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PROCEEDINGS OF THE NUTRITION SOCIETY

ABSTRACTS OF COMMUNICATIONS

The Four Hundred and Forty-sixth Meeting of the Nutrition Society was held in the Royal Society of Medicine, 1 Wimpole Street, London on Thursday, 10 December 1987, when the following papers were read:

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The metabolism of tryptophan during pregnancy. By D. J. NAISMITH and K. MAITLAND-SMITH, *Department of Food and Nutritional Sciences, King's College London, London W8 7AH*

Although amino acid oxidation is, in general, markedly depressed during pregnancy in well-nourished rats, the activity of tryptophan 2,3-dioxygenase (TD, *EC* 1.13.11.11) is increased by almost 300% (Naismith & Morgan, 1975). It seemed likely that this change in the rate of tryptophan degradation must saturate the oxidative branch of the tryptophan metabolic pathway and thus divert the intermediate acroleyl aminofumarate to the synthesis of NAD(P). This hypothesis was tested.

Ten adult littermate triplets were used: one group acted as virgin controls (A), and groups B and C were mated. A high-protein (200 g/kg) diet was given during the first 2 weeks to all animals, to minimize the influence of protein intake on fetal growth. During the final week a low-protein (60 g/kg) diet was given, providing half the recommended intake of tryptophan. All rats were fed on half the recommended intake of niacin (10 mg nicotinamide/kg diet) throughout the experiment except for group C, which received 200 mg/kg during the 3rd week. The rats were killed on the morning of day 22 of pregnancy. No difference was observed between groups B and C in total food consumption or in weight gain. The results are summarized in the Table.

	Maternal						Fetal			
	TD activity (units/liver)		NAD(P) (μmol/liver)		Methylnicotinamide excretion (μmol/48 h)		Wt (g)		NAD(P) (μmol/g liver)	
Group	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
A	8·2	1·04	8·89	0·58	2·6	0·51	—	—	—	—
B	28·3	2·56	8·23	0·82	5·4	0·96	4·5	0·13	0·44	0·05
C	31·5	1·76	10·07	0·90	41·3	4·48	4·6	0·08	0·43	0·02

Although the diet was low in protein during the last week of pregnancy, a large increase (245%) in TD activity was again observed (group B), indicating hormonal rather than dietary control. Generous supplementation of the diet with pre-formed niacin did not suppress enzyme activity (group C) or improve mean pup birth weight. Comparing pregnant rats (group B) with their virgin controls, no depletion of maternal liver NAD(P) was apparent, nor did supplementation with niacin (group C) significantly raise the liver total NAD(P). Likewise, no difference was found in the NAD(P) concentrations in the fetal livers. During days 19–21 the rats were transferred to metabolic cages, and complete 48 h urine collections were made for analysis of methylnicotinamide. Compared with their controls, the dams fed on the 'pellagragenic' diet excreted more than twice as much methylnicotinamide.

It is concluded that the physiological adjustment in tryptophan that occurs in late pregnancy ensures a more than adequate supply of nicotinamide nucleotides to satisfy the needs of the dam and her offspring.

Naismith, D. J. & Morgan, B. L. G. (1975). *Proceedings of the Nutrition Society* **34**, 27A.

Comparative effect of four different legume species on the plasma lipid levels of hypercholesterolaemic pigs. By SUSAN M. SHUTLER and A. G. LOW, *AFRC Institute for Grassland and Animal Production, Shinfield, Reading RG2 9AQ* and ANN F. WALKER, *University of Reading, Whiteknights, Reading RG6 2AT*

It has recently been shown (Shutler *et al.* 1988*a,b*) that baked beans are able to lower plasma cholesterol levels in humans, and in pigs fed on a cholesterol-raising diet. The aim of the present experiment was to investigate the cholesterol-lowering properties of other legume species which might be used in a lipid-lowering diet.

Six groups of six Large White × Landrace boars, starting weight 25–30 kg, were fed for 6 weeks on the experimental diets. Control group 1 received a casein-based, semi-purified diet; control group 2 received the same diet supplemented with 10 g crystalline cholesterol/kg. The four remaining groups received diets based on that of control group 2, but substituted with 300 g boiled legume/kg (dry matter basis) and adjusted for fat, fibre and protein contents accordingly. The legumes investigated were baked beans (*Phaseolus vulgaris*), marrowfat peas (*Pisum sativum*), split red lentils (*Lens culinaris*) and butter beans (*Phaseolus lunatus*).

The pigs were fed twice daily at 30 g/kg body-weight per d. Blood samples were taken every 14 d after an overnight fast. Mean baseline plasma lipid levels for all animals were (mg/l): total cholesterol 950 (SD 166), high-density lipoprotein (HDL)-cholesterol 322 (SD 54), HDL: total cholesterol ratio 0·34 (SD 0·064), triglycerides 273 (SD 62).

	Control 1		Control 2		Baked beans		Peas		Lentils		Butter beans	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Total plasma cholesterol (mg/l)	1387*	108	5148†	1949	2611*†	955	2994*†	1063	3659†	1026	1803*	551
HDL-cholesterol (mg/l)	600*	79	937†	305	1034†	389	894†	214	919†	259	714	108
HDL: total cholesterol ratio	0·43*	0·027	0·19†	0·033	0·40*	0·053	0·33	0·135	0·26*	0·053	0·43*	0·142
Triglycerides (mg/l)	297	74	329	147	215	73	179	53	270	47	341	151

*Significantly different from control group 2: $P<0·05$.
†Significantly different from control group 1: $P<0·05$.

