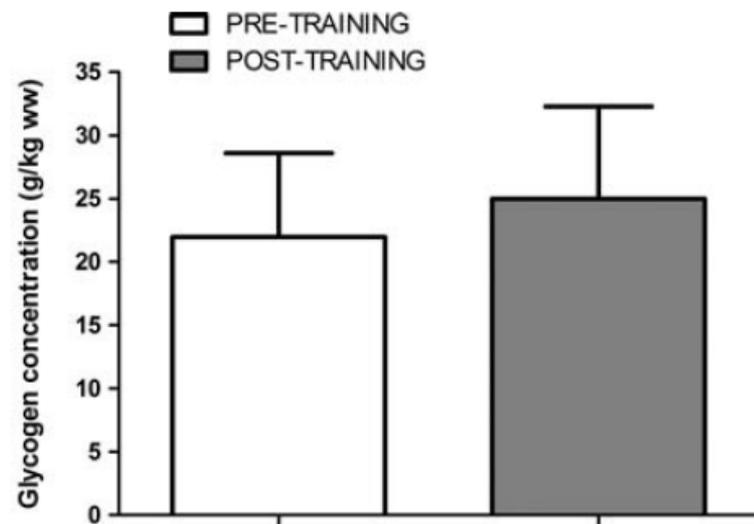
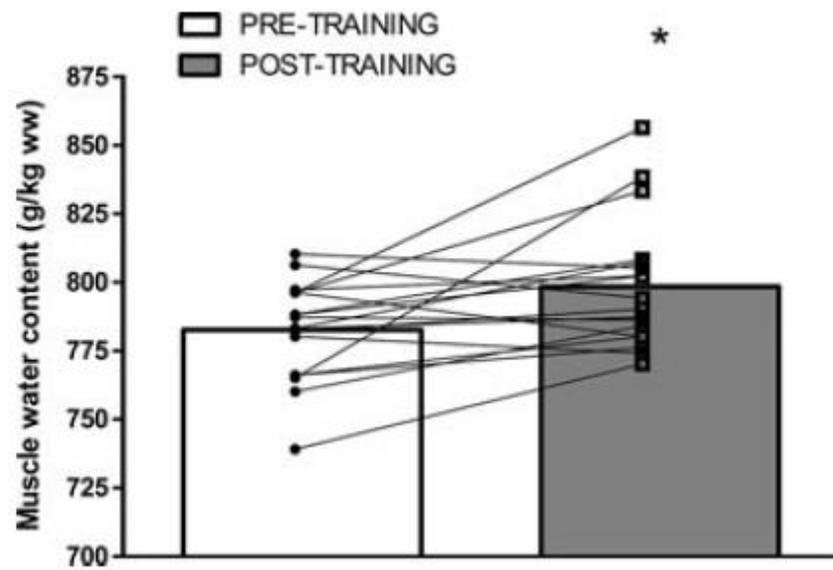
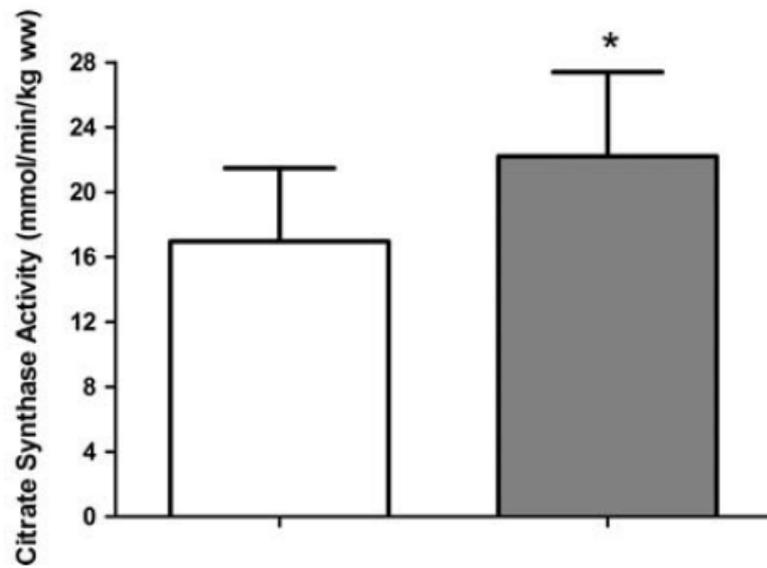
- 18 homens obesos com síndrome metabólica
- 4 meses
- 3 x por semana
- 4 séries de 4 minutos a 90% FCmáx: 3 minutos a 70% FCmáx - **intervalado extensivo**
- Bicicleta
- Dexa
- Biópsia

TABLE 1. Exercise and anthropometric changes with 4 months of aerobic interval training.

