

The role of proteins in plant-based diet

Jean-François Huneau

Equipe PROSPECT, UMR Université Paris-Saclay-AgroParisTech-INRAE PNCA
Campus Agro Paris-Saclay, 22 place de l'Agronomie,
91123 Palaiseau cedex

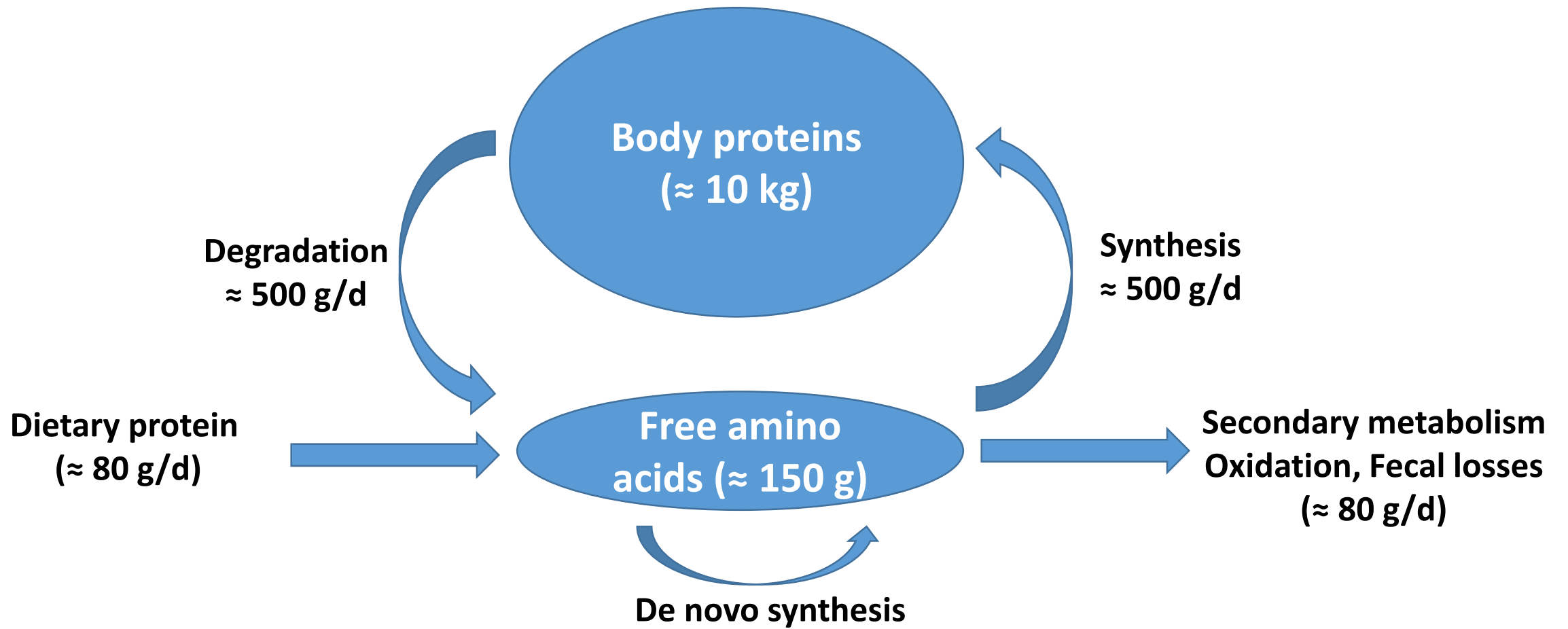
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Protein metabolism and functions



Protein requirements in humans

Protein requirements based on nitrogen requirements, assuming 6.25 g protein/g N

Age	Maintenance requirement	Growth requirement	Total requirement	Safe level	Safe level
Years	g protein/kg body weight per day				% energy
1	0.66	0.29	0.95	1.14	5.9
3	0.66	0.07	0.73	0.90	4.5
5	0.66	0.06	0.69	0.85	4.3
9	0.66	0.09	0.75	0.92	5.8
13	0.66	0.07	0.73	0.90	6.4
15	0.66	0.06	0.72	0.88	7.7
> 18	0.66	0	0.66	0.83	10.0

WHO, 2002

Indispensable amino acid requirements in humans

Amino acid requirements of infants, children and adolescents (mg/kg body weight per day)

Age (y)	His	Ile	Leu	Lys	SAA	AAA	Thr	Trp	Val
0.5	22	36	73	64	31	59	34	9.5	49
1-2	15	27	54	45	22	40	23	6.4	36
3-10	12	23	44	35	18	30	18	4.8	29
11-14	12	22	44	35	17	30	18	4.8	29
15-18	11	21	42	33	16	28	17	4.5	28
>18	10	20	39	30	15	25	15	4.0	26

WHO, 2002

Protein deficiency

No specific marker for protein deficiency

- Loss of lean body mass
- Growth retardation
- Reduced bone mass
- Reduced humoral and cellular immunity
- Reduced plasma protein concentrations and oedema

Protein requirement
Adult : > 10% energy
Children : 5-8% energy

+

Food group	% energy as protein
Bread & cereal products	10-12
Legumes	23-26
Vegetables	18-22
Fruits	4-6
Potatoes & tubers	5-8
Meat & Fish	55-65
Dairy products	23-28
Mixed dishes	12-20