All legume species, except lentils, caused a significant depression of the diet-induced hypercholesterolaemia when compared with control group 2 (Table). Butter beans were the most effective in this respect. HDL-cholesterol levels rose in all groups, particularly those given dietary cholesterol. Legumes tended to maintain the HDL: total cholesterol ratio at or above the basal level, whereas this ratio was decreased in control group 2. Plasma triglyceride levels were not affected by any of the diets.

We conclude that baked beans, marrowfat peas and butter beans may all be suitable for further investigation for use in a lipid-lowering diet.

SMS is supported by a MAFF postgraduate studentship.

Shutler, S. M., Low, A. G. & Walker, A. F. (1988*a*). *Proceedings of the Nutrition Society* **47**, 97A.
Shutler, S. M., Tredger, J. A. & Bircher, G. M. (1988*b*). *Proceedings of the Nutrition Society* **47**, 98A.

A possible role for phosphofructokinase in the acute deactivation of lipogenesis in the mammary gland of starved–refed lactating rats given intragastric triacylglycerol. By S. W. MERCER and D. H. WILLIAMSON, *Metabolic Research Laboratory, Nuffield Department of Clinical Medicine, Radcliffe Infirmary, Woodstock Road, Oxford OX2 6HE*

Refeeding chow diet to starved, lactating rats rapidly activates lipogenesis and glucose uptake in the mammary gland, and intragastric triacylglycerol inhibits this process (Mercer & Williamson, 1988). A time-course study, investigating the sequence of metabolic events that occur in the gland following refeeding–triolein loading, is reported here.

Lactating Wistar rats (mid-lactation) were refed 5 g chow diet after 18 h starvation, then intubated intragastrically with triolein (2 ml) or paraffin oil (refed controls). There was little re-activation of lipogenesis (measured in vivo with ^3H_2O) in the mammary gland over the first 30 min of refeeding, but a high lipogenic activity occurred in the refed controls between 30–60 min and 60–90 min. Triolein (at 30 min) had no effect on lipogenesis in the gland between 30–60 min, but a marked suppression occurred between 60–90 min (control refed (n 5), 56·9 (SE 12·8); refed + triolein (n 9), 12·8 (SE 3·9) μmol ^3H_2O incorporated/h per g tissue; $P<0·05$).

Mammary gland glucose and glucose 6-phosphate (G6P) concentrations decreased on refeeding, and lactate, pyruvate and fructose 1,6-bisphosphate (F1,6bP) concentrations increased. Triolein intubation had no effect on glucose, lactate or pyruvate concentrations in the gland, but significantly increased the G6P and significantly decreased the F1,6bP concentrations. This cross-over in the ratio of G6P:F1,6bP (indicative of an inactivation of phosphofructokinase) was detected by 60 min, and by 90 min had reached starved values.

Intravenous infusion of the lipoprotein lipase (*EC* 3.1.1.34) inhibitor, Triton WR1339, prevented triolein from inhibiting lipogenesis in the mammary gland, suggesting that dietary lipid normally acts by a direct action involving the uptake of plasma triacylglycerol as non-esterified fatty acids. Additionally, phosphofructokinase (PFK) activity (as indicated by the G6P:F1,6bP ratio) was not inactivated by triolein in the presence of Triton WR1339.

Citrate (acting via ATP) is an allosteric regulator of PFK in the mammary gland (Zammit, 1979). Although ATP concentration in the gland remained constant, citrate concentration was decreased by refeeding and increased by triolein loading ($P<0·001$). However, giving triolein to the Triton WR1339-treated rats prevented this rise in citrate in the gland.

We conclude that the rapid inhibition of lipogenesis in the mammary gland of starved–refed lactating rats by dietary triolein occurs via a direct mechanism, and appears to involve rapid changes in the activity of PFK in the tissue.

Mercer, S. W. & Williamson, D. H. (1988). *Proceedings of the Nutrition Society* **47** (In the Press).
Zammit, V. A. (1979). *FEBS Letters* **108**, 193–196.

The effect of lateral hypothalamic lesion on brown adipose tissue activity in the genetically obese (*fa/fa*) rat. By S. J. HOLT and D. A. YORK, *Department of Human Nutrition, S.O.B.A.P.S., Southampton University, Southampton SO9 3TU*

Lesions of the lateral hypothalamus (LHA) result in aphagia and long-term maintenance of a lower body-weight. The acute response to LHA lesion is a 'hypermetabolic' state which involves increased activity of the sympathetic nervous system, in particular, brown adipose tissue (BAT) (Yoshida *et al.* 1983). The genetically obese (*fa/fa*) rat has a lower level of BAT thermogenesis compared with the lean (*Fa/?*) rat, and this may contribute to the development of the obese state. A defective centrally mediated sympathetic control of BAT has been implicated in the obese (*fa/fa*) rat (Holt *et al.* 1987) and we have therefore examined the effect of LHA lesion on BAT activity in this genotype.

Male lean and obese rats with an initial body-weight of 155 (SE 5) g and 170 (SE 10) g respectively, were anaesthetized with valium and fentanylfluanisone and placed in a stereotaxic frame. A fine bipolar steel electrode was stereotaxically implanted into the LHA and a lesion made by passing a direct current of 2 mA for 20 s. Sham animals were treated similarly, but no current was passed. After recovery the animals were fed on a mixture of ground chow (900 g/l) and chocolate chip cookies (100 g/l) which was made into a paste with water to ensure adequate hydration of the animals. After 4 d the chocolate chip cookies were omitted. Sham controls were either pair-fed to the food intake of lesioned animals or fed *ad lib.* Animals were killed 10 d post-lesion, interscapular BAT was excised, and the mitochondria isolated and specific [^{3}H]GDP binding measured.

