Case No.: IPR2023-00207
U.S. Patent No. 11,224,241

Nutrition & Dietetics 2007; **64** (Suppl. 4): S113–S119 DOI: 10.1111/j.1747-0080.2007.00197.x

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Section 2: Key nutrients delivered by red meat in the diet

This section begins with the nutritional composition of red meat, and then focuses on the key nutrients delivered through the consumption of red meat in the context of the Australian diet. The reviews draw on the scientific literature to provide an overview of the metabolism and associations with clinical conditions of each of these nutrients. They then provide a perspective on the contributions of red meat in the diet to meet nutritional requirements. Williams provides up-to-date nutritional composition information; Truswell outlines the clinical conditions associated with vitamin B12 deficiency; Samman focuses on metabolism, food sources and requirements for iron and zinc; and Howe and colleagues provide an update on the nutritional implications of the long-chain omega-3 fatty acids. To conclude this section, Baghurst provides a perspective on food guides and the implications for red meat as a core food in the diet

Nutritional composition of red meat

Peter WILLIAMS
ARC Key Centre for Smart Foods, University of Wollongong, Wollongong, New South Wales, Australia

KEY POINTS

The lean component of red meat is:

- An excellent source of high biological value protein, vitamin B12, niacin, vitamin B6, iron, zinc and phosphorus
- A source of long-chain omega-3 polyunsaturated fats, riboflavin, pantothenic acid, selenium and, possibly, also vitamin D
- Relatively low in fat and sodium
- A source of a range of endogenous antioxidants and other bioactive substances, including taurine, carnitine, carnosine, ubiquinone, glutathione and creatine

INTRODUCTION

The Food Standards Australia New Zealand (FSANZ) Food Standards Code defines meat as 'the whole or part of the carcass of any buffalo, camel, cattle, deer, goat, hare, pig, poultry, rabbit or sheep, slaughtered other than in a wild state, but does not include eggs, or foetuses'.[1] This definition does not include kangaroo meat, which is now widely available for purchase in Australia and is likely to be considered as meat.

The term 'meat' may refer only to meat flesh (skeletal muscle plus any attached connective tissue or fat), but the FSANZ definition also includes offal (i.e. meat other than meat flesh, including brain, heart, kidney, liver, pancreas, spleen, thymus, tongue and tripe) although it excludes bone and bone marrow.

In Australia, the term 'red meat' is used by the meat industry to refer to meat from cattle, sheep and goat (i.e. beef, veal, lamb, mutton and goat meat). It does not include meat from pigs (e.g. pork, bacon, ham) or kangaroo, nor less common game meats like buffalo and camel, although nutrient composition of some of these products is now becoming available.[2] Purchased red meat usually consists of both lean tissue (muscle) and fat tissue, which can be either distributed throughout the muscle as marbling (internal fat) or surrounding the muscle meat as selvage or external fat. In trimmed lean meat, it is usually the external fat only that is removed.[3] Processed meat means a product containing no less than 30% meat, that has undergone a method of preservation other than freezing, and includes manufactured meat and cured and/or dried meat flesh (e.g. sausages, salami, canned meats).[1] This paper outlines the key nutrients for which red meat could be considered a significant dietary source based on data of relative composition.

NUTRIENT COMPOSITION OF RED MEAT

Red meat contains high biological value protein and important micronutrients that are needed for good health throughout life. It also contains a range of fats, including essential omega-3 polyunsaturated fats. Recent analyses have shown that there has been a significant trend to leaner cuts of meat over the past two decades.[4] While the nutritional composition will vary somewhat according to breed, feeding regimen, season and meat cut, the following discussion will show that, in general, lean red meat has a relatively low fat content, is moderate in cholesterol, and is rich in protein and many essential vitamins and minerals.

