Protein and Performance: The Power of Protein in Augmenting Exercise Adaptations

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Public service announcement

Protein Mythology: "High dietary protein *causes* kidney (and liver [sic]) problems"

- There are ***no data*** that link higher protein diets to renal disease: the FAO/WHO report says this as does the current IOM document that sets the DRI for North Americans
- In the most recent round of discussions in setting the new DRI, the IOM concluded, "…protein content of diet is ***not related to progressive decline in kidney function*** with age."
- From the WHO/FAO report: "…the suggestion that the decline of glomerular filtration rate that occurs with advancing age in healthy subjects ***can be attenuated by reducing the protein in the diet has no foundation.***"

Protein Mythology: "High dietary protein *causes* kidney (and liver [sic]) problems"

- E.L. Knight et al. *Ann Intern Med* **138:** 460–467, 2003. stated, "… [there was] ***no significant association between protein intake and change in glomerular filtration rate in women with normal renal function****"

* GFR > 55 mL/min per 1.73 m^2

- Bernstein et al. JADA 2007 Apr;107(4):644-50. "From these studies, ***we cannot conclude whether… there is a long-term association between amount of animal or vegetable protein intake and change in normal renal function.***"

Flawed (circular) logic

- People with CKD and renal failure are on low protein protein diets
- Low protein diets prolong survival in these persons
- "Therefore" [sic] high(er) protein diets cause renal disease

W R O N G !

- It is time for people to STOP saying that higher protein diets CAUSE kidney disease! That's simply incorrect

Protein Mythology: "High Protein *Causes* Bone Loss"

- The acid-ash hypothesis: protein and grain foods, with a low potassium intake, produce a diet acid load, net acid excretion (NAE), increased urine calcium, and release of calcium from the skeleton, leading to osteoporosis

- Meta-analysis (Fenton et al. *J Bone Miner Res.* 2009): "There is ***no evidence*** from superior quality balance studies ***that increasing the diet acid load promotes skeletal bone mineral loss or osteoporosis.*** Changes of urine calcium do not accurately represent calcium balance. Promotion of the 'alkaline diet' to prevent calcium loss is not justified."

- Dietary protein is beneficial to bone health under conditions of adequate calcium intake (Mangano et al. Curr Opin Clin Nutr Metab Care. 2014): "…randomized controlled trials show that ***protein's positive effect on bone health is augmented by increased calcium intake***… The positive effects of protein intake on bone health may ***only be beneficial under conditions of adequate calcium intake.*** "

What I tell athletes (and mere mortals) about protein

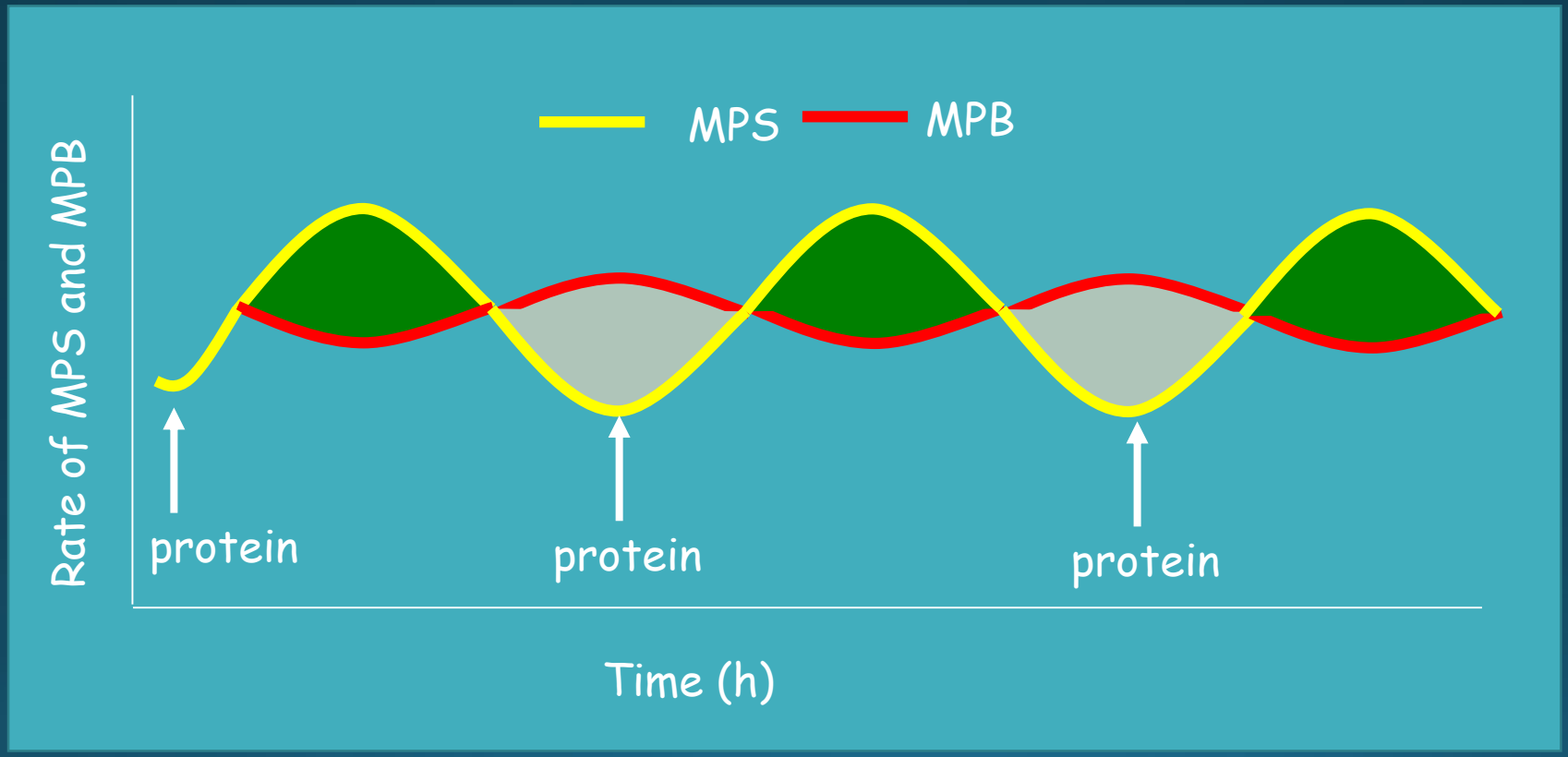
1. Exercise is KING! But…

Nutrition is QUEEN, together they form a kingdom (Jack LaLanne, 1914-2011)

2. All the 'good stuff' happens in recovery… so practice the 3R's
   - Rehydration, Refuel, Repair
3. When it comes to Protein:
   - Athletes could benefit from more than the minimum
   - Nutrient-dense protein foods should be a core choice to improve overall diet quality

