Exercício e Lipídios

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1

Quais são os objetivos dessa aula?

2

Intensidade do Exercício

Duração do Exercício

Alimentação

Suplementos

3

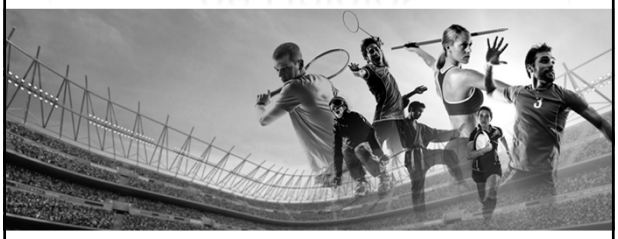
Lipídios

Homem (80 kg):

- AGNE = **0,4 g**
- TAG plasma = **4 g**
- Tecido adiposo = **12.000 g**
- TAG intramuscular = **300 g**

4

Exercício e Metabolismo de Lipídios



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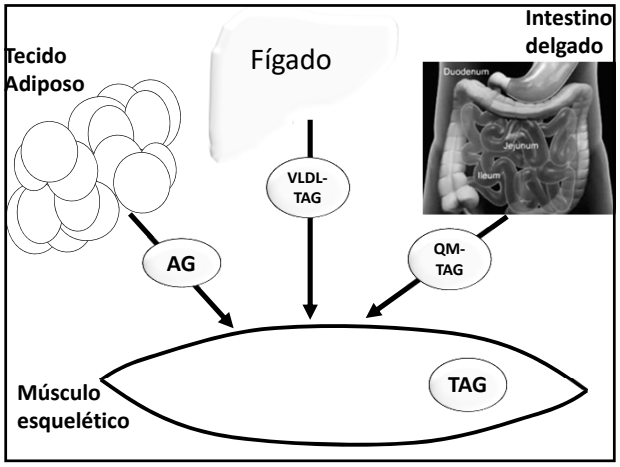

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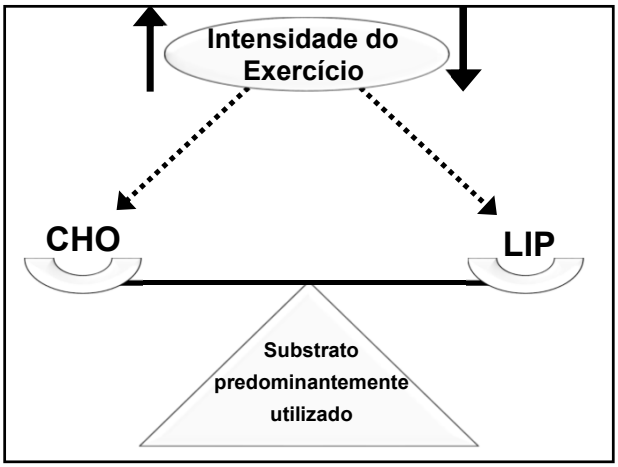

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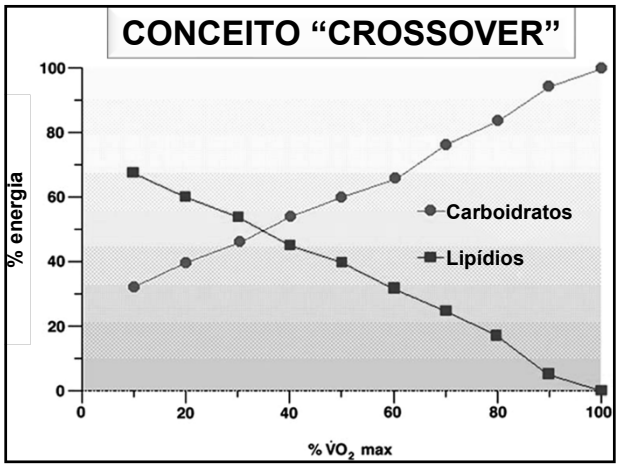

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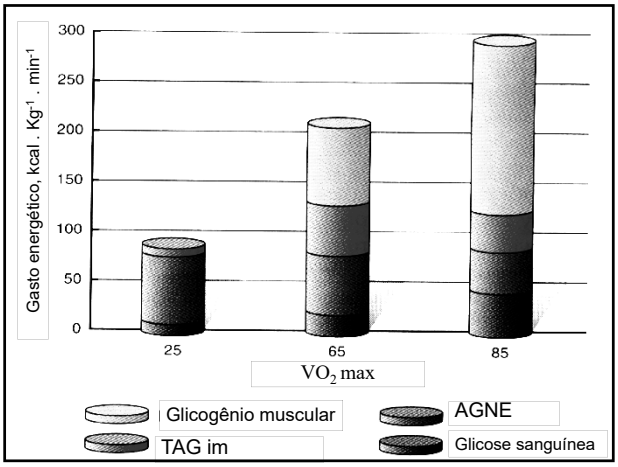
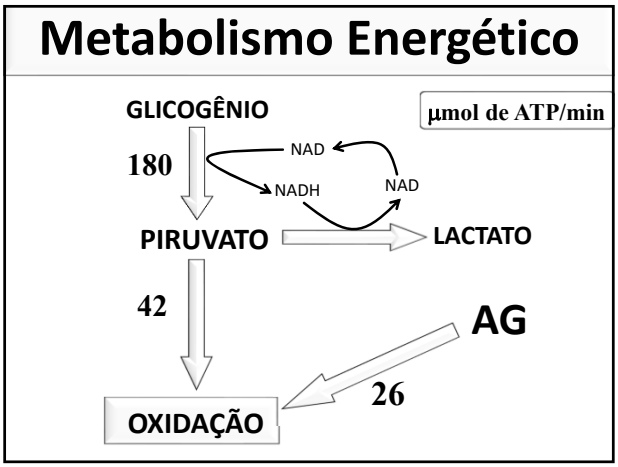


9

POR QUE DURANTE O EXERCÍCIO INTENSO, A PRINCIPAL RESERVA ENERGÉTICA DO ORGANISMO NÃO REPRESENTA O PRINCIPAL SUBSTRATO OXIDADO?

10

Metabolismo Energético



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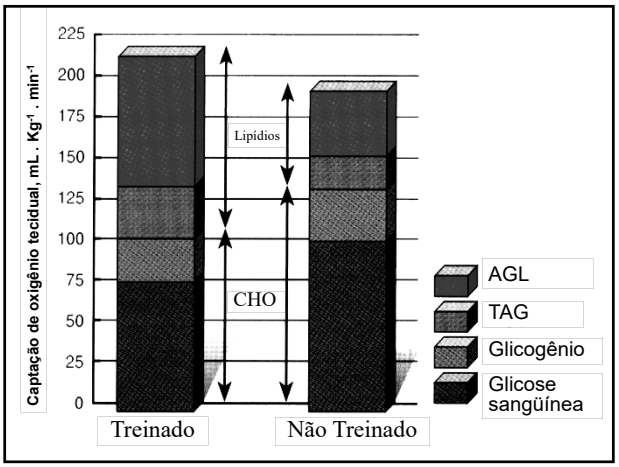

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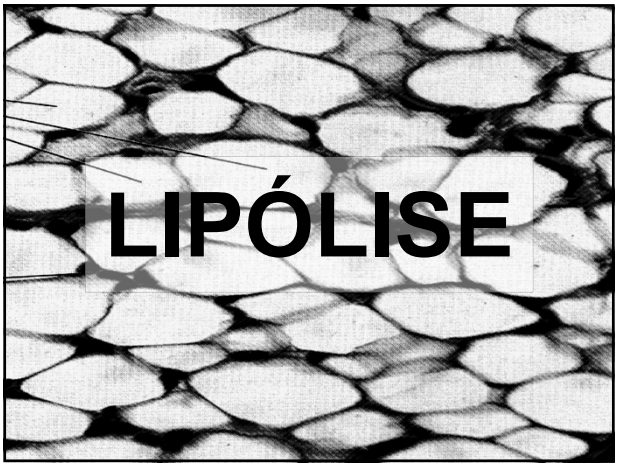
Exercício e Oxidação Lipídica

1) Lipólise no tecido adiposo
2) Transporte de AGNE plasmáticos
3) Transporte através do sarcolema
4) Transporte intracitoplasmático
5) Ativação do AG
6) Transporte mitocondrial
7) Processos oxidativos

13



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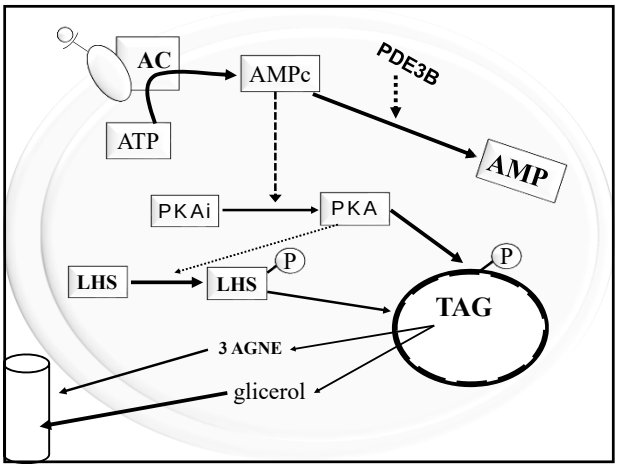

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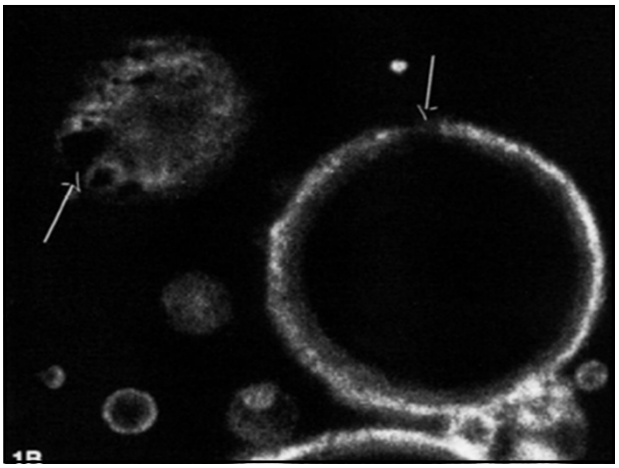

