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Dietary protein and physical activity: effects on muscle protein synthesis

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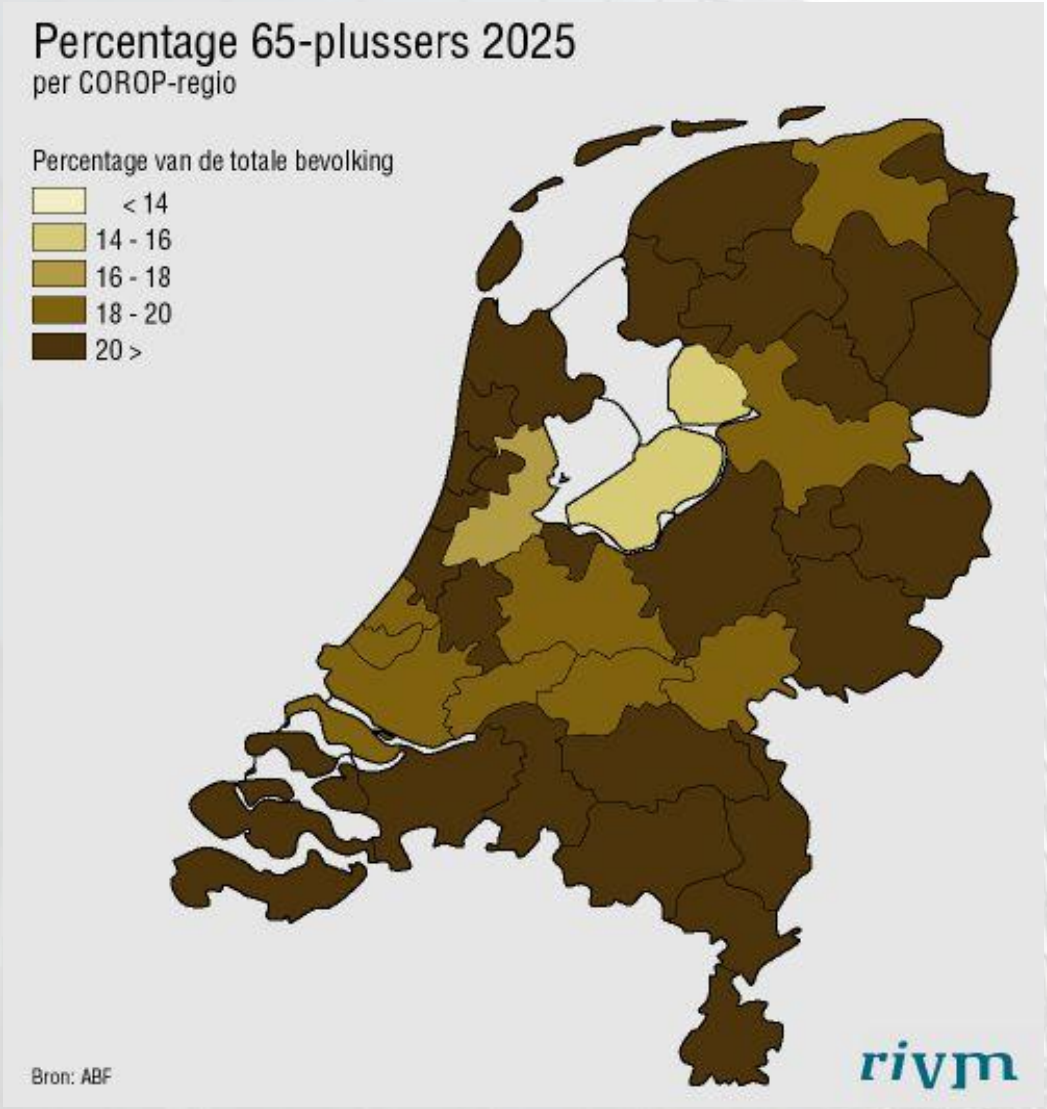
THE UNIVERSITY OF MELBOURNE

nutrim

Aging


Percentage 65-plussers 2025
per COROP-regio
Percentage van de totale bevolking
< 14
14 - 16
16 - 18
18 - 20
20 >
Bron: ABF
rivm

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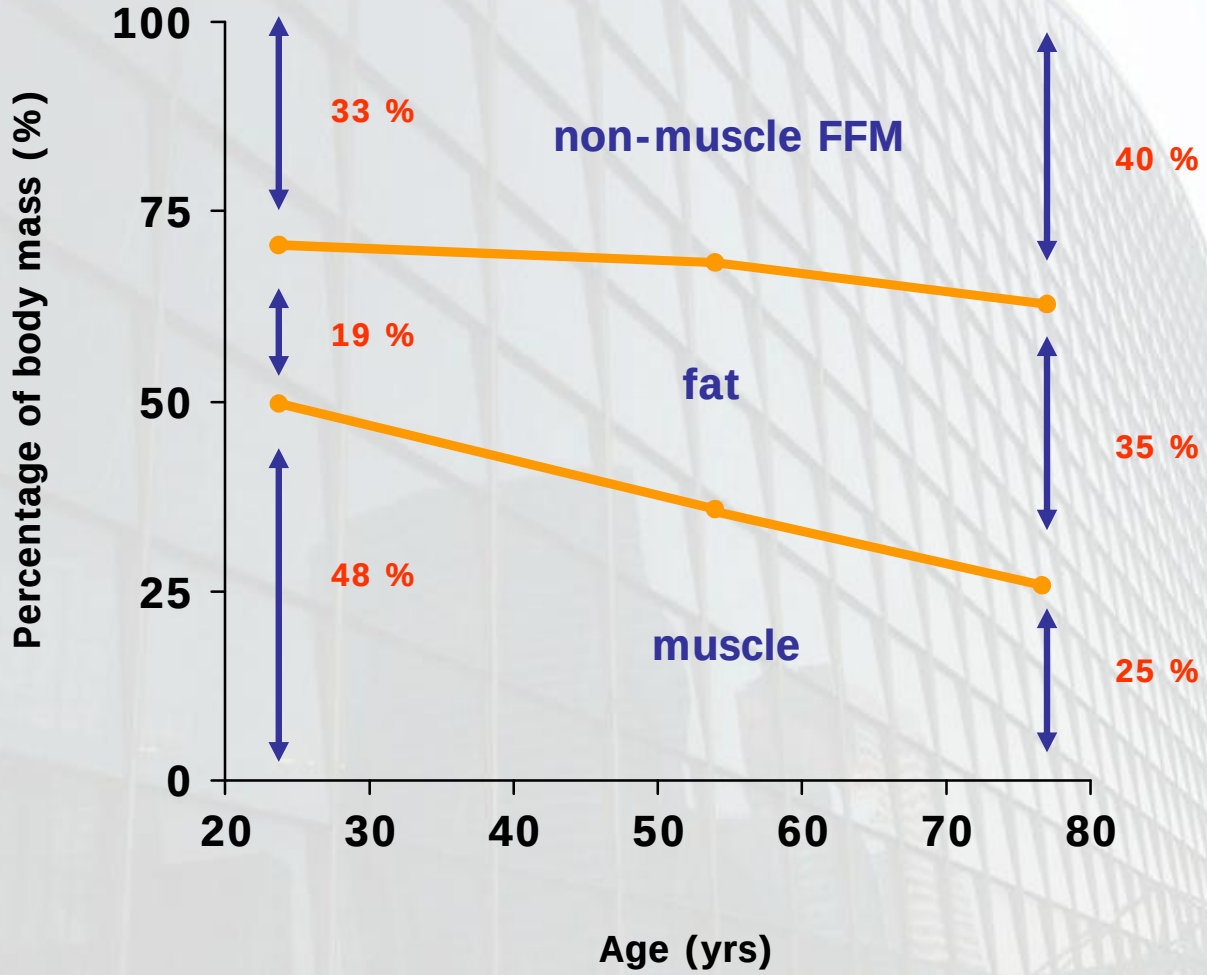
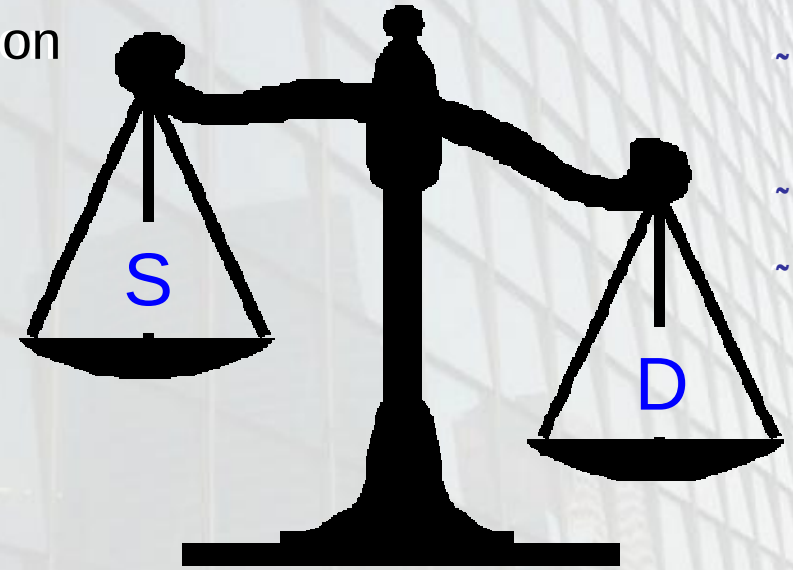
Aging: loss of muscle mass



Adapted from Short and Nair. *Curr Opin Clin Nutr Metab Care 3: 39-44, 2000*

Sarcopenia

- Anti-growth factors
- Hormonal changes
- Satellite cell aging
- Poor nutrition
- Inactivity