Virtually no diet that provides sufficient energy is deficient in protein



Protein deficiency only occurs in the context of insufficient energy intake

Protein quality in plant-based diets : digestibility

True ileal digestibility for animal and plant proteins in adult humans

Protein	Digestibility	Reference
Milk protein	95.5 ± 0.4	Bos <i>et al.</i> , 1999
Well-cooked bovine meat	90.1 ± 2.1	Oberli <i>et al.</i> , 2015
Rare bovine meat	94.1 ± 0.7	Oberli <i>et al.</i> , 2015
Soy protein	91.7 ± 1.8	Gaudichon <i>et al.</i> , 2002
Pea protein	89.4 ± 1.1	Gausserès <i>et al.</i> , 1997
Wheat gluten	90.3 ± 4.3	Bos <i>et al.</i> , 2005
Lupin protein	91.0 ± 3.0	Mariotti <i>et al.</i> , 2002
Rapeseed protein	84.0 ± 8.8	Bos <i>et al.</i> , 2007
Zein	60.2 ± 4.5	Calvez <i>et al.</i> , 2021

Protein quality in plant-based diets : amino acid profiles

Simplified amino acid profiles and protein digestibility corrected amino acid score for animal and plant proteins

	Egg	Milk	Bovine meat	Wheat	Rice	Quinoa	Soy	Chick pea	Wheat/ Chick pea (1:2)	Adult profile	3-10y profile
Leu	8.4	8.9	8.2	7.0	8.6	7.1	7.6	7.9	7.3	5.9	6.1
Lys	7.1	7.8	8.5	2.7	2.7	6.5	5.9	7.6	5.5	4.5	4.8
Met + Cys	5.1	3.0	7.0	4.3	4.3	4.3	2.5	2.3	3.3	2.2	2.4
Trp	1.3	1.2	0.9	1.2	1.3	1.4	1.5	1.0	1.1	0.6	0.66
Thr	4.3	4.0	4.9	2.9	3.6	3.6	4.1	3.9	3.5	2.3	2.5
PDCAAS ¹	1.00	1.00	1.00	0.54	0.54	1.00	1.00	1.00	1.00		

¹ considering a digestibility of 95% for animal proteins and 85% for plant proteins

Protein and amino acid adequacy in adult vegetarians and vegans

Protein and amino-acid intakes in male meat-eaters, vegetarians and vegans in the EPIC-Oxford cohort

	Meat-eaters (n=98)	Vegetarians (n=98)	Vegans (n=98)	Requirement ¹
Protein (% energie)	15.0 [13.6-16.9]	13.3 [11.8-14.2]	12.6 [11.6-13.9]	10
Leu (g)	6.13 [5.90-6.35]	5.21 [5.03-5.39]	4.33 [4.17-4.49]	2.73
Lys (g)	5.01 [4.78-5.24]	3.76 [3.60-3.93]	2.82 [2.69-2.95]	2.10
Met (g)	1.67 [1.60-1.74]	1.24 [1.20-1.29]	0.88 [0.84-0.92]	0.70
Cys (g)	1.04 [1.00-1.08]	0.88 [0.85-0.91]	0.84 [0.81-0.87]	0.28
Thr (g)	2.99 [2.88-3.10]	2.43 [2.34-2.52]	2.19 [2.11-2.27]	1.05
Trp (g)	0.93 [0.90-0.96]	0.82 [0.79-0.85]	0.77 [0.74-0.79]	0.06

¹ assuming a body weight of 70 kg

Schmidt et al. 2016

Protein intake, growth and body composition in vegetarian and vegan children

Protein intakes and body composition in 5 to 10-y-old children consuming omnivore, vegetarian or vegan of diets

	Ominivores (n=72)	Vegetarians (n=63)	Vegans (n=52)	Reference intake
Age (y)	7.7 ± 1.7	7.6 ± 1.6	7.6 ± 1.6	
% boys	47.2	49.2	42.3	
Protein (g) ¹	57.3 [46.9, 64.5]	45.1 [40.5, 51.5]	42.4 [34.9, 48.4]	16-27
Δ Height Zscore ²	-	-0.45 [-0,77, -0.12]*	-0.55 [-0,97, -0.12]**	
Δ BMI Zscore ²	-	-0.24 [-0,54, 0,06]	-0.50 [-0,82, -0.17]**	
Lean mass index Zscore ²	-	0.02 [-0,28, 0,32]	0.20 [-0,13, 0.53]	
Fat mass index Zscore ²	-	-0.33 [-0,68, 0,01]	-0.78 [-1.14, -0.42]**	

¹ median an interquartile range - ² mean and 95% CI

Desmond et al. 2021

Protein in plant-based diets

- Vegetable proteins are slightly less digestible than animal proteins
- Cereal proteins contain limiting quantities of lysine, but lysine requirement can be met with a diversified intake of plant proteins
- Because children's protein requirement corresponds to 5-8% of their energy requirement and because proteins contribute at least to 10-15% of the energy of diets, a protein deficiency only occurs in the event of insufficient energy intake.
- Protein is not an issue in vegetarian and vegan diets