Table 1 presents the typical nutrient composition of samples of fat-trimmed Australian red meat (beef, veal, lamb and mutton), based on recent analyses of national retail samples,[5–7] and compares this with the new Australian recommended dietary intakes (RDI).[8] While there are some differences between the four meats, in general lean red meat is a particularly good source of protein, niacin, vitamin B6, vitamin B12, phosphorus, zinc and iron, with 100 g

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Table 1 Average nutrient composition (per 100 g) of the lean component of Australian red meat[5–7]

	Beef[a]	*Veal*[b]	*Lamb*[c]	*Mutton*[d]	*Adult Australian RDI*
Moisture (g)	73.1	74.8	72.9	73.2	
Protein (g)	23.2	24.8	21.9	21.5	46–64
Fat (g)	2.8	1.5	4.7	4.0	–
Energy (kJ)	498	477	546	514	6.5–15.8 MJ
Cholesterol (mg)	50	51	66	66	–
Thiamin (mg)	0.04	0.06	0.12	0.16	1.1–1.2
Riboflavin (mg)	0.18	0.20	0.23	0.25	1.1–1.6
Niacin (mg)	5.0	16.0	5.2	8.0	14–16
Vitamin B6 (mg)	0.52	0.8	0.10	0.8	1.3–1.7
Vitamin B12 (μg)	2.5	1.6	0.96	2.8	2.4
Pantothenic acid (mg)	0.35	1.50	0.74	1.33	4–6
Vitamin A (μg)	<5	<5	8.6	7.8	700–900 μg RE[e]
Beta-carotene (μg)	10	<5	<5	<5	700–900 μg RE[e]
Alpha-tocopherol (mg)	0.63	0.50	0.44	0.20	7–10
Sodium (mg)	51	51	69	71	460–920
Potassium (mg)	363	362	344	365	2800–3800
Calcium (mg)	4.5	6.5	7.2	6.6	1000–1300
Iron (mg)	1.8	1.1	2.0	3.3	8–18
Zinc (mg)	4.6	4.2	4.5	3.9	8–14
Magnesium (mg)	25	26	28	28	310–420
Phosphorus (mg)	215	260	194	290	1000
Copper (mg)	0.12	0.08	0.12	0.22	1.2–1.7
Selenium (μg)	17	<10	14	<10	60–70

[a] Mean values for diced, stir-fry, round, rump, topside, silverside, fillet, sirloin, scotch fillet, T-bone, blade and chuck steak.
[b] Mean values for stir-fry, diced, leg steak and culet.
[c] Mean values for diced, stir-fry, leg roast, easy-carve roast, mini-roast, chump chop, loin chop, cutlet and easy-carve shoulder.
[d] Mean values for leg roast and casserole mutton.
[e] RE = retinol equivalents (=1 μg retinol or 6 μg or beta-carotene).
RDI = recommended dietary intake.

providing more than 25% RDI of these nutrients. It also provides more than 10% RDI of riboflavin, pantothenic acid and selenium. Of the four meats, mutton is particularly nutrient-dense, and the richest source of thiamin, vitamins B6 and B12, phosphorus, iron and copper.

Protein and amino acids

Raw red muscle meat contains around 20–25 g protein/100 g. Cooked red meat contains 28–36 g/100 g, because the water content decreases and nutrients become more concentrated during cooking. The protein is highly digestible, around 94% compared with the digestibility of 78% in beans and 86% in whole wheat.[9] Protein from meat provides all essential amino acids (lysine, threonine, methionine, phenylalanine, tryptophan, leucine, isoleucine, valine) and has no limiting amino acids. Protein Digestibility Corrected Amino Acid Score is a method of evaluating the protein quality, with a maximum possible score of 1.0. Animal meats like beef have a score of approximately 0.9, compared with values of 0.5–0.7 for most plant foods.[10] The amino acid glutamic acid/glutamine is present in meat in the highest amounts (16.5%), followed by arginine, alanine and aspartic acid.

Fat

Table 2 shows examples of the amount of separable fat found on typical retail cuts of red meat available for sale in Australia.[4,11] There is a wide variation in the amount of total separable fat between the different beef and lamb cuts, ranging from 37% in loin lamb chops to only 1% in veal steak.