- Low-grade inflammation
- Hormonal changes
- Insulin-resistance

Regulation of muscle mass – balance between synthesis and degradation

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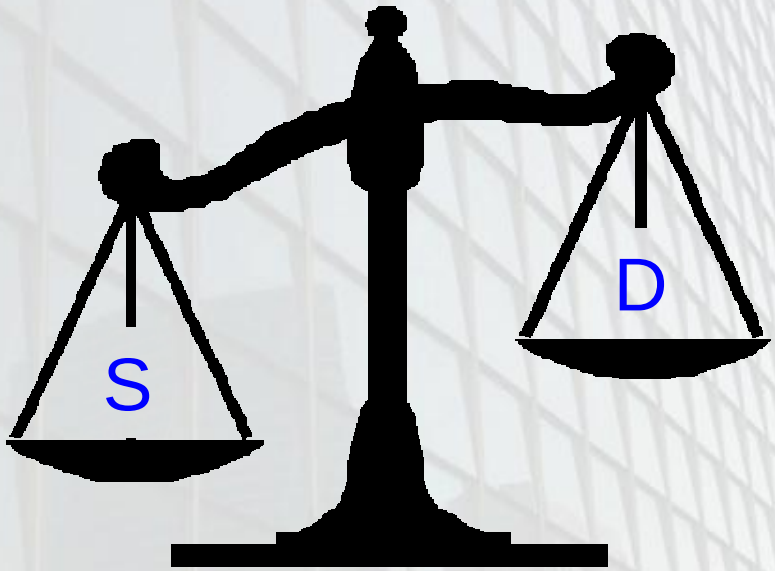
Sarcopenia: interventions

NUTRITION

EXERCISE



Regulation of muscle mass – balance between synthesis and degradation

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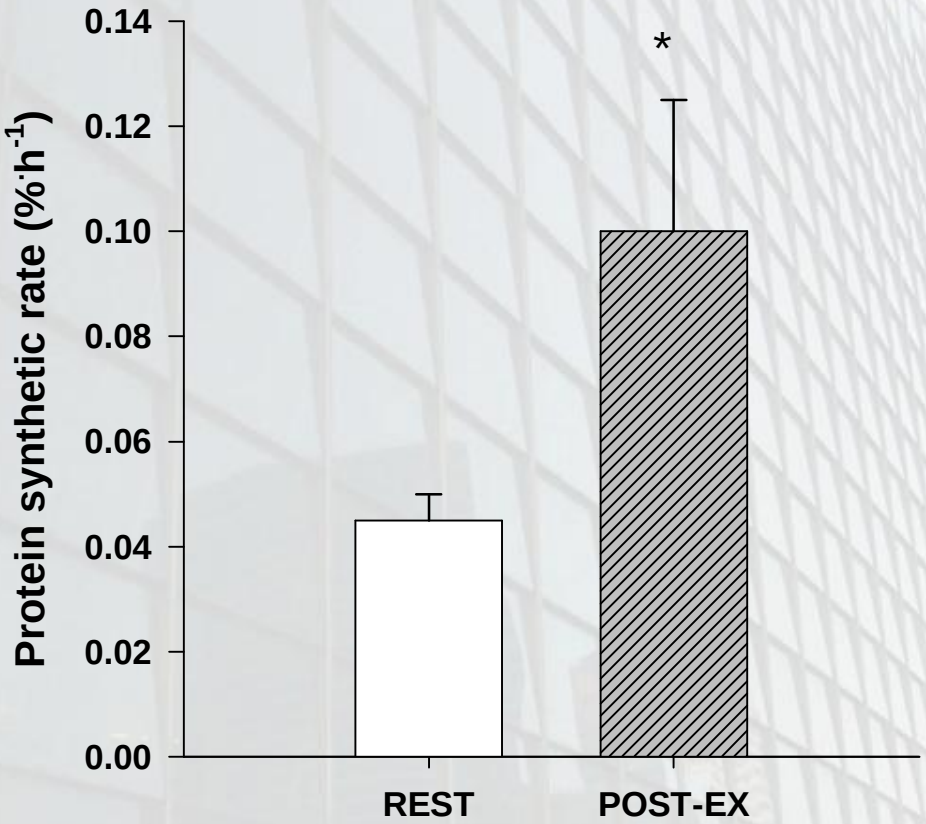
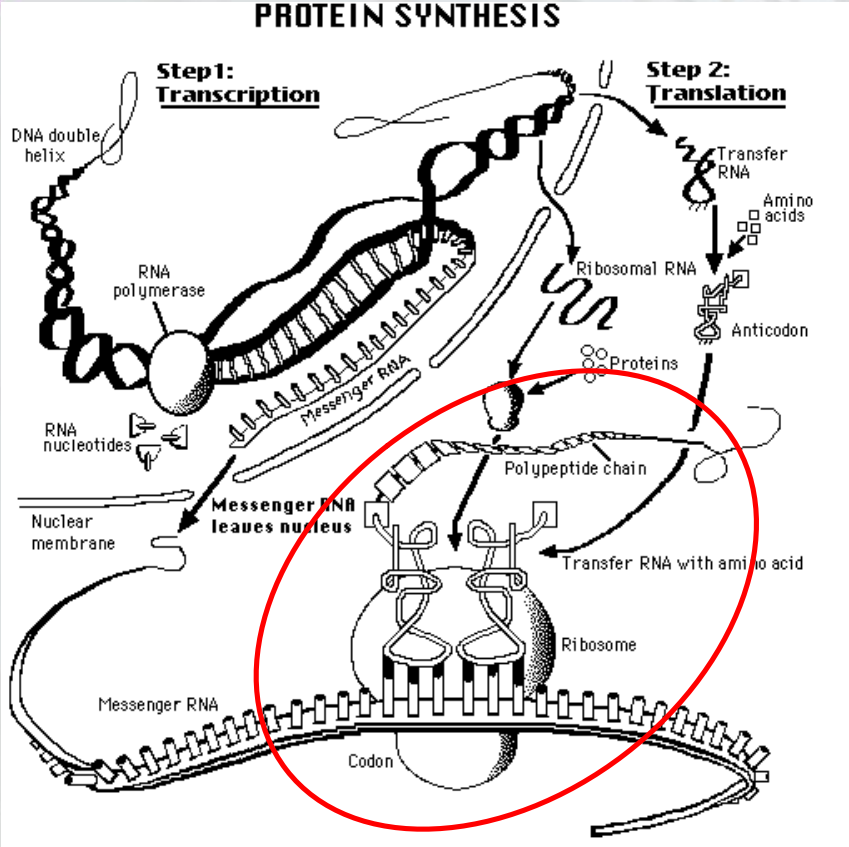
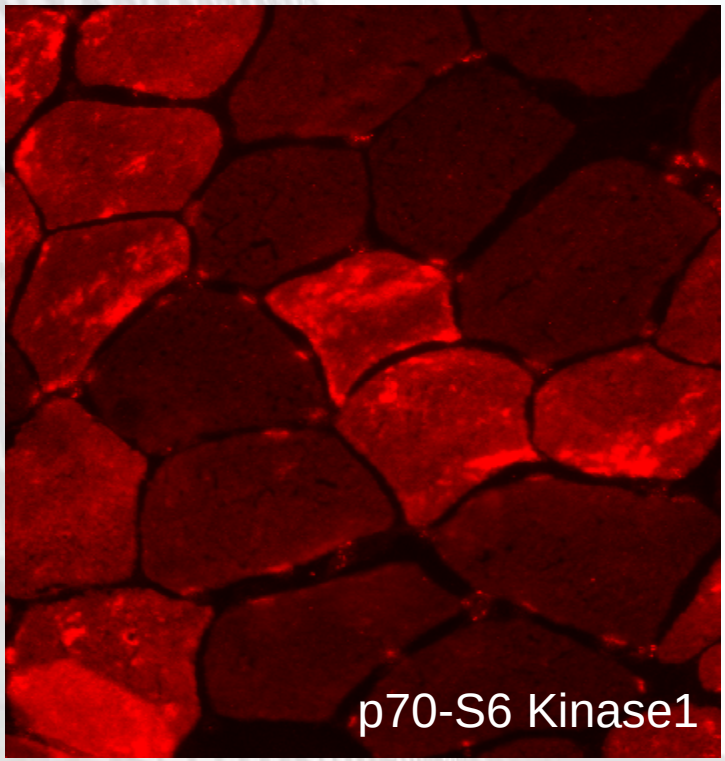
Exercise and protein synthesis



Adapted from Chesley , et al. J Appl Physiol 73: 1383-1388, 1992.

Protein synthesis and signaling





Koopman, et al. Am J Physiol Endocrinol Metab 290: E1245-E1252, 2006

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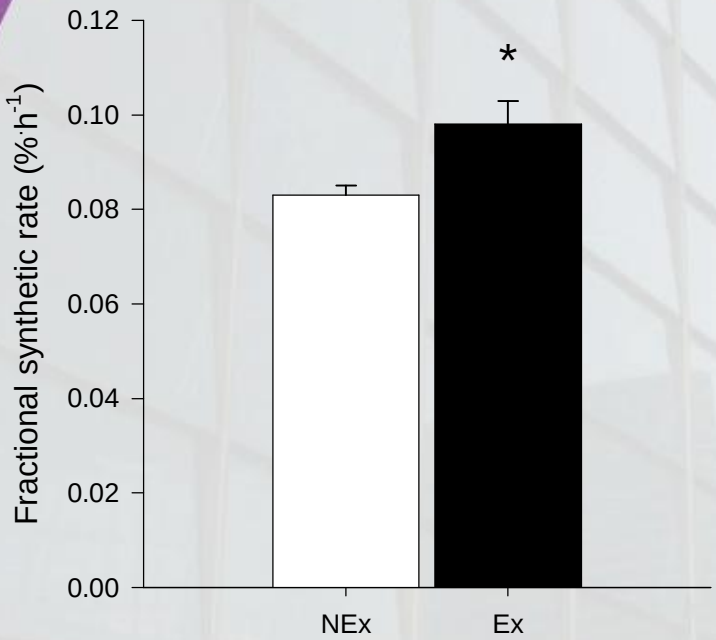
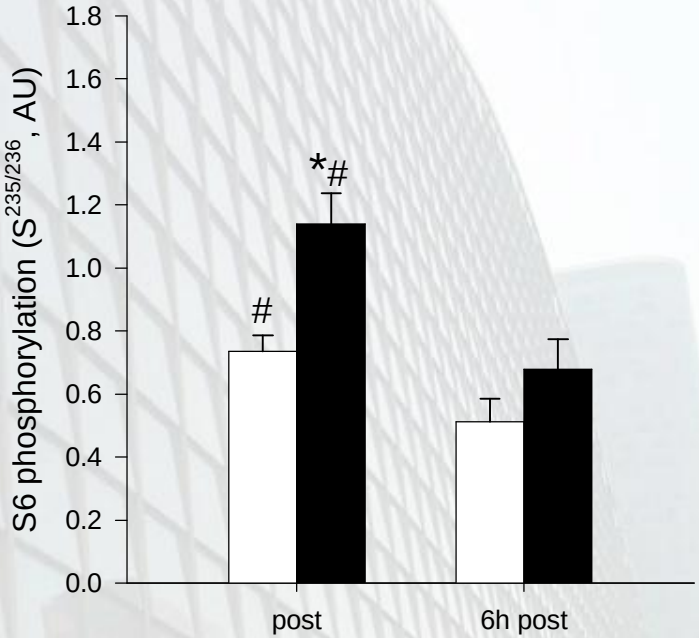
Exercise, FSR and signaling