(Values are means, with their standard errors, for five animals per group)

		Lean			Obese		
		Sham		Lesioned	Sham		Lesioned
		Ad lib.	Pair fed		*Ad lib*	Pair fed	
Food intake (kJ/10 d)	Mean	1710^{a}	897^{b}	897^{b}	2357^{c}	1155^{d}	1155^{d}
	SEM	47·8	63·6	63·6	106	59·9	59·9
BAT total protein (mg)	Mean	38·6^{a}	33·2^{b}	40·8^{a}	19·3^{c}	18·9^{c}	30·5^{b}
	SEM	1·3	1·2	2·4	0·7	0·5	1·9
[^{3}H]GDP binding (pmol/mg protein)	Mean	250^{a}	200^{a,c}	307^{b}	169^{c}	159^{c}	346^{b}
	SEM	10·3	8·3	13·1	9·8	10·7	28·9

Individual differences of means were statistically tested by the Tukey test.
$^{a-d}$ Values with different superscript letters are significantly different ($P<0·05$).

In both lean and obese lesioned rats food intake was reduced by 50% compared with their respective controls, but the LHA-lesioned obese rats still had a higher food intake than the LHA-lesioned lean rats. The restoration of high levels of BAT protein and mitochondrial GDP binding in the LHA-lesioned obese rats suggests the restoration of normal sympathetic drive to the tissue and may imply that the LHA normally inhibits sympathetic drive to BAT in the obese rat.

Holt, S. J., Wheal, H. V. & York, D. A. (1987). *Brain Research* **405**, 227–233.
Yoshida, T., Kemnitz, J. W. & Bray, G. A. (1983). *Journal of Clinical Investigation* **72**, 919–927.

The effects of restricted food intake on intestinal secretion in the rat small intestine. By A. YOUNG, HELEN C. NZEGWU and R. J. LEVIN, *Department of Physiology, The University, Sheffield S10 2TN*

Following total starvation both the small and large intestine of the rat become hypersecretory in response to cholinergic stimuli (Levin & Young, 1986; Levin *et al.* 1987*a,b*). Little is known concerning the effects of an acute restriction in food intake on intestinal secretion. This was investigated using three groups of rats: fed controls (n 10), 72 h starved rats (n 10) and semi-starved rats fed on 33% (8 g/d) of their normal diet for 9 d (n 20). Sheets of proximal duodenum, jejunum and ileum were removed from rats following pentobarbitone anaesthesia. Electrogenic ion secretion was monitored as the short circuit current (Isc) using standard techniques measuring both basal Isc and maximal changes in Isc above basal level (ΔIsc) in response to 1 mM-serosal bethanecol. Bethanecol is a stable muscarinic cholinergic agonist which binds to muscarinic receptors present on the enterocyte and elicits a rise in intracellular calcium ion levels. The data were analysed using non-parametric ANOVA (Kruskal–Wallis) followed by Conover's multiple comparison t test.

Compared with fed controls, semi-starvation had no effect on basal Isc in any of the three areas examined. In the proximal duodenum, semi-starvation had no effect on the ΔIsc, it was only elevated following 72 h starvation (+ 152%, $P<0{\cdot}001$). In the jejunum, the ΔIsc in the semi-starved group was elevated (+ 43%, $P<0{\cdot}001$), but was less than that of the 72 h starved group (+ 72%, $P<0{\cdot}001$). The ΔIsc in the ileum was elevated following 9 d semi-starvation (+ 61%, $P<0{\cdot}001$) which was also less than the ΔIsc for the 72 h starved group (+ 102%, $P<0{\cdot}001$).

Thus semi-starvation has no effect on basal Isc in the small intestine, but causes hypersecretion following cholinergic stimulation in every area except the proximal duodenum, although the hypersecretion is always less than that observed following 72 h of total starvation.

Financial support from the British Digestive Foundation is gratefully acknowledged.

Levin, R. J., Nzegwu, H. C. & Young, A. (1987*a*). *Journal of Physiology* **396**, 33P.
Levin, R. J., Wragg, M. S. & Young, A. (1987*b*). *Journal of Physiology* **386**, 63P.
Levin, R. J. & Young, A. (1986). *Journal of Physiology* **378**, 23P.

Early developmental changes in 24 h energy expenditure in obese and lean Zucker rats and its relation to body composition. By PAUL HAGGARTY, ELINOR M. GRIEVE and SUSANNAH L. CHRISTIE, *Rowett Research Institute, Bucksburn, Aberdeen AB2 9SB*

Energy expenditure (EE) per kg body-weight decreases with age and it has been suggested that this may be due, at least in part, to changes in body composition during development in man, (Food and Agriculture Organization/World Health Organization/United Nations University, 1985) and in animals (Barcroft, 1946; Kleiber, 1961; Blaxter, 1962).

In order to circumvent variability in EE, fat-free mass (FFM) and carcass protein have been used as units of expression since these are assumed to be representative of the mass of metabolically active tissue in the body. The universal applicability of this approach was investigated in rats of different body composition and stage of development.

EE (24 h) was measured in six obese and six lean rats by indirect open circuit calorimetry. Rapid changes in EE were determined using 'fast-response' calculations as described by Brown *et al.* (1984). The EE of both phenotypes was measured at 22, 24, 28, 32, 36 and 40 d of age. At the end of each 24 h measurement a rat was killed and the composition of the carcass (protein and FFM) was determined after removal of the gut contents.

	EE (kJ/rat per d)					
Age (d) . . .	22	24	28	32	36	40
Lean	70	84	107	137	150	181
Obese	72	83	101	134	158	162

The Table shows that there was no consistent difference in EE between obese and lean rats: both phenotypes exhibited a linear increase in EE with age. However, when the maintenance requirement was calculated after compensating for the rate and energy cost of tissue deposition, the obese rat was found to have a lower maintenance requirement than the lean animal. Within these integrated 24 h values there were patterns in EE which can only be observed using fast response calculations. There was little obvious diurnal variation in either phenotype related to the light–dark cycle; however, there was a tendency for both phenotypes to develop a pattern of 'basal' EE punctuated by peaks of EE. This pattern was absent immediately after weaning but evolved with age.

