UNIVERSITÀ CATTOLICA del Sacro Cuore

Principi e adattamenti dell'allenamento della forza: dalle molecole al movimento

The University of Nottingham

UNITED KINGDOM · CHINA · MALAYSIA

ADATTAMENTI NEUROMUSCOLARI ALL'ALLENAMENTO DELLA FORZA

Marco V. Narici

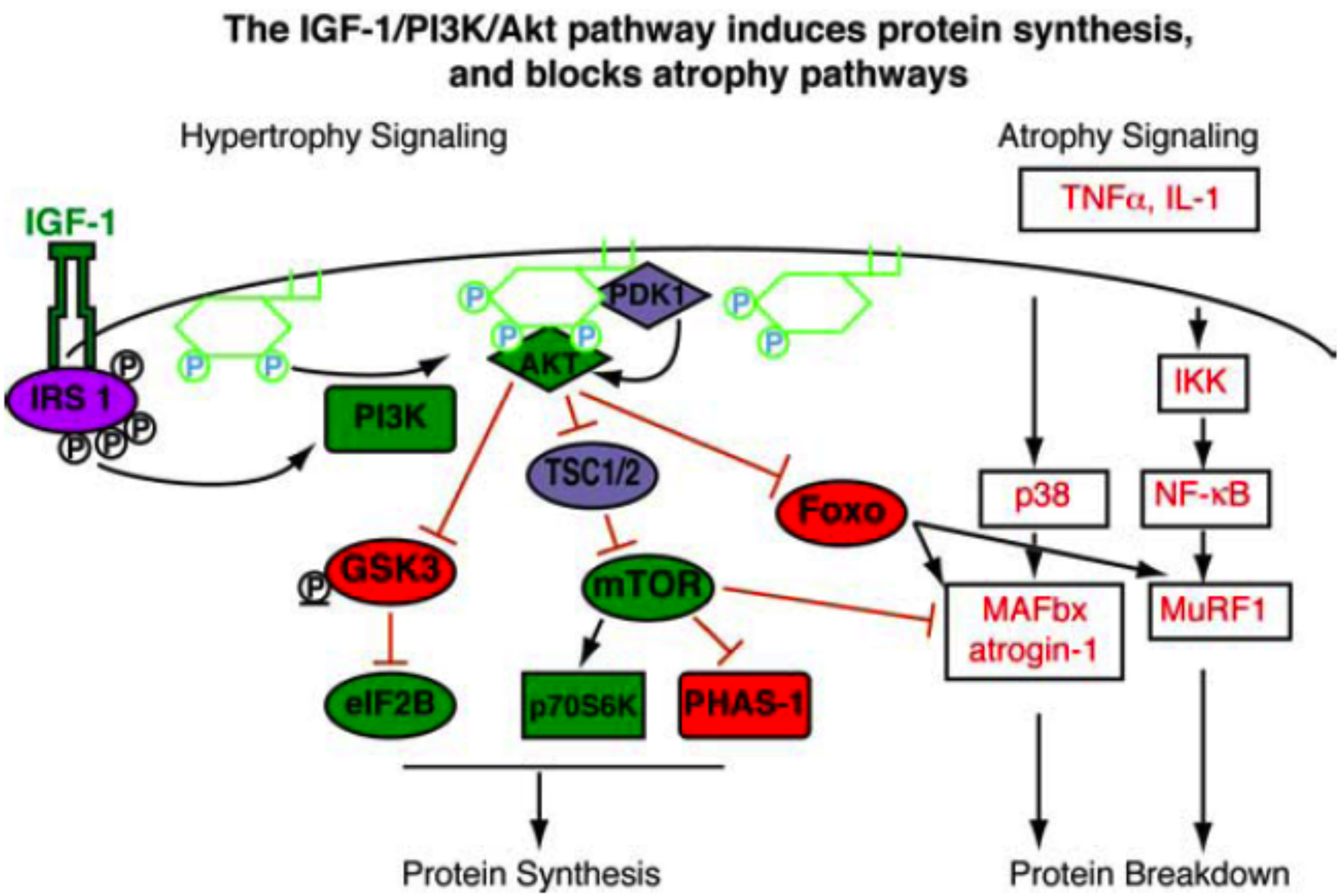
School of Medicine, Faculty of Medicine & Health Sciences,