Non-exercised (control) leg
Exercised leg

Witard, et al. Med Sci Sports Exerc 2009, in press

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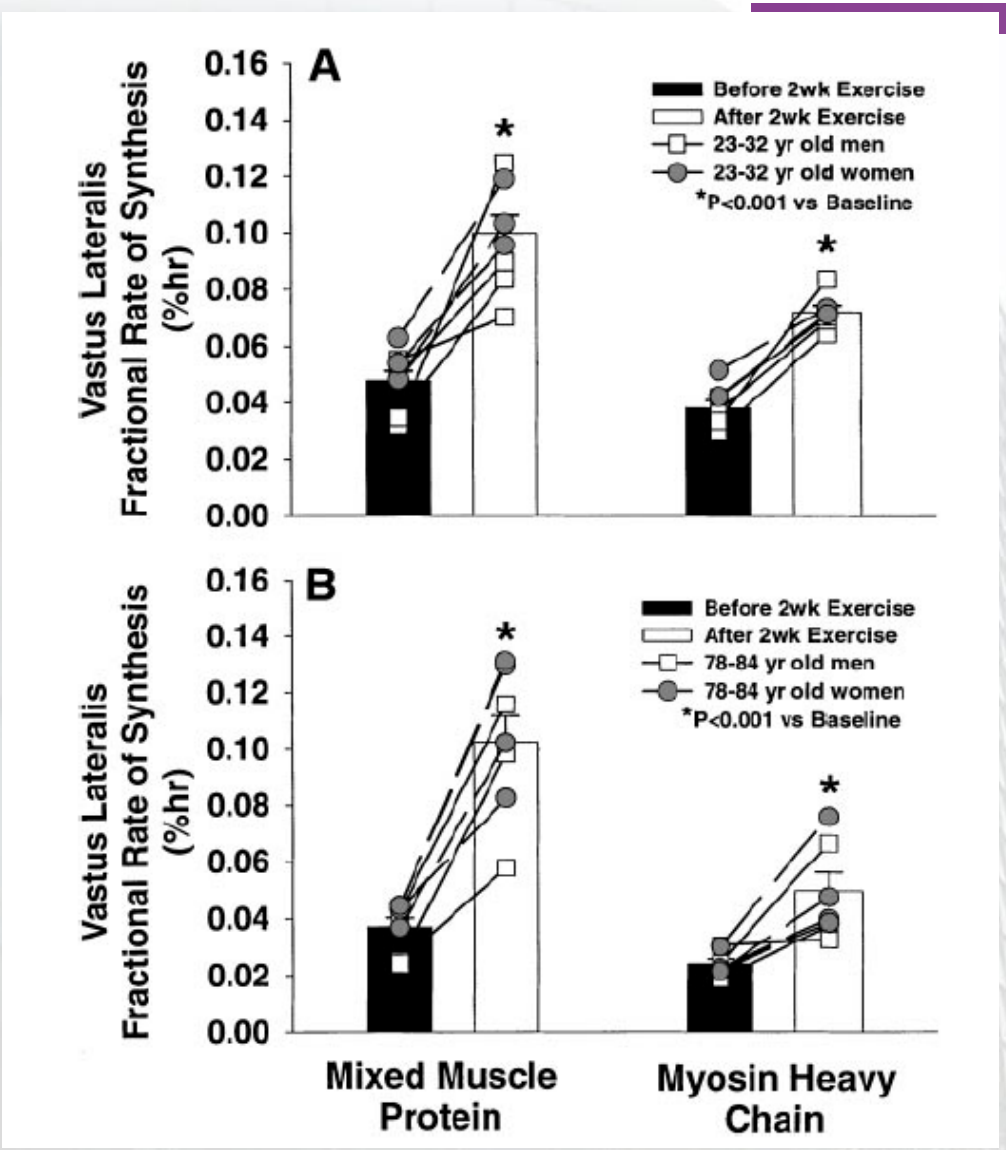
Exercise in the elderly & MPS



Hasten et al. Am J Physiol Endocrinol Metab 278: E620-626., 2000.

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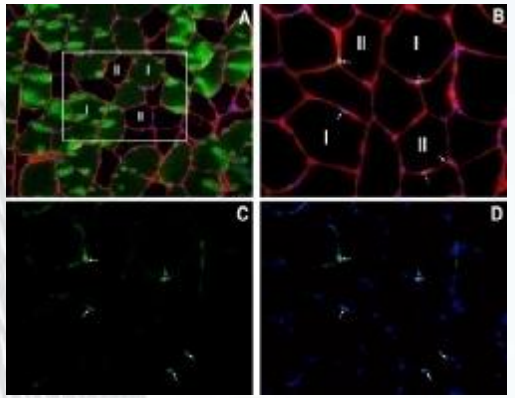
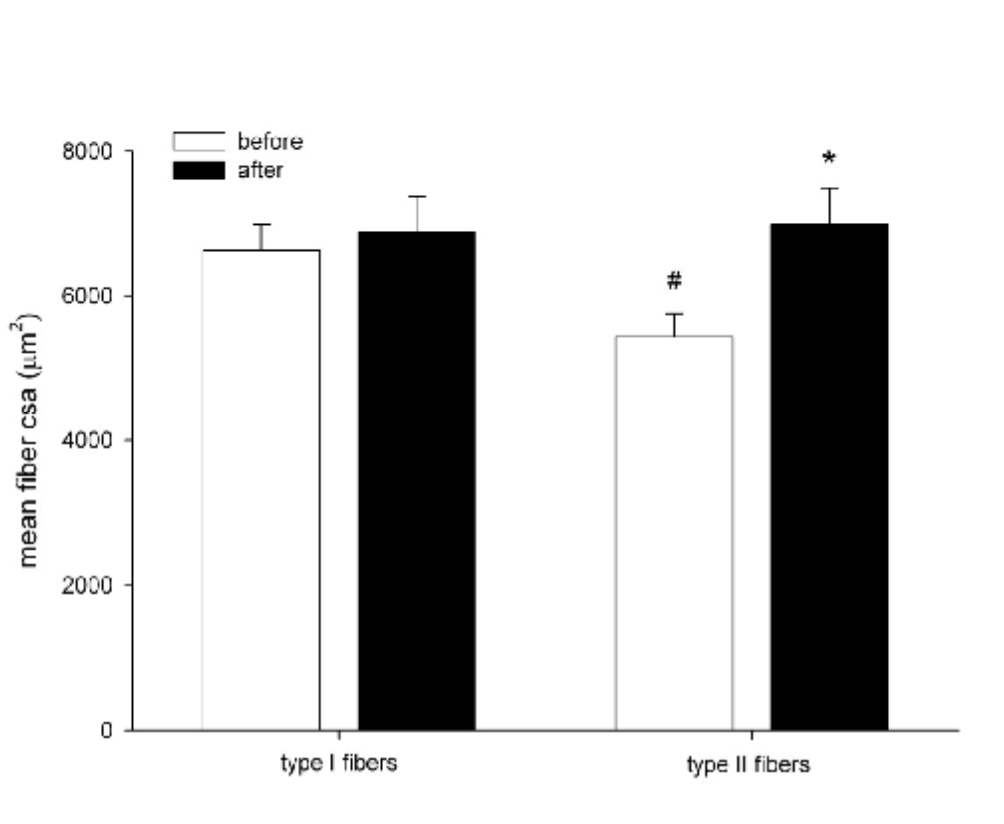
Resistance exercise and muscle mass





Verdijk, Koopman & van Loon, unpublished observations

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Nutrition and Protein Synthesis

- **insulin**

  (Fryburg et al, 1995; Gelfand et al, 1987; Hillier et al, 1998; Biolo et al, 1999; Borsheim et al 2004; Koopman et al, 2005)

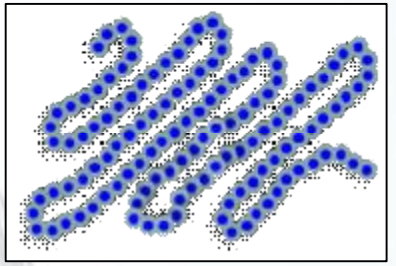
- **amino acids**

  (Biolo et al, 1997; Rasmussen et al, 2000; Borsheim et al, 2002; Tipton et al, 1999, 2001, 2003, 2004; Miller et al, 2003; Koopman et al, 2004 2005)