When EE was related to the protein content and FFM of the carcass the resulting plot was curvilinear. Parallel curve analysis showed that there was no significant difference between phenotypes. Food intake increased with age in both phenotypes and was greater in the obese rats only on days 28, 32 and 36. However, inclusion of this variable in combination with body protein or FFM in a multiple regression model did not alter the non-linearity of the response. The results indicate that the expression of EE per FFM or carcass protein content may not be appropriate when comparing the EE of animals over even relatively small age differences.

Barcroft, J. (1946). *Research on Prenatal Life*. Oxford: Blackwell.

Blaxter, K. L. (1962). *The Energy Metabolism of Ruminants*. London: Hutchinson & Co. Ltd.

Brown, D., Cole, T. J., Dauncey, M. J., Marrs, R. W. & Murgatroyd, P. R. (1984). *Medical and Biological Engineering and Computing* **22**, 333–338.

Food and Agriculture Organization/World Health Organization/United Nations University (1985). *Energy and Protein Requirements, Technical Report Series* no. 724. Geneva: WHO.

Kleiber, M. (1961). *Fire of Life*. New York: Kreiger Publishing Co. Inc.

A study of vegetarianism in female undergraduates at the University of East Anglia. By SUSAN J. FAIRWEATHER-TAIT and ZOE PIPER, *AFRC Institute of Food Research, Colney Lane, Norwich NR4 7UA* and AMANDA FORSTER, *Biological Sciences, University of East Anglia, Norwich NR4 7TJ*

Meat is regarded as an important source of iron in the diet. It is therefore possible that the elimination of meat from the diet of nutritionally vulnerable people, for example female undergraduates, may result in a higher level of Fe deficiency than is found in their omnivorous counterparts (Bergan & Brown, 1980).

A questionnaire was sent to all female undergraduates (*n* 2010) at the University of East Anglia, requesting information pertaining to vegetarianism. There were 441 returns (response rate 22%), 349 from omnivores (79%) and 92 from vegetarians (21%).

A fasting blood sample was taken from fourteen omnivores and fifteen vegetarians, selected at random, for Fe status measurements (see Table).

	Omnivores		Vegetarians		Statistical significance
	Mean	SEM	Mean	SEM	
Age (years)	20·3	0·5	19·7	0·4	NS
Wt (kg)	57·4	1·4	59·9	2·1	NS
Height (m)	1·644	0·017	1·662	0·019	NS
Ponderal index ($Ht/\sqrt[3]{Wt}$)	42·7	0·4	42·6	0·3	NS
Packed cell volume	0·422	0·006	0·405	0·007	$P<0·1$
Haemoglobin (Hb; g/l)	141·7	1·9	134·7	2·4	$P<0·05$
Mean cell Hb concentration (g/l)	336	2·5	333	3·4	NS
Plasma Fe (mg/l)	0·98	0·06	1·17	0·11	NS
Transferrin saturation (%)	37·8	2·7	40·5	3·7	NS
Plasma ferritin (μg/l)	17·4	3·5	16·4	2·2	NS

NS, not significant.

Both groups had plasma ferritin values of less than 20 μg/l, indicating low Fe stores, which could lead to Fe-deficiency anaemia. There was a small difference in Fe status between the two dietary groups. The mean blood Hb concentration of the vegetarians was significantly lower than that of the omnivores. Four of the vegetarians, but none of the omnivores, regularly took mineral supplements. When data from these were excluded from the statistical analysis, the mean Hb concentration fell to 132·6 g/l and the difference then reached a greater level of statistical significance ($P<0·01$). Similar trends were observed in the values for packed cell volume. Further work is required to determine whether or not female vegetarian undergraduates have a higher risk of iron deficiency than omnivores.

The authors thank Dr R. Shepherd for help with the questionnaire design, Miss B. Wharf for assistance with blood sampling, and Mr A. J. A. Wright for analytical assistance.

Bergan, J. G. & Brown, P. T. (1980). *Journal of the American Dietetic Association* **76**, 151–155.

Adipose tissue linoleic acid levels in peptic ulcer disease. By J. KEARNEY, M. J. GIBNEY, P. W. N. KEELING, J. KEATING, N. KENNEDY and MARGARET KENNEDY, *Division of Nutritional Sciences, Department of Clinical Medicine, Trinity College Medical School, St. James's Hospital, Dublin 8, Irish Republic*

It has recently been proposed that the decline in peptic ulcer disease during this century is causally related to increased intakes of essential fatty acids leading to an increased capacity for the synthesis of cyto-protective eicosanoids (Hollander & Tarnawski, 1986). The present study set out to examine long-term dietary intakes of linoleic acid (18:2*n*-6) in normal healthy controls and in patients with endoscopically diagnosed non-ulcer dyspepsia or peptic ulcer disease. The long-term intakes of linoleic acid were assessed from the fatty acid composition of abdominal subcutaneous adipose tissue biopsies, obtained using the vacutainer method. Nutrient intakes were assessed using the dietary history technique over a 7 d period and body fat (% wt/wt) was computed from skinfold thickness. The results are given in the Table.

	Normal healthy controls (*n* 40)		Non-ulcer dyspepsia (*n* 40)		Peptic ulcer disease (*n* 37)	
	Mean	SD	Mean	SD	Mean	SD
Body mass index	24·4	3.6	24.2	4·9	25·1	4·1
% Body fat	26·8	7·5	26·9	7·8	23·6	9·6
Energy (MJ/d)	10·2	2·7	10·1	3·8	11·0	3·7
Dietary fibre (MJ/d)	20·2	11·1	15·9*	6·2	15·2*	7·8
Linoleic acid (% wt/wt):						
Diet	7·7	7·4	5·5	4·1	5·9	4·5
Adipose tissue	15·0	4·1	12·8*	3·5	11·7***	2.7

Significantly different from control value: *$P<0·05$, ***$P<0·001$.