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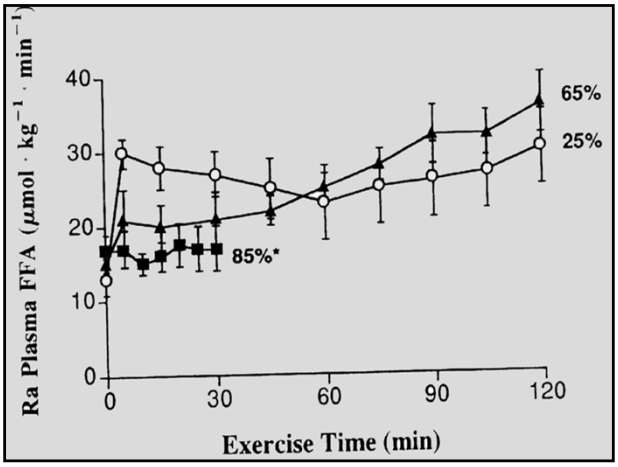

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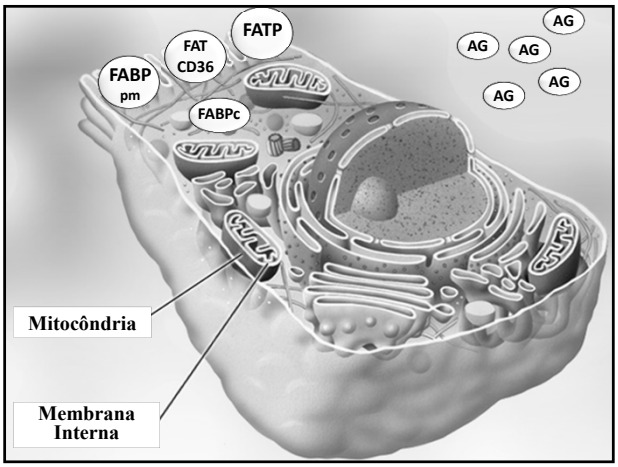
Transporte através do Sarcolema

18



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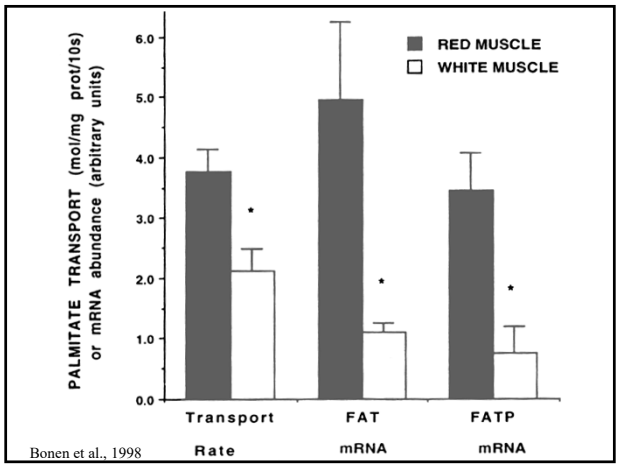

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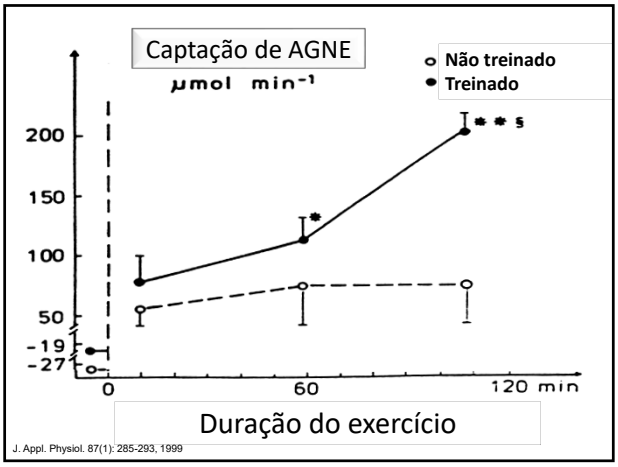

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- ✓ **Ativação de AG**
- ✓ **Transporte Mitocondrial**

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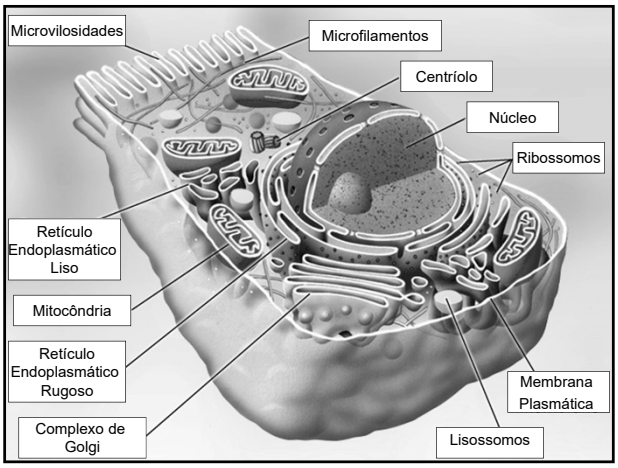

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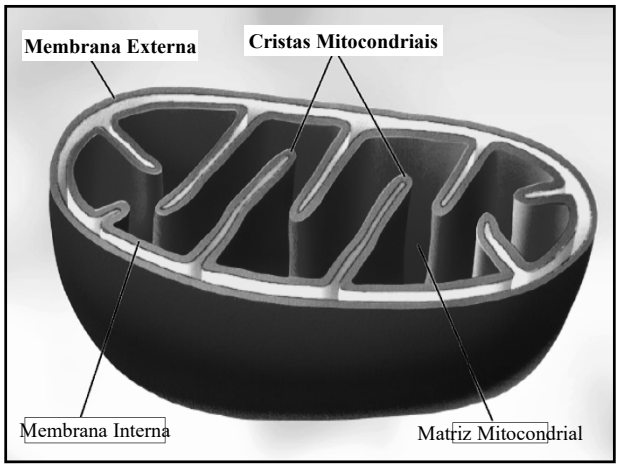

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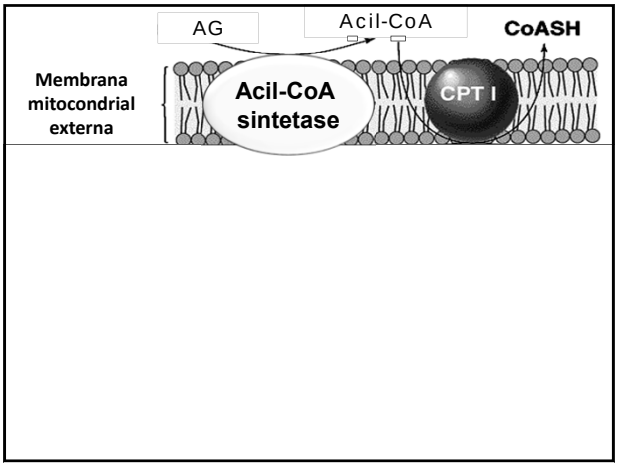

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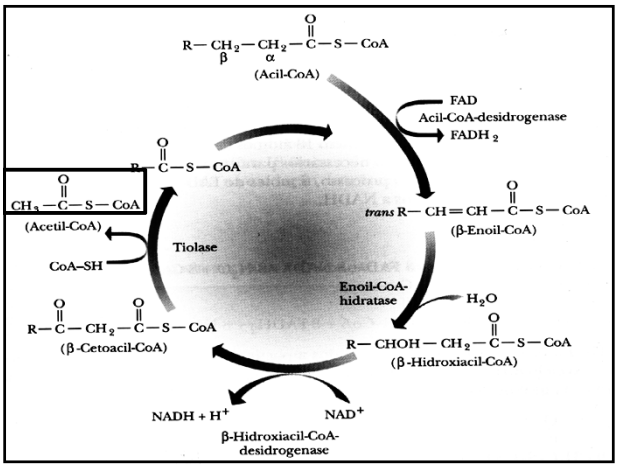
Processos Oxidativos

26



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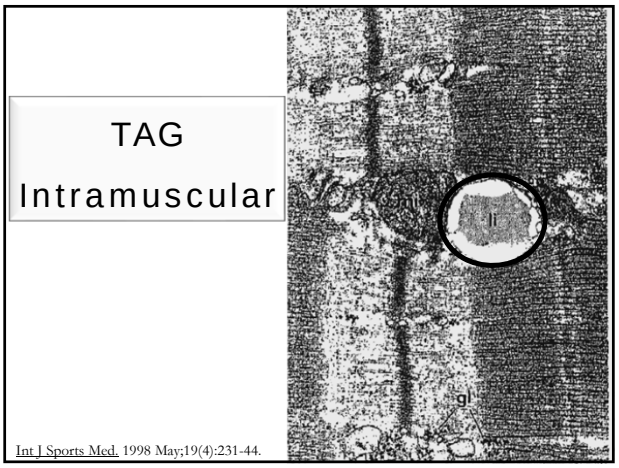

Int J Sports Med. 1998 May;19(4):231-44.