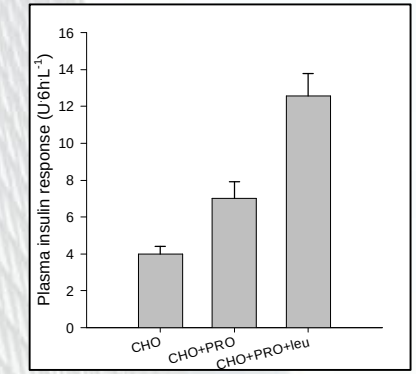
→ **net protein balance**

Role of Amino Acids

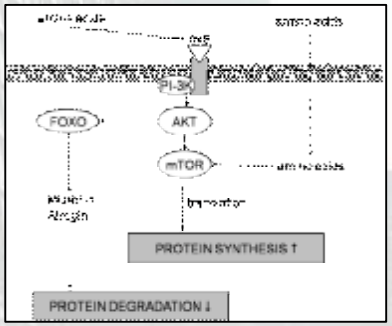
Building blocks for protein



Strong stimulators of hormone secretion



Signaling molecules



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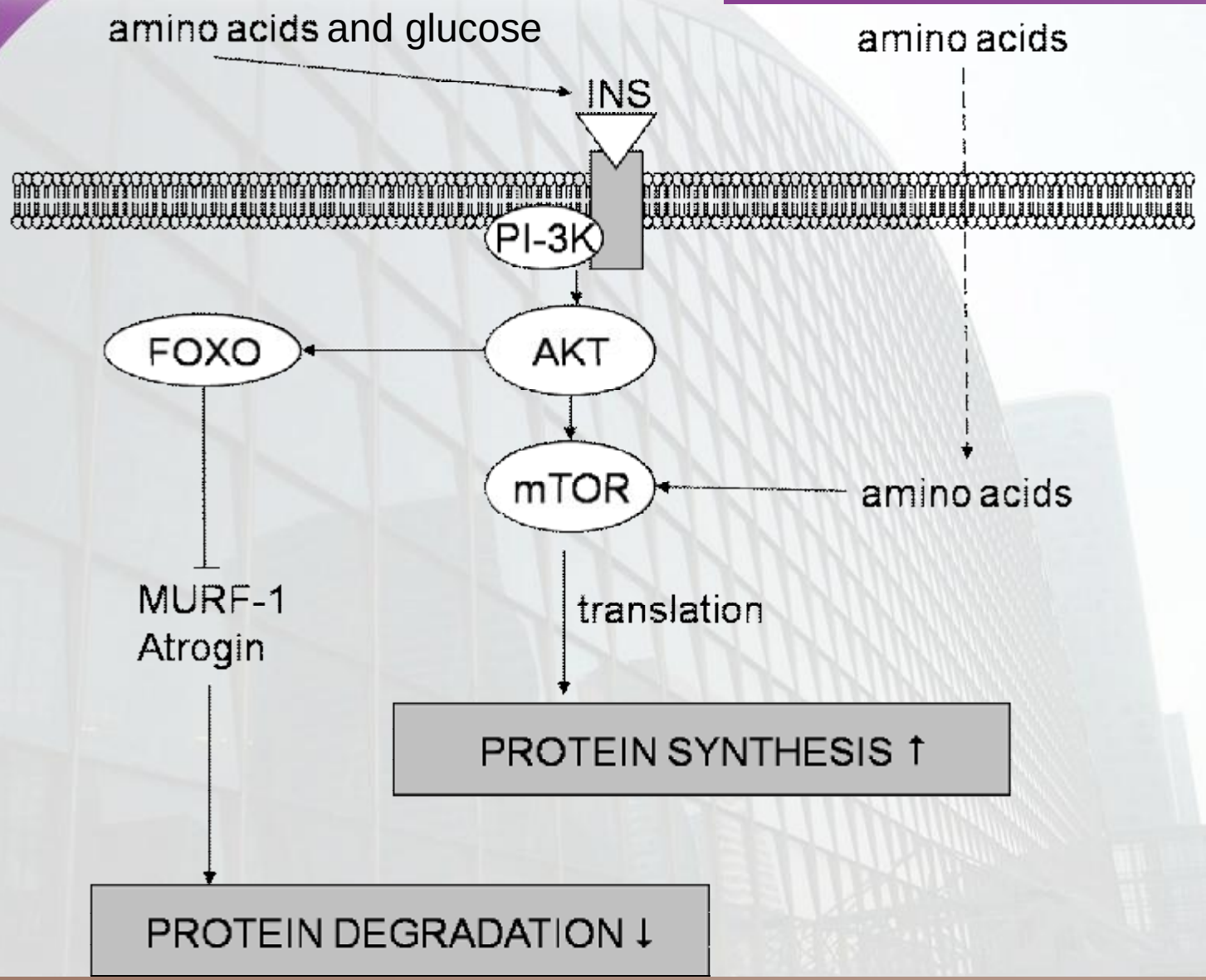
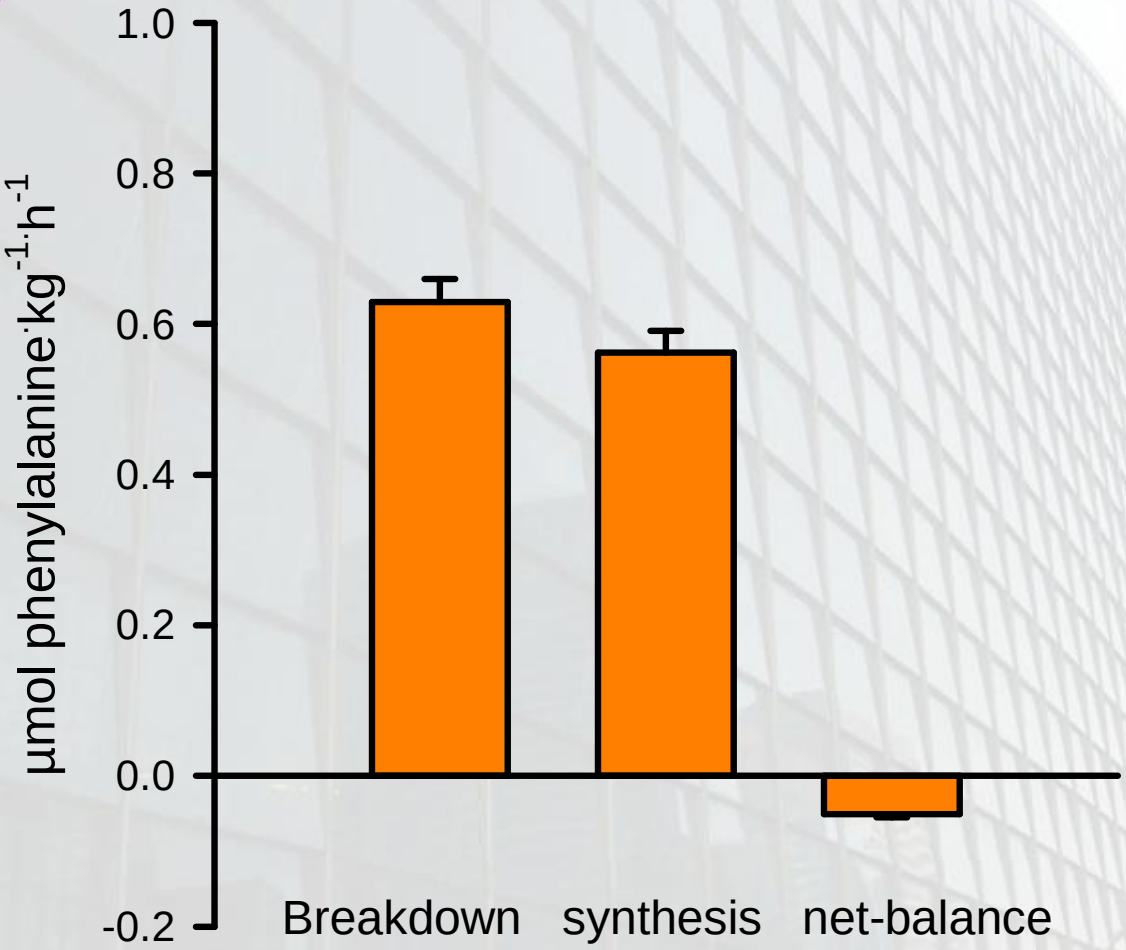
Nutrition and Protein Synthesis



Post-exercise nutrition: carbohydrate



0.3 g CHO kg^{-1} h^{-1}

Koopman, et al. Am J Physiol Endocrinol Metab 288: E645-653, 2005.

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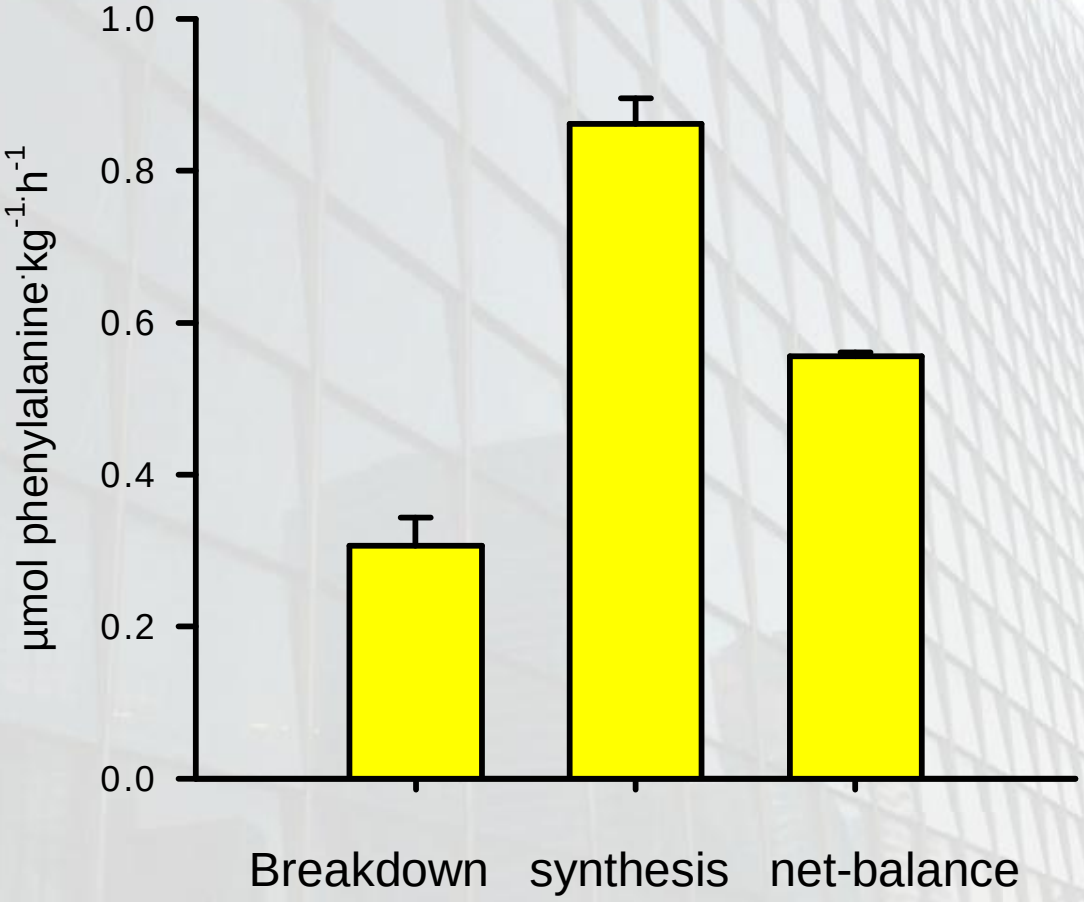
Post-exercise nutrition: protein