University of Nottingham

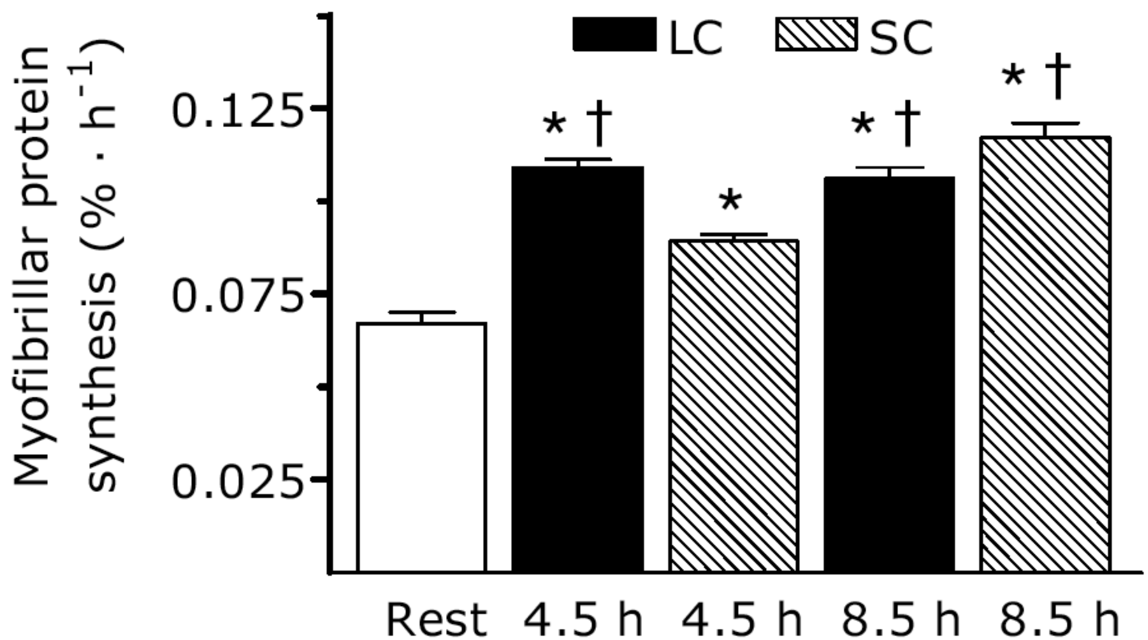
United Kingdom

Loading and muscle mass

Signaling pathways controlling protein synthesis and breakdown

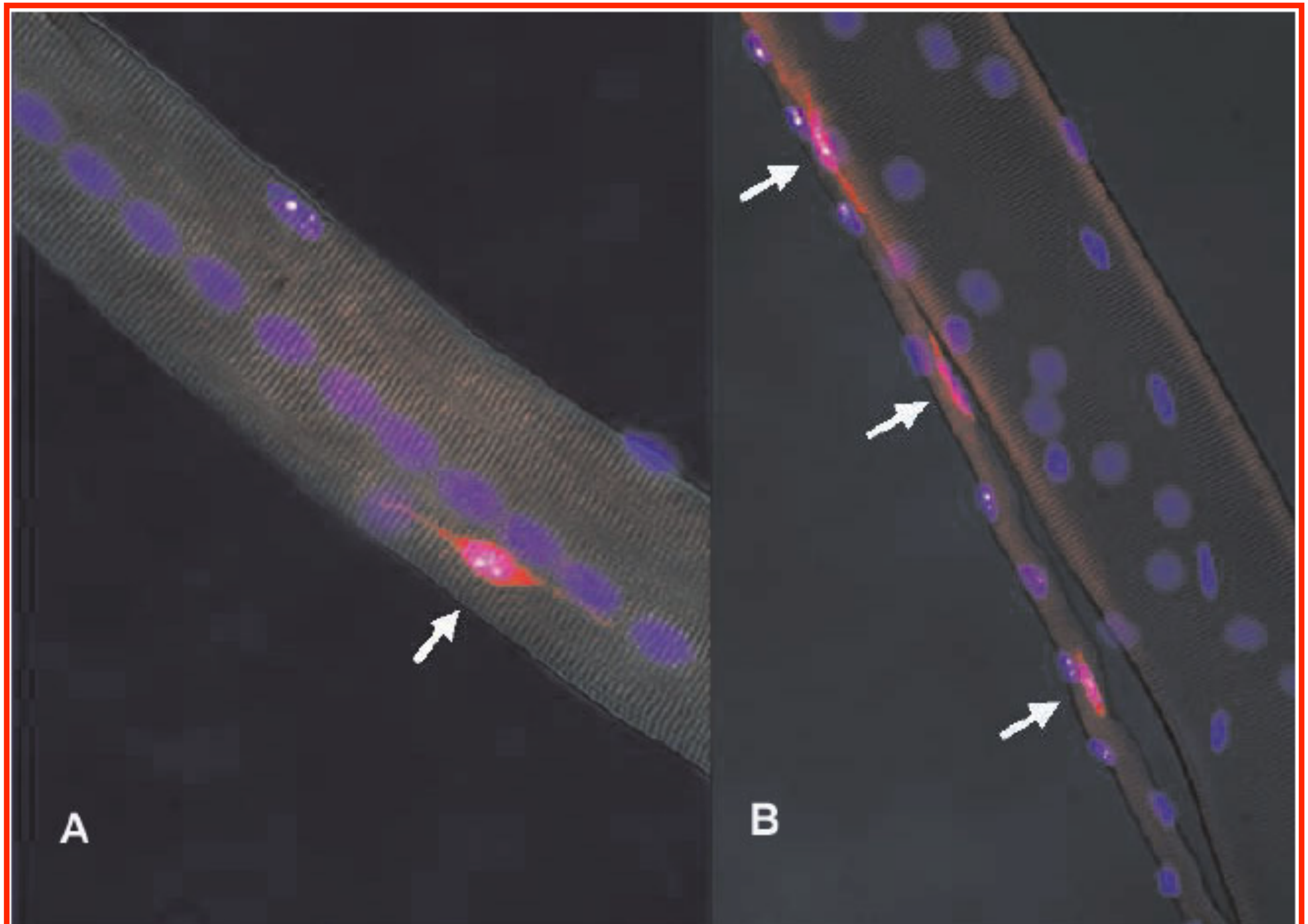


Myofibrillar protein synthesis response to one ecc/con RE session

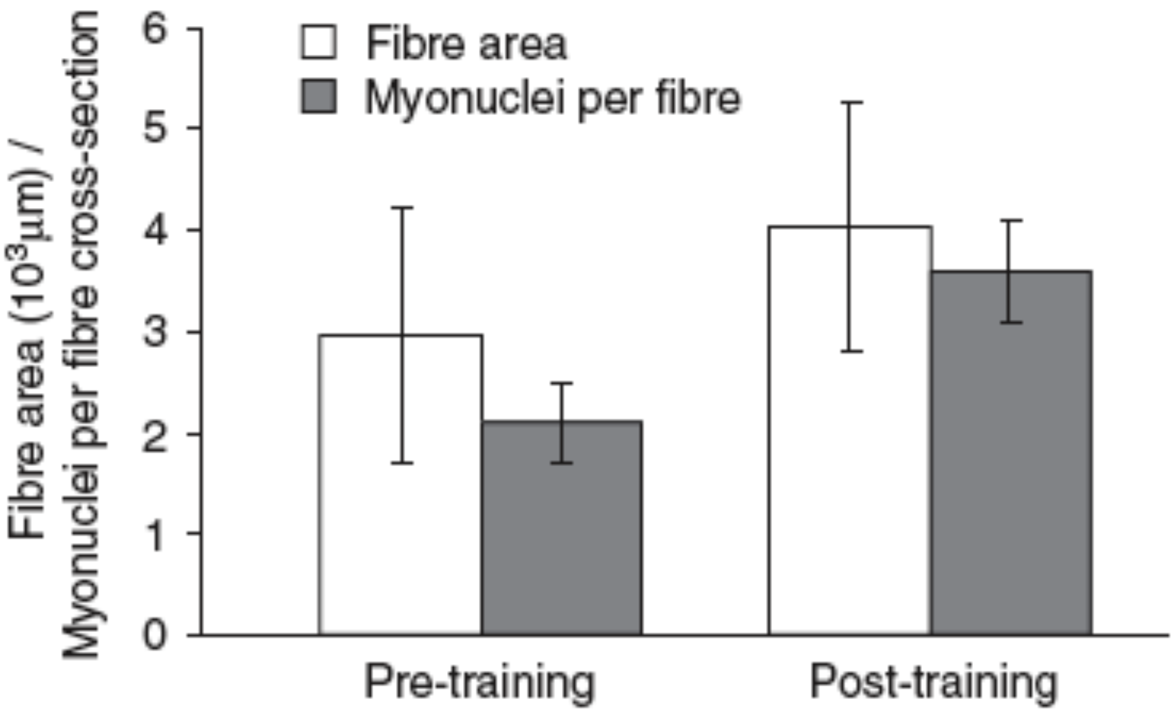


Moore et al (2005) Am J Physiol Endocrinol Metab

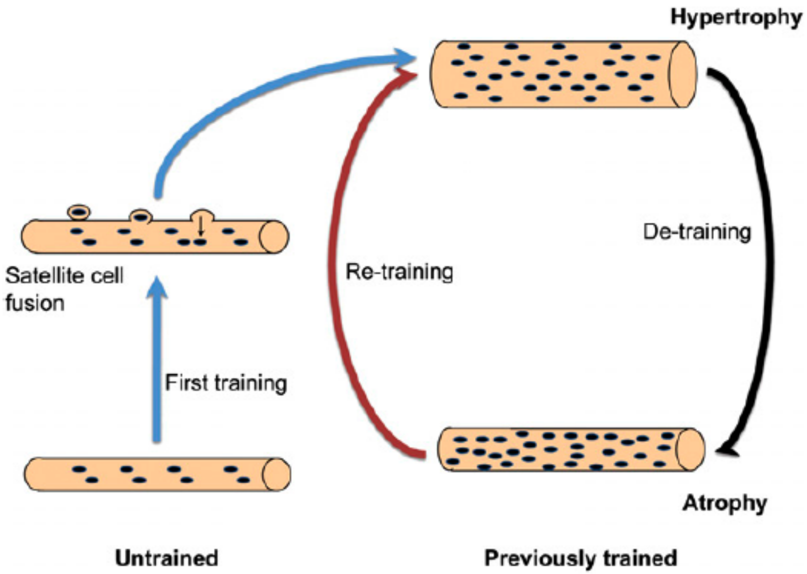
Satellite cells & muscle growth

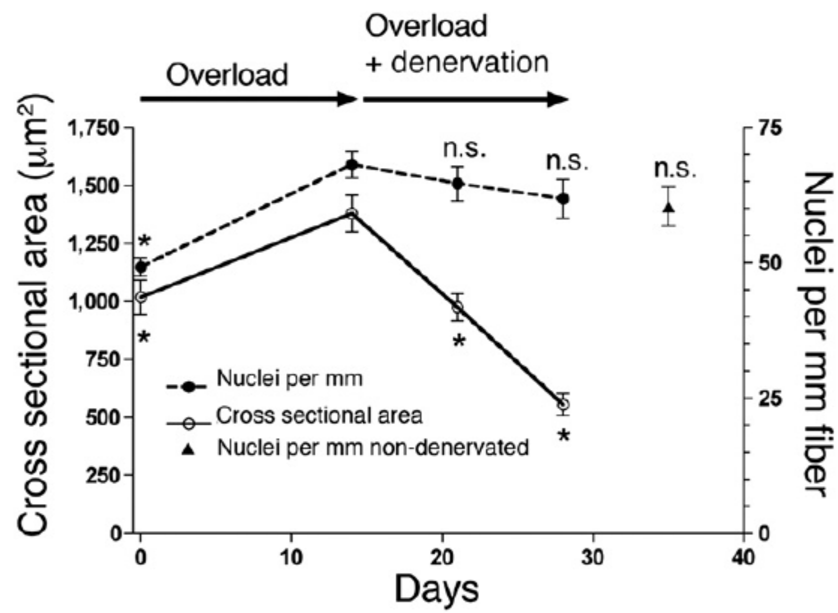


Fibre hypertrophy and myonuclei number

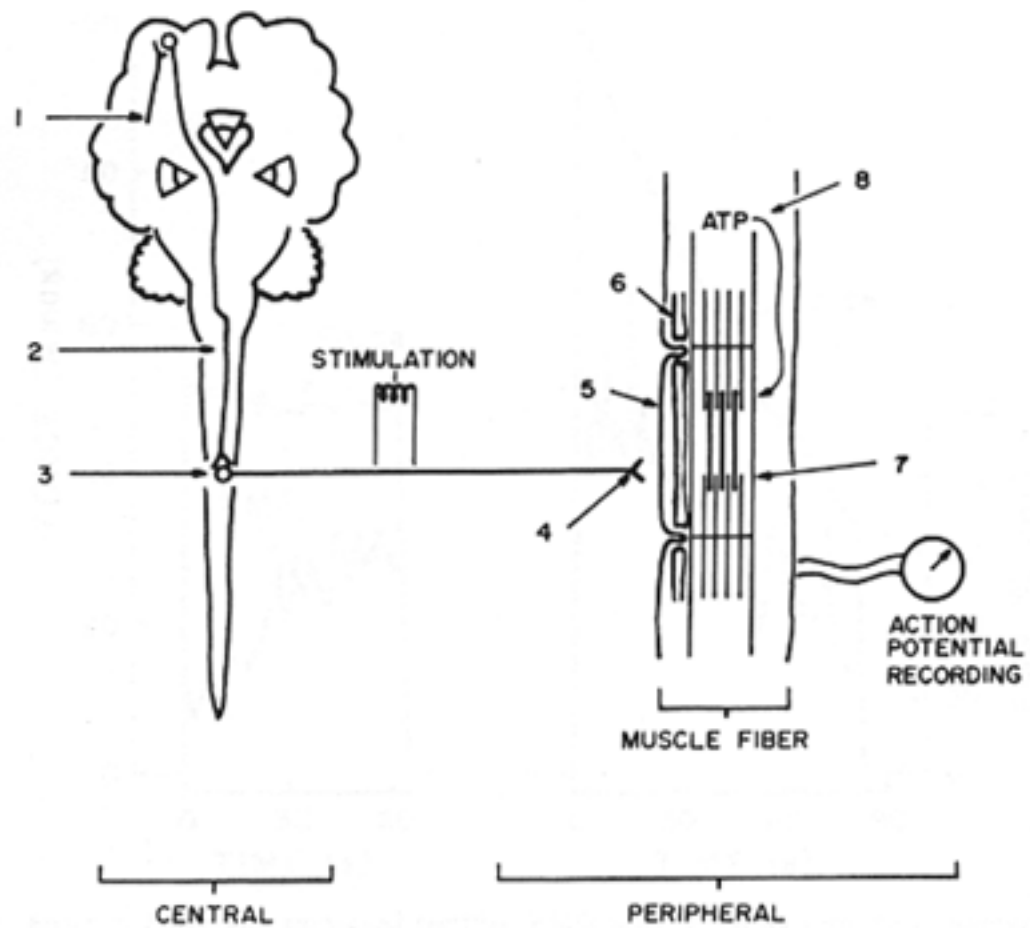


‘Muscle memory’

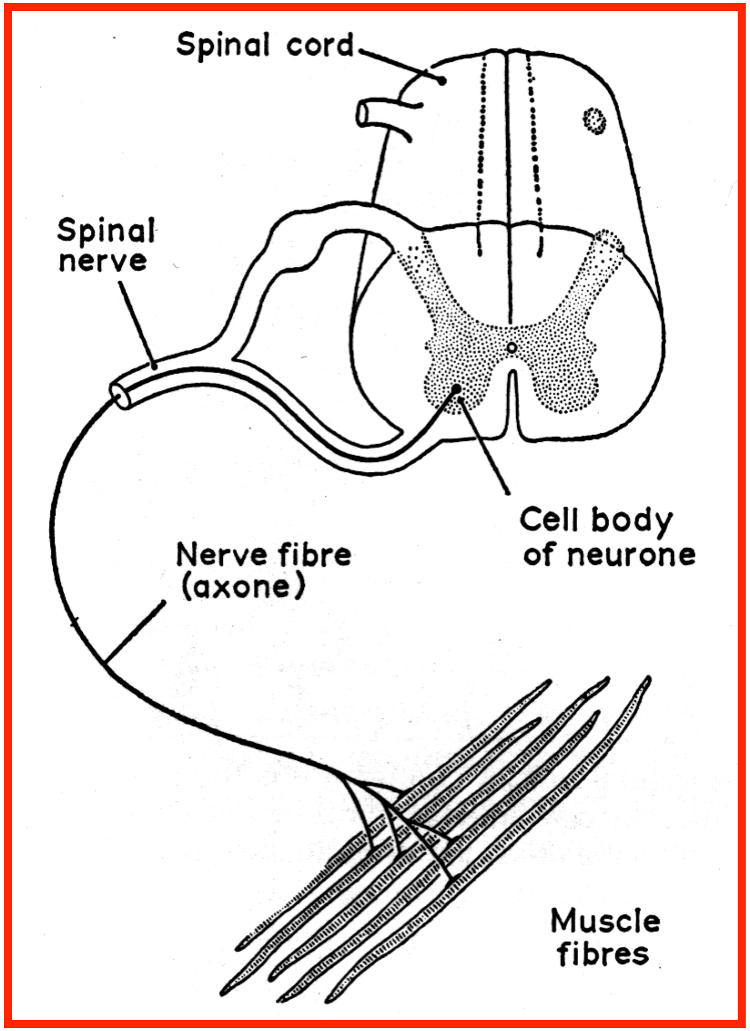




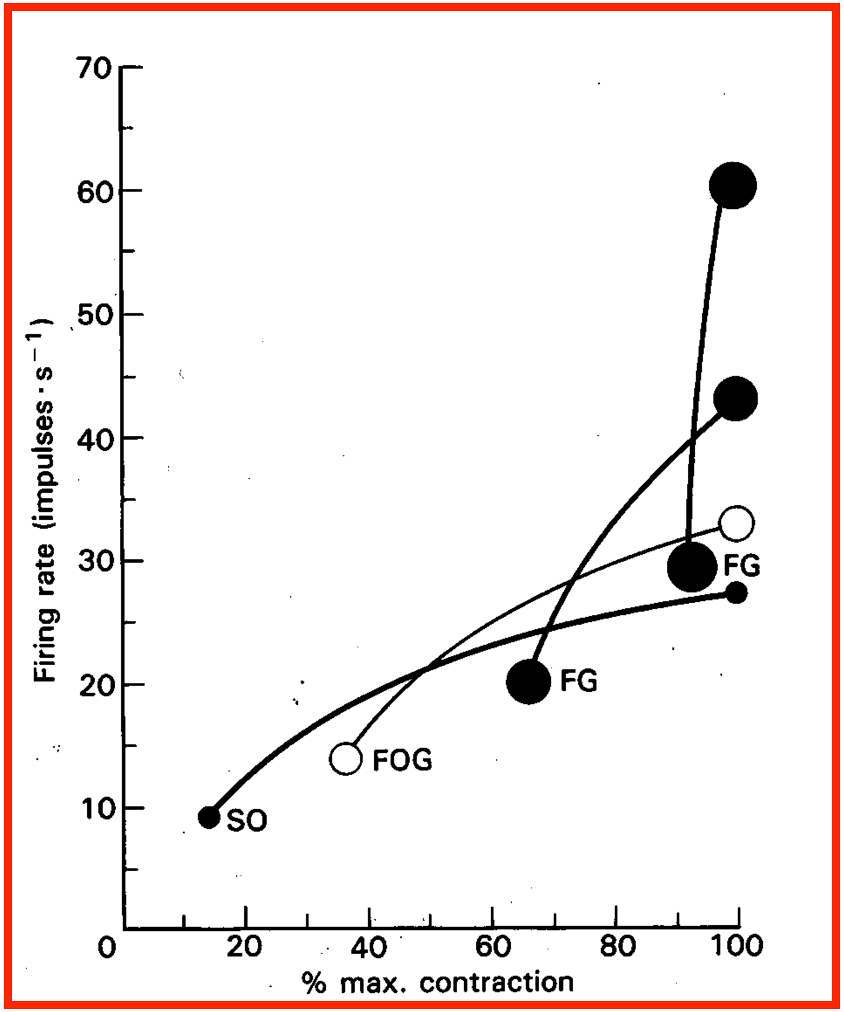
Central and Peripheral Neural Pathways involved in Force Development