The gross composition values show that there generally appears to be less separable fat in the untrimmed raw retail samples collected in 2002 compared with those reported from 1983 to 1986.[12,13] For example, the percentage separable fat has declined from 18% to 12% in rump steak and from 10% to 6.6% in fillet steak. This trend to lower-fat cuts has been due to three factors: selective breeding and feeding practices designed to increase the carcase lean-to-fat ratio; meat classification and marketing systems designed to favour leaner products; and modern butchery techniques such as seaming out whole muscles and trimming away intermuscular fat.[14]

Given the trend to prepare and consume meat after trimming external fat, the most recent nutritional analyses show that all trimmed lean red meats are relatively low in fat (<7%) and have moderate cholesterol content, with the

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Table 2 Lean and separable fat from untrimmed raw boneless Australian red meat (mean weight)[4,11]

Meat cut	*% Lean*	*% External fat*	*% Internal fat*
Beef			
Topside roast	91	6	3
Silverside roast	89	7	4
Blade steak	88	6	6
Porterhouse steak	77	18	5
Stir-fry	98	2	0
Scotch fillet	81	8	11
Veal			
Leg steak	99	0	1
Diced	98	2	0
Cutlet	93	1	6
Lamb			
Leg roast	83	11	6
Chump chop	75	15	10
Diced	98	2	0
Easy-carve shoulder	77	12	11
Loin chop	63	29	8
Mutton			
Leg	85	9	6
Casserole	90	10	0

exception of mince meats (Table 3). An important contributor to the leanness of muscle meat in Australian beef and lamb is that almost all animals are pasture (grass) fed for most of their lives, although some are given short periods of grain finishing before slaughter (D Thomason, MLA, personal communication).

Fatty acids

While discussion on the fat content of red meat may focus on the saturated fat content, the amount of saturated fat in Australian beef and lamb is actually lower than the total amount of unsaturated fats on a per edible portion basis.

Table 4 shows the average fatty acid profiles of beef, veal, lamb and mutton compared with other white meats and fish. Saturated fatty acids comprise, on average, 40% of total fatty acids in the lean component and 48% in the fat component of red meat. In beef and veal, approximately half of the saturated fatty acid in both the lean and fat component of red meat is palmitic acid (16:0), and about a third is stearic acid (18:0). In lamb and mutton, the proportions of these two fatty acids are more similar. There is little variation between cuts in the proportion of fatty acids.

Polyunsaturated fatty acids (PUFA) range from 11% to 29% of total fatty acids. Pasture fed beef is a better source of omega-3 fats than grain feed beef, and this explains the better fatty acid ratio in Australian red meat compared with that in the USA, where there is extensive grain feeding.[17,18] Beef and lamb also have more omega-3 fatty acids than either chicken or pork, although fish is still a significantly better source than any of the red meats.

Table 3 Fat and cholesterol content of trimmed raw and cooked Australian red meat (per 100 g)[5]

Meat cut	*Total fat (g)*	*Cholesterol (mg)*
Beef		
Diced, raw	2.7	54
Diced, cooked	3.0	77
Round steak, raw	1.7	62
Round steak, cooked	2.0	75
Topside roast, raw	4.7	35
Topside roast, cooked	2.8	62
Sirloin steak, raw	1.9	58
Sirloin steak, cooked	3.8	70
Scotch fillet, raw	2.8	58
Scotch fillet, cooked	4.5	70
Regular mince, raw	10.8	76
Regular mince, cooked	12.7	99
Low-fat mince, raw	6.8	61
Low-fat mince, cooked	9.0	81
Veal		
Leg steak, raw	1.5	57
Leg steak, cooked	1.9	85
Cutlet, raw	1.1	35
Cutlet, cooked	2.0	41
Lamb		
Diced, raw	5.2	78
Diced, cooked	6.5	96
Leg roast, raw	3.2	71
Leg roast, cooked	6.0	80
Easy-carve shoulder, raw	4.3	54
Easy-carve shoulder, cooked	5.4	86
Chump chop, raw	4.3	73
Chump chop, cooked	10.2	93
Cutlet, raw	6.7	67
Cutlet, cooked	8.6	96
Lamb mince, raw	6.9	61
Lamb mince, cooked	8.5	93
Mutton		
Leg roast, raw	4.2	76
Leg roast, cooked	11.4	130
Casserole, raw	3.8	56
Casserole, cooked	7.7	63