0.3 g CHO kg^{-1} h^{-1}

0.2 g PRO kg^{-1} h^{-1}

Koopman, et al. Am J Physiol Endocrinol Metab 288: E645-653, 2005.

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Protein/AA intake increases MPS

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Anabolic properties of leucine

Leucine stimulates muscle protein synthesis and inhibits proteolysis

Buse and Reid, 1975

Leucine administration inhibits protein breakdown

Combaret et al., 2005

Leucine administration stimulates protein synthesis

Anthony et al., 1999, 2000, 2002
Dardevet et al., 2000, 2002
Rieu et al., 2003
Guillet et al., 2004
Crozier et al., 2005

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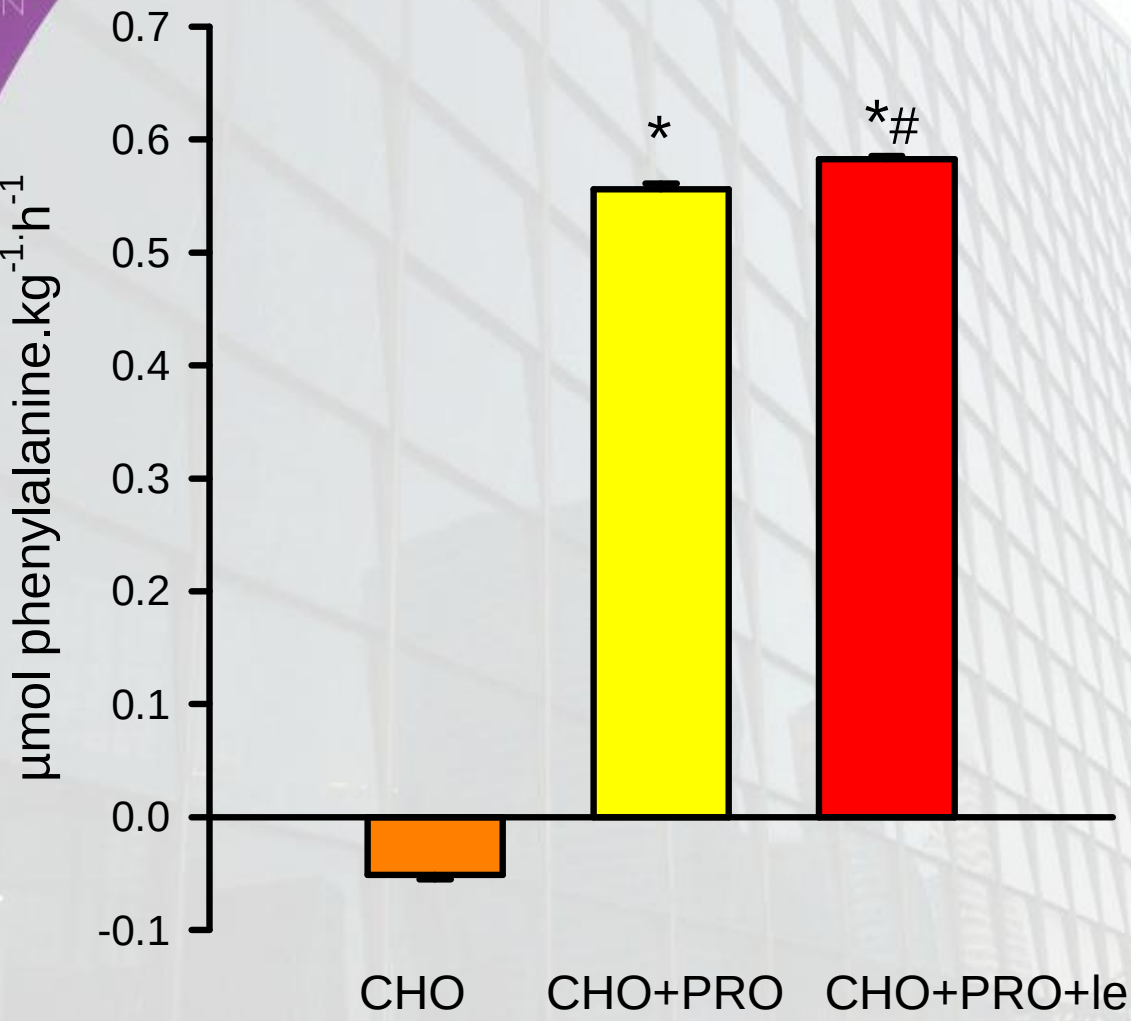
Post-exercise nutrition: protein



0.3 g CHO kg^{-1} h^{-1}

0.2 g PRO kg^{-1} h^{-1}

0.1 g leu kg^{-1} h^{-1}

Koopman, et al. Am J Physiol Endocrinol Metab 288: E645-653, 2005.

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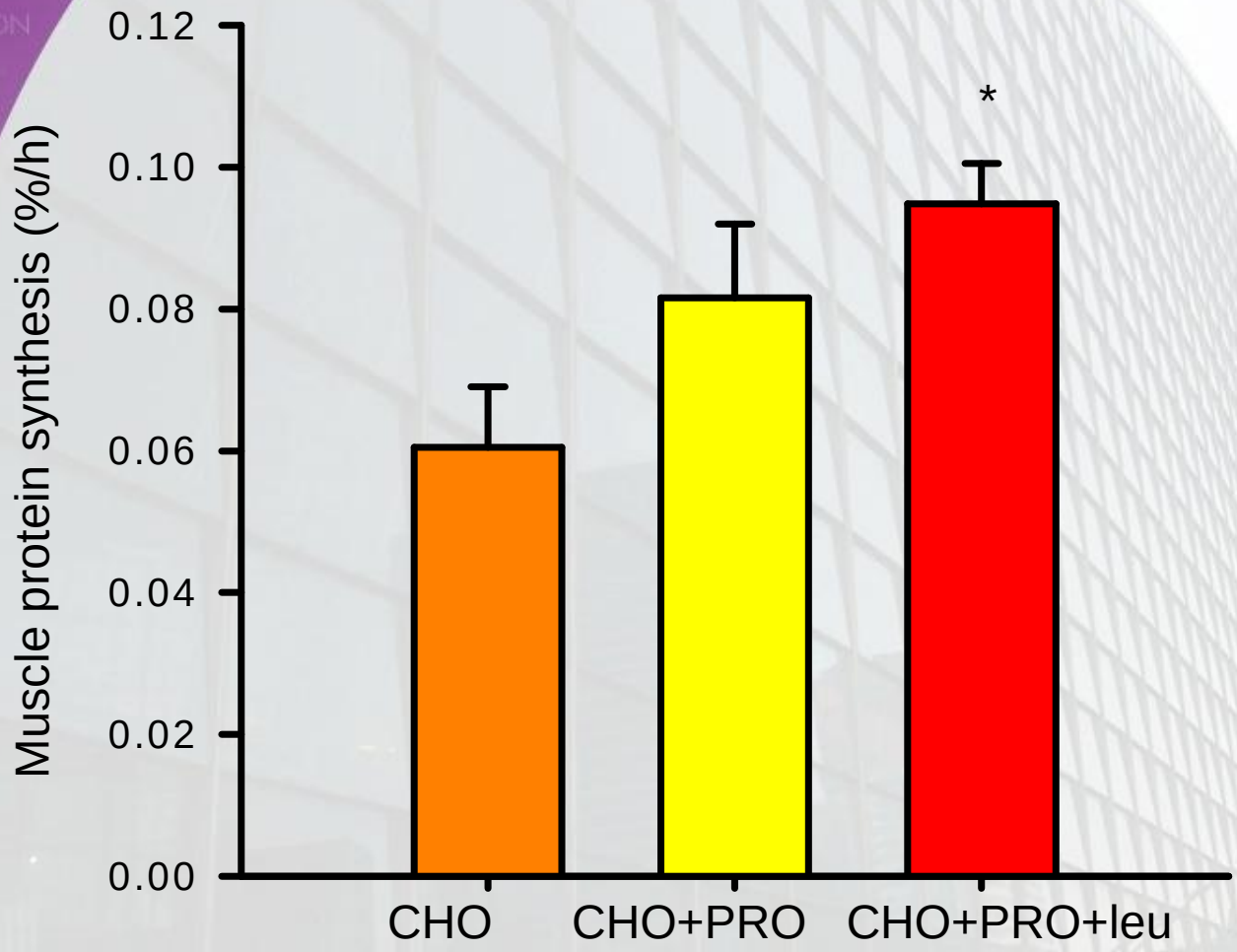
Effect on Skeletal Muscle



Koopman, et al. Am J Physiol Endocrinol Metab 288: E645-653, 2005.