With the exception of dietary fibre intakes and adipose tissue linoleic acid, there were no significant differences between the groups. Both patient groups suffered upper gastrointestinal tract symptoms and both showed lower intakes of dietary fibre and linoleic acid. It is possible that the changes in eating habits observed in such patients are a consequence of the symptoms.

Hollander, D. & Tarnawski, A. (1986). *Gut* **27**, 239–242.

The very-low-birth-weight infant on total parenteral nutrition: effect of time of introduction of amino acids on nitrogen balance, growth and hormonal status. By JOCELYN R. SAINI and JANE B. MORGAN, *Department of Biochemistry, University of Surrey, Guildford, Surrey GU2 5XH* and P. MACMAHON and I. Z. KOVAR, *Department of Child Health, Charing Cross Hospital, London W6 8RF*

The aim of the present study was to compare the effect of nitrogen balance and growth of very-low-birth-weight (VLBW) infants following the introduction of amino acids at either 1 or 3 days after birth (protocol otherwise identical).

Thirteen infants were studied. In seven, amino acids (Vamin®; Kabivitrum, Sweden) were introduced at a mean age of 24 (SEM 1) h after birth (early group, E). In six infants amino acids were introduced at a mean age of 79 (SEM 6) h (late group, L). The mean gestational age in each group was 28 (SEM 1) weeks. The mean birth weights were 933 (SEM 109) and 894 (SEM 67) g in groups E and L respectively (not significant). Sequential 24 h metabolic balance studies for N were conducted for the first 10 d of life. Infants were weighed daily and crown–heel length and head circumference (HC) were measured weekly. Growth hormone (GH) and insulin concentrations were assayed at 1–3, 4–7 and 8–10 d.

Post-natal age (d) . . .		1–3			4–6			7–9		
	Group	Mean	SEM	*n*	Mean	SEM	*n*	Mean	SEM	*n*
Energy intake	E	202**	12	7	272	16	7	293	12	6
(kJ/kg per d)	L	152	8	6	284	16	6	346*	16	6
N intake (mg/	E	310***	29	7	285	68	7	402	57	6
kg per d)	L	24	10	6	252	20	6	447	34	6
N retention (mg/	E	137***	24	7	−50	123	7	299	60	6
kg per d)	L	−138	32	6	49	70	6	233	54	6
Post-natal age (d) . . .		**1–3**			**4–7**			**8–10**		
GH (mU/l)	E	137	40	6	82	32	6	53	31	5
	L	179	22	6	81	39	6	81	24	5
Insulin (pmol/l)	E	38	11	7	87	23	6	145	54	6
	L	45	7	6	92	25	6	87	47	6

*$P<0{\cdot}05$, **$P<0{\cdot}01$, ***$P<0{\cdot}001$.

There was no significant difference between the groups for rate of crown–heel length or HC increase. Mean length increased by 7 (SEM 2) mm/week and HC by 4 (SEM 1) mm/week in group E. Mean length increased by 5 (SEM 2) mm/week and HC by 3 (SEM 1) mm/week in the L group. By the end of the study period the E and L groups had regained 95 and 93% of birth weight respectively. At no stage in the study period did incremental weight differ between the two groups.

The introduction of amino acids to the VLBW infant in the first 24 h after birth significantly increased N retention and energy intake in the first few days of life. This did not result in a significant increase in growth rate or affect the plasma hormone levels of GH or insulin.

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Hypercarotenaemia in Alzheimer's disease? By S. SINGH[1], J. KELLEHER[1], G. P. MULLEY[2] and M. S. LOSOWSKY[1], [1]*Department of Medicine* and [2]*Department of Medicine for the Elderly, St James's University Hospital, Leeds*

Alzheimer's disease (ALZ) is the most common type of dementia and is a major cause of morbidity in the elderly population. Patients with ALZ are recognized to suffer pronounced weight loss (Singh *et al.* 1986); anorexia nervosa is another condition associated with weight loss. Hypercarotenaemia is recognized to occur in anorexia nervosa (Pops & Schwabe, 1968) and in the present study we have looked at carotene metabolism in female ALZ patients and used a group of non-demented (ND) female patients of a similar age as controls:

		Serum carotene (μg/l)		Serum vitamin A (μg/l)		
Group	*n*	Mean	SD	Mean	SD	Correlation coefficient
ALZ	25	1400**	670	580	130	0·24*
ND	20	760	310	650	220	0·62

Significantly different from ND group (Mann-Whitney): *$P<0·05$, **$P<0·01$.

It can be seen that on average ALZ patients had hypercarotenaemia. Increased intake of carotene, and hyperlipidaemia and hypothyroidism are recognized causes of hypercarotenaemia (Cohen, 1958).

Our observations (Singh *et al.* 1986) suggest that increased dietary intake of carotene is a very unlikely cause in ALZ patients. In the present study we measured plasma lipids, and ALZ patients were not hyperlipidaemic. We also measured thyroid function and found a small but significantly lower level of total thyroxine and free thyroxine in the ALZ patients and thus hyperthyroidism is unlikely to be the cause of the carotenaemia.

Carotene is a precursor of vitamin A and so it is to be expected that under normal circumstances there would be a correlation between serum carotene and serum vitamin A levels. This was seen in the ND group, but not in the ALZ group. One possibility is that the hypercarotenaemia seen in ALZ patients is due to decreased conversion of carotene to vitamin A.