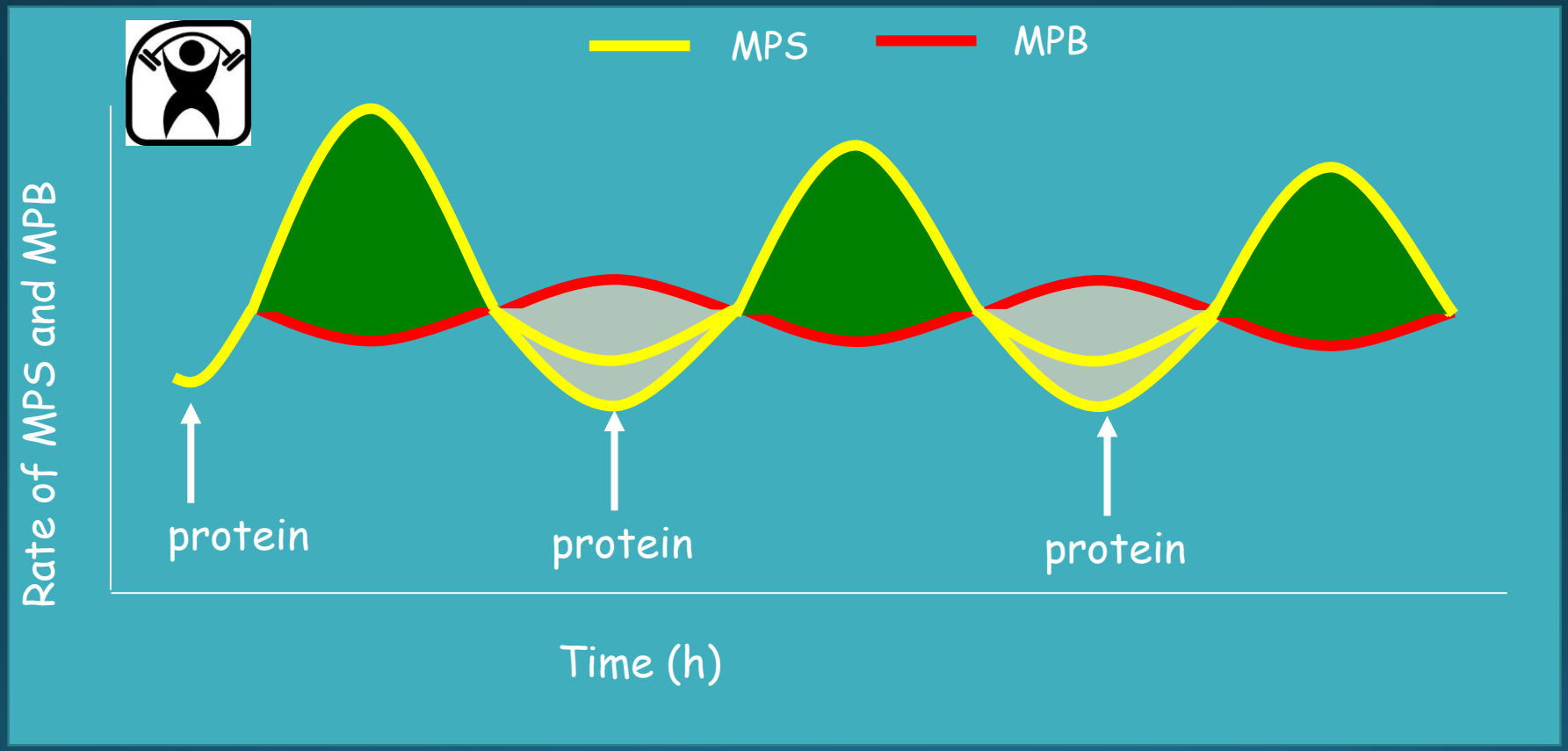
How is muscle mass regulated?

Variations in protein synthesis determine net protein balance



T.A. Churward-Venne, N.A. Burd, and S.M. Phillips. *Nutr. Metab.* 9(1): 40, 2012.

With resistance exercise: variations in protein synthesis are *greater* in the fed state and decline less in the fasted state



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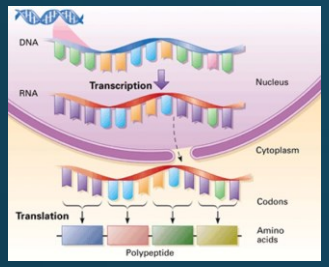
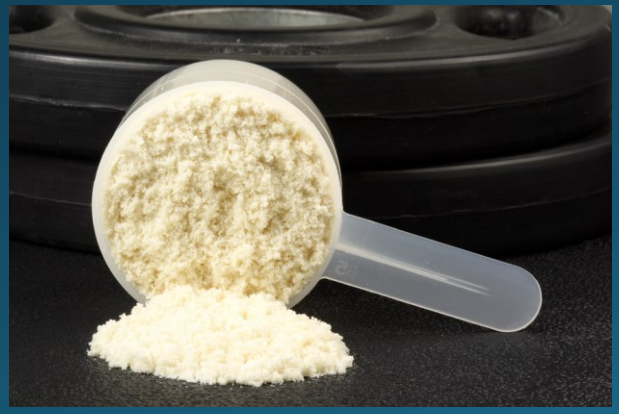
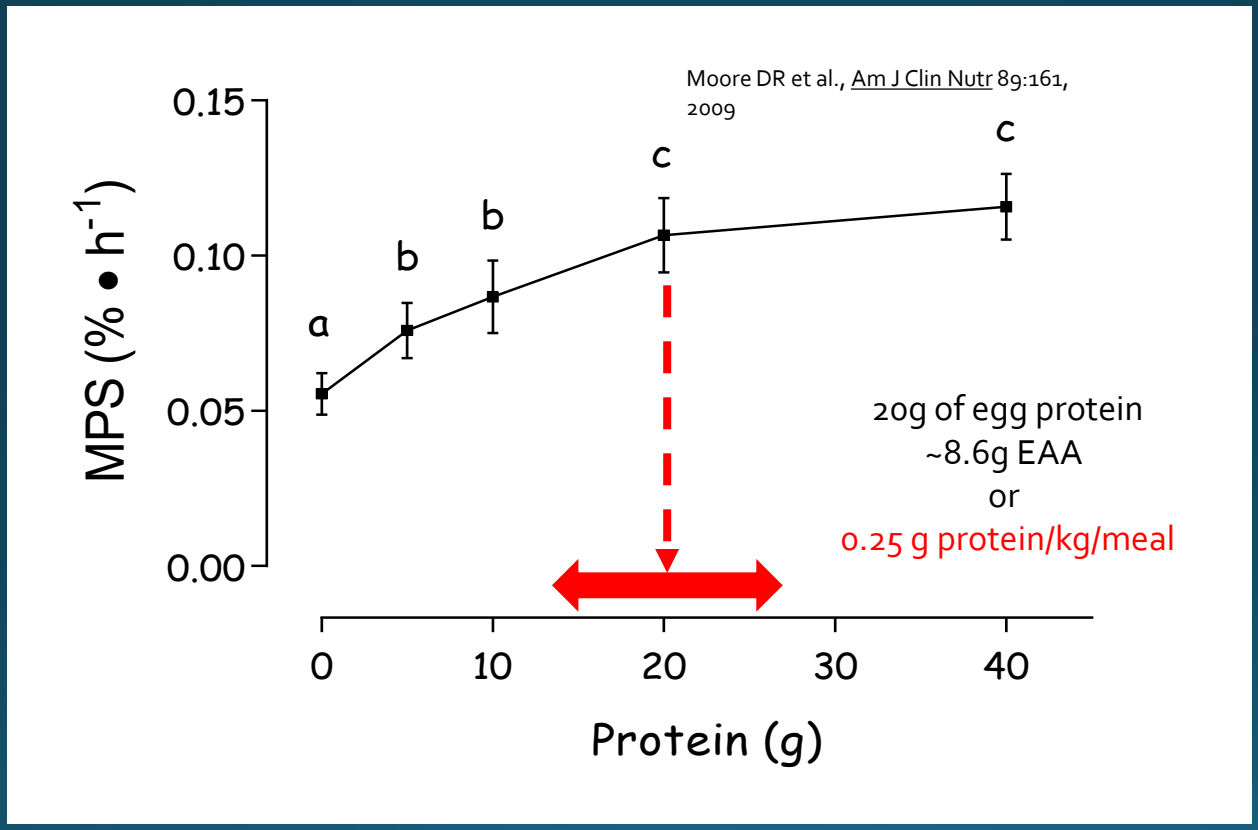