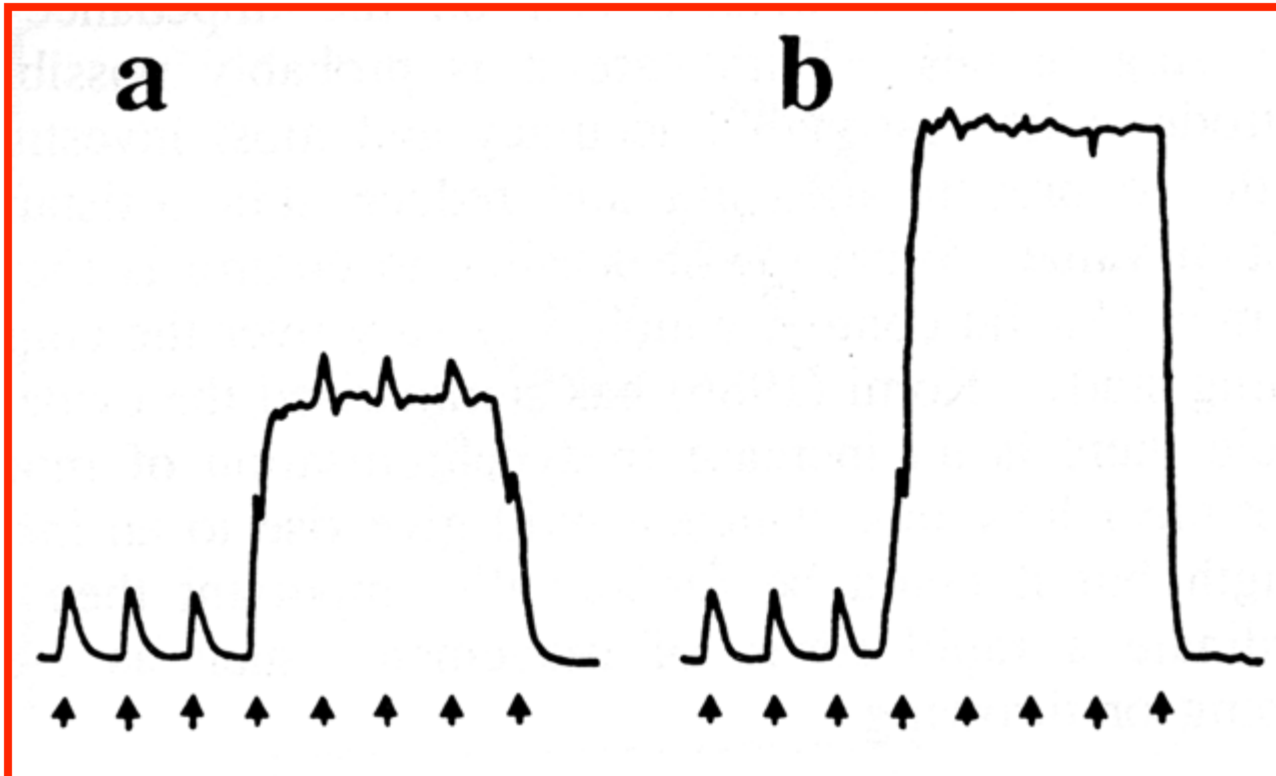
The motor unit



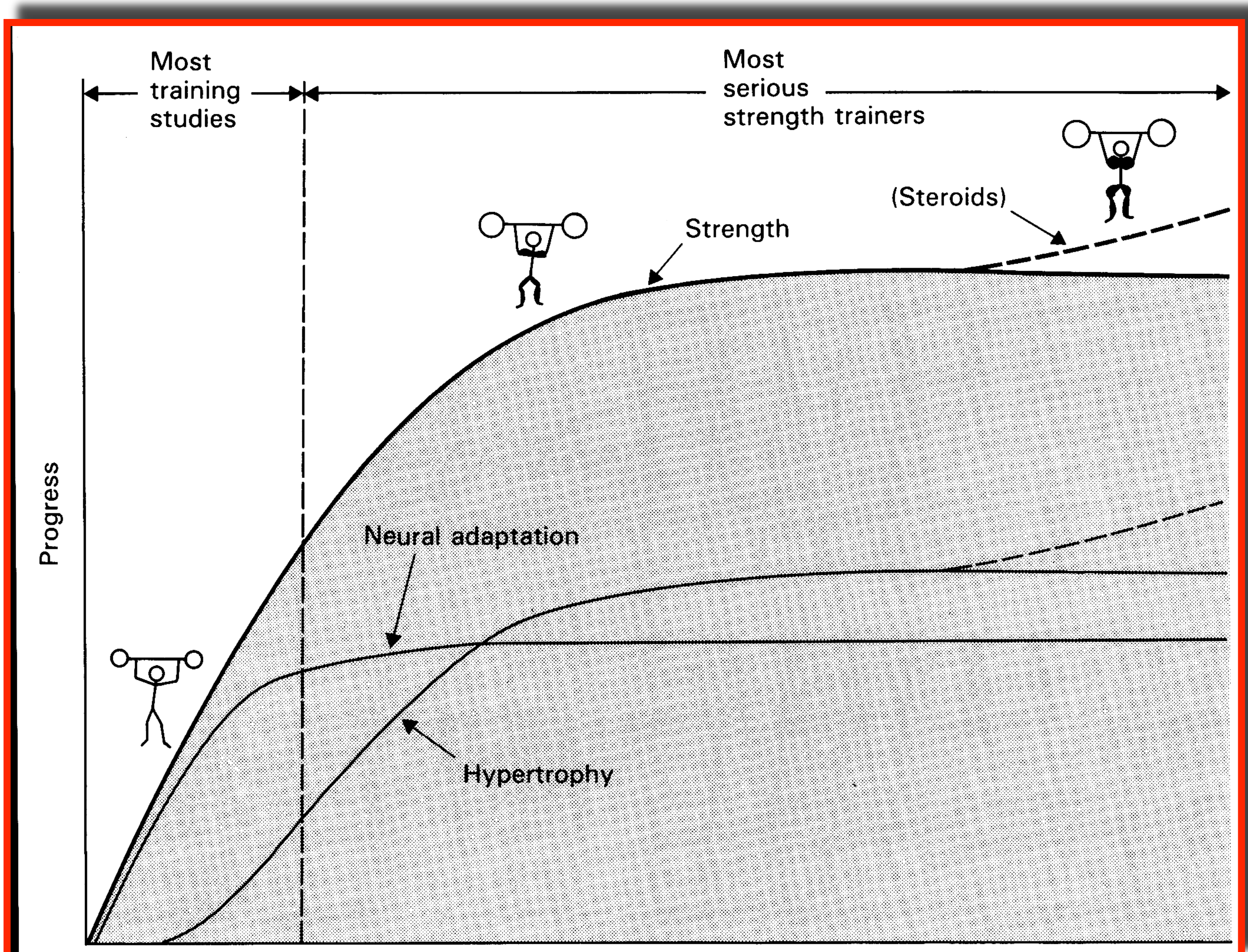
Recruitment of motor units: 'Henneman's Size Principle'