This is the first easily measurable biochemical anomaly to be described in ALZ.

Cohen, L. (1958). *Annals of Internal Medicine* **48** (2), 219–227.

Pops, M. A. & Schwabe, A. D. (1968). *Journal of the American Medical Association* **205**, 533.

Singh, S., Johnson, A. W., Mulley, G. P. & Losowsky, M. S. (1986). *Proceedings of the Nutrition Society* **45**, 85A.

Non-steroidal anti-inflammatory agents and protein turnover in the elderly. By M. E. GANN[1], M. A. MCNURLAN[1], K. C. MCHARDY[1,2], E. MILNE[1] and P. J. GARLICK[1], [1]*Rowett Research Institute, Bucksburn, Aberdeen AB2 9SB* and [2]*Department of Medicine, Aberdeen Royal Infirmary, Aberdeen AB9 2ZD*

The non-steroidal anti-inflammatory drug, indomethacin, has previously been shown to block insulin-mediated stimulation of muscle protein synthesis in response to nutrient intake in rats (McNurlan *et al.* 1987). This is thought to be due to the ability of these drugs to inhibit the synthesis of prostaglandins involved in the regulation of protein synthesis.

Non-steroidal anti-inflammatory drugs are used extensively in the elderly, with over 15 million prescriptions issued annually in the UK alone. These drugs are mainly prescribed for chronic musculoskeletal conditions to a population already at risk of body protein loss due to their age and immobility. Any adverse effects on food-stimulated protein anabolism in the elderly would have important clinical implications.

The effect of non-steroidal anti-inflammatory drugs on protein metabolism was investigated in a group of nine elderly volunteers (mean age 75 years) who had been receiving either indomethacin or naproxen continuously for at least 3 months. Whole-body protein synthesis rates were measured with [^{15}N]glycine on two occasions. Volunteers were first studied while on their accustomed non-steroidal anti-inflammatory drug therapy, then again 1 week after stopping the drug. Changes in diet before the study day, levels of activity or indices of inflammation were either controlled or assessed on each study day. Rates of nitrogen flux were calculated from the excretion of ^{15}N in both urinary ammonia and urea with a correction for ^{15}N retained in the body urea pool (end-product average; Fern *et al.* 1981).

	N flux (g N/9 h)		Protein synthesis (g N/9 h)		Net N retention (g N/9 h)	
	Mean	SEM	Mean	SEM	Mean	SEM
With drug	18·61	1·46	13·71	1·40	4·13	0·34
Without drug	18·07	1·28	13·73	1·25	4·69	0·69

Results show no demonstrable effect of non-steroidal anti-inflammatory drugs on rates of protein synthesis in these elderly subjects during feeding. Furthermore, net N retention with continued chronic drug ingestion was no different from that measured 1 week after drug withdrawal. It is reassuring to observe that the considerable alleviation of pain in a large group of individuals is not accompanied by the potentially detrimental effect on dietary protein retention observed in experimental animals.

Fern, E. G., Garlick, P. J., McNurlan, M. A. & Waterlow, J. C. (1981). *Clinical Science* **61**, 217–228.
McNurlan, M. A., McHardy, K. C., Broom, J., Milne, E., Fearn, L. M., Reeds, P. J. & Garlick, P. J. (1987). *Clinical Science* **73**, 69–75.

Thyroid involvement in metabolic responses to mild cold is impaired in obese diabetic women. By M. E. J. LEAN and P. R. MURGATROYD, *MRC Dunn Nutrition Laboratory, 100 Tennis Court Road, Cambridge CB2 1QL* and I. ROTHNIE and I. W. REID, *Department of Chemical Pathology, University of Aberdeen, Aberdeen*

Exposure to extremes of temperature has been found to affect serum thyroid-stimulating hormone (TSH) and thyroid hormone concentrations (O'Malley *et al.* 1984) but metabolic thermogenesis has been disputed as a physiological regulatory mechanism in adult humans (Hervey & Tobin, 1983). The effect of mild cold (22°, with reference to 28°, thermoneutral) was studied by overnight whole-body indirect calorimetry (Lean & Murgatroyd, 1987): minimum sleeping energy expenditure (EE) was significantly increased in six normal-weight women (mean age 31 years, weight 64 kg, body mass index 23) but significantly reduced in five obese type II diabetic women (mean age 55 years, 93 kg, body mass index 35). Biochemical measurements are now presented, from fasting blood samples taken at 09.00 hours after 12 h exposure to each temperature.

		Controls		Obese diabetics		Statistical significance
		Mean	SEM	Mean	SEM	
TSH (mU/l)	28°	1·3	0·1	2·2	0·2	
	22°	1·6	0·2	2·0	0·3	
	Difference	+0·3	0·1	−0·1	0·3	$P<0·02$
T_4 (nmol/l)	28°	100	7	102	4	
	22°	107	5	103	5	
	Difference	+7	4	+1	5	NS
Free T_3 (pmol/l)	28°	5·3	0·1	4·6	0·3	
	22°	5·9	0·1	4·5	0·3	
	Difference	+0·5	0·1	−0·1	0·1	$P<0·01$
Sleeping EE (watts)	28°	66·0	2·9	78·2	9·2	
	22°	68·4	3·1	75·1	7·7	
	Difference (%)	+3·8	1·3	−3·5	1·5	$P<0·001$

NS, not significant.