The recent development of Nutrient Reference Values for Australians recommended a daily adequate intake of long-chain omega-3 fats (docosahexaenoic acid (DHA), eicosapentaenoic acid (EPA) and docosapentaenoic acid) of 160 mg for men and 90 mg for women, with higher targets of 610 mg and 430 mg respectively to reduce the risk of long-term chronic disease.[8] As the levels of long-chain PUFA found in Australian beef, veal and lamb muscle meat are greater than 30 mg per serving (135 g) of red meat, they are considered a source of long-chain omega-3 PUFA according to Australian food regulations (Food Standards Australia New Zealand 2002)[1]. Mutton muscle meat, which has more than 60 mg EPA + DHA per serving of red meat, can be described as a good source of long-chain omega-3 polyunsaturated fats. Red

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Table 4 Fatty acid profile of raw lean meats (g/100 g edible portion)

Fatty acid	*Beef* [a]	*Veal* [a]	*Lamb* [a]	*Mutton* [a]	*Skinless chicken* [b]	*Lean pork* [c]	*White fish* [d]	*Oily fish* [e]
C14:0	0.096	0.034	0.101	0.060	0.020	0.010	0.020	0.680
C15:0	0.012	0.006	0.016	0.011	0.000	0.000	0.000	0.070
C16:0	0.607	0.215	0.842	0.667	0.340	0.250	0.180	2.170
C17:0	0.028	0.009	0.051	0.036	0.010	0.000	0.000	0.050
C18:0	0.356	0.119	0.644	0.609	0.120	0.130	0.050	0.350
Total saturated	1.149	0.409	1.730	1.464	0.500	0.400	0.300	3.320
C14:1	0.025	0.007	0.004	0.003	0.000	0.000	0.000	0.000
C16:1	0.082	0.033	0.066	0.039	0.004	0.030	0.060	0.590
C18:1	1.103	0.356	1.995	1.370	0.620	0.390	0.110	2.190
C20:1	0.015	0.048	0.010	0.011	0.010	0.010	0.010	1.340
Total monounsaturated	1.205	0.399	2.066	1.413	0.700	0.430	0.200	5.390
C18:2 ω-6	0.204	0.090	0.321	0.339	0.210	0.120	0.010	0.250
C18:3 ω-3	0.048	0.022	0.072	0.107	0.010	0.010	0.000	0.130
C20:3 ω-6	0.020	0.012	0.009	0.009	0.008	0.003	0.000	0.000
C20:4 ω-6	0.076	0.056	0.094	0.101	0.030	0.019	0.040	0.050
C20:5 ω-3 (EPA)	0.031	0.028	0.028	0.044	0.005	0.000	0.048	0.913
C22:5 ω-3 (DPA)	0.051	0.033	0.044	0.053	0.009	0.006	0.021	0.194
C22:6 ω-3 (DHA)	0.006	0.003	0.013	0.020	0.009	0.004	0.111	1.118
Total polyunsaturated	0.448	0.259	0.603	0.673	0.300	0.200	0.200	2.655
Total ω-3	0.136	0.086	0.157	0.224	0.033	0.020	0.180	2.355
Total ω-6	0.300	0.244	0.424	0.449	0.258	0.148	0.050	0.250
Ratio ω-3/ω-6	0.45	0.36	0.37	0.50	0.13	0.14	3.60	10.42