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Intramuscular triacylglycerol, glycogen and acetyl group metabolism during 4 h of moderate exercise in man

J. Physiol. 541(3): 969-978, 2002

- ✓ Ciclistas treinados
- ✓ Duração: 240 minutos; 57% VO_{2max}
- ✓ Biopsia: 0', 10', 120' e 240'
- ✓ Refeição: 2 h antes do exercício

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240 min Exercício (57 % VO_2 max)

Time (min)	RER	Blood glycerol (μmol l^{-1})
0	NM	119 ± 18
10	NM	128 ± 14
30	0.89 ± 0.01	147 ± 12
60	0.88 ± 0.01	211 ± 32
90	0.86 ± 0.02	301 ± 46 *
120	0.85 ± 0.02	380 ± 49 *
150	0.83 ± 0.01	501 ± 55 *
180	0.83 ± 0.02	608 ± 51 *
210	0.82 ± 0.01	655 ± 36 *
240	0.81 ± 0.01	701 ± 58 *

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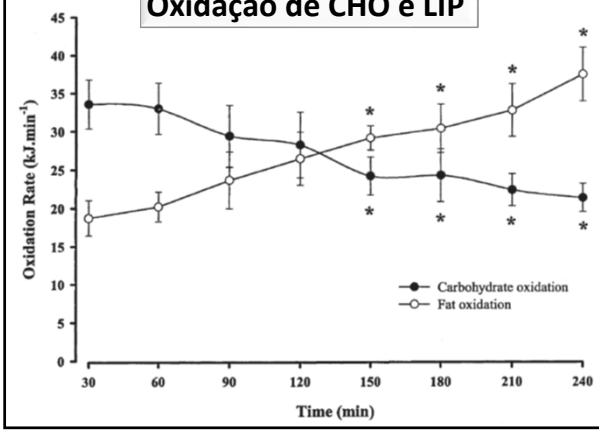
Oxidação de CHO e LIP



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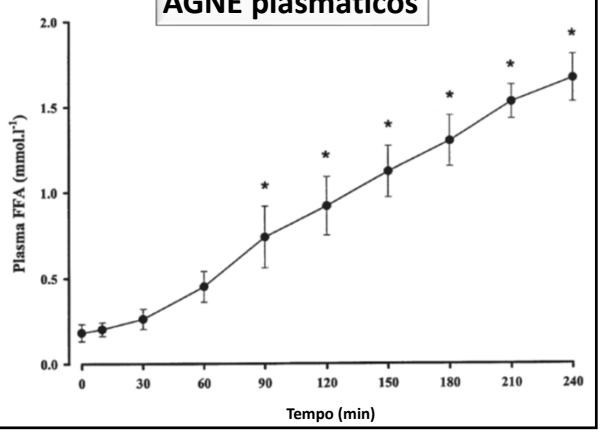
AGNE plasmáticos



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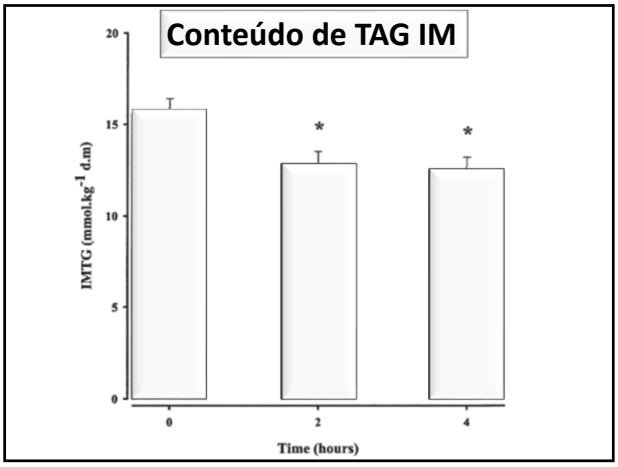
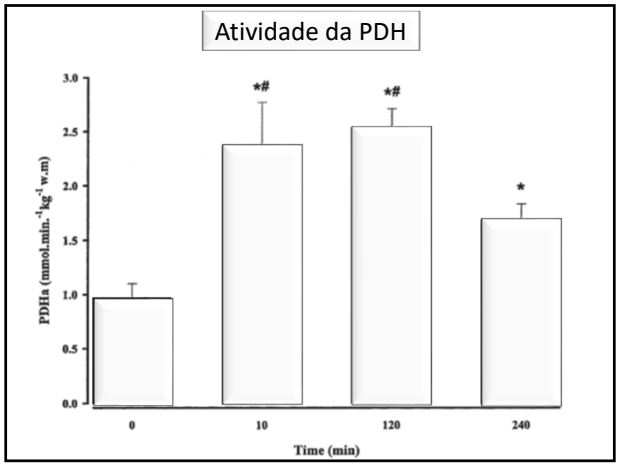
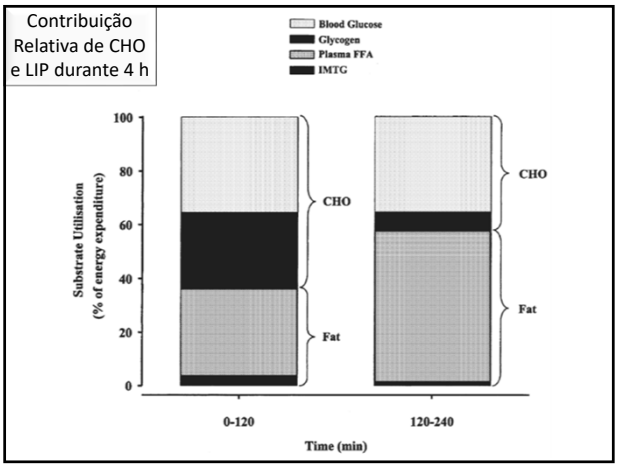

Conteúdo de TAG IM
IMTG (mmol.kg-1 d.m)
Time (hours)
0
2
4
*
*

33


Atividade da PDH
PDHa (mmol.min-1.kg-1 w.m)
Time (min)
0
10
120
240
*#
*#
*

34


Contribuição Relativa de CHO e LIP durante 4 h
Blood Glucose
Glycogen
Plasma FFA
IMTG
Substrate Utilisation (% of energy expenditure)
CHO
Fat
CHO
Fat
0-120
120-240
Time (min)

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Metabolism of Complex Carbohydrates
Metabolism of Cofactors and Vitamins
Interação do Metabolismo de CHO e LIP no Exercício Físico
Energy Metabolism
Metabolism of Other Substances

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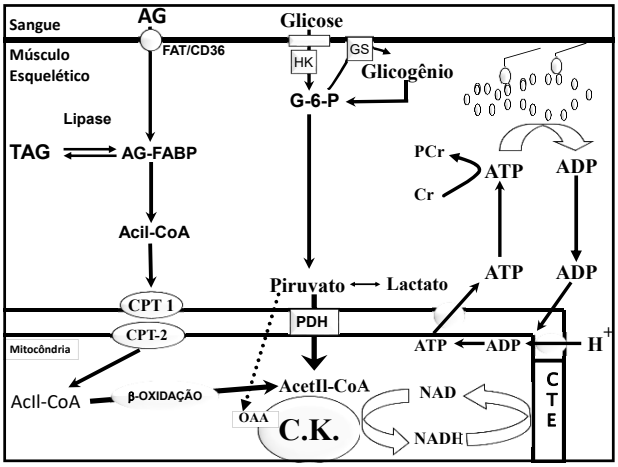

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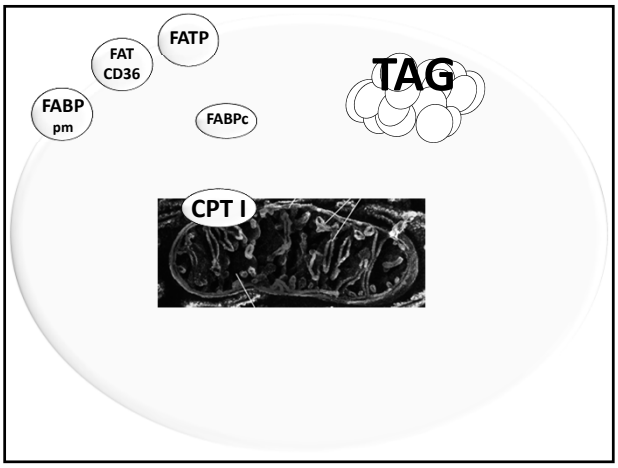
O que limita a oxidação de Ácidos Graxos no exercício físico?

40-60% VO_2 max ⇨ 70-85% VO_2 max

38



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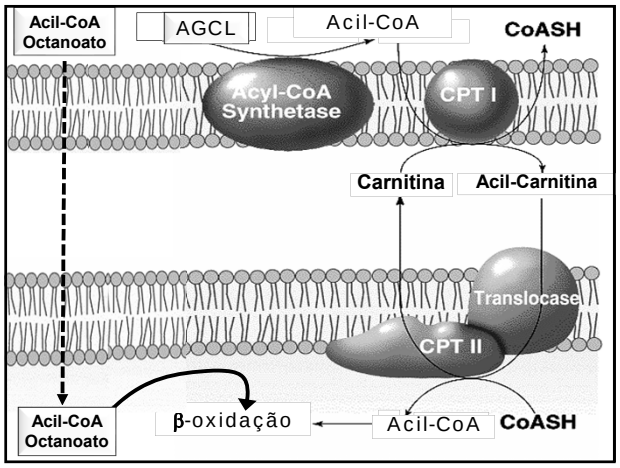

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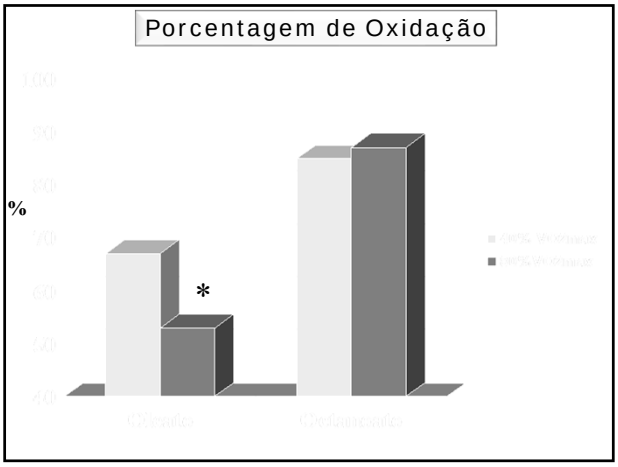

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Am. J. Physiol. Endocrinol. Metab.
278: E462–E468, 2000.