Fasting plasma glucose was elevated in the diabetic women (9·4 (SD 2·5) mmol/l) but there were no differences between the two temperatures. Serum thyroxine (T_4) (in-house double antibody assay), free 3,5,3′-triiodothyronine (T_3) (Amerlex-M; Amersham International, Amersham, Bucks) and TSH (Amerwell; Amersham International) were within the normal reference range in all subjects. Serum T_4 did not show any differences between the groups, nor any effect due to temperature. There were significant differences in free T_3 ($P<0·05$) at the two temperatures in the control subjects, but no differences in the obese diabetic women. Both TSH and free T_3 responses to mild cold revealed significant differences between the groups, assessed by Fisher's Exact Test (see Table). The difference in sleeping EE at 22° with reference to 28° correlated significantly with changes in serum TSH and free T_3 (both $P<0·05$) by Spearmans Rank-Order Correlation test. Changes in TSH and free T_3 were themselves significantly correlated ($P<0·01$).

Normal physiological thermogenesis of adult humans on exposure to a cool environment may thus be mediated by a pituitary–thyroid mechanism. The abnormal responses of obese diabetic women to mild cold were associated with impaired TSH and thyroid hormone responses.

Hervey, G. R. & Tobin, G. (1983). *Clinical Science* **64**, 7–18.

Lean, M. E. J. & Murgatroyd, P. R. (1987). *Proceedings of the Nutrition Society* **46**, 18A.

O'Malley, B. P., Cook, N., Richardson, A., Barnett, D. B. & Rosenthal, F. D. (1984). *Clinical Endocrinology* **21**, 285–291.

The use of a nutritional risk score in identifying patients who may benefit from sip-feed supplementation in hospital. By CHRISTINE M. WILLIAMS[1], L. DRIVER[1], J. OLDER[2] and J. W. T. DICKERSON[1], [1]*Department of Biochemistry, University of Surrey, Guildford, Surrey GU2 5XH* and [2]*Royal Surrey County Hospital, Egerton Road, Guildford, Surrey*

Despite widespread recognition of the important relation between nutritional status and clinical outcome (Hill *et al.* 1977), convincing evidence for beneficial effects of nutritional support in hospital patients is lacking. Sip-feed supplements are widely used in supplemental feeding programmes in hospital patients but potential benefits of such feeds have not been fully evaluated.

Preliminary results from a randomized controlled trial of sip-feed supplements in elderly patients admitted for orthopaedic surgery are presented. Various criteria have been used to designate patients into malnourished and well-nourished groups for the purpose of supplement studies. In the present study we have used a nutritional risk score (NRS) to allocate patients into 'high-' and 'low-risk' groups. Half of the patients in the high-risk group were randomly allocated to receive a nutritionally complete sip-feed supplement (approximately 2·98 MJ, 26·3 g protein/d) in addition to normal food. Information was collected on each patient at regular intervals (anthropometric measurements, muscle function, mental function, biochemical assessments and clinical information). Results are shown for anthropometric, muscle function and serum albumin measurements, made on admission and at discharge from hospital.

The results demonstrate that high-risk patients who did not receive supplementation showed significant decrements in triceps skinfold thickness (TSF) and mid-upper arm muscle circumference (MUAMC). No significant changes were observed in hand-grip strength in any group. A significant decrement in albumin concentration was observed in the low-risk group but not in either of the high-risk groups. Significant differences in clinical outcome (duration of stay and mobility) were observed between high- and low-risk groups, but not between supplemented and unsupplemented patients.

					High-risk							
	Low-risk (*n* 22)				Non-supplement (*n* 16)				Supplement (*n* 12)			
	Admission		Discharge		Admission		Discharge		Admission		Discharge	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
TSF (mm)	16·8	6·2	17·5	4·9	13·2	6·6	10·7**	5·2	14·6	5·3	16·6	4·3
MUAMC (mm)	233	33	236	29	236	34	224***	31	227	30	227	27
Hand-grip strength	22·0	11·6	23·0	11·4	16·3	8·5	18·0	8·2	14·3	5·9	15·2	4·4
Serum albumin (g/l)	35·9	5·5	30·3**	4·9	33·7	6·3	31·1	4·3	30·1	5·6	28·4	2·8

Significantly different from admission value: $^{**}P<0{\cdot}01$, $^{***}P<0{\cdot}001$.

The results suggest that the NRS may provide a useful means of identifying patients who could benefit from supplementation and demonstrate that sip-feed supplements prevent losses of tissue reserves. However, in the amounts provided over a duration of stay of 2 weeks, they are insufficient to influence clinical outcome.

Hill, G. L., Black, H. R. L. & Pickford, I. (1977). *Lancet* ii, 689–693.

Equipment for estimating carbon dioxide turnover rate in undisturbed grazing sheep. By R. W. MAYES, C. S. LAMB and PATRICIA M. COLGROVE, *Macaulay Land Use Research Institute, Bush Estate, Penicuik, Midlothian EH26 0PY*

Methods have been developed to estimate carbon dioxide turnover in grazing ruminants by infusing [^{14}C]sodium bicarbonate into the jugular vein or peritoneal cavity and estimating the specific radioactivity of CO_2 in jugular blood or in saliva (Corbett *et al.* 1971). A major problem of making such arrangements is the need to gather and restrain the animals in order to obtain samples for specific-radioactivity determination. Whilst the repeated handling of animals can be reduced by continuous withdrawal of saliva through a catheter, continuous sampling of blood is more difficult because of clot formation. A system is described whereby the isotope is continuously infused and blood removed by a portable infusion pump; the blood is passed through a fraction-collector to obtain discrete samples.