[a] Average values from 2002 analyses of Australian red meat.[15]
[b] Values for raw lean chicken breast from NUTTAB 2006.[16]
[c] Values for raw lean pork fillet from NUTTAB 2006.[16]
[d] Values for raw flathead from NUTTAB 2006.[16]
[e] Values for canned red salmon from NUTTAB 2006.[16]
DHA = docosahexaenoic acid; DPA = docosapentaenoic acid; EPA = eicosapentaenoic acid.

meat is frequently consumed by Australians and makes the second greatest contribution to intake of long-chain omega-3 PUFA, after fish, in the Australian diet.[19]

Trans-fatty acids

Trans-fatty acids are found in ruminant fat as a result of biohydrogenation by rumen bacteria. *Trans*-fatty acids (18:1 *trans*) in raw muscle meat vary from as little as 22 mg/100 g in veal to 123 mg/100 g in lamb, but is generally less than 3% of the total fatty acid content.[15] Levels in both raw and cooked muscle meat are higher in lamb and mutton than in beef and veal.

Choline

Choline is a precursor of a number of compounds, including neurotransmitters and membrane phospholipids. Although choline can be made in the body, dietary essentiality has been demonstrated, and the new Australian Nutrient Reference Values recommend an adequate intake of 550 mg/day for men and 425 mg/day for women.[8] The best dietary sources are milk, liver and eggs, but meat is also a significant source and beef contains 78 mg/100 g.[20]

Vitamins

As with other animal foods, red meat is an excellent source of bioavailable vitamin B12, providing over two-thirds of the daily requirement in a 100 g serve (Table 1). Up to 25% RDI of riboflavin, niacin, vitamin B6 and pantothenic acid can also be provided by 100 g of red meat, but compared with pork, it is a relatively poor source of thiamin. Liver is an excellent source of vitamin A and folate, but the levels in lean muscle meat tissue are low. For all these vitamins, older animals tend to have higher concentrations, so the levels in beef are generally higher than those in veal, and mutton has more than lamb. Levels of vitamin D in meat are low and difficult to measure and have often not been included in food composition data previously. However, recent assays of meat in New Zealand have reported levels of 0.10 μg vitamin D3 and 0.45 μg 25-OH D3 per 100 g in beef and levels of 0.04 and 0.93 μg/100 g respectively in lamb.[21] Given the higher biological activity of the 25-OH vitamin D, this means that 100 g of cooked beef could provide 12% of the estimated adequate intake of 10 μg/day for a 51- to 70-year-old individual,[8] and cooked lamb could provide more than 25%, and hence be an important source of this nutrient, especially for housebound elderly people.

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Minerals

Beef and lamb meat are among the richest sources of the minerals iron and zinc, with 100 g providing at least one-quarter of daily adult requirements (Table 1). The iron in meat is mostly haem iron, which is well absorbed, and meat protein also appears to enhance the absorption of iron from meat. Similarly, absorption of zinc from a diet high in animal protein is greater than from plant foods, and the requirements for zinc may be as much as 50% higher for vegetarians.[8] Red meats are also good sources of selenium, providing over 20% RDI per 100 g serve, although it is likely that selenium values in meat will be significantly affected by where animals feed and the time of the year of sampling. Lean meat is low in sodium, with a potassium–sodium ratio of >5. The copper content in raw lean cuts range from 0.055 to 0.190 mg/100 g in beef and veal, 0.090 to 0.140 mg/100 g in lamb, and 0.190 to 0.240 mg/100 g in mutton, all significantly higher than values reported in British meat.[22]

MEAT-BASED BIOACTIVE COMPOUNDS

In addition to the traditional essential nutrients with defined requirements, there are a number of meat-based bioactive substances that have been studied for their potential beneficial effects.[23]