Feeding-induced changes in *MPS* are enhanced by resistance exercise and fasted state losses are lower – *resistance exercise is fundamentally anabolic, this effect is long lasting!*

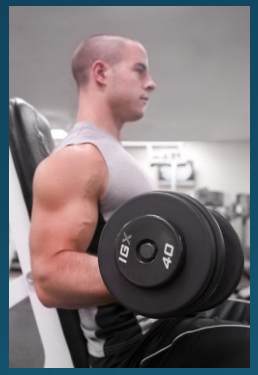
What is an *optimal* amount of protein in a single dose after exercise?



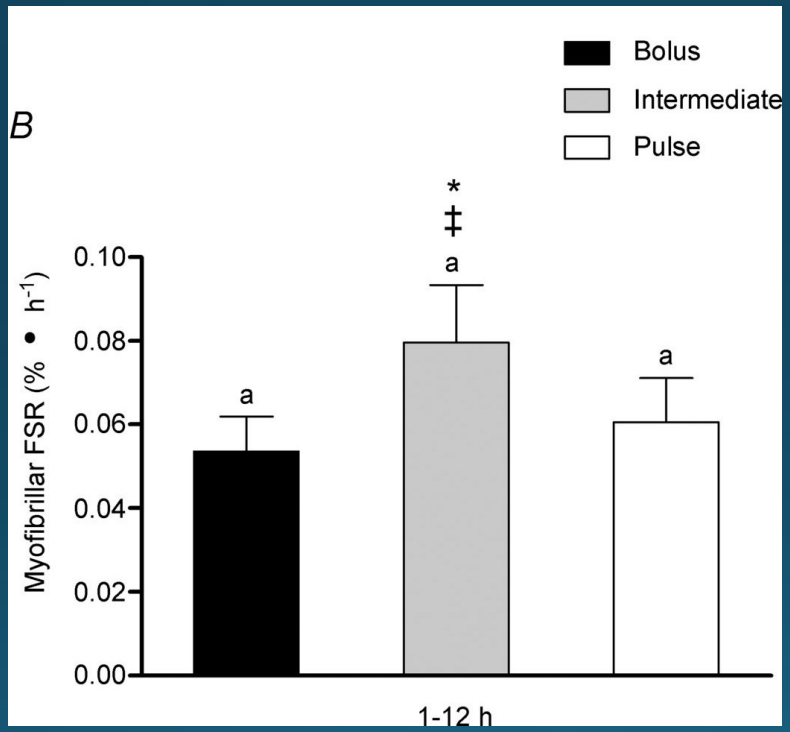
Maximal rate of muscle protein synthesis at 20g



20g of protein (~0.25 g protein/kg/meal) *maximally stimulates MPS* after resistance exercise in young men



Repeated doses of 20g of whey give the greatest anabolic response in a 12h period

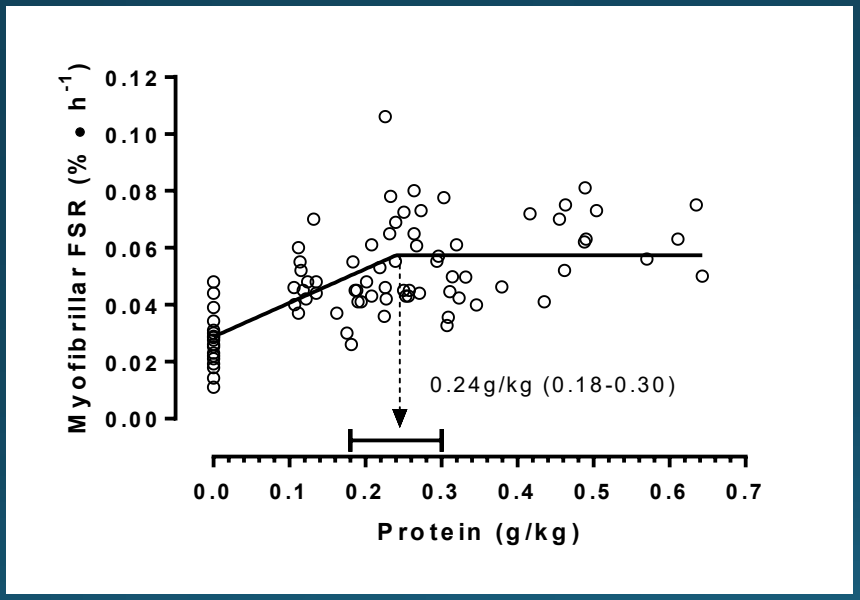


Areta J L et al. J Physiol 2013

The Journal of Physiology

Bolus – 40g every 6h
Intermediate – 20g every 3h
Pulse – 10g every 1.5h

MPS is maximally stimulated following a protein dose (per meal) of 0.24g/kg



Moore et al. *J. Gerontol. A Biol. Sci. Med. Sci.* 70(1): 57-62, 2015

Across the course of 12h *feeding (per 3h) of a dose of 20g (~0.25 g/kg/meal)* was superior to feeding large (40g) or small frequent meals (10g) to stimulate MPS

When are we in our longest period of muscle loss?