Sensitivity of CPT I to malonyl-CoA in trained and untrained human skeletal muscle

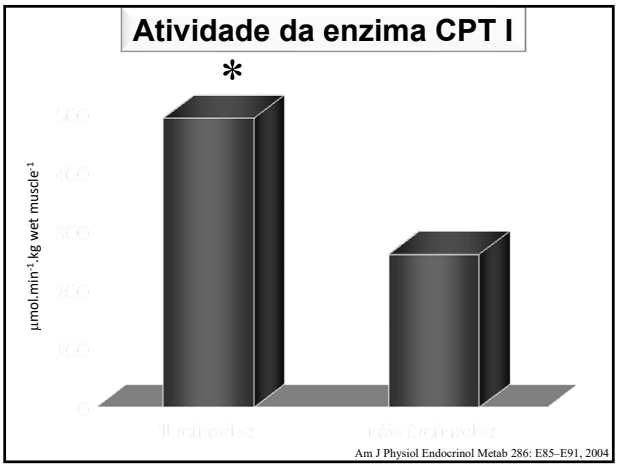
EMMA C. STARRITT, RICHARD A. HOWLETT, GEORGE J. F. HEIGENHAUSER, AND LAWRENCE L. SPRIET
Department of Human Biology and Nutritional Sciences, University of Guelph, Ontario N1G 2W1; Department of Medicine, McMaster University, Hamilton, Ontario, Canada L8N 3Z5; and Department of Physiology, The University of Melbourne, Parkville, 3052, Australia

Am J Physiol Endocrinol Metab 286: E85–E91, 2004.
First published September 3, 2003; 10.1152/ajpendo.00237.2003.

Regulation of CPT I activity in intermyofibrillar and subsarcolemmal mitochondria from human and rat skeletal muscle

Veronic Bezaire,[1] George J. F. Heigenhauser,[2] and Lawrence L. Spriet[1]
[1]*Department of Human Biology and Nutritional Sciences, University of Guelph, Guelph N1G 2W1; and* [2]*Department of Medicine, McMaster University, Hamilton, Ontario, Canada L8N 3Z5*

42



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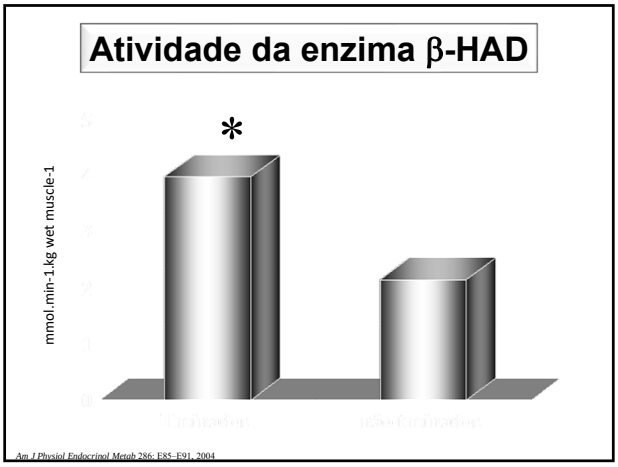

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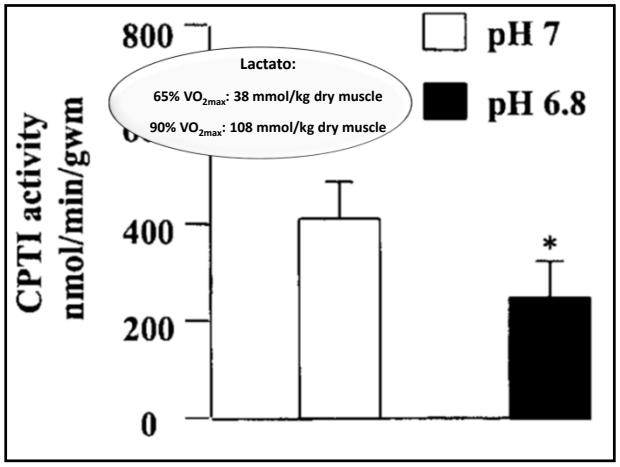

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Quais são os principais fatores que influenciam a utilização de substratos no exercício físico?

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Intensidade do Exercício

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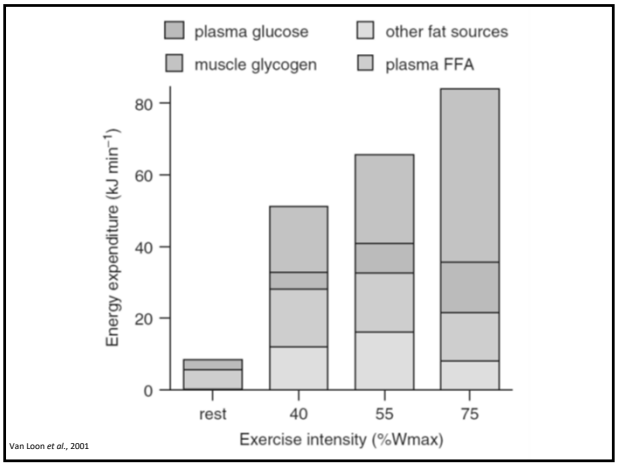

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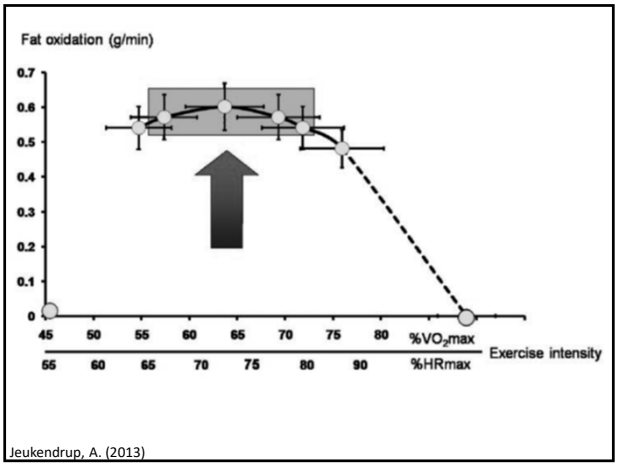

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Duração do Exercício

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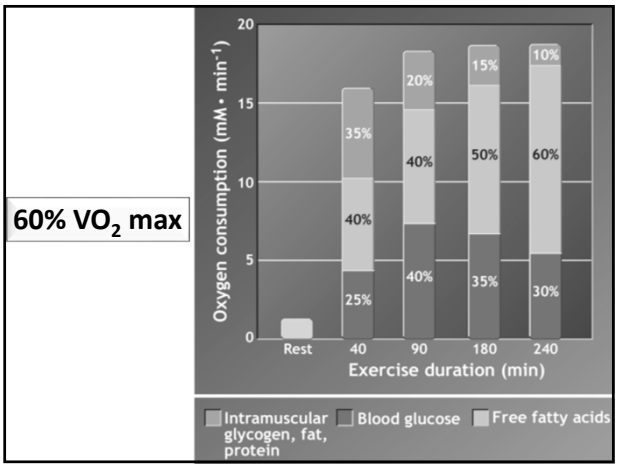

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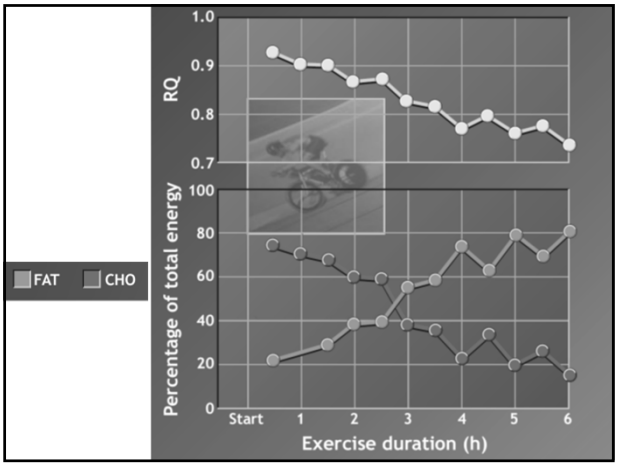

FAT
CHO
RQ
1.0
0.9
0.8
0.7
Percentage of total energy
100
80
60
40
20
0
Start
1
2
3
4
5
6
Exercise duration (h)

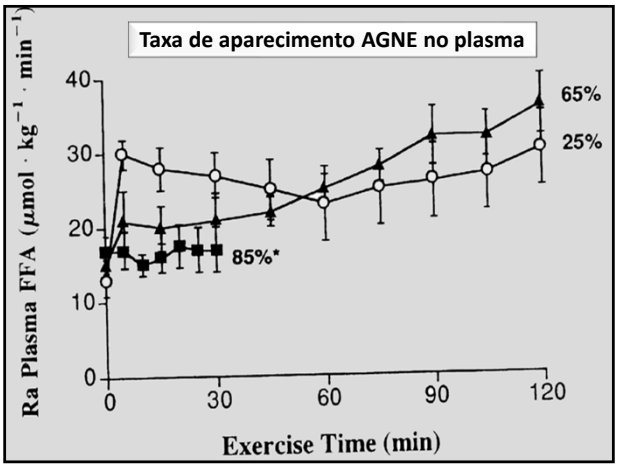
53


Alimentação

54


Fat Loading

55


Taxa de aparecimento AGNE no plasma
Ra Plasma FFA (μmol · kg⁻¹ · min⁻¹)
40
30
20
10
0
65%
25%
85%*
0
30
60
90
120
Exercise Time (min)