Muscle activation during voluntary contraction

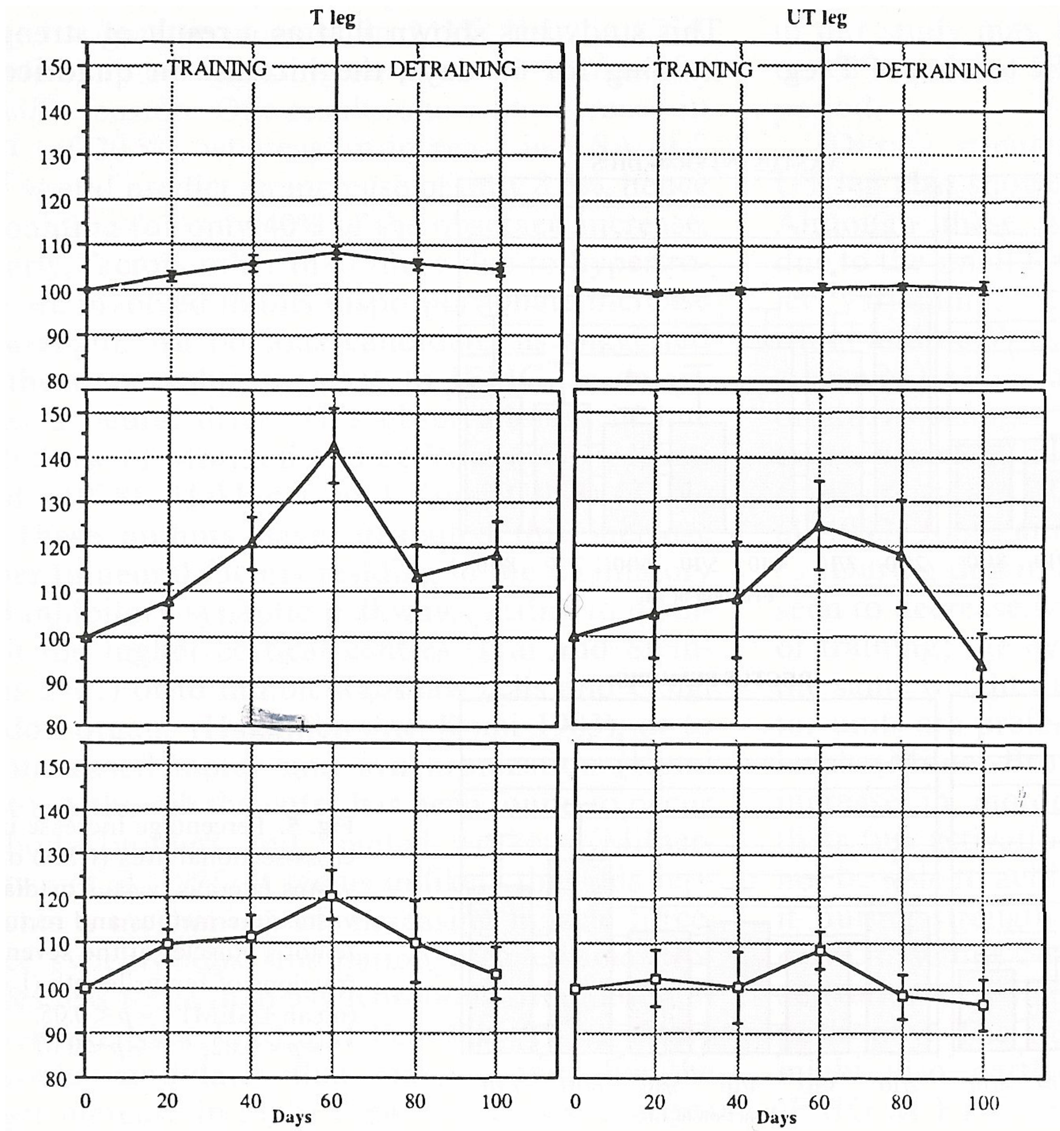


Time course of neural and muscular adaptations



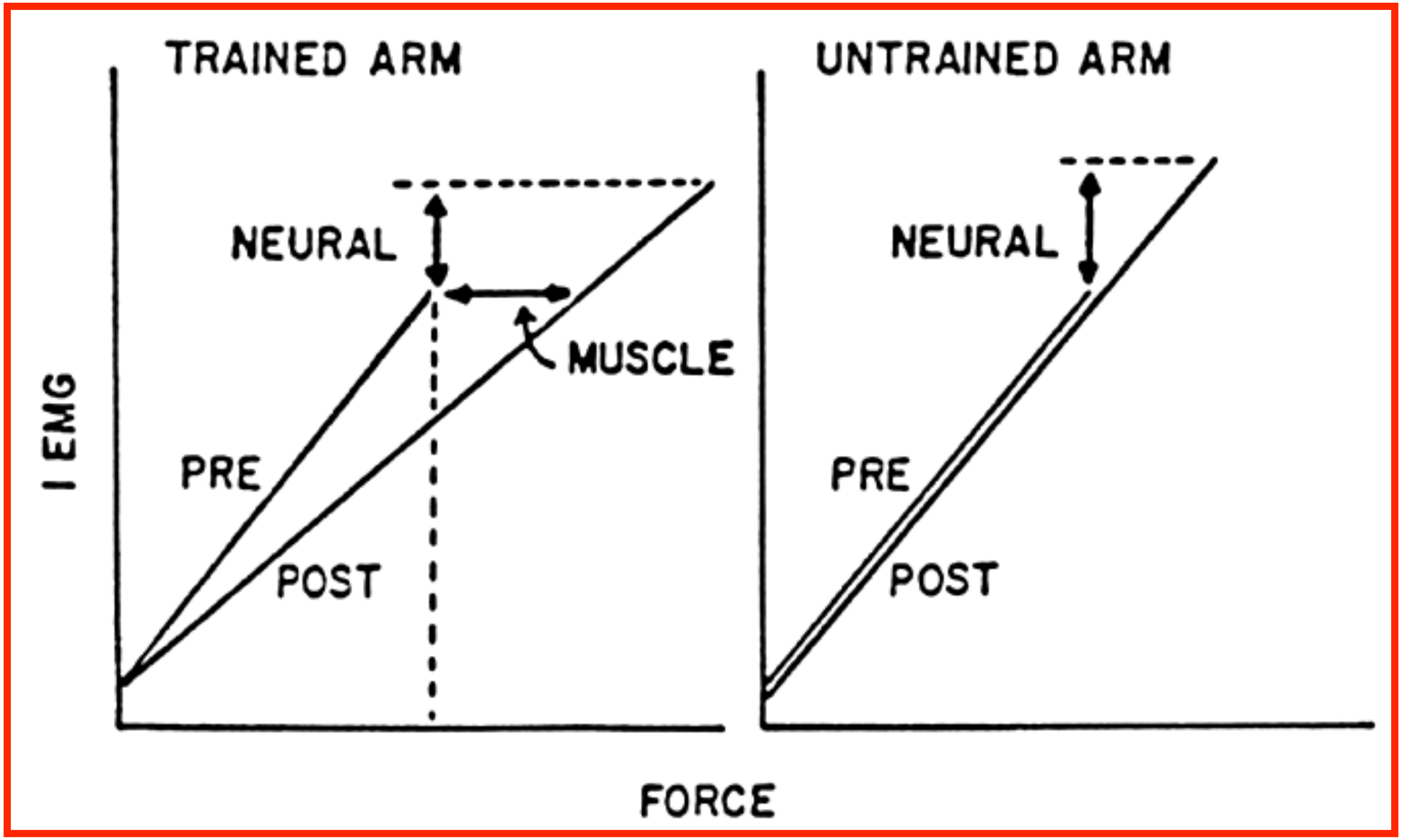
Sale DG. In Strength & Power in Sports. Ed. PV Komi, Blackwells publ (1992)

Strength, CSA and EMG with training and detraining

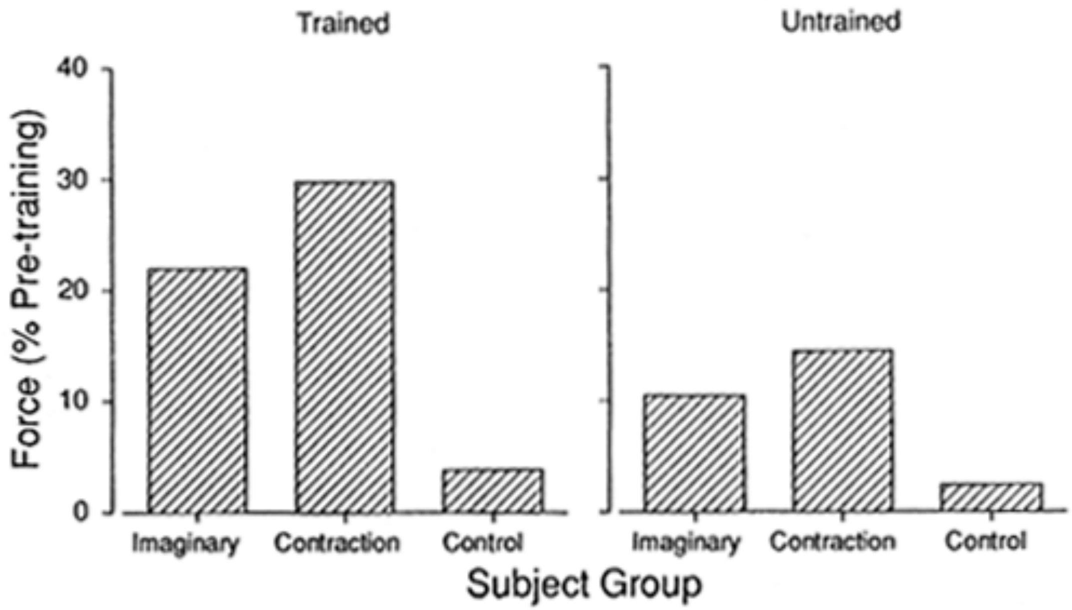


Narici et al. Eur J Appl Physiol 59, 1989

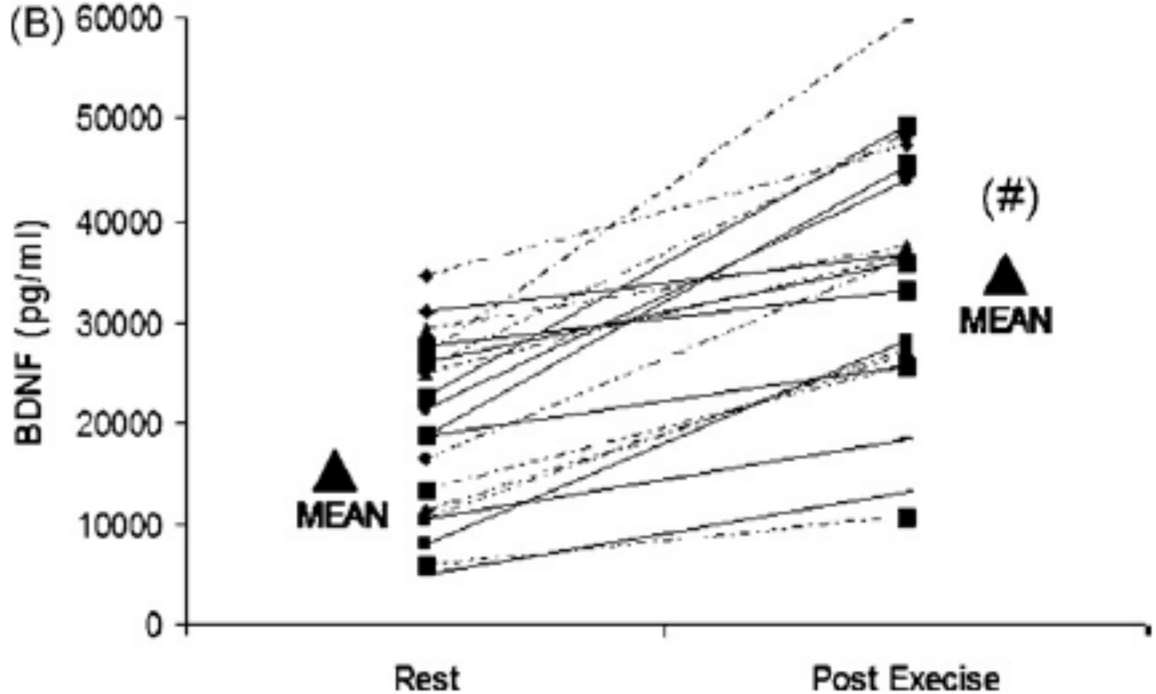
Neural and muscular factors' contribution to strength gains