When we are sleeping…

Protein Ingestion before Sleep Improves Post-exercise Overnight Recovery

RES, PETER; GROEN, BART; PENNINGS, BART; BEELEN, MILOU; WALLIS, GARETH; GIJSEN, ANNEMIE; SENDEN, JOAN; VAN LOON, LUC. Medicine & Science in Sports & Exercise. 44(8):1560-1569, August 2012.

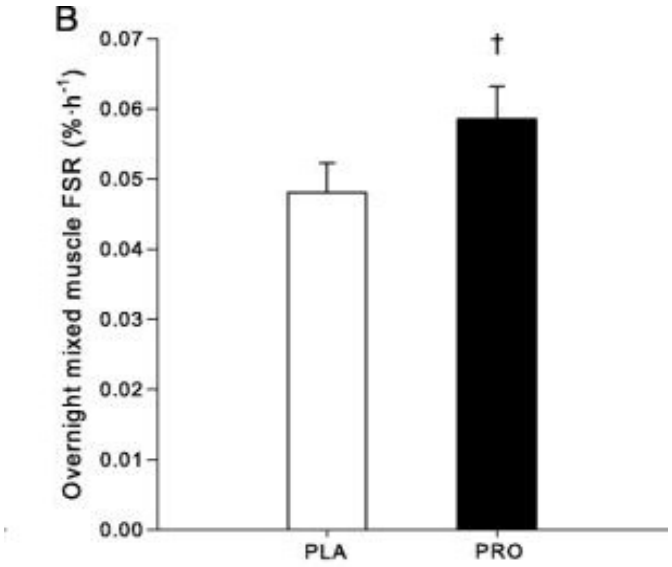
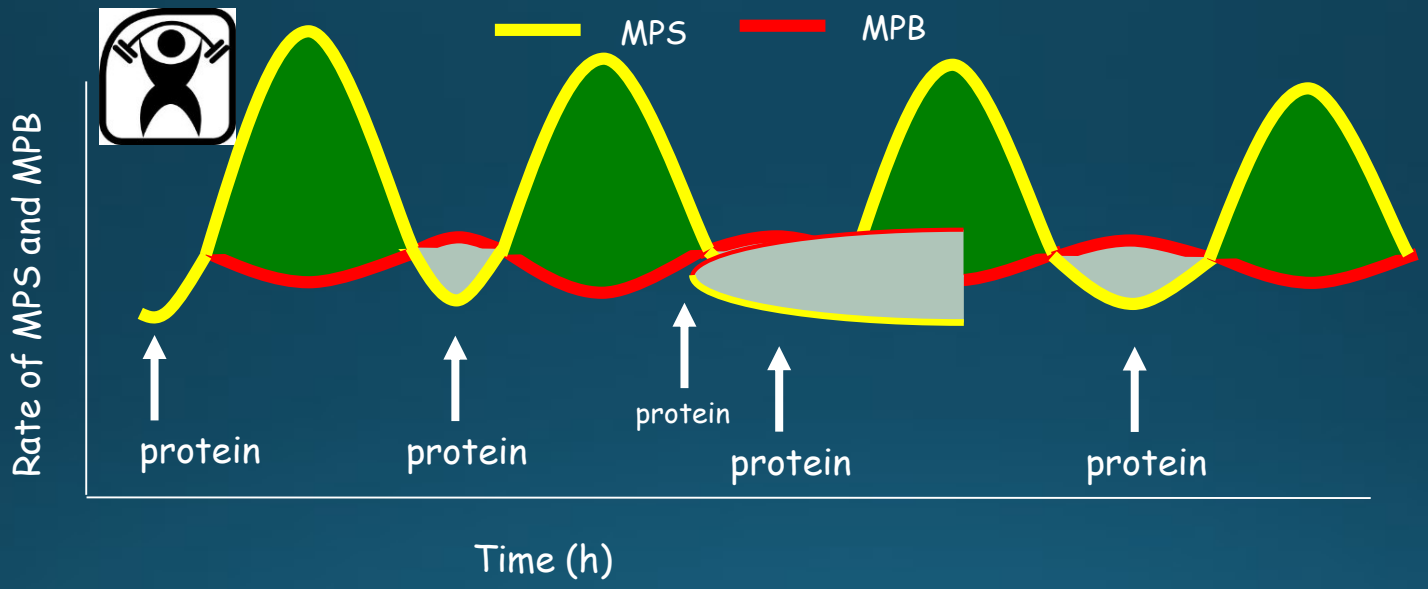


FIGURE 5 . A, Rates of whole-body protein breakdown, synthesis, and oxidation rates and net protein balance (expressed as micromoles of phenylalanine per kilogram per 7.5 h) in the PRO and PLA experiments measured during the 7.5 h of overnight recovery. B, Mixed muscle protein FSR during overnight recovery (0-7.5 h) in the PRO and PLA experiments using average plasma [ring-2H5]phenylalanine enrichment as a precursor. **Following ingestion of 40g of protein.**

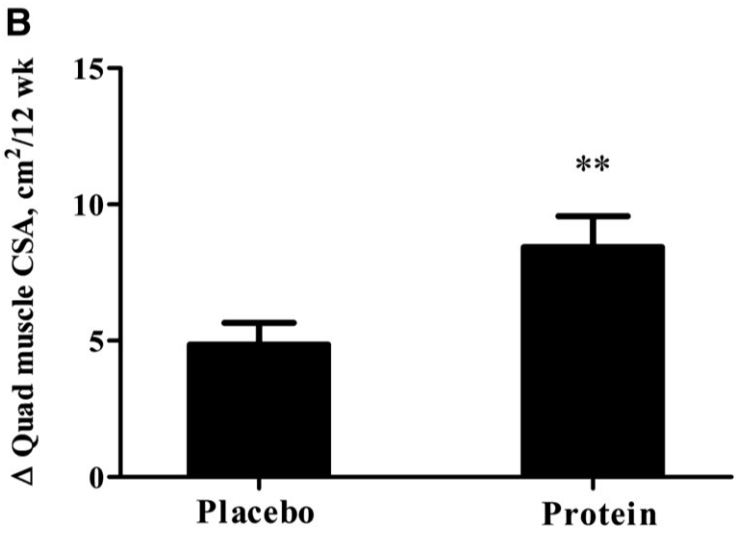
Pre-sleep protein consumption *attenuates overnight reductions in MPS* and *may* facilitate recovery protein tissue remodeling?