56

Ciclo Glicose-Ácidos Graxos

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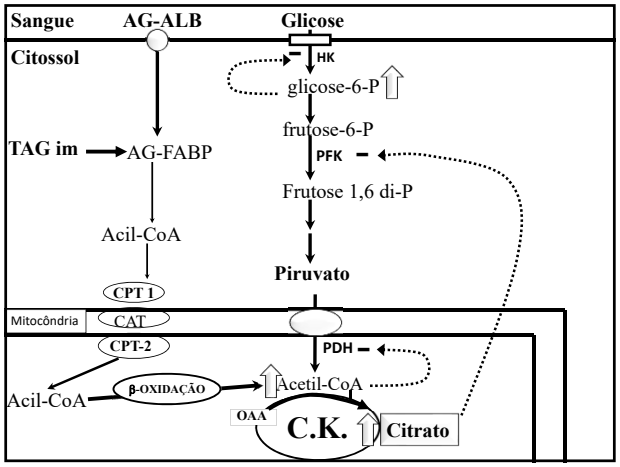

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Elevação Aguda de AG no plasma

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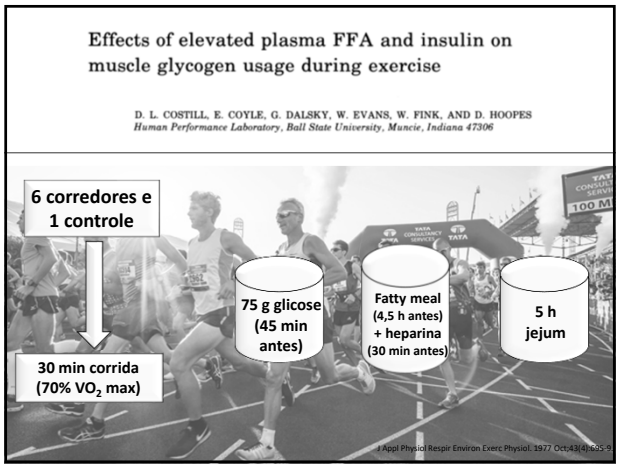

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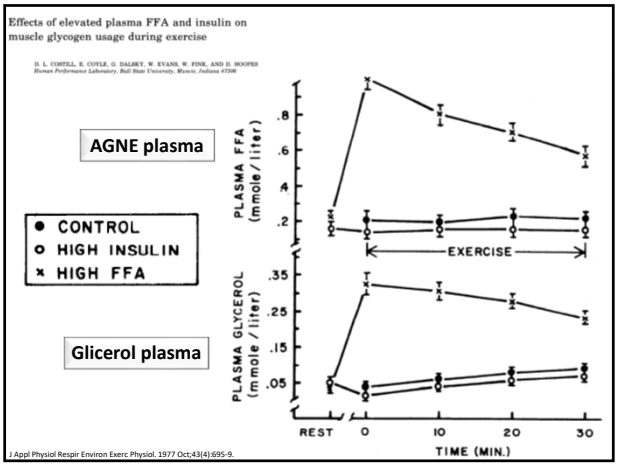
Effects of elevated plasma FFA and insulin on muscle glycogen usage during exercise
AGNE plasma
CONTROL
HIGH INSULIN
HIGH FFA
Glicerol plasma
PLASMA FFA (mmole / liter)
PLASMA GLYCEROL (mmole / liter)
EXERCISE
REST
TIME (MIN.)
J Appl Physiol Respir Environ Exerc Physiol. 1977 Oct;43(4):695-9.

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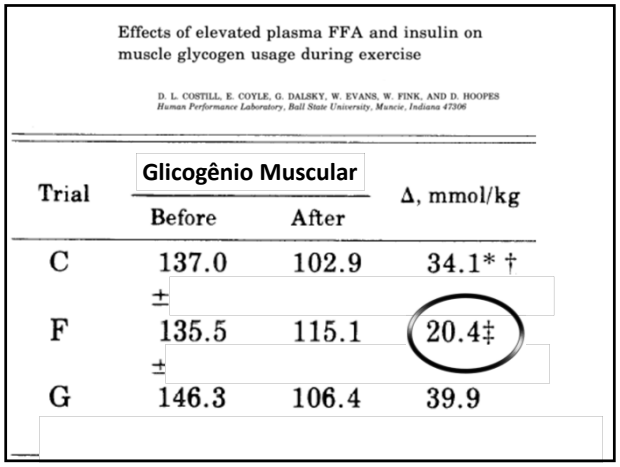
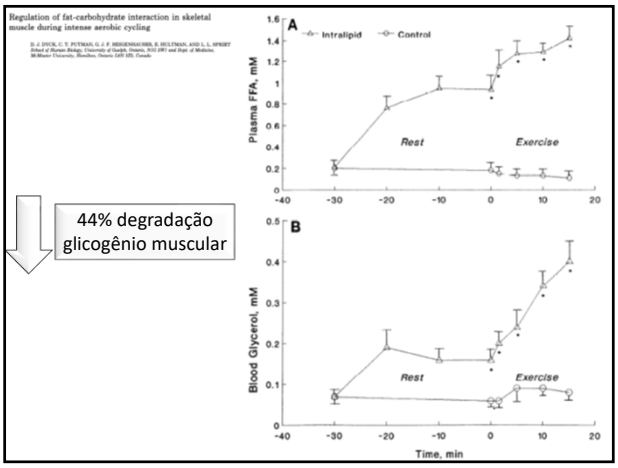
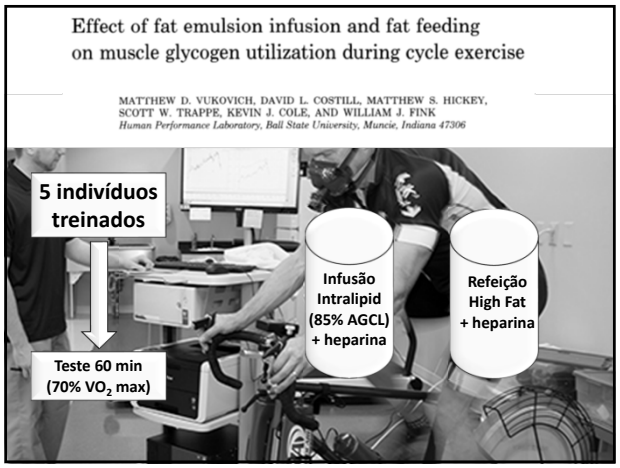

Effects of elevated plasma FFA and insulin on muscle glycogen usage during exercise
D. L. COSTILL, E. COYLE, G. DALSKY, W. EVANS, W. FINK, AND D. HOOPES
Human Performance Laboratory, Ball State University, Muncie, Indiana 47306
Glicogênio Muscular
Trial
Before
After
Δ, mmol/kg
C 137.0 102.9 34.1* †
F 135.5 115.1 20.4‡
G 146.3 106.4 39.9

62


Regulation of fat-carbohydrate interaction in skeletal muscle during intense aerobic cycling
44% degradação glicogênio muscular
A
Intralipid
Control
Plasma FFA, mM
Rest
Exercise
B
Blood Glycerol, mM
Time, min

63


Effect of fat emulsion infusion and fat feeding on muscle glycogen utilization during cycle exercise
MATTHEW D. VUKOVICH, DAVID L. COSTILL, MATTHEW S. HICKEY, SCOTT W. TRAPPE, KEVIN J. COLE, AND WILLIAM J. FINK
Human Performance Laboratory, Ball State University, Muncie, Indiana 47306
5 indivíduos treinados
Infusão Intralipid (85% AGCL) + heparina
Refeição High Fat + heparina
Teste 60 min (70% VO2 max)

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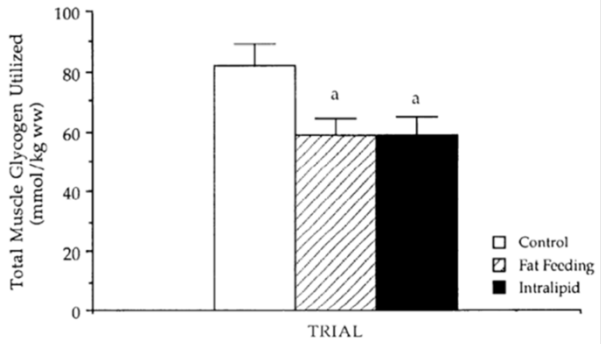
Degradação de Glicogênio Muscular



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High-Fat e Performance

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Weeks 1-7	Week 8
65% carbohydrate; 15% lipid; 20% protein	Remain
62% lipid; 21% carbohydrate; 17% protein	Switch to

J Physiol 1996;492:293

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J Physiol 595.9 (2017) pp 2785–2807

Low carbohydrate, high fat diet impairs exercise economy and negates the performance benefit from intensified training in elite race walkers

Louise M. Burke[1,2], Megan L. Ross[1,2], Laura A. Garvican-Lewis[1,2], Marijke Welvaert[3,4], Ida A. Heikura[1,2], Sara G. Forbes[1], Joanne G. Mirtschin[1], Louise E. Cato[1], Nicki Strobel[5], Avish P. Sharma[6] and John A. Hawley[2,7]

Dietary intervention:

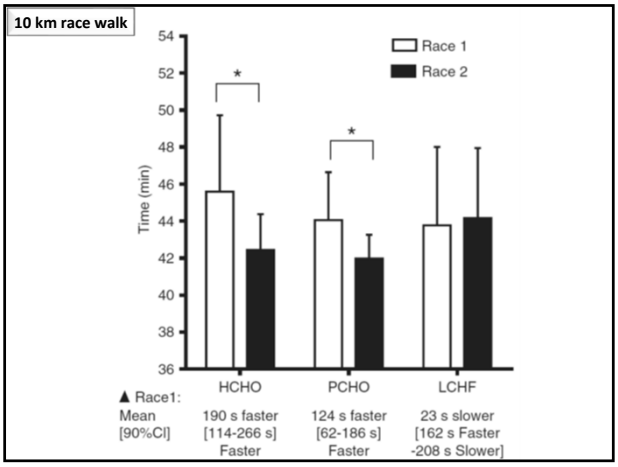
HCHO: 8.6 g.kg^{-1} CHO, 2.1 g.kg^{-1} PROTEIN, 1.2 g.kg^{-1} FAT