	Pretraining	Posttraining	% Change	P value
$\dot{V}O_{2\text{peak}}$ ($\text{mLO}_2 \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$)	28.8 ± 7	32.1 ± 8	11%	0.001*
FO_{max} ($\text{g} \cdot \text{min}^{-1}$)	0.24 ± 0.09	0.32 ± 0.11	33%	0.003*
Workload _{max} (W_{max})	232 ± 67	255 ± 75	10%	0.001*
Body weight (kg)	95.21 ± 10	93.36 ± 10	-1.9%	0.022*
BMI ($\text{kg} \cdot \text{cm}^{-2}$)	33.4 ± 3	32.7 ± 2	-2.2%	0.013*
Waist circumference (cm)	109 ± 5	107 ± 5	-1.8%	0.016*
Fat mass (kg)	31.9 ± 4.3	30.1 ± 5.1	-5.4%	0.044*
FFM (kg)	59.9 ± 9	60.3 ± 8	0.5%	0.477
Right leg FFM (kg)	9.84 ± 1.84	10.02 ± 1.85	1.8%	0.023*

Data are mean \pm SD for 18 subjects. *Significantly different from pretraining.



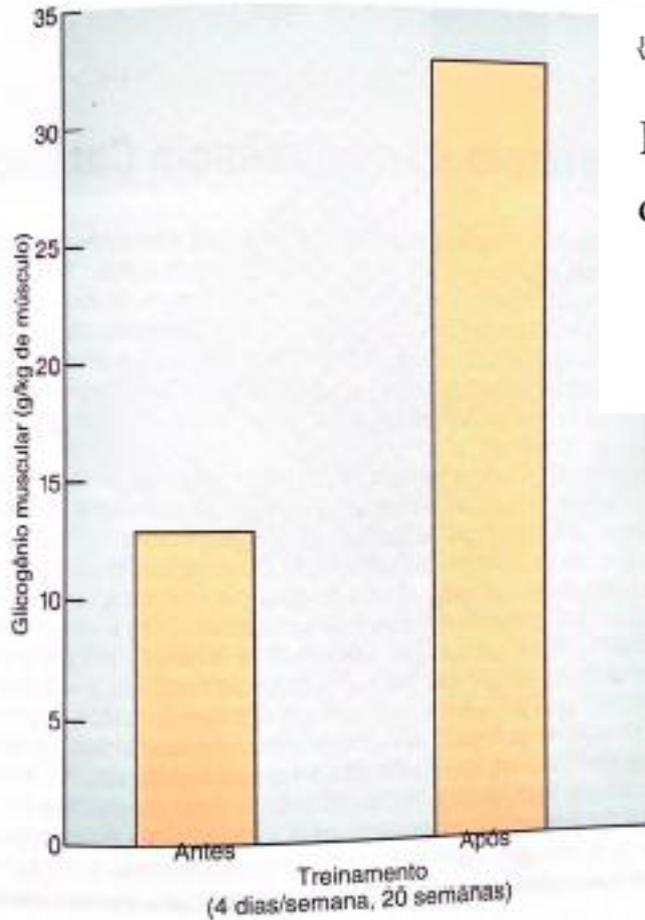


JOURNAL OF APPLIED PHYSIOLOGY
Vol. 34, No. 1, January 1973. Printed in U.S.A.

Effect of training on enzyme activity and fiber composition of human skeletal muscle

P. D. GOLLNICK, R. B. ARMSTRONG, B. SALTIN, C. W. SAUBERT IV,
W. L. SEMBROWICH, AND R. E. SHEPHERD

Department of Physical Education for Men, Washington State University, Pullman, Washington 99163



13 a 15g/kg e aumento 2,5x



Triacylglycerol intramuscular



The Ultrastructure of the Normal Human Skeletal Muscle

**A Morphometric Analysis on Untrained Men, Women
and Well-Trained Orienteers***

**Hans Hoppeler, Pierre L  thi, Helgard Claassen, Ewald R. Weibel, and
Hans Howald**

**Anatomisches Institut der Universit  t Bern and
Forschungsinstitut der Eidg. Turn- und Sportschule M  gglingen, Switzerland**