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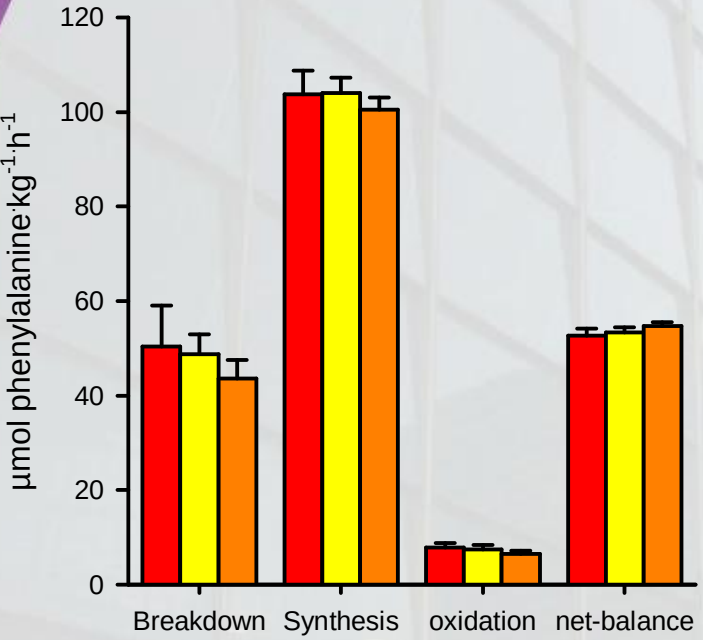
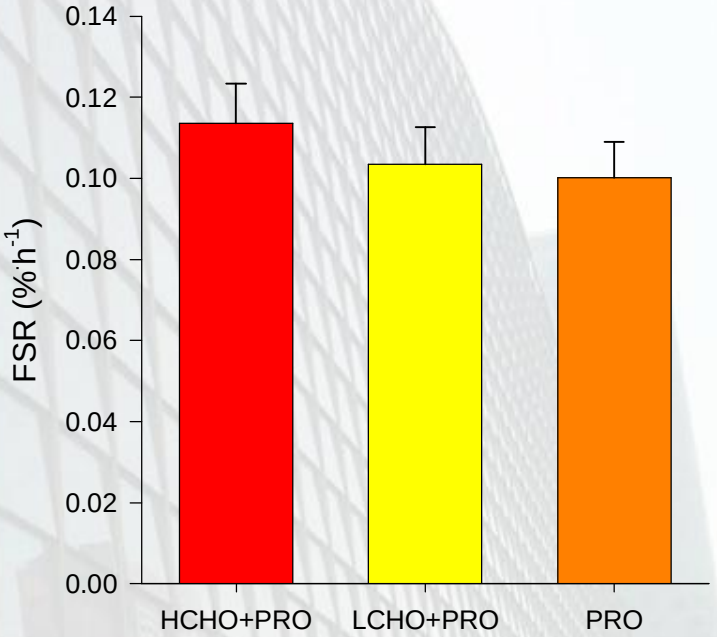
Carbohydrate content





HCHO+PRO 0.6 g CHO kg^{-1} h^{-1} 0.3 g PRO kg^{-1} h^{-1}

LCHO+PRO 0.15 g CHO kg^{-1} h^{-1} 0.3 g PRO kg^{-1} h^{-1}

PRO 0.3 g PRO kg^{-1} h^{-1}

Koopman, et al. Am J Physiol Endocrinol Metab 293: E833-842, 2007.

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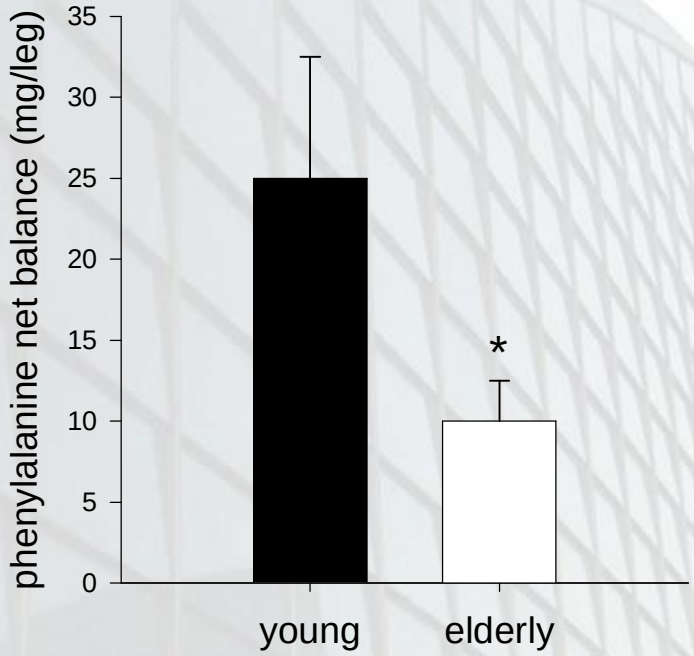
Nutrition in the Elderly



Anabolic response to the intake of food seems to be reduced in the elderly

Impaired glucose tolerance / insulin sensitivity
Impaired amino acid sensitivity
Increased AA utilization in splanchnic area

Katsanos, et al. Am J Clin Nutr 82: 1065-1073, 2005.

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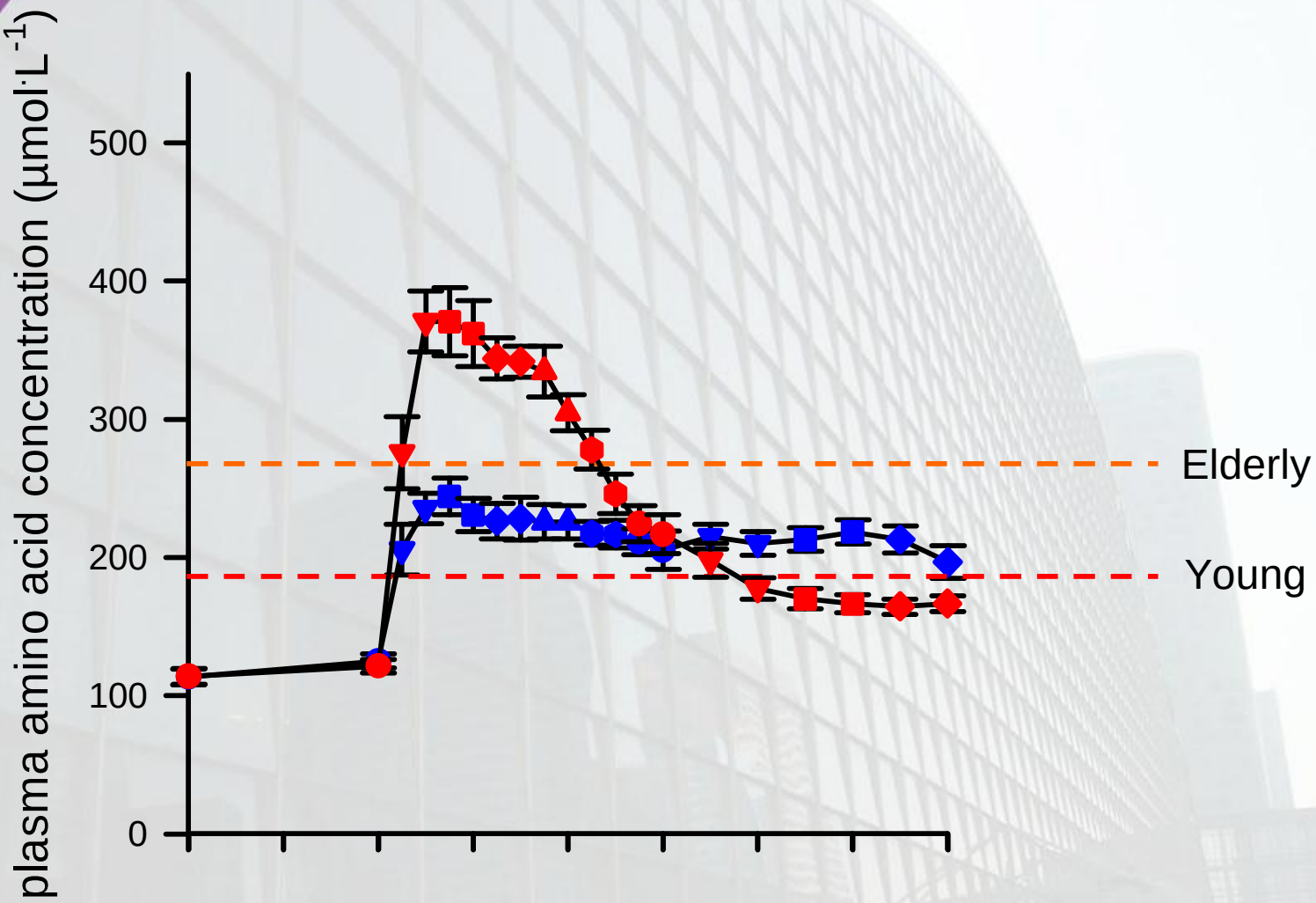
Aging: a shift in anabolic threshold?