PCHO: 8.3 g.kg^{-1} CHO, 2.2 g.kg^{-1} PROTEIN, 4.7 g.kg^{-1} FAT

LCHF: <50 g.d^{-1} CHO, 2.2 g.kg^{-1} PROTEIN, 1.2 g.kg^{-1} FAT

68

10 km race walk



69

0195-9131/16/4803-0543/0
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DOI: 10.1249/MSS.0000000000000852

SPECIAL COMMUNICATIONS

AMERICAN COLLEGE of SPORTS MEDICINE

ACADEMY OF NUTRITION AND DIETETICS
DIETITIANS OF CANADA

Nutrition and Athletic Performance

JOINT POSITION STATEMENT

AG saturados < 10% VCT

Evitar ingestão Lipídios < 20% VCT

70

Journal of the International Society of Sports Nutrition

REVIEW Open Access

ISSN exercise & sports nutrition review update: research & recommendations

Chad M. Kerksick[1*], Colin D. Wilborn[2], Michael D. Roberts[3], Abbie Smith-Ryan[4], Susan M. Kleiner[5], Ralf Jäger[6], Rick Collins[7], Mathew Cooke[8], Jaci N. Davis[9], Effego Galvan[10], Mike Greenwood[11], Lonnie M. Lowery[12], Robert Wildman[13], Jose Antonio[14] and Richard B. Kreider[15*]

Ingestão de Lipídios

~ 30% VCT

1 g LIP/ kg peso

Balanço Energético

Estoques TAG IM

AG essenciais

71

Journal of the International Society of Sports Nutrition

REVIEW Open Access

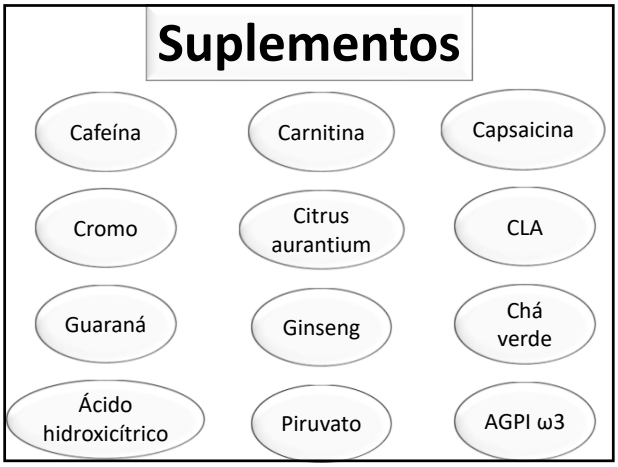
ISSN exercise & sports nutrition review update: research & recommendations

Chad M. Kerksick[1*], Colin D. Wilborn[2], Michael D. Roberts[3], Abbie Smith-Ryan[4], Susan M. Kleiner[5], Ralf Jäger[6], Rick Collins[7], Mathew Cooke[8], Jaci N. Davis[9], Effego Galvan[10], Mike Greenwood[11], Lonnie M. Lowery[12], Robert Wildman[13], Jose Antonio[14] and Richard B. Kreider[15*]

Ingestão de Lipídios

Gordura corporal em atletas → **~ 20% VCT**

72


Suplementos
Cafeína
Carnitina
Capsaicina
Cromo
Citrus aurantium
CLA
Guaraná
Ginseng
Chá verde
Ácido hidroxicítrico
Piruvato
AGPI ω3

73


Kerksick et al. Journal of the International Society of Sports Nutrition (2018) 15:38
https://doi.org/10.1186/s12970-018-0242-y
Journal of the International Society of Sports Nutrition
REVIEW
Open Access
ISSN exercise & sports nutrition review update: research & recommendations
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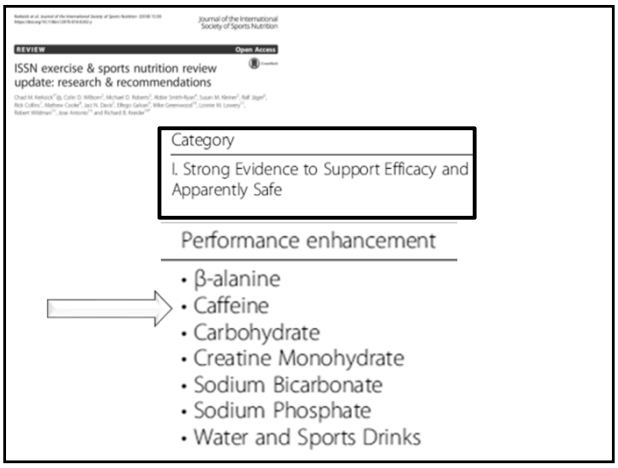
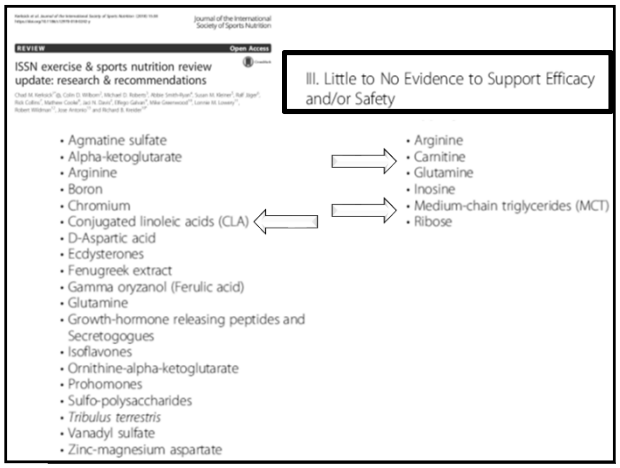
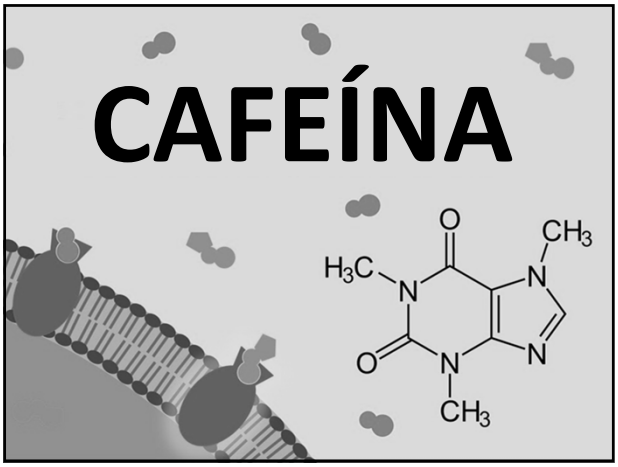
74


ISSN exercise & sports nutrition review update: research & recommendations
Category
I. Strong Evidence to Support Efficacy and Apparently Safe
Performance enhancement
• β-alanine
• Caffeine
• Carbohydrate
• Creatine Monohydrate
• Sodium Bicarbonate
• Sodium Phosphate
• Water and Sports Drinks

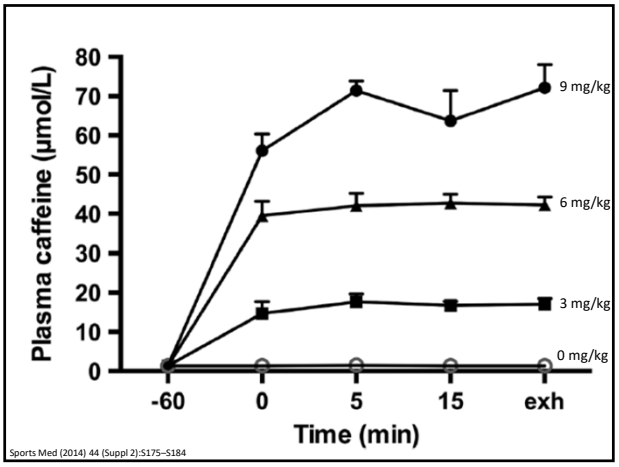
75


ISSN exercise & sports nutrition review update: research & recommendations
III. Little to No Evidence to Support Efficacy and/or Safety
• Agmatine sulfate
• Alpha-ketoglutarate
• Arginine
• Boron
• Chromium
• Conjugated linoleic acids (CLA)
• D-Aspartic acid
• Ecdysterones
• Fenugreek extract
• Gamma oryzanol (Ferulic acid)
• Glutamine
• Growth-hormone releasing peptides and Secretogogues
• Isoflavones
• Ornithine-alpha-ketoglutarate
• Prohomones
• Sulfo-polysaccharides
• Tribulus terrestris
• Vanadyl sulfate
• Zinc-magnesium aspartate
• Arginine
• Carnitine
• Glutamine
• Inosine
• Medium-chain triglycerides (MCT)
• Ribose