A more optimal way to consume protein throughout the day



Changes in Quad CSA during the 12 wk (B) in healthy young men who did or did not receive protein supplementation.

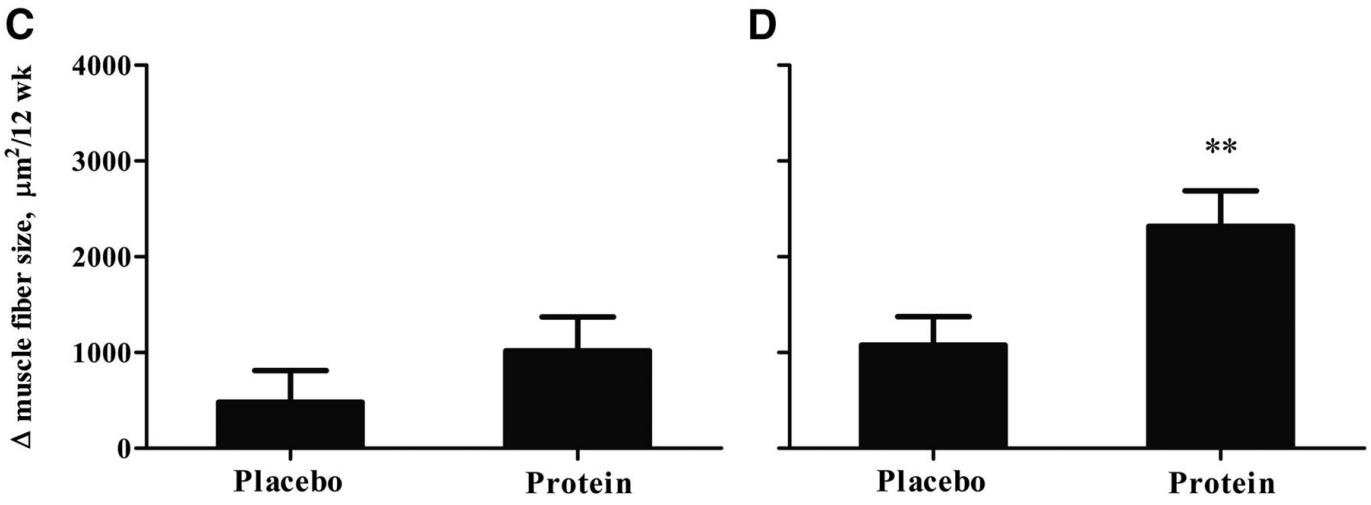
JN THE JOURNAL OF NUTRITION



Tim Snijders et al. J. Nutr. 2015;145:1178-1184

Muscle fiber size before and after 12 wk of resistance-type exercise training (A, B) and changes during 12 wk (C, D) in healthy young men who did or did not receive protein supplementation.

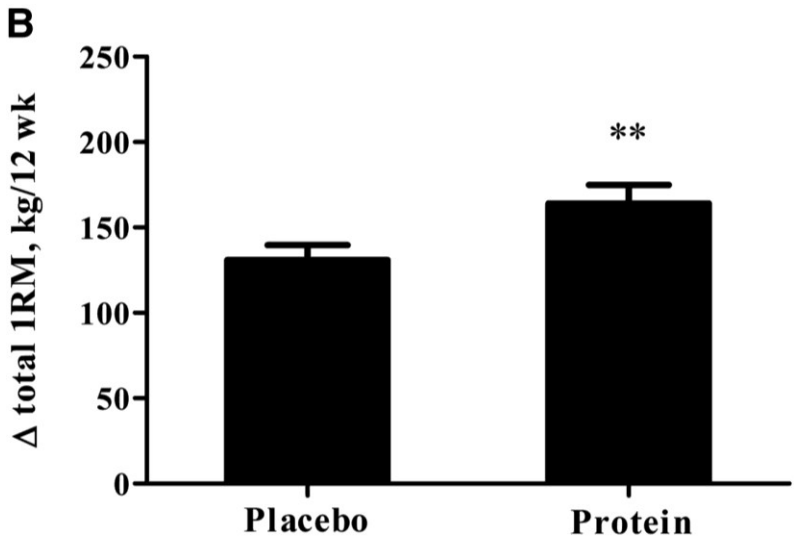
JN THE JOURNAL OF NUTRITION



Tim Snijders et al. J. Nutr. 2015;145:1178-1184

JN THE JOURNAL OF NUTRITION

Total 1RM (sum of all 1RM tests) strength before and after 12 wk of resistance-type exercise training (A) and changes during 12 wk (B) in healthy young men who did or did not receive protein supplementation.



Tim Snijders et al. J. Nutr. 2015;145:1178-1184

What does this all mean?

Repeat…

Protein recommendations to maximize hypertrophy

- 4 equally spaced protein containing meals/d: ~0.25-0.3 protein/kg/meal
- 1 pre-sleep meal (larger): ~0.5-0.6 g protein/kg/meal
- For a 120kg football player

[4 (daytime meals) X 36] + [1 (pre-sleep meals) X 72] = 216 g/d or 1.8 g/kg/d

- For a 50kg female x-country runner

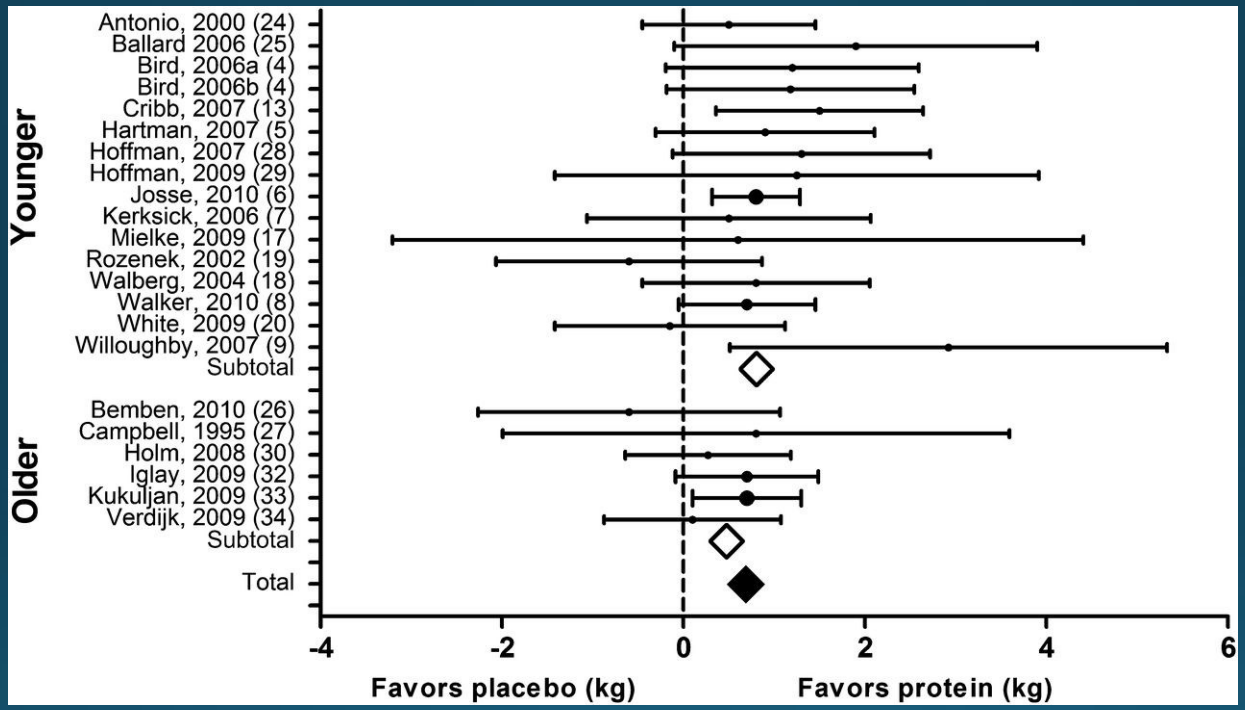
[4 (daytime meals) X 18] + [1 (pre-sleep meals) X 36] = 108 g/d or 1.8 g/kg/d