Taurine

An amino acid in meat of particular interest is taurine. Meat is rich in taurine (110 mg/100 g in lamb and 77 mg/100 g in beef),[24] and is the most abundant dietary source. While taurine can be derived from methionine and cysteine metabolism, there have been suggestions that it should be considered a conditionally essential amino acid during lactation, during times of immune challenge, and may offer protection against oxidative stress.[25,26]

Carnitine

L-carnitine (beta-hydroxy-gamma-trimethyl amino butyric acid) transports long-chain fatty acids across the inner mitochondrial membranes to produce energy during exercise. Although not an essential nutrient, needs appear to be increased during pregnancy and after strenuous exercise, and a recommended intake of 24–81 mg/day has been proposed.[27] It is found in skeletal muscle and is particularly abundant in sheep muscle at up to 209 mg/100 g[28] and in beef at around 60 mg/100 g.[29]

Conjugated linoleic acid

Conjugated linoleic acid (CLA) has antioxidant and immunomodulatory properties and may also play a role in the control of obesity.[30] As rumen bacteria convert linoleic acid to CLA, it is most abundant in the fat of ruminant animals, although CLA is also present in partially hydrogenated vegetable oils. The CLA content of meat is affected by several factors, including breed, age and food composition.[31] It is mostly present in the fat component of red meat (approximately 1 g/100 g) but is also found in the muscle meat: 10–46 mg/100 g in raw meat and 30–100 mg/100 g in cooked red meat.[15]

Endogenous antioxidants

Several endogenous compounds (including ubiquinone, glutathione, lipoic acid, spermine, carnosine, anserine) have been studied in skeletal muscle.[32] Both carnosine and anserine are antioxidative histidyl dipeptides and the most abundant antioxidants in meat. Carnosine is present at around 365 mg/100 g in beef[33] and 400 mg/100 g in lamb.[24] Because carnosine is absorbed into the plasma intact, it is a potentially important dietary antioxidant.[34] Coenzyme Q10 (ubiquinone) also has antioxidant properties, and supplements have shown beneficial effects in some studies.[35] Levels in meat are estimated to be around 2 mg/100 g in both beef and sheep meat.[33] Glutathione is a component of glutathione peroxidase enzymes, which have an important antioxidant role in the body. It may also play a role in immune response and enhancing iron absorption by contributing to the 'meat factor'. Glutathione levels in red meat are estimated to be 12–26 mg/100 g in beef,[36] and most meats contain approximately twice the level of glutathione of poultry and up to 10 times the content found in fish.

Creatine

Creatine and its phosphorylated derivative creatine phosphate play an important role in muscle energy metabolism and, under some circumstances, creatine supplements can enhance muscle performance.[37] Red meat contains approximately 350 mg/100 g[33] and is the principal dietary source for humans. Creatine in meat is readily absorbed,[38] but typical intakes are unlikely to provide the levels of creatine used for supplementation of sports performance (up to 15 g/day).

NUTRIENT COMPOSITION OF ORGAN MEATS

Table 5 provides a comparison of the nutrient content of liver, kidney, heart, brains and tripe from beef and lamb. From this table, the following general statements can be made:

- All organ meats (except tripe) are extremely rich in vitamin B12, with much more than 100% of the RDI in 100 g
- Liver is a rich source of protein, iron, zinc, riboflavin, niacin, vitamin A and folate
- Kidney is rich in protein, thiamin, riboflavin, iron and a source of folate
- Heart is a good source of iron and zinc, but not as good as liver and kidney

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Table 5 Selected nutrients (per 100 g) in raw liver, kidney, heart, brain and tripe [a]