Imagined contraction training

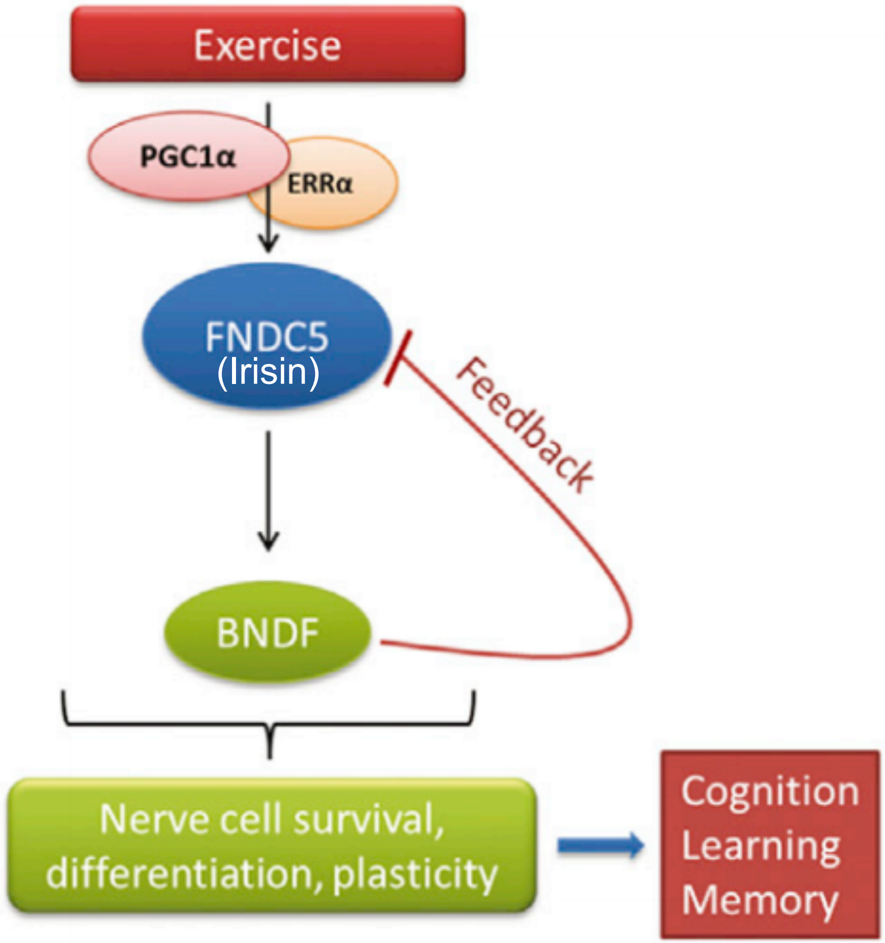


Effect of ST on Neurotrophins



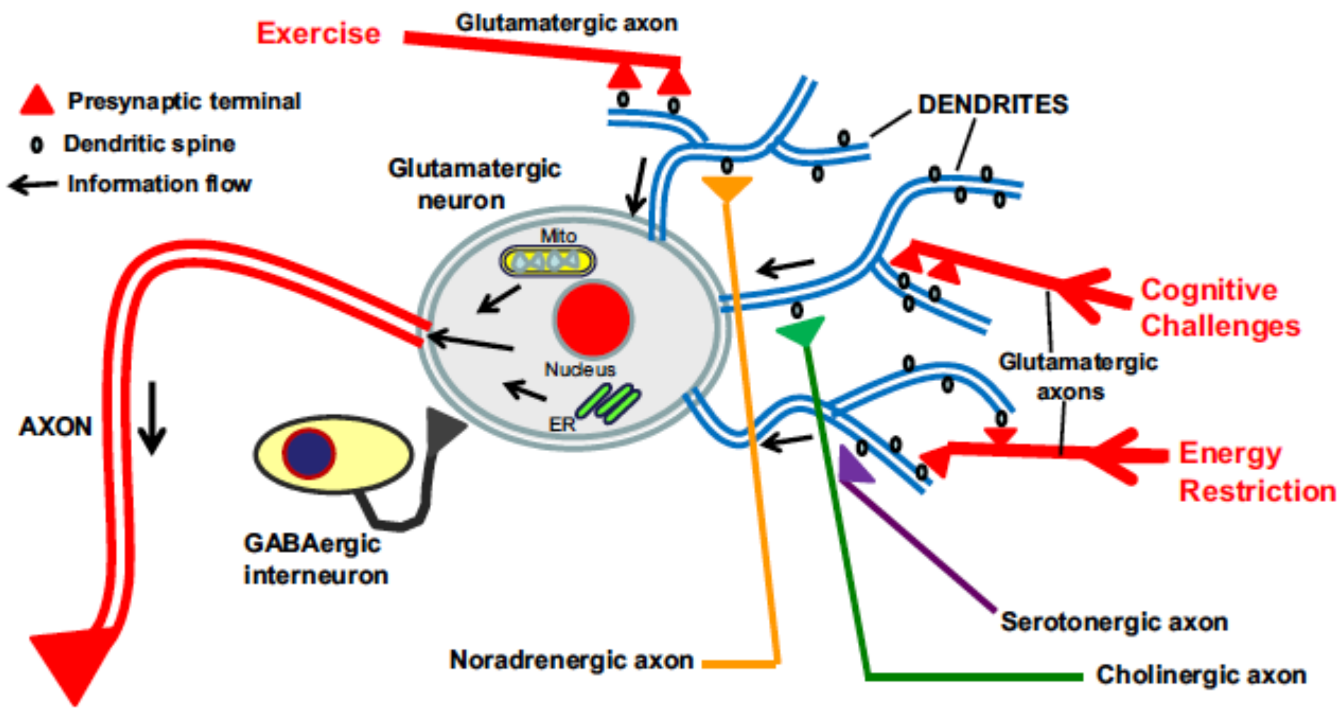
BDNF role in brain and neural plasticity*: proliferation, differentiation, survival of MN, neurogenesis, synaptic plasticity, cognitive function and well being*

Exercise boosts brain heath



Wrann et al Cell 2013

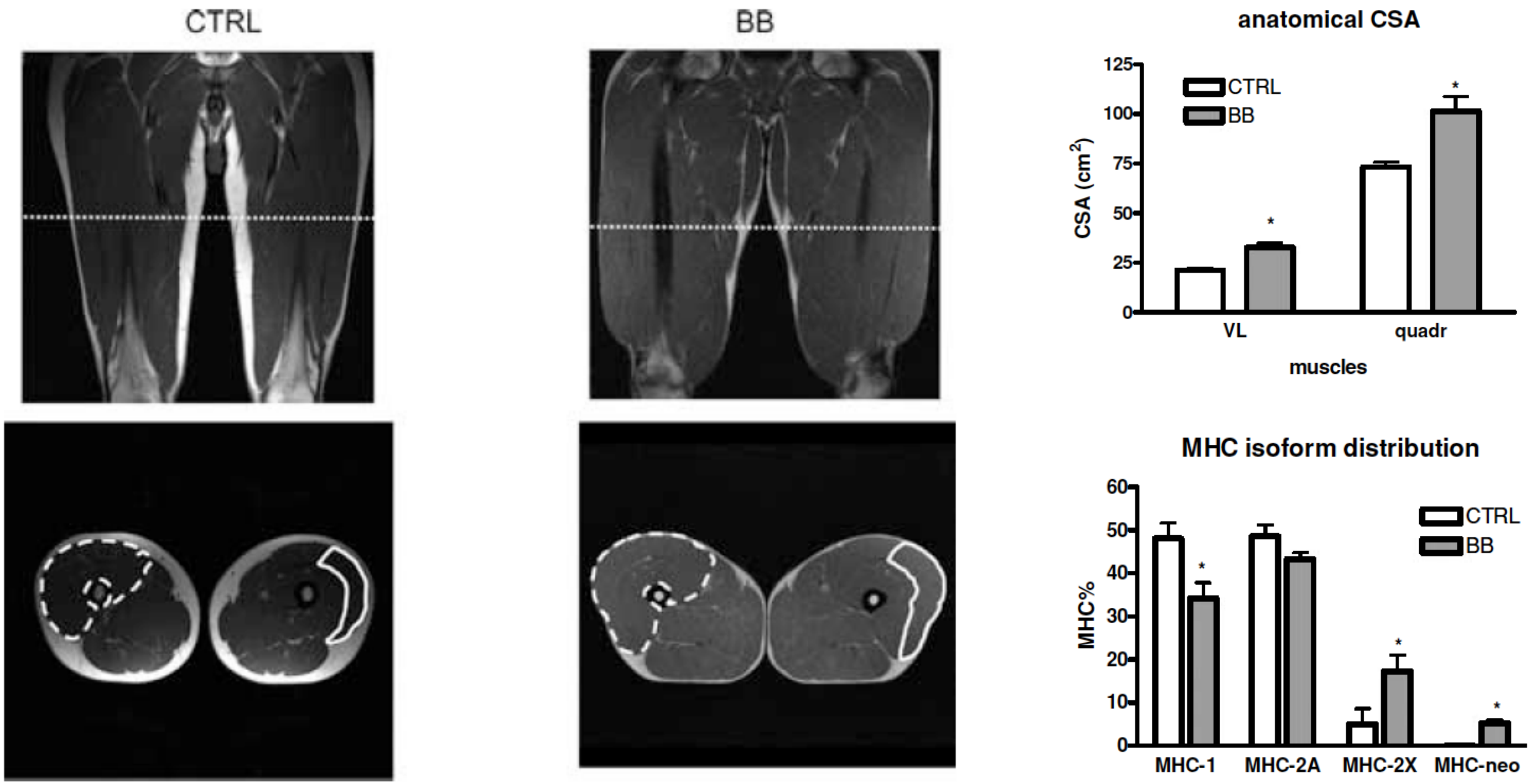
Exercise, cognitive activity, caloric restriction activate the same molecular pathways



Exercise increases Ca2+ influx which then activates signaling pathways that: **1)** induce the expression of genes involved in synaptic plasticity and cell survival, including those encoding neurotrophic factors, protein chaperones, and antioxidant enzymes; **2)** modify mitochondrial energy metabolism and free radical generation; and **3)** trigger Ca2+ release from the endoplasmic reticulum (ER).

Mattson, *Cell* 2012

Muscle size and composition in body builders vs normals

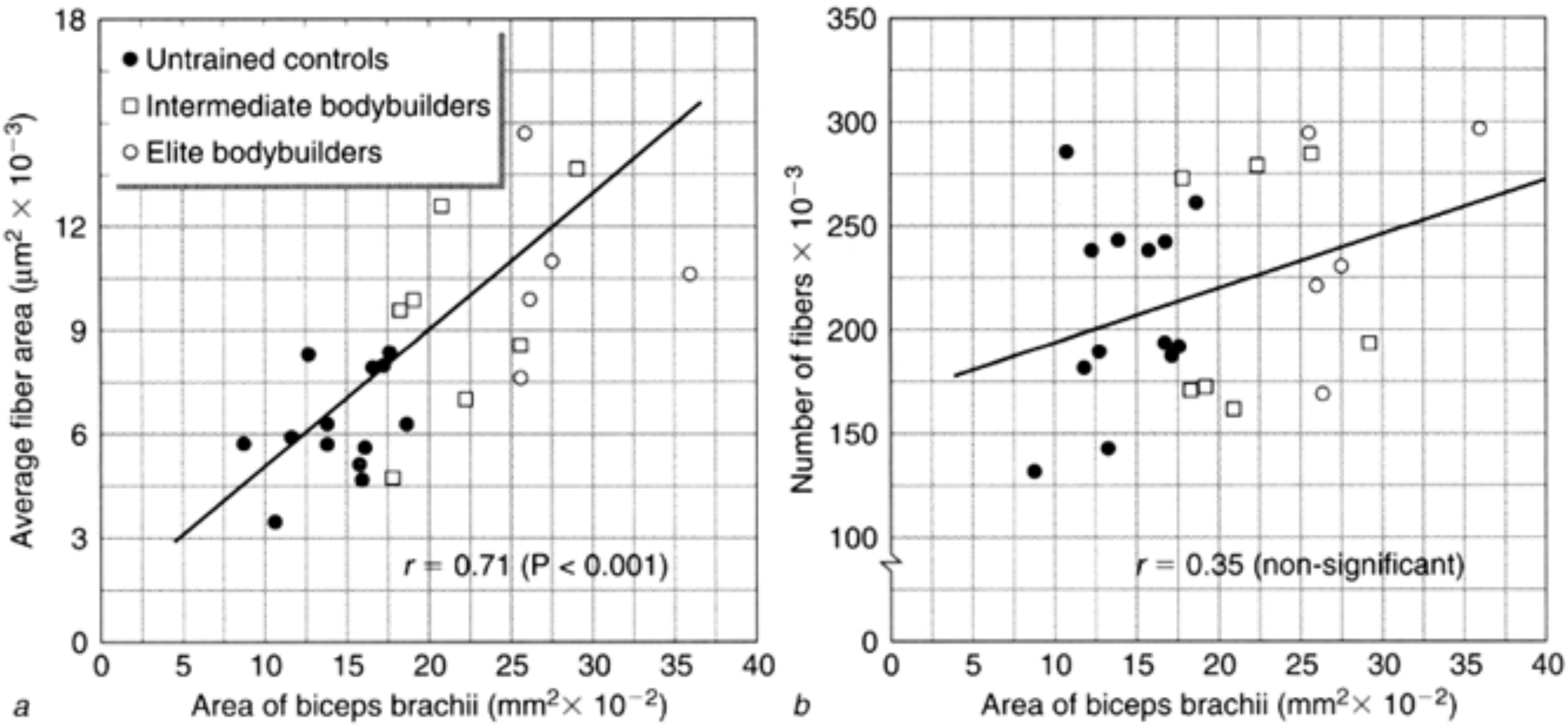


Training-induced fibre transformations

Reference	Duration of bout	Duration of training		Type, % I	IIA	IIB
High intensity						
Simoneau et al. [28]	15–90 s	(4–5)	15 wks	↑	↔	↓
Jansson et al. [29]	30 s	(2–3)	4–6 wks	↓	↑	↔
Jacobs et al. [30]	15–30 s	(2–3)	6 wks	↘	↑	↔
Esbjörnsson et al. [31]	10 s	(3)	6 wks	↓	↑	↓
Linossier et al. [32]	5 s	(4)	7 wks	↑	↔	↓
Staron et al. [33] (strength)	3 × 6–12 s (70–85%)	(2)	6–13 wks	↔	↑	↓
Adams et al. [34] (strength)	3 × 6–12 s (70–85%)	(2)	19 wks	↔	↗	↓
Cadefeau et al. [35]	–		8 months	↑	↓	↓
Low intensity						
Andersen and Henriksson [36]	30 min	(4)	8 wks	↔	↑	↓
Howald et al. [37]	30 min	(5)	6 wks	↑	↗	↓
Bauman et al. [38]	30 min	(5)	8 wks	↔	↑	↓
Ingjer [39] (cross-country skiing)	45 min	(3)	24 wks	↔	↑	↓

Training was in the form of cycling unless stated otherwise. Training days per week indicated in parenthesis.