- TIMING and MEAL SPACING are important

Does all this really matter? Does protein really increase mass/strength?

Evidence-Based Medicine too the rescue…

Forest plot of the results of a random-effects meta-analysis shown as pooled mean differences with 95% CIs on *fat-free mass* in younger and older subjects (weighted mean difference: 0.69 kg; 95% CI: 0.47, 0.91 kg; P < 0.00001).



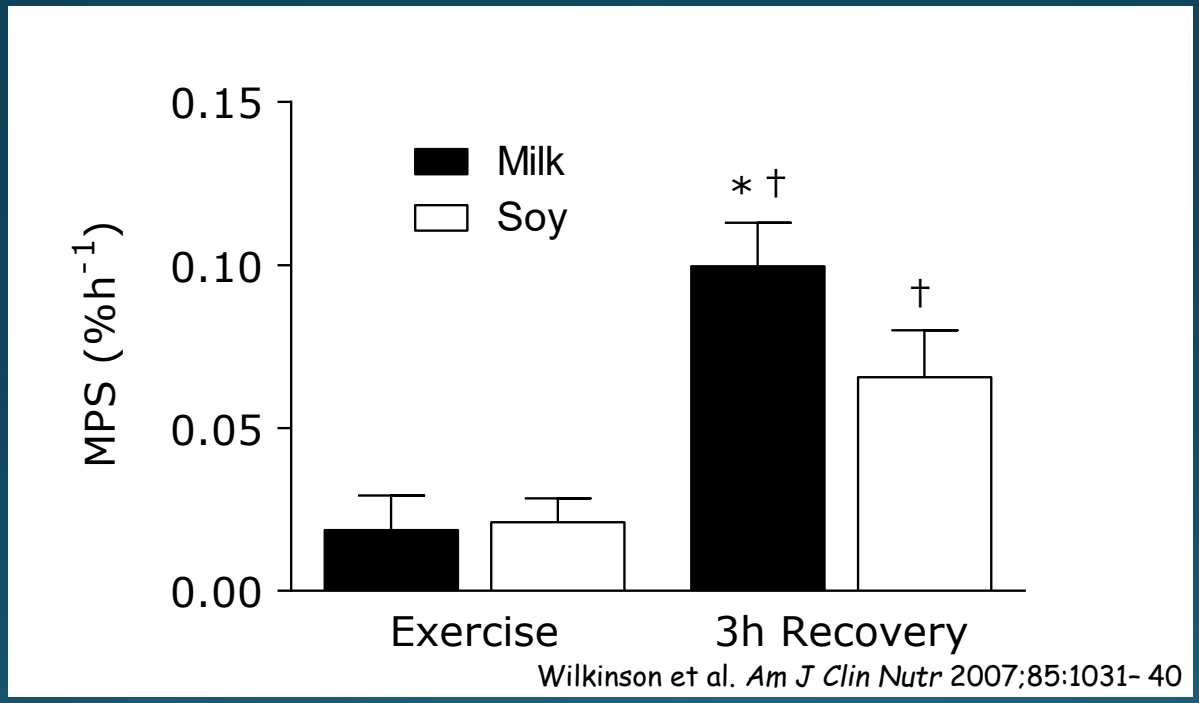
The American Journal of Clinical Nutrition

Cermak N M et al. Am J Clin Nutr 2012;96:1454-1464

Protein supplementation helps augment hypertrophy…

Is the protein source important?

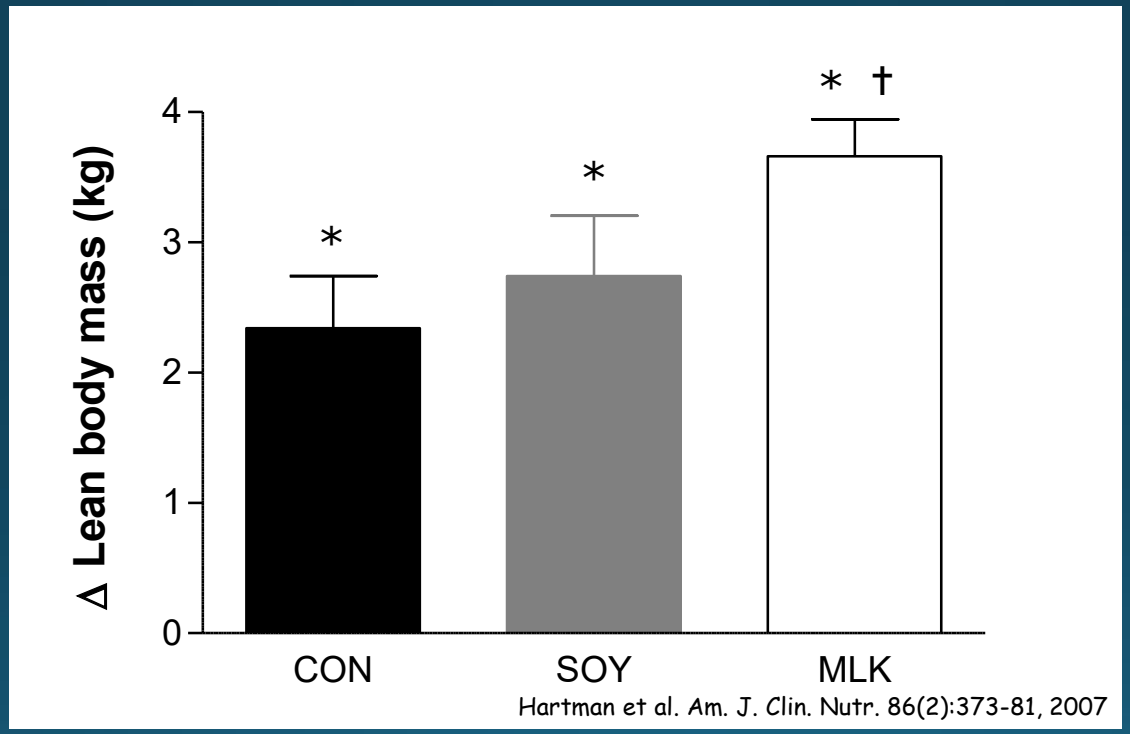
Post-exercise consumption of milk promotes greater net balance than soy