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Nutritional Interventions

- Increasing the amount of protein
  - è Pulse feeding
- Fast versus Slow digestible proteins
- Leucine supplementation

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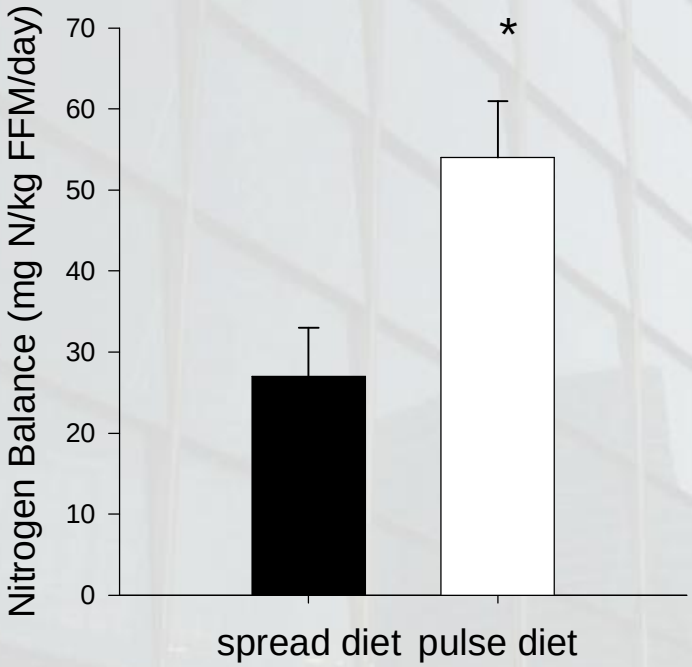
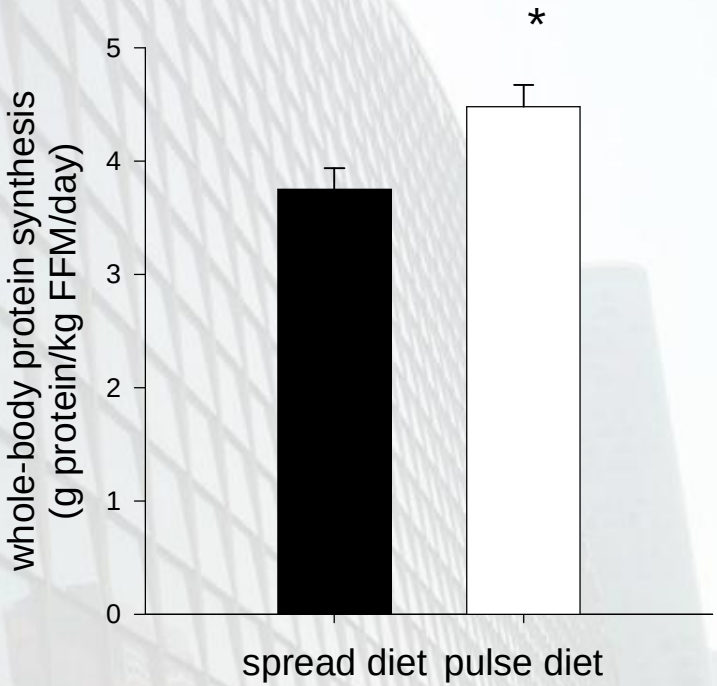
Pulse feeding: whole-body effects





Arnal, et al. Am J Clin Nutr 69: 1202-1208, 1999.

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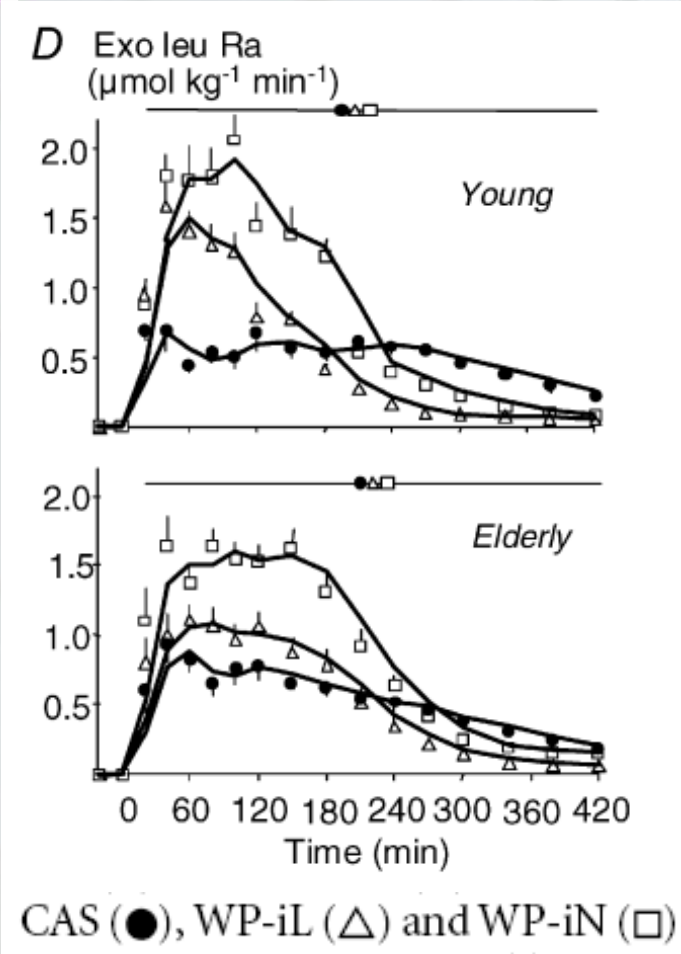
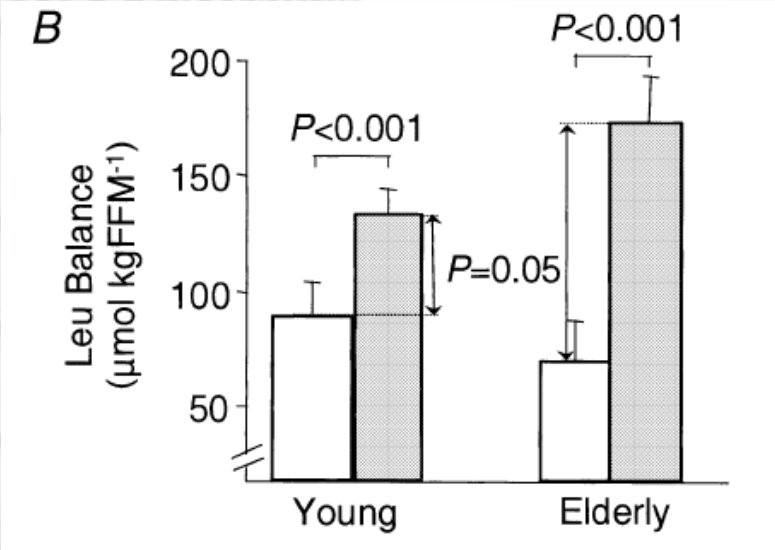
Slow vs Fast: whole-body effects



CAS (●), WP-iL (△) and WP-iN (□)

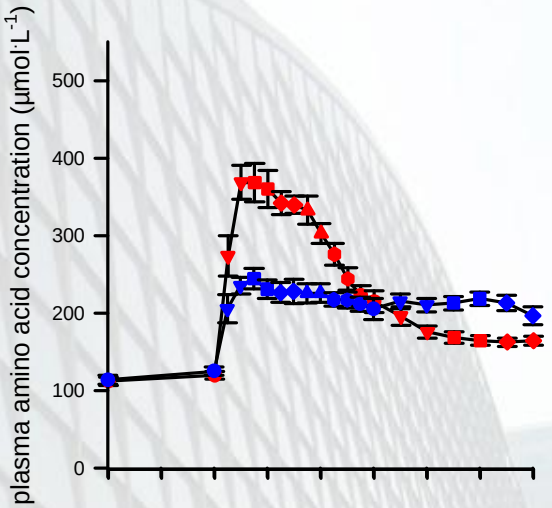


CAS, 34 g
WP, iN, 34 g

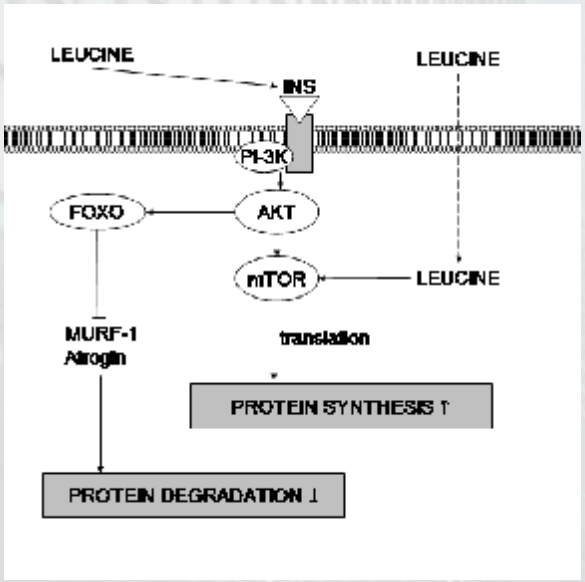
Dangin, et al. J Physiol 549: 635-644, 2003.

Potential of Whey Protein

"Fast" protein
compared to casein



High leucine content (>10%)