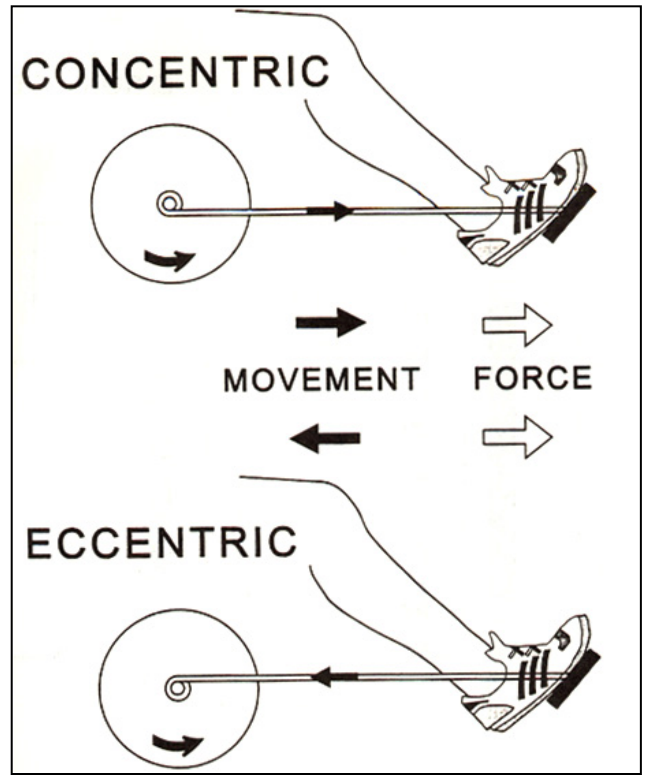
Hyperplasia?



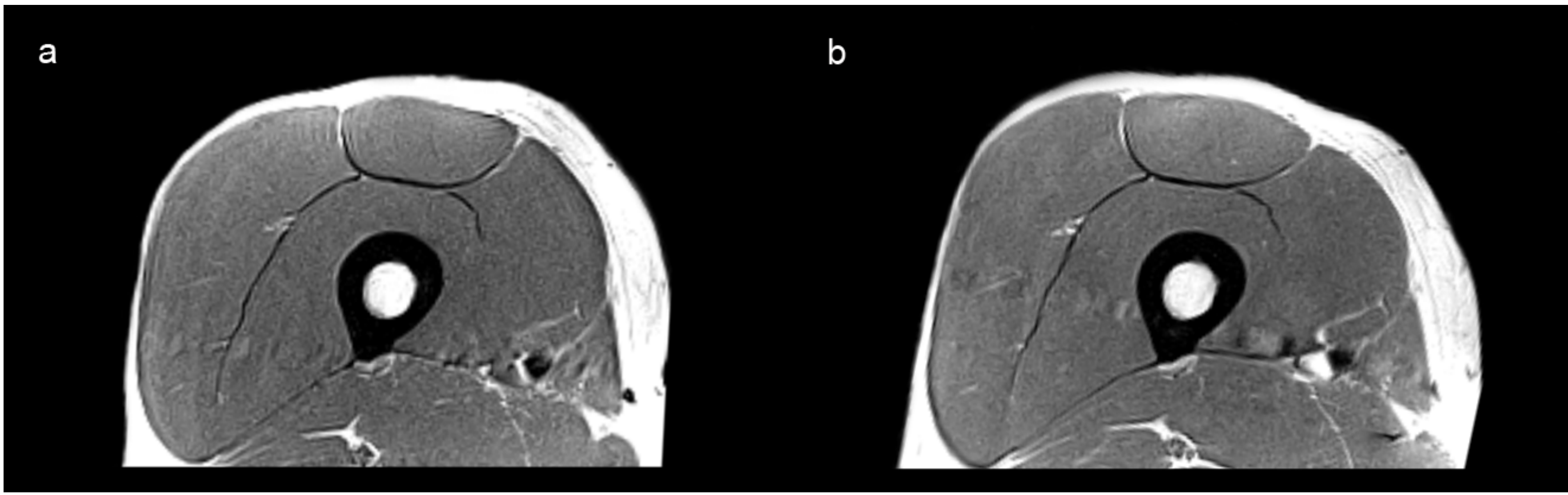
Early skeletal muscle hypertrophy and architectural changes in response to high-intensity resistance training

O. R. Seynnes, M. de Boer and M. V. Narici

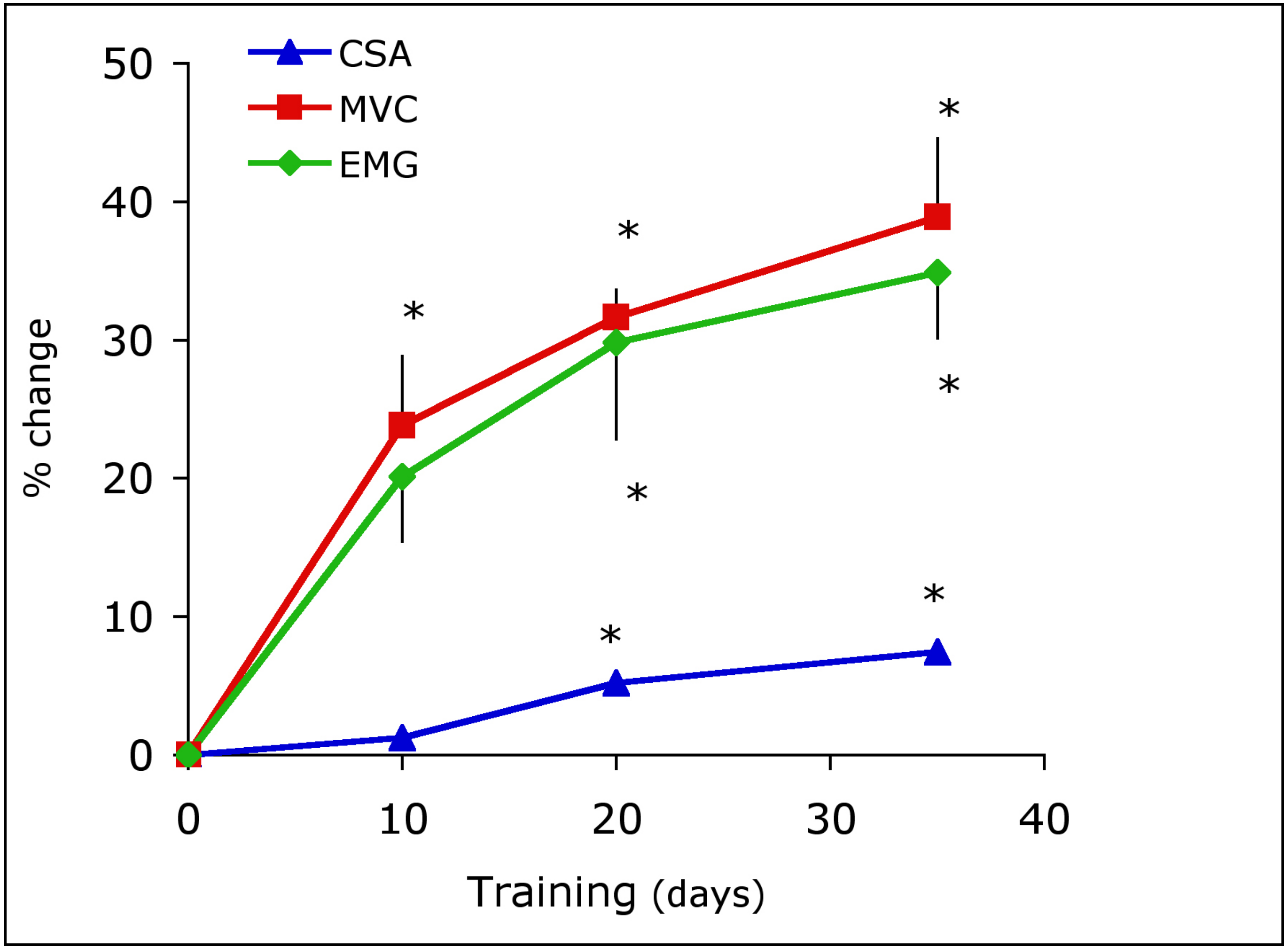
J Appl Physiol 102:368-373, 2007. First published Oct 19, 2006; doi:10.1152/japplphysiol.00789.2006



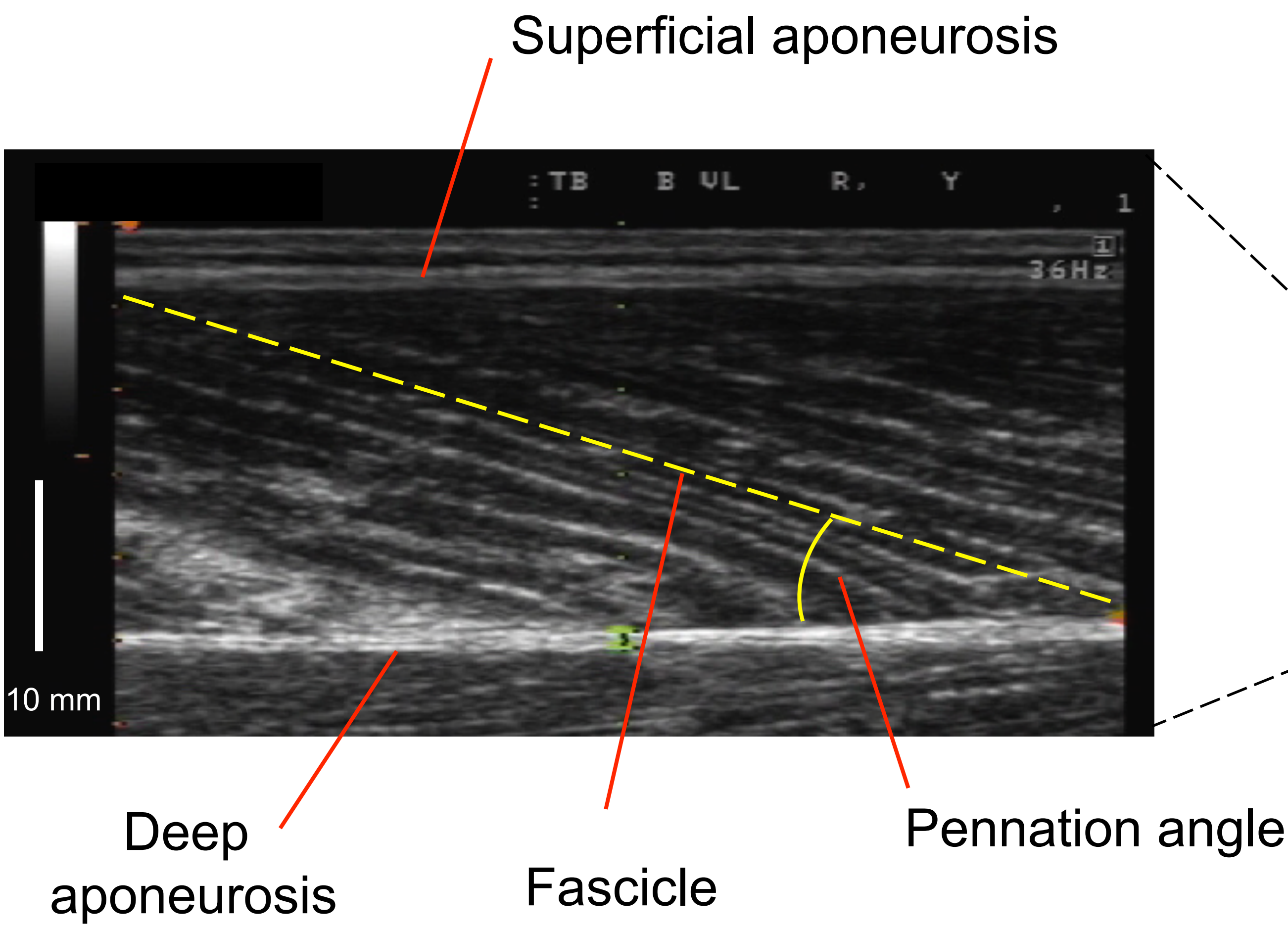
Muscle MRI before & after 35-day resistance training