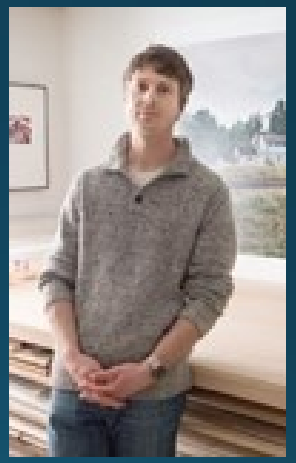


Wilkinson et al. *Am J Clin Nutr* 2007;85:1031- 40

Does this work in the long term?

12 weeks of resistance training with milk consumption promotes greater lean mass gains in young men





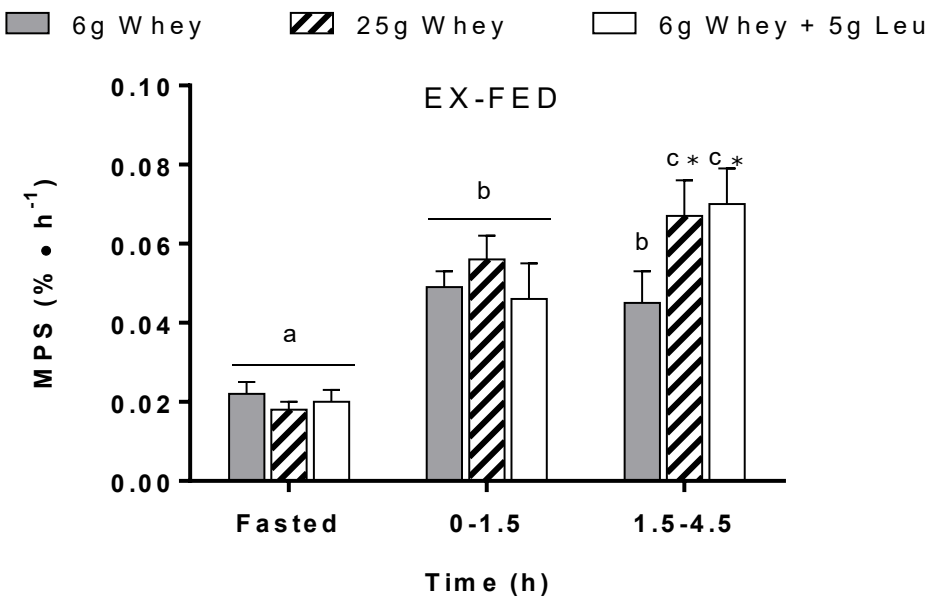
What's the active AA in whey protein?

Essential Amino Acids		Nonessential Amino Acids	
Histidine	(HISS-tuh-deen)	Alanine	(AL-ah-neen)
Isoleucine	(eye-so-LOO-seen)	Arginine	(ARJ-ih-neen)
Leucine	(LOO-seen)	Asparagine	(ah-SPAR-ah-geen)
Lysine	(LYE-seen)	Aspartic acid	(ah-SPAR-tic acid)
Methionine	(meh-THIGH-oh-neen)	Cysteine	(SIS-teh-een)
Phenylalanine	(fen-il-AL-ah-neen)	Glutamic acid	(GLU-tam-ic acid)
Threonine	(THREE-oh-neen)	Glutamine	(GLU-tah-meen)
Tryptophan	(TRIP-toe-fan, TRIP-toe-fane)	Glycine	(GLY-seen)
		Proline	(PRO-leen)
Valine	(VAY-leen)	Serine	(SEER-een)
		Tyrosine	(TIE-roe-seen)

The American Journal of Clinical Nutrition

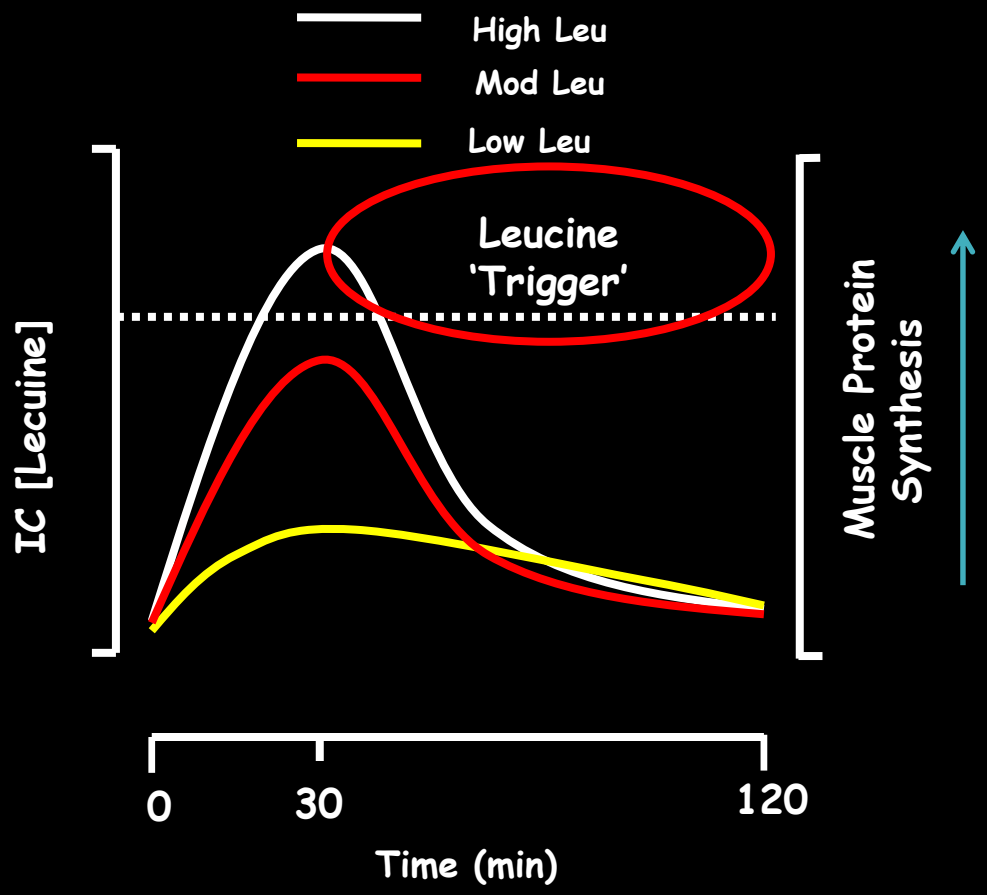
Leucine supplementation of a low-protein mixed macronutrient beverage enhances myofibrillar protein synthesis in young men: a double-blind, randomized trial[1,2,3]