Received June 18, 1973

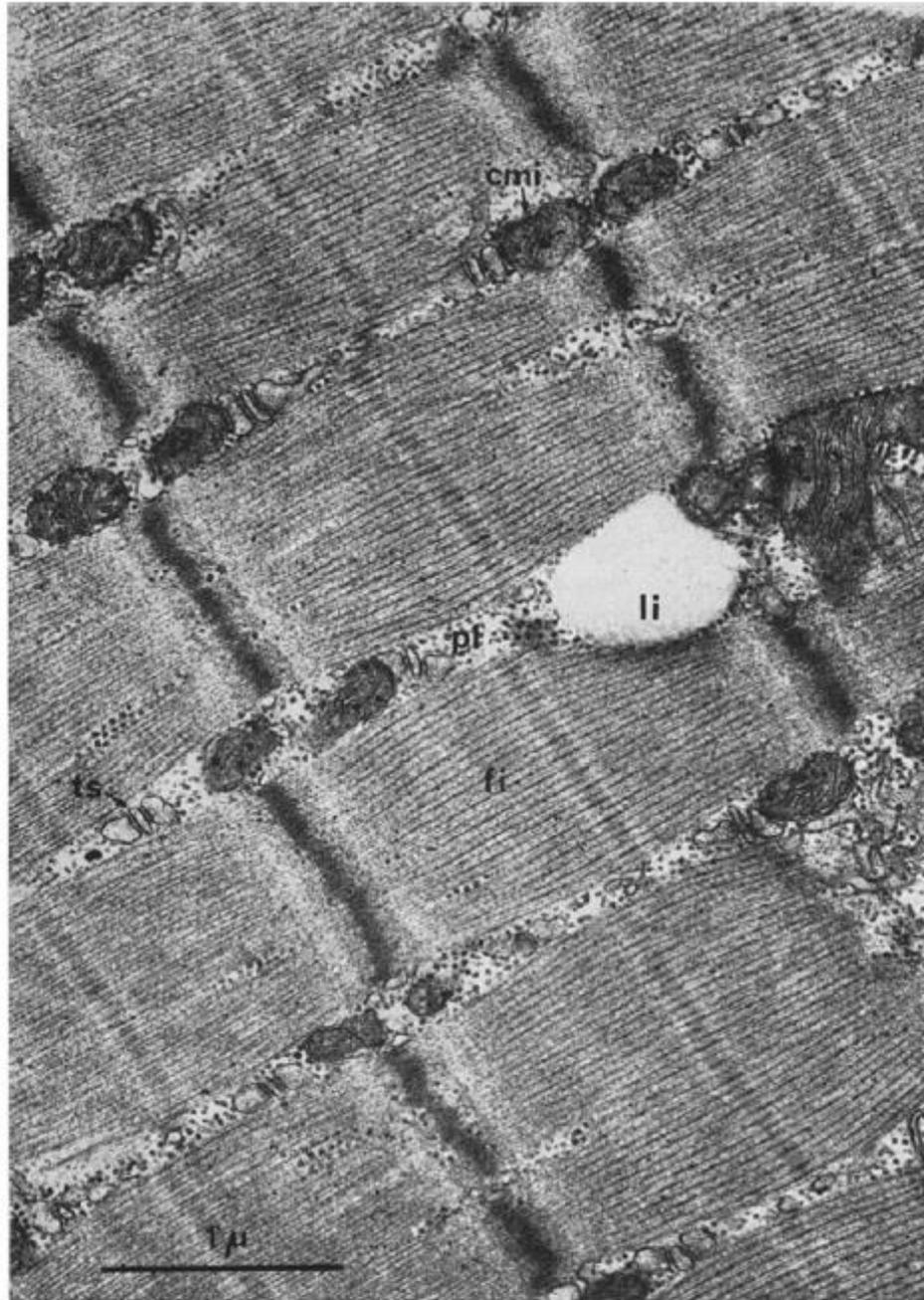


Fig. 2. Longitudinal section of *m. vastus lateralis* of trained man showing myofibrils

Concluindo....

- Aumento da densidade mitocondrial
- Aumento da atividade de enzimas oxidativas
- Aumento da proporção de Fibras do tipo I
- Aumento de glicogênio e lipídio intramuscular
- ❖ Mesmo em protocolos de exercício mais intenso