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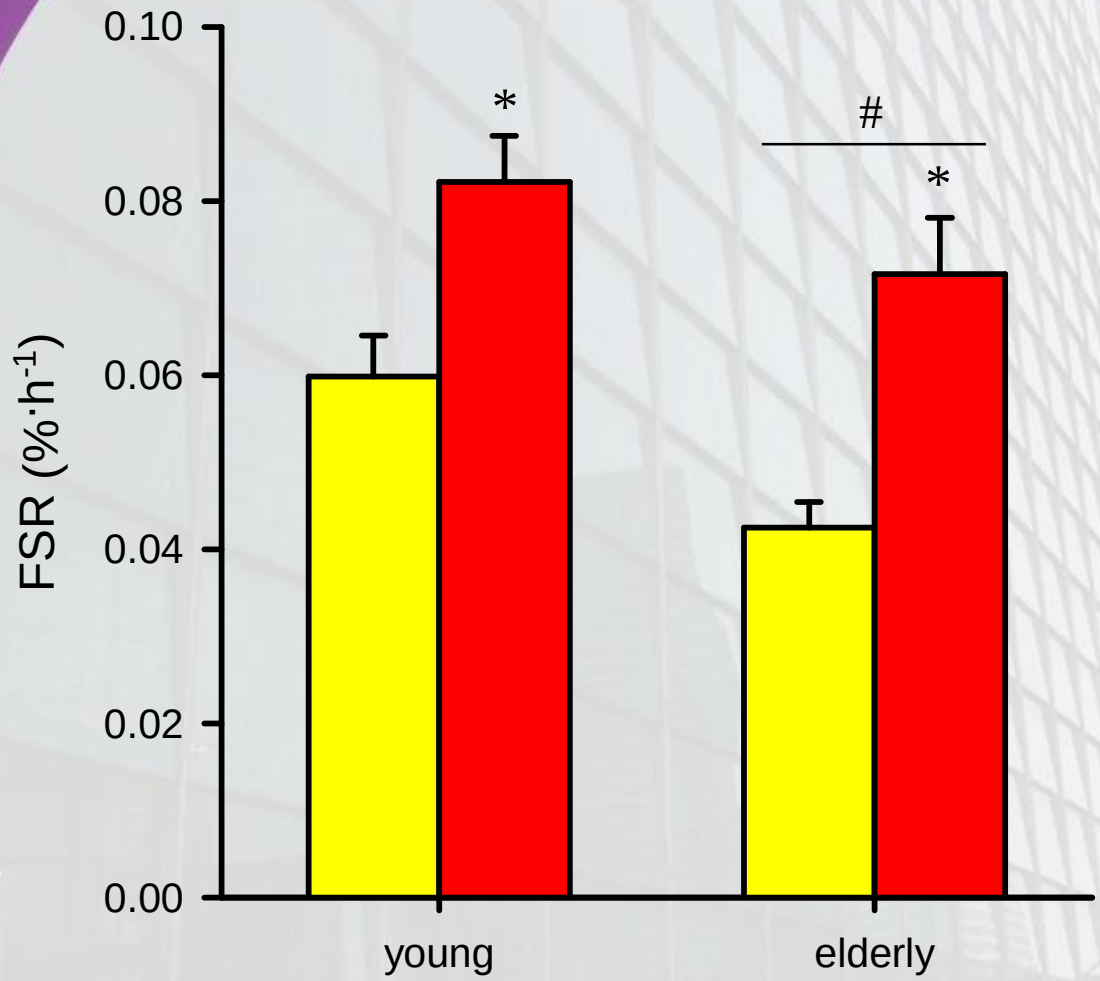
Post-exercise: protein + Leucine



CHO
CHO+PRO+LEU

0.49 g CHO kg^{-1} h^{-1}
0.16 g PRO kg^{-1} h^{-1}
0.03 g leu kg^{-1} h^{-1}

Koopman, et al. Am J Clin Nutr 84: 623-632, 2006.

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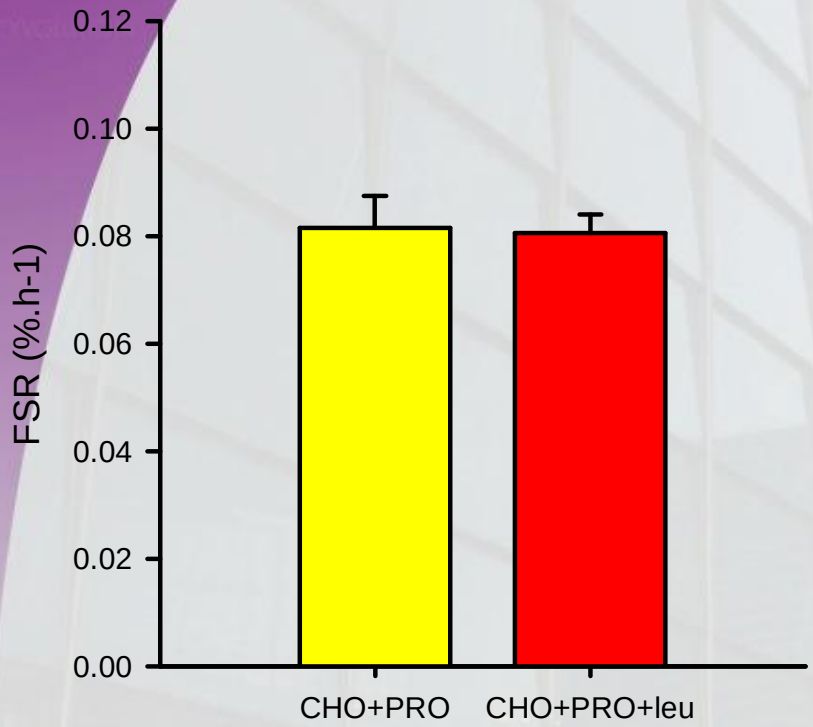
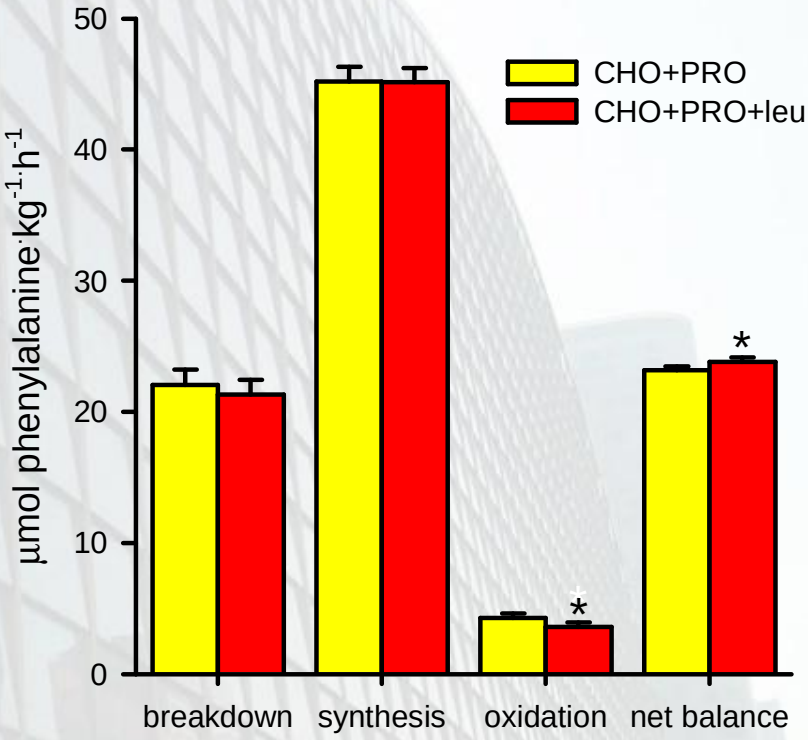
Surplus value of leucine





0.49 g CHO kg^{-1} h^{-1}
0.16 g PRO kg^{-1} h^{-1}

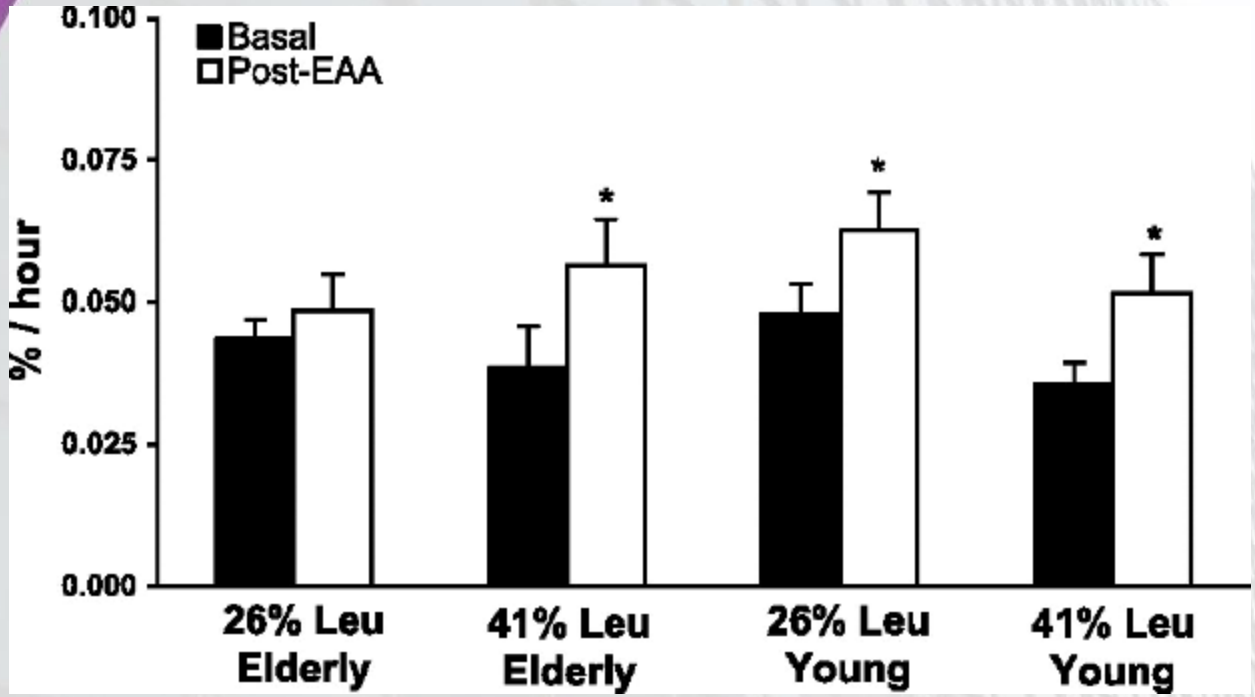
VS.

0.49 g CHO kg^{-1} h^{-1}
0.16 g PRO kg^{-1} h^{-1}
0.03 g leu kg^{-1} h^{-1}

Koopman, et al. Br J Nutr 99: 571-580, 2008.

Considerations

~ Amount of protein/leucine



~ Timing of food intake

Katsanos et al. Am J Physiol 291:E381-387, 2006

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Summary / Conclusions

- Potential Interventions to attenuate the loss of muscle mass associated with aging:
  - è (Resistance) exercise
  - è Protein supplementation
- Exercise and Protein intake acutely increases muscle protein synthesis in young and elderly humans
- Whey protein could be beneficial because of its fast digestion and absorption and high leucine content

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