Tyler A Churchward–Venne, Leigh Breen, Danielle M Di Donato, Amy J Hector, Cameron J Mitchell, Daniel R Moore, Trent Stellingwerff, Denis Breuille, Elizabeth A Offord, Steven K Baker, and Stuart M Phillips



Churchward-Venne T A et al. Am J Clin Nutr 2013;99:276-286

The 'Leucine Trigger' Hypothesis



Protein quality – PDCAAS vs. DIAAS

Protein Digestibility-Corrected Amino Acid Scores and Digestible Indispensable Amino Acid Scores Differentially Describe Protein Quality in Growing Male Rats[1,2,3]

Shane M Rutherfurd[4,*], Aaron C Fanning[5], Bruce J Miller[5], and Paul J Moughan[4]

TABLE 1

True ileal nitrogen digestibility and true fecal nitrogen digestibility determined in growing male rats for the 14 protein sources ranked for ileal nitrogen digestibility[1]

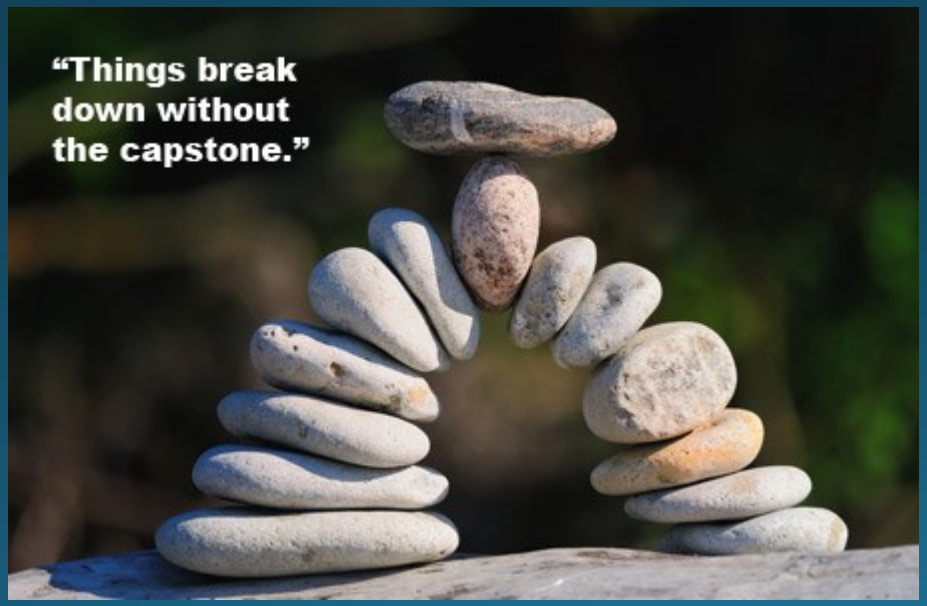
	True nitrogen digestibility, %				
Protein source	Ileal	Fecal	Overall SEM[2]	*P*	Overestimation,[2] %
WPI	99.0	102	0.54	<0.001	2.7
PPC	97.2	99.0	1.45	0.18	—
WPC	95.3	99.8	0.90	<0.001	4.8
SPI A	95.0	98.2	1.00	0.004	3.3
SPI B	94.4	98.5	0.64	<0.001	4.4
MPC	92.1	98.1	1.10	<0.001	6.6
Roasted peanuts	90.9	98.4	1.71	<0.001	8.2
Cooked rolled oats	88.5	95.2	1.23	0.003	7.6
Cooked peas	88.4	89.0	1.51	0.66	—
Cooked kidney beans	79.6	80.4	4.47	0.85	—
RPC	79.6	88.1	1.32	<0.001	11
Cooked rice	72.8	86.6	3.60	0.003	19
Wheat bran	72.7	85.3	3.28	0.001	17
Corn–based breakfast cereal	66.7	81.8	1.88	<0.001	23

TABLE 5

The DIAAS and PDCAAS determined in growing male rats for the 14 protein sources[1]

	DIAAS	PDCAAS
MPC	1.18	1.00
WPI	1.09	1.00
WPC	0.973	1.00
SPI B	0.906	1.00
SPI A	0.898	0.979
PPC	0.822	0.893
Cooked peas	0.579	0.597
Cooked kidney beans	0.588	0.648
Cooked rice	0.595	0.616
Cooked rolled oats	0.542	0.670
Wheat bran	0.411	0.525
Roasted peanuts	0.434	0.509
RPC	0.371	0.419
Corn-based breakfast cereal	0.012	0.078

Nutrient-dense protein as a capstone principle in dietary planning



Why Protein-Containing Foods?

- Consumption of protein at levels above the RDA may have benefits
- Within the context of the current protein sources consumption of ***nutrient-rich*** protein foods increases overall diet quality and contributes to nutrient adequacy
- Without ingestion of ***nutrient-rich sources of protein*** it is difficult, particularly within current dietary practices, to achieve intakes of many nutrients

What Nutrients?

- Shortfall nutrients – promote increased intakes: Calcium, Vitamin D, Potassium, Fiber, Iron, Folate, and Vitamin B_{12}
- Excess nutrients – promote decreased intakes: Sodium, Solid fats (saturated and *trans* fatty acids), Sugars, and Refined grains
- Importantly, ***reduce energy intake*** *– consume less energy-dense and nutrient-poor foods ('empty calories')* and more ***nutrient-dense foods***

Protein-containing, nutrient-rich foods

- Lean meats and Poultry* (iron, zinc, B12)
- Fat-free or Low-fat Milk and Dairy* (calcium, vit D, potassium,
- Eggs* (iron, folate, B12, lutein)
- Seafood* (n-3 fats, B-vitamins, vitamin A)
- Beans and Peas (legumes)

* Excellent sources of protein *and* amongst the top 10 protein-containing foods North Americans

A great resource

http://ajcn.nutrition.org/content/101/6.toc#SupplementProteinSummit2.0EvaluatingtheRoleofProteininPublicHealth

McMaster University

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