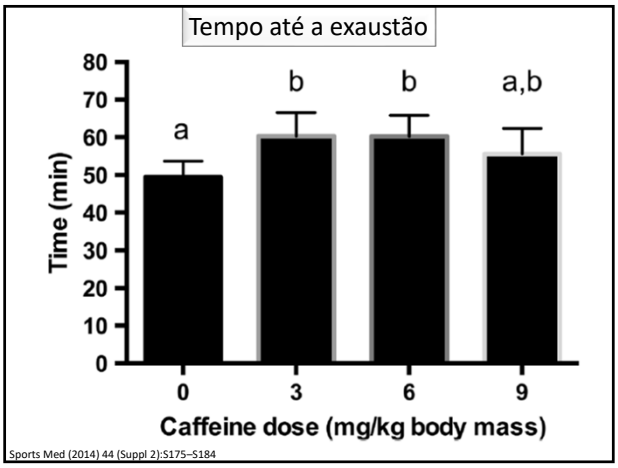
76


CAFEÍNA
O
CH3
H3C
N
N
O
N
N
CH3

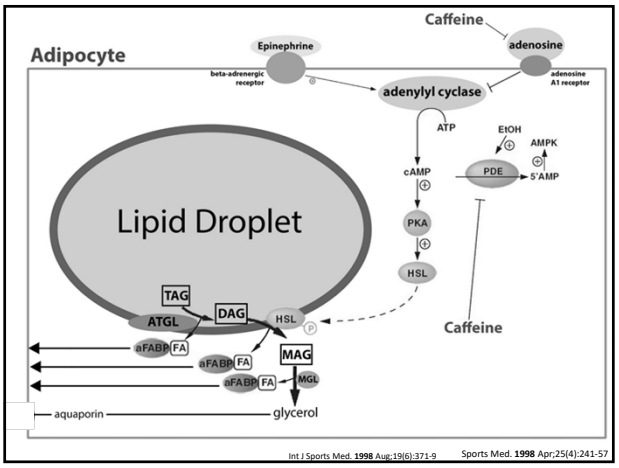
77


Plasma caffeine (µmol/L)
80
70
60
50
40
30
20
10
0
9 mg/kg
6 mg/kg
3 mg/kg
0 mg/kg
-60
0
5
15
exh
Time (min)
Sports Med (2014) 44 (Suppl 2):S175–S184

78


Tempo até a exaustão
Time (min)
80
70
60
50
40
30
20
10
0
a
b
b
a,b
0
3
6
9
Caffeine dose (mg/kg body mass)
Sports Med (2014) 44 (Suppl 2):S175–S184

79


Caffeine
Adipocyte
Epinephrine
adenosine
beta-adrenergic receptor
adenosine A1 receptor
adenylyl cyclase
ATP
EtOH
AMPK
cAMP
PDE
5'AMP
Lipid Droplet
PKA
HSL
TAG
ATGL
DAG
HSL
Caffeine
aFABP
FA
MAG
MGL
aquaporin
glycerol
Int J Sports Med. 1998 Aug;19(6):371-9
Sports Med. 1998 Apr;25(4):241-57

80

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DIETITIANS OF CANADA

Nutrition and Athletic Performance

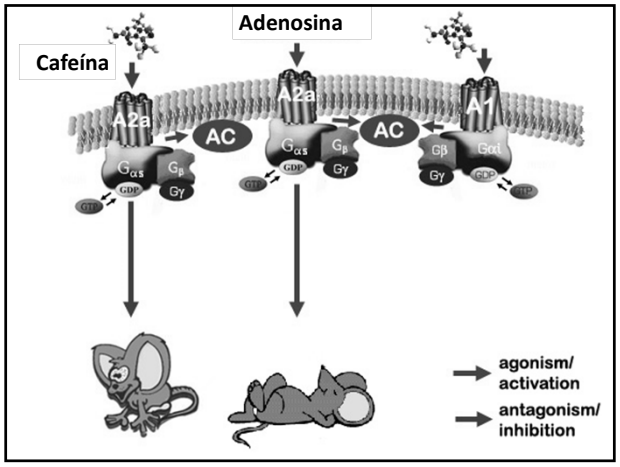
JOINT POSITION STATEMENT

⇩ Percepção de Fadiga

⇧ Liberação de Cálcio do retículo sarcoplasmático

National Collegiate Athletic Association: < 15 µg cafeína/mL urina

81



82

International Journal of Sport Nutrition and Exercise Metabolism, 2018, 28, 104-125
https://doi.org/10.1123/ijsnem.2018-0020
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Human Kinetics
CONSENSUS STATEMENT

IOC Consensus Statement: Dietary Supplements and the High-Performance Athlete

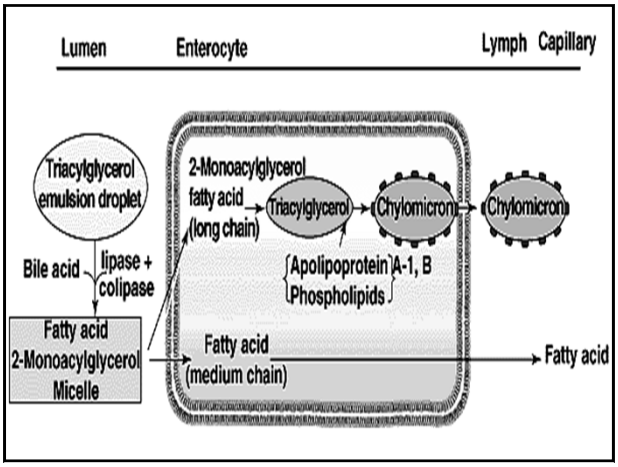
Table 3 Supplements With Good to Strong Evidence of Achieving Benefits to Performance When Used in Specific Scenarios (see Peeling et al., 2018 for further details)

Caffeine	
[illegible]	Caffeine is a stimulant that possesses well-established benefits for athletic performance across endurance-based situations, and short-term, supramaximal, and/or repeated sprint tasks.
Mechanism	Adenosine receptor antagonism; increased endorphin release; improved neuromuscular function; improved vigilance and alertness; reduce perception of exertion during exercise (Burke, 2008; Spriet, 2014)
Protocol of use	3–6 mg/kg of BM, in the form of anhydrous caffeine (i.e., pill or powder form), consumed ~60 min prior to exercise (Ganio et al., 2009). Lower caffeine doses (<3 mg/kg BM, ~200 mg), provided both before and during exercise; consumed with a CHO

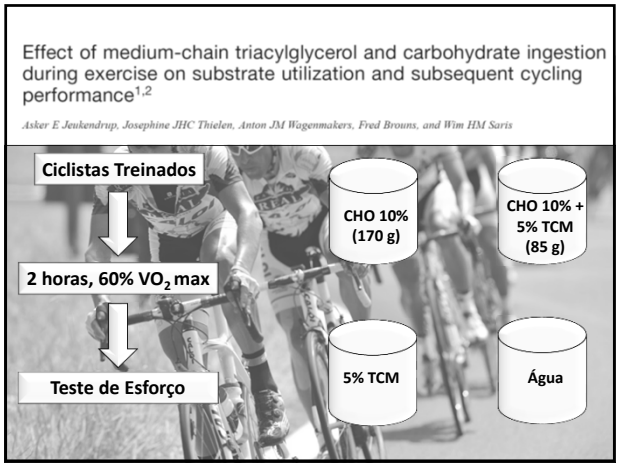
83

TCM

84



85



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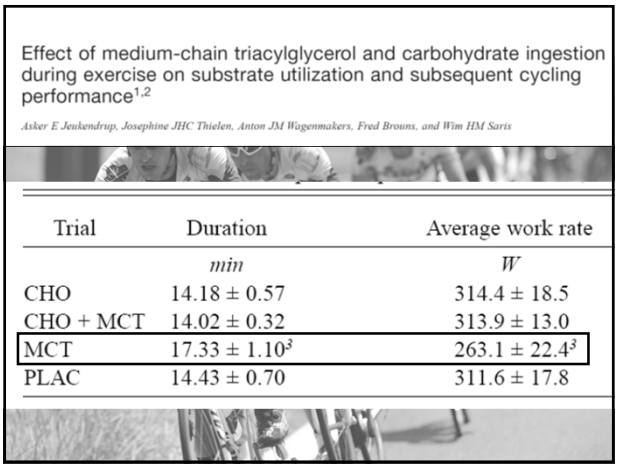
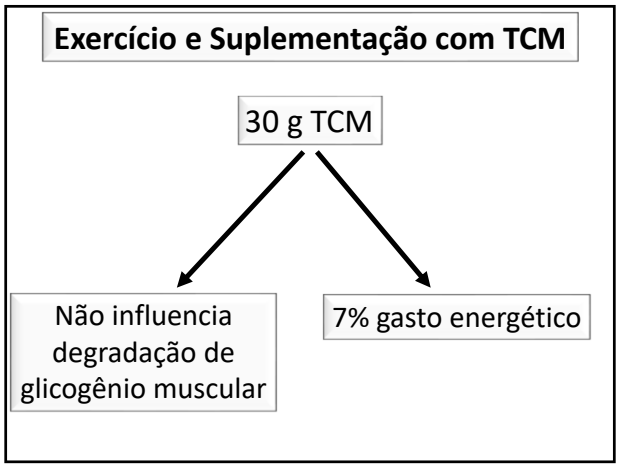
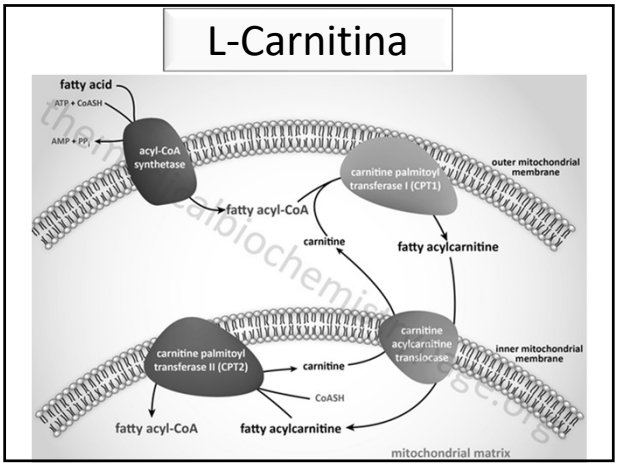