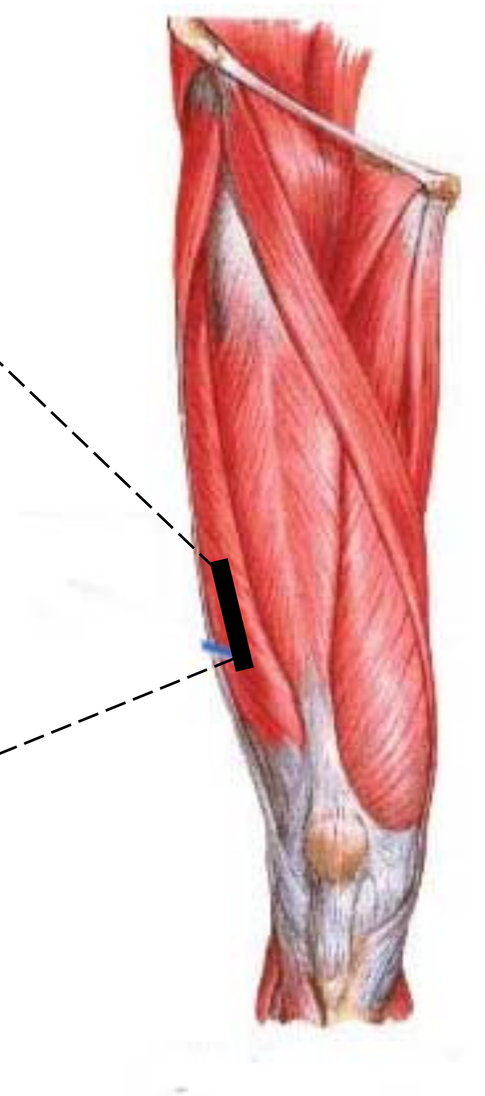


Changes in MVC, CSA, & EMG



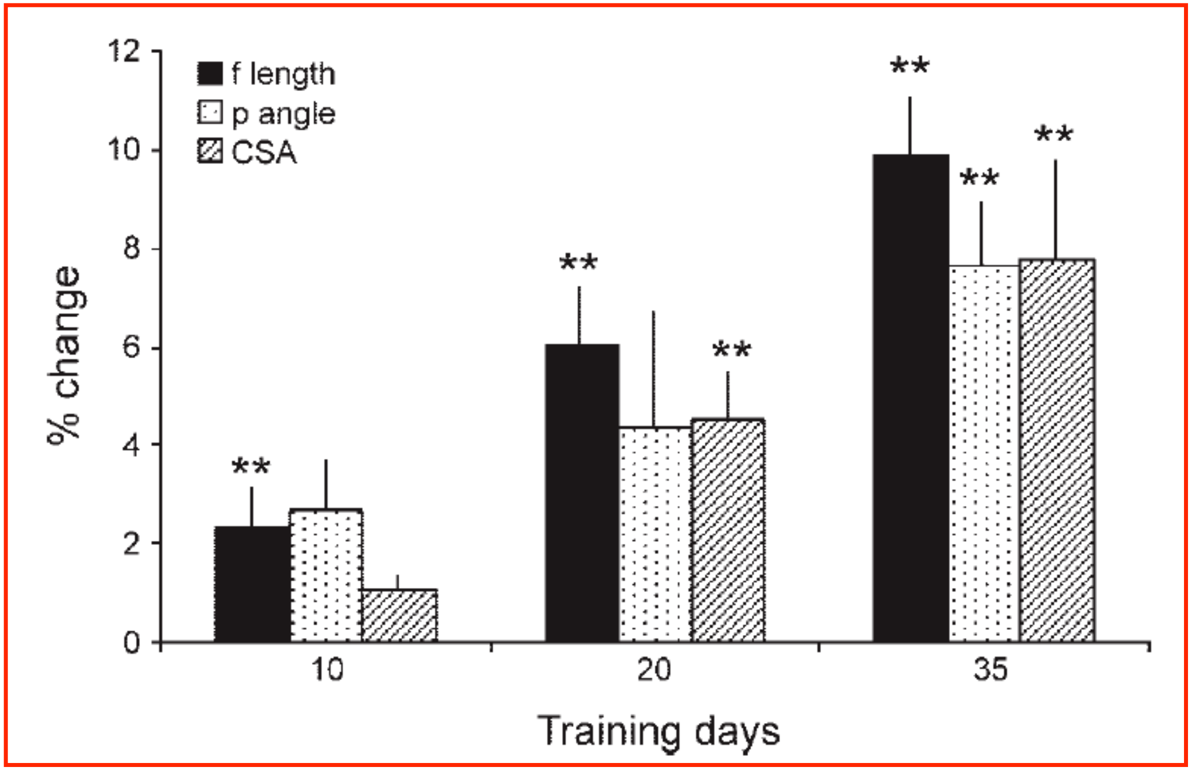
Muscle Architecture Measurements



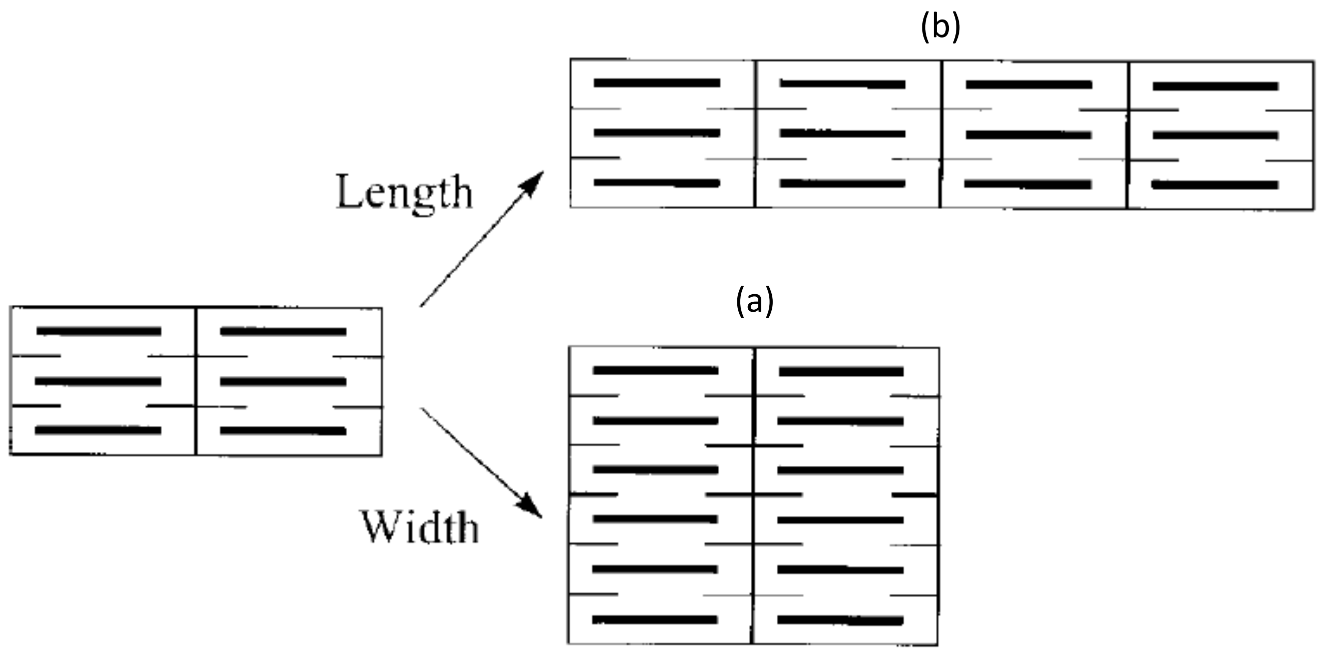


Functional importance of muscle architecture:
Length-Force & Force-Velocity relationships

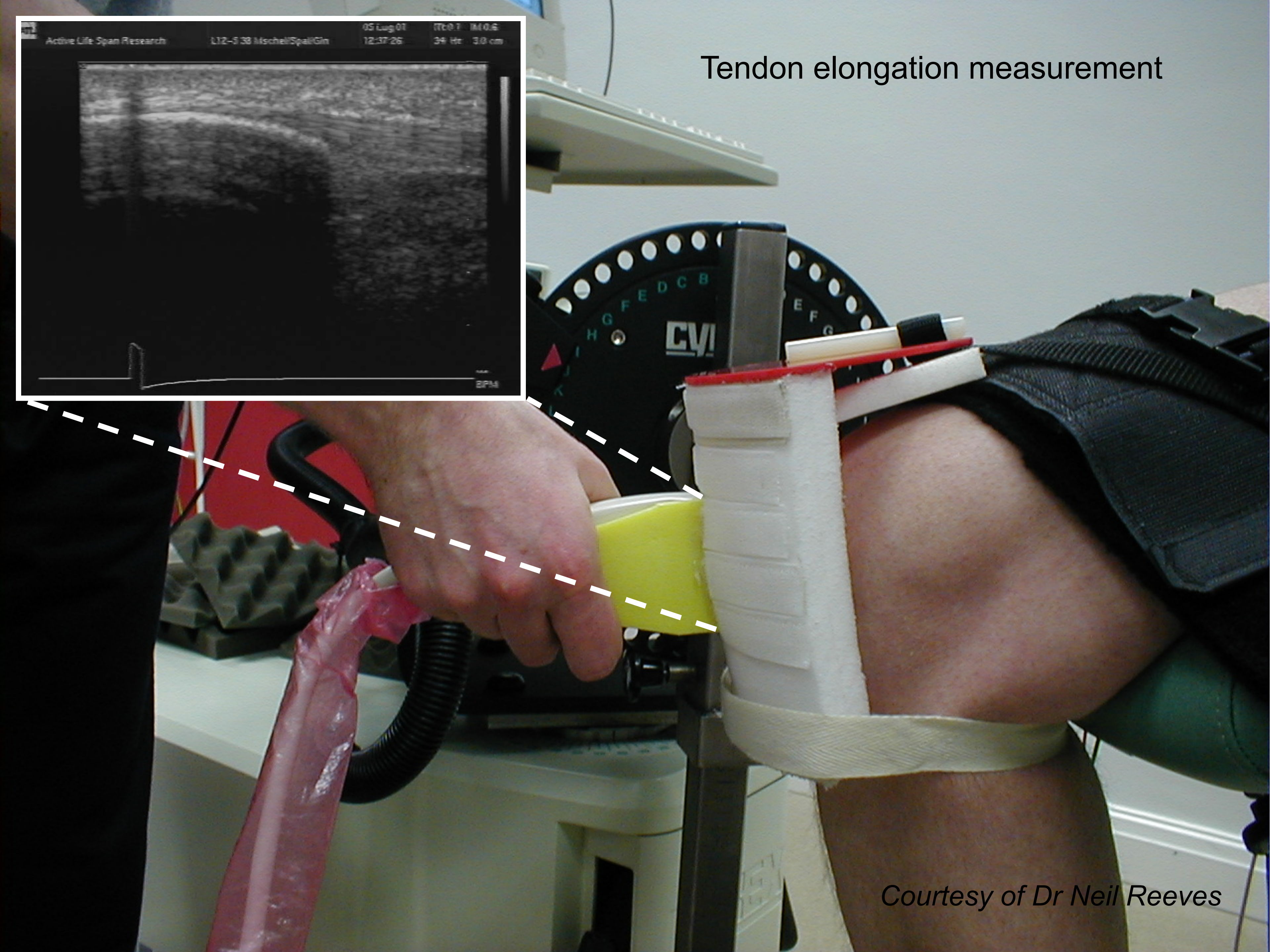
Changes in VL fibre length, pennation angle & CSA during 35-day RT



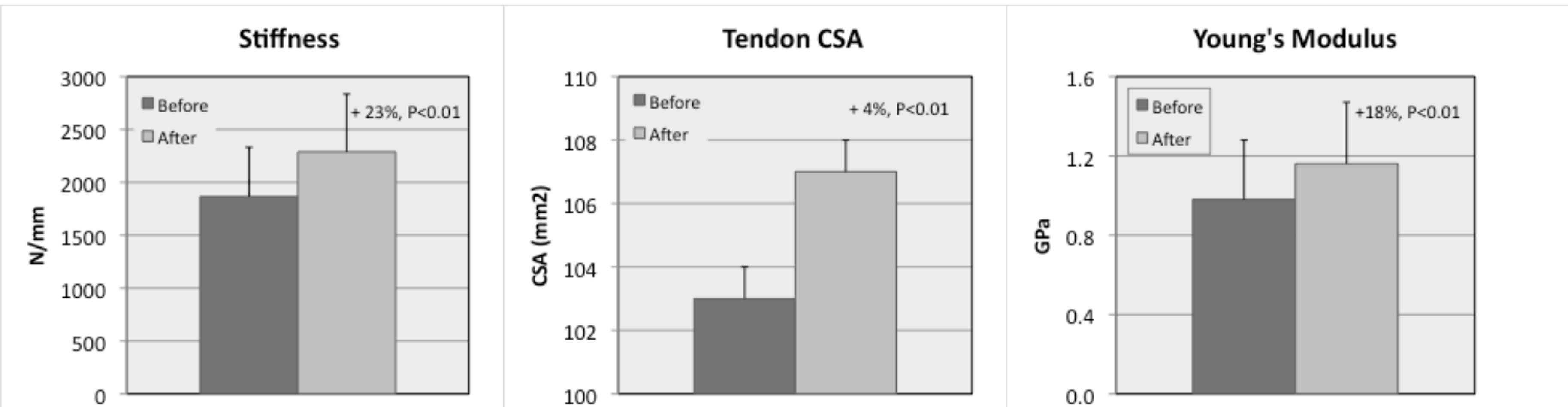
Sarcomere assembly with hypertrophy



Russel B et al. J. Appl. Physiol. (2000) 88: 1127–1132


Tendon elongation measurement
Active Life Span Research
CVI
Courtesy of Dr Neil Reeves

Tendon changes after ST



J Appl Physiol 107: 523–530, 2009.
First published May 28, 2009; doi:10.1152/japplphysiol.00213.2009.