	Liver		*Kidney*		*Heart*		*Brain*	*Tripe*
	Beef	*Lamb*	*Beef*	*Lamb*	*Beef*	*Lamb*	*Lamb*	*Beef*
Protein (g)	20.0	21.4	18.2	17.1	18.2	17.8	12.3	13.2
Fat (g)	8.6	7.5	1.6	2.5	3.0	5.6	8.0	2.1
Saturated fat (g)	2.8	2.2	0.6	0.9	1.2	2.3	2.2	0.9
Long-chain omega-3 fat (mg)	561	361	47	103	54	102	574	20
Cholesterol (mg)	271	433	313	338	103	129	1352	82
Thiamin (mg)	0.23	0.24	0.40	0.56	0.50	0.61	0.14	0
Riboflavin (mg)	4.80	2.80	3.60	2.10	1.50	1.10	0.40	0.10
Niacin (mg)	9.4	10.9	6.5	7.6	6.9	5.9	5.1	0.2
Folate (μg)	290	230	98	28	3	2	3	5
Vitamin B12 (μg)	59	90	28	52	9	10	11	1
Retinol equivalents (μg)	13 877	31 400	155	93	10	0	0	0
Zinc (mg)	3.6	4.3	1.8	2.6	1.6	1.6	1.1	1.2
Iron (mg)	5.8	9.5	5.4	9.8	5.0	3.9	1.7	0.4
Magnesium (mg)	15	19	15	16	17	17	12	6
Sodium (mg)	78	67	160	190	91	82	120	100
Potassium (mg)	320	300	250	260	280	260	340	23

[a] Folate values from US data;[39] all other values from NUTTAB 2006.[16]

Table 6 Percentage of male adult recommended dietary intake (RDI) or adequate intake (AI) provided by 100 g of lean red meat and some vegetarian protein sources

	RDI/AI for men aged 31–50 years	*Beef* [a] *% of RDI*	*Lamb*[a] *%*	*Egg*[b] *%*	*Cheddar cheese*[b]	*Baked beans salt reduced*[b]	*Walnuts*[b] *%*
Protein	64 g	36	34	21	40	7	23
Long-chain omega-3 fat	160 mg	50	53	111	55	0	0
Thiamin	1.2 mg	3	8	8	3	4	28
Riboflavin	1.3 mg	25	15	31	39	0	14
Niacin	16 mg	31	70	0	<1	5	9
Vitamin B6	1.3 mg	23	43	5	6	8	33
Vitamin B12	2.4 μg	79	71	58	35	0	0
Pantothenic acid	6 mg	12	13	34	7	<1	11
Vitamin A	900 μg	<1	<1	25	43	<1	<1
Vitamin E	10 mg	7	5	22	40	1	26
Phosphorus	1000 mg	22	23	20	47	8	37
Zinc	14 mg	30	31	9	26	4	18
Iron	8 mg	24	25	26	3	20	31
Magnesium	420 mg	6	6	2	7	6	36
Selenium	70 μg	29	21	37	15	5	3
Sodium	920 mg	6	7	13	72	23	<1
Potassium	3800 mg	9	9	3	2	6	12

[a] Average values from 2002 analyses of Australian red meat.[5]
[b] Values from NUTTAB 2006.[16]

- Brains and tripe are not particularly good sources of vitamins or minerals
- All organ meats are high in cholesterol, especially brains, and mostly low in sodium
- Liver is such a rich source of retinol that consumption of large amounts is not recommended in pregnancy.[40]

SUMMARY

The Australian Guide to Healthy Eating recommends that a healthy diet include 1–2 serves per day of meat or equivalents such as eggs, nuts or legumes.[41] However, the vegetarian alternatives that are used as protein sources have very different nutritional profiles from red meat, as shown in Table 6, which compares the percentage of an adult male daily requirement provided by 100 g of food. Lean beef and lamb are better protein sources than all the options except cheese, and are mostly lower in sodium. The meats are higher in zinc and niacin than all the alternatives, and also higher in omega-3 fats than the vegetable sources; a better source of vitamin B6 (except for the walnuts); richer in selenium (except in comparison to eggs); and are the best

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source of vitamin B12, which is absent entirely from the vegetable products. Egg, cheese and nuts are also much higher sources of total fat than lean beef or lamb. Thus, data on the nutritional composition of lean red meat highlight the relative value of this food category in delivering essential nutrients in a reasonably balanced form.

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