Trial	Duration	Average work rate
	min	*W*
CHO	14.18 ± 0.57	314.4 ± 18.5
CHO + MCT	14.02 ± 0.32	313.9 ± 13.0
MCT	17.33 ± 1.10[3]	263.1 ± 22.4[3]
PLAC	14.43 ± 0.70	311.6 ± 17.8

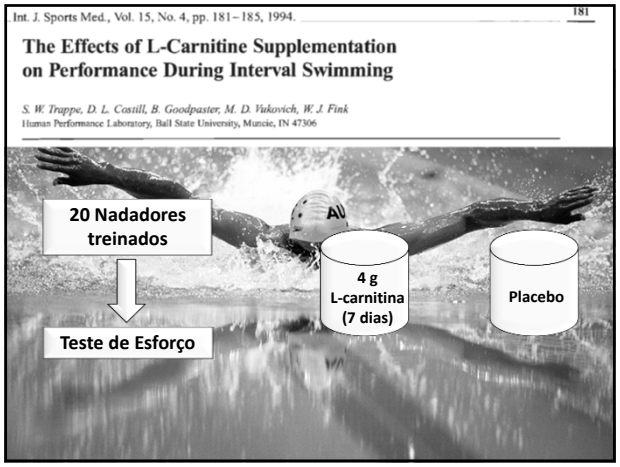
87



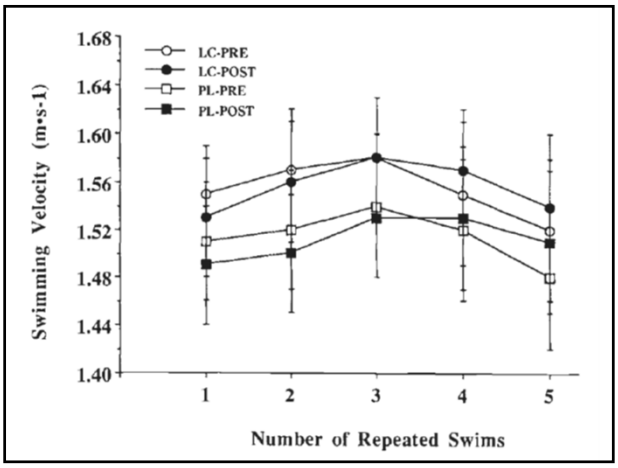
88


L-Carnitina
fatty acid
ATP + CoASH
AMP + PPi
acyl-CoA synthetase
carnitine palmitoyl transferase I (CPT1)
outer mitochondrial membrane
fatty acyl-CoA
carnitine
fatty acylcarnitine
carnitine acylcarnitine translocase
inner mitochondrial membrane
carnitine palmitoyl transferase II (CPT2)
carnitine
CoASH
fatty acyl-CoA
fatty acylcarnitine
mitochondrial matrix

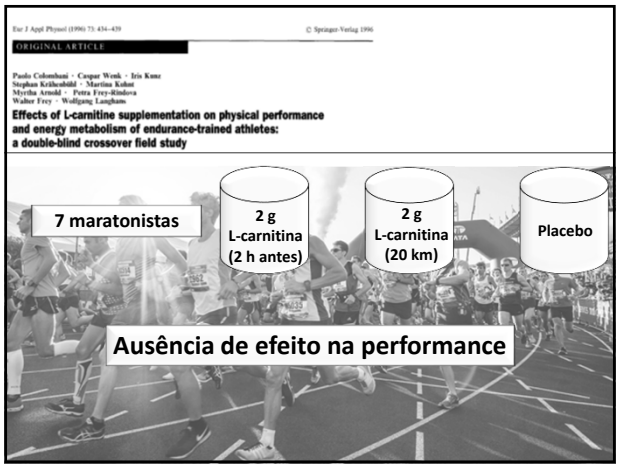
89


Int. J. Sports Med., Vol. 15, No. 4, pp. 181–185, 1994.
181
The Effects of L-Carnitine Supplementation on Performance During Interval Swimming
S. W. Trappe, D. L. Costill, B. Goodpaster, M. D. Vukovich, W. J. Fink
Human Performance Laboratory, Ball State University, Muncie, IN 47306
20 Nadadores treinados
Teste de Esforço
4 g L-carnitina (7 dias)
Placebo

90


LC-PRE
LC-POST
PL-PRE
PL-POST
Swimming Velocity (m•s-1)
1.68
1.64
1.60
1.56
1.52
1.48
1.44
1.40
1
2
3
4
5
Number of Repeated Swims

91

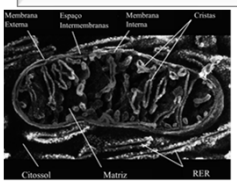

ORIGINAL ARTICLE
Effects of L-carnitine supplementation on physical performance and energy metabolism of endurance-trained athletes: a double-blind crossover field study
7 maratonistas
2 g L-carnitina (2 h antes)
2 g L-carnitina (20 km)
Placebo
Ausência de efeito na performance

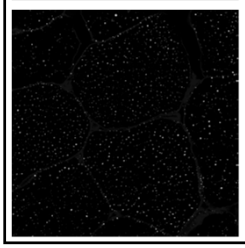
92

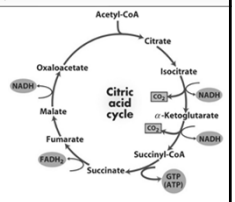
Considerações Finais

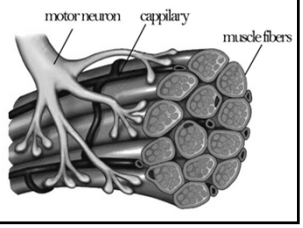
93

Treinamento Físico e Adaptações Metabólicas

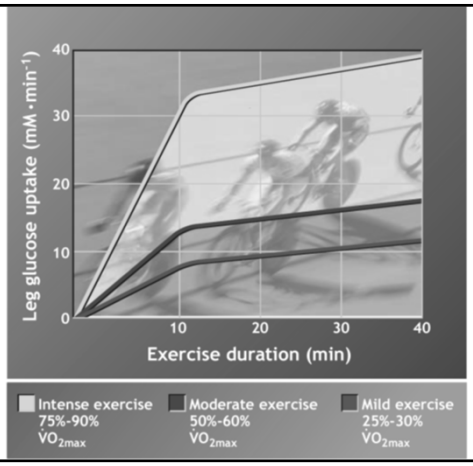








94



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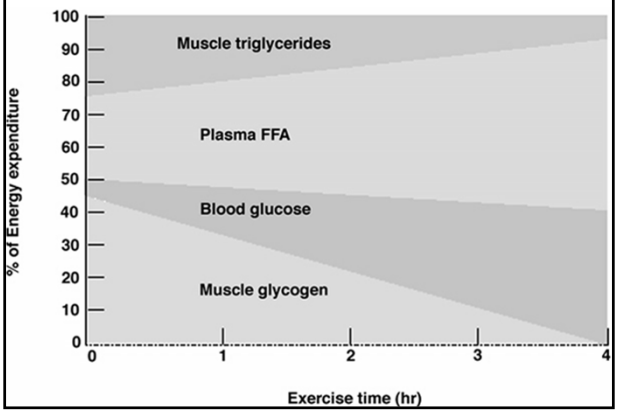
Duração do Exercício e Substrato Muscular



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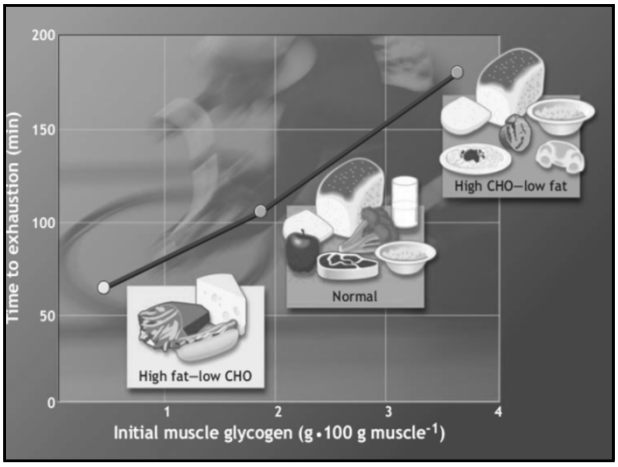

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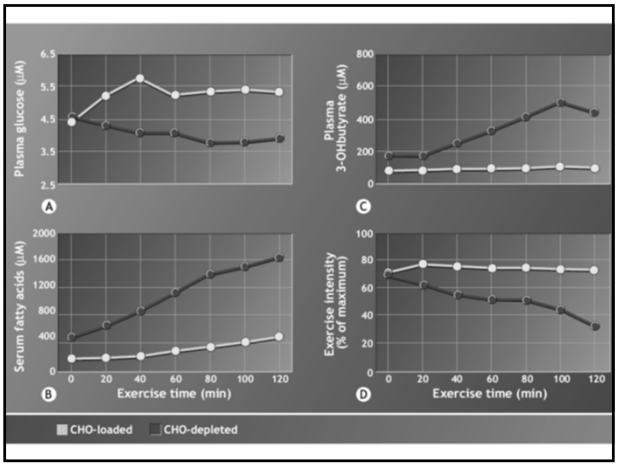

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DIETITIANS OF CANADA

Nutrition and Athletic Performance

Modificações dietéticas, reposição hídrica, suplementos alimentares e drogas: comprovação de ação ergogênica e potenciais riscos para a saúde

AG saturados < 10% VCT

Lipídios: 20% - 35% VCT

Evitar Lipídios < 20% VCT

Lipídios: ~ 30% VCT
1 g LIP/ kg peso

10% Sat, 10% AGMI, 10%AGPI

Journal of the International Society of Sports Nutrition

REVIEW Open Access

ISSN exercise & sports nutrition review update: research & recommendations

Lipídios: ~ 30% VCT
1 g LIP/ kg peso

Gordura corporal em atletas → **~ 20% VCT**

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