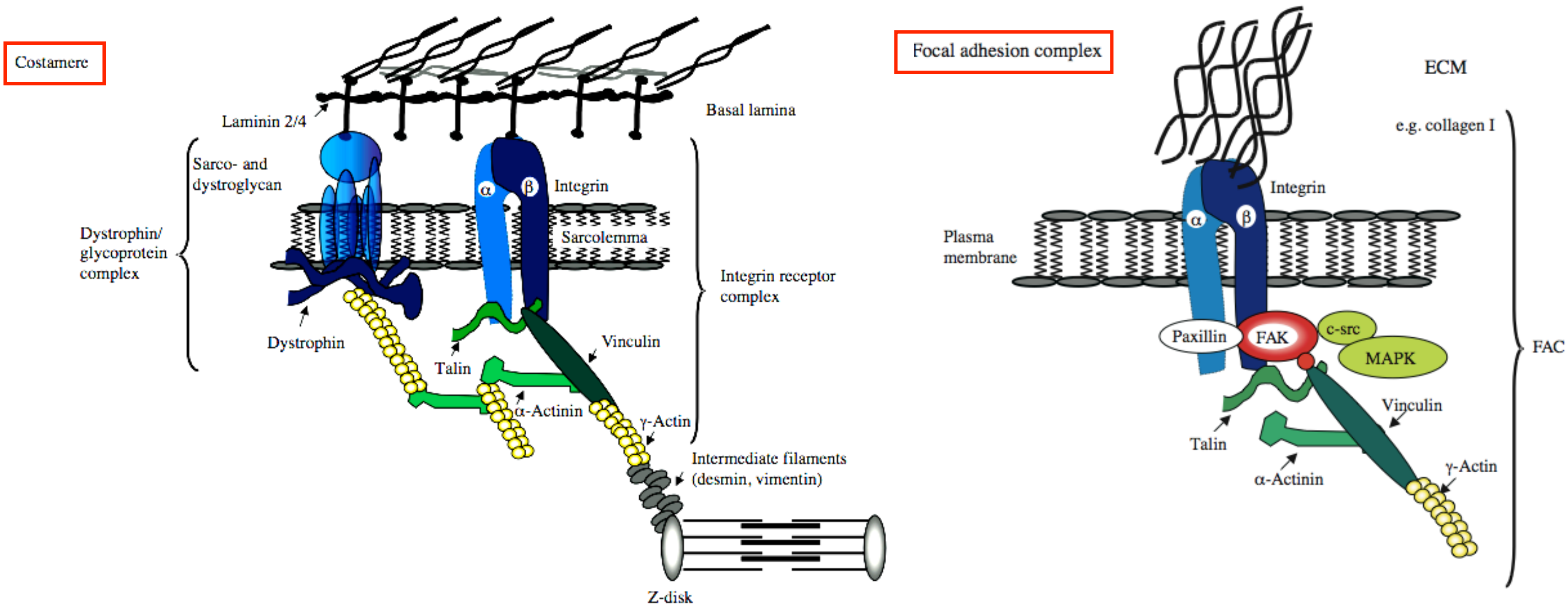
Training-induced changes in structural and mechanical properties of the patellar tendon are related to muscle hypertrophy but not to strength gains

O. R. Seynes,[1] R. M. Erskine,[1] C. N. Maganaris,[1] S. Longo,[1] E. M. Simoneau,[2] J. F. Grosset,[3] and M. V. Narici[1]

[1]*Institute for Biomedical Research into Human Movement and Health, Manchester Metropolitan University, Manchester, United Kingdom;* [2]*Laboratoire d'Automatique, de Mécanique et d'Informatique industrielles et Humaines, Université de Valenciennes et du Hainaut-Cambrésis, Valenciennes, France; and* [3]*Laboratoire de Biomécanique, Equipe Biomécanique, Sport et Santé, Université Paris 13-Arts et Métiers ParisTech CNRS UMR, Bobigny, France*

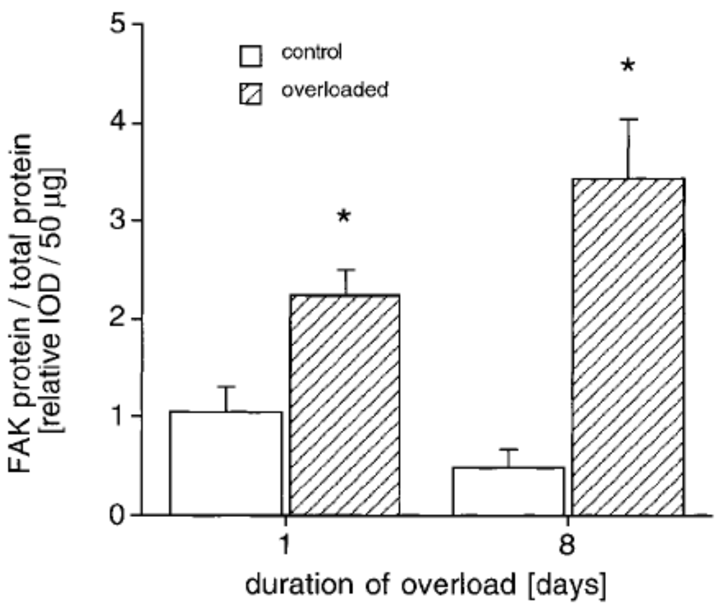
What regulates sarcomere remodeling ?

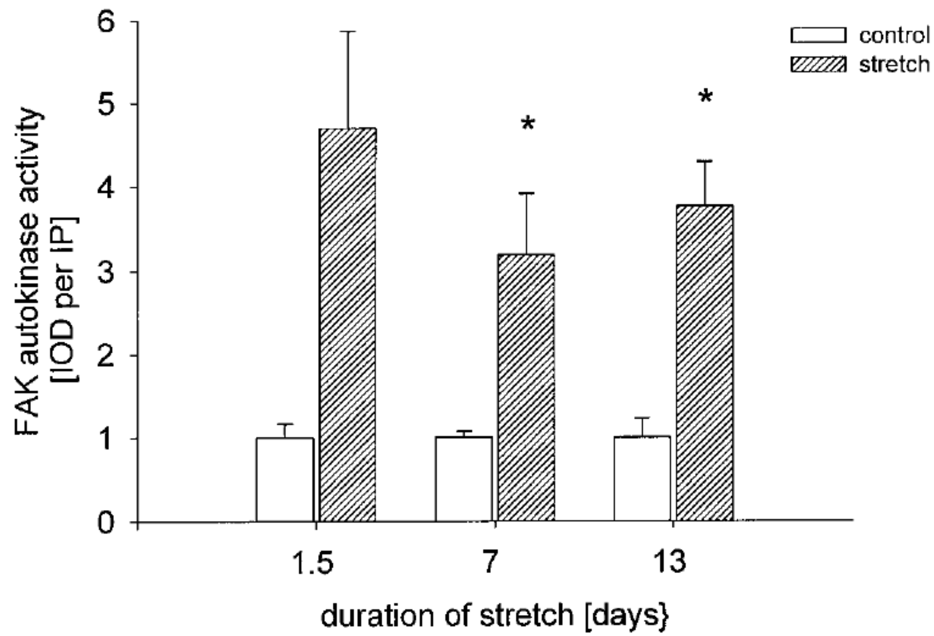
Mechano-transduction in sk.muscle



Narici MV & Maganaris CN, **Exerc Sport Sci Revs**, 35, 126-134, 2007

FAK protein content and activity increase with skeletal muscle hypertrophy

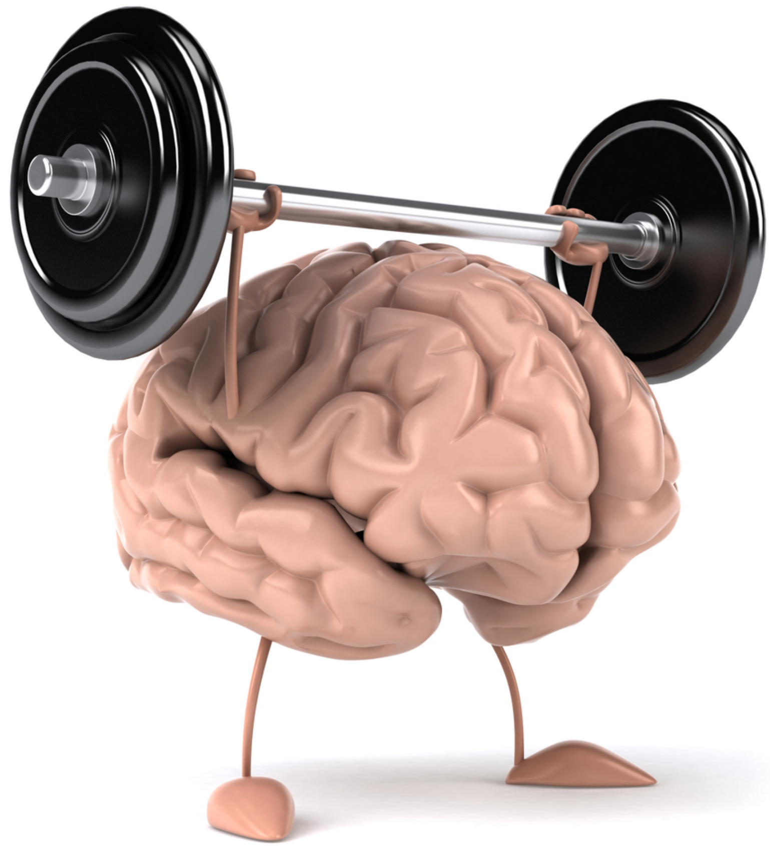




Conclusioni

- Il muscolo scheletrico mostra grande plasticita’ in risposta all’allenamento della forza
- L’aumento di forza e’ il risultato dell’intervento di fattori muscolari e neuronali
- L’attivazione dei processi molecolari avviene nell’arco di poche ore dall’inizio dell’esercizio. I processi cellulari vengono innescati sin dai primi 1-2 giorni dell’esercizio.
- Il muscolo ha ‘memoria’, la capacita’ di sviluppare ipertrofia rimane attiva anche a distanza di tre mesi dall’interruzione dell’allenamento
- L’allenamento della forza produce anche adattamenti tendinei: il tendine diventa piu resistente allo stiramento e dunque meno soggetto a rischio di danno.
- L’allenamento fisico aumenta la produzione di neurotrofine che favoriscono la comunicazione tra muscolo e sistema nervoso centrale e periferico

Good to train your muscles…**but** don’t forget the brain!



Ackowledgements

bbsrc
biotechnology and biological sciences research council

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SEVENTH FRAMEWORK PROGRAMME

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