The solution of ^{14}C-labelled sodium bicarbonate is contained in a collapsible metal-lined tube located in a rigid cylinder containing water. Tracer solution is infused into the left jugular vein through a catheter by pumping water into the rigid cylinder. Cross-contamination of the sample from the isotope solution, by diffusion of CO_2 through the walls of the silicone-rubber pump tubing (Sanchez & Morris, 1984), is thus avoided. The blood is continuously removed through a catheter situated in the right jugular vein. In order to prevent clotting, isotonic saline solution containing lithium heparin (100000 IU/l) is infused to within 1 mm of the tip of the catheter through a tube situated coaxially inside the catheter. The blood is removed at about seven times the pumping rate of the heparinized saline solution. The blood passes through a fraction-collector to collapsible polyvinyl chloride sample pouches. The fraction-collector consists of a 12-position rotary switching valve driven by a geared motor. The switching period of the valve can be adjusted in 30-s steps from one to 255 steps. The voltage supply to the infusion pump is adjustable and a voltage regulator is fitted in order to prevent fluctuations in battery voltage from affecting the rotor speed of the pump.

Tests of the equipment have been carried out with eleven grazing ewes. Over a collection period of 36 h, with a nominal switching period for the fraction-collector of 80 min and a sample size of 20 ml, 85% of potential samples were successfully taken. Further tests are under way to validate the technique in open-circuit respiration chambers.

Corbett, J. L., Farrell, D. J., Leng, R. A., McClymont, G. L. & Young, B. A. (1971). *British Journal of Nutrition* **26**, 277–291.

Sanchez, M. D. & Morris, J. G. (1984). *Canadian Journal of Animal Science* **64**, Suppl., 332–334.

Dependence of energy expenditure on carbohydrate and not on fat intake in post-obese and control women. By M. E. J. LEAN, *MRC Dunn Nutrition Laboratory, 100 Tennis Court Road, Cambridge CB2 1QL,* P. GARTHWAITE, *Department of Statistics, Aberdeen University, Aberdeen* and W. P. T. JAMES, *Rowett Research Institute, Bucksburn, Aberdeen AB2 9SB*

The thermic effect of dietary fat is less than that of carbohydrate (Flatt, 1985), so high-fat diets may contribute to obesity through lower diet-induced thermogenesis as well as through higher energy density. Such considerations, however, do not explain why only some people become overweight. The present study examined the interaction of dietary factors with predisposition to obesity by studying the contributions of carbohydrate and fat intake to energy expenditure (EE), measured by 24 h whole-body indirect calorimetry in six lean control (body mass index (BMI) 20 (SE 2)) and in six post-obese women (BMI 24 (SE 2)) weight-stable for 6 months after slimming.

Subjects were studied after a 2·5 MJ supper and 12 h overnight equilibration and familiarization in the calorimeter chamber. Energy requirement for energy balance was established individually from a previous fasting study and this amount was given during 'low-fat' (3% total energy as fat, 82% as carbohydrate) and 'high-fat' (40% total energy as fat, 45% as carbohydrate) regimens, and on an overfed day when an extra 50% carbohydrate was added to the high-fat diet. Protein intake was constant at 15% of total energy requirement.

Diet . . .		Low-fat	High-fat	Overfed
24 h EE (watts)	Control	80·0	79·1	80·0
	Post-obese	81·2	77·8	82·2
WMR (watts)	Control	91·2	90·8	91·3
	Post-obese	90·4	87·9	91·5
SMR (watts)	Control	58·8	58·8	58·5
	Post-obese	61·8	59·4	60·6

Mean EE used for analysis of variances are shown in the Table. The contributions of dietary fat and carbohydrate were assessed by multiple stepwise regression analysis, incorporating a factor to allow for inter-individual differences. There was no detectable effect on 24 h EE from the different fat intakes in either group, although there was some indication of a negative relation to sleeping metabolic rate (SMR) in the post-obese, the thermic effect of feeding being reflected entirely in the waking metabolic rate (WMR), 09.00–21.00 hours, by comparison with the fasting study. Carbohydrate intake correlated with 24 h EE but the relations were significantly different ($P<0·02$) in the post-obese and control groups. 24 h EE was lower ($P<0·05$) in the post-obese when the diet contained 45% total energy as carbohydrate, but increased with higher carbohydrate intakes ($P<0·001$) to reach the level of controls when carbohydrate formed about 70% total energy.

These results support the suggestion of Flatt *et al.* (1985) that fat does not influence EE, and additionally indicate reasons for suspecting a special problem with high-fat, low-carbohydrate diets in those individuals who are prone to obesity.

Flatt, J. P. (1985). In *Substate and Energy Metabolism*, pp. 58–69 [J. S. Garrow and D. Halliday, editors]. London: J. Libbey.

Flatt, J. P., Ravussin, E., Acheson, K. J. & Jequier, E. (1985). *Journal of Clinical Investigation* **76**, 1019–1024.

The energy expenditure of large and small eaters. By G. MCNEILL, A. MCBRIDE, J. S. SMITH and W. P. T. JAMES, *Rowett Research Institute, Bucksburn, Aberdeen AB2 9SB*

It is commonly held that some people of normal weight can eat large amounts of food without gaining weight, while others must constantly restrict their food intake to maintain a normal body-weight. To investigate this phenomenon, we have studied the energy expenditure of two groups of normal-weight young men who had very different energy intakes, as recorded by 7 d weighed food intake records. The average energy intake of the five 'large eaters' was 15·3 (SD 2·3) MJ/d, while that of the five 'small eaters' was 8·5 (SD 1·0) MJ/d ($P<0·01$). All the subjects were healthy and weight-stable at the time of the study.

The Table shows that there was no significant difference in age, weight, height, or % body fat between the two groups. Energy expenditure measurements included basal metabolic rate (BMR) by ventilated hood indirect calorimetry, and measurements of 24 h energy expenditure on a controlled activity pattern in a whole-body indirect calorimeter chamber. The results show that under these controlled conditions there was no significant difference in BMR or 24 h energy expenditure between the two groups.

		Age (years)	Weight (kg)	Height (m)	% Fat	BMR (kJ/d)	Energy expenditure (kJ/d)
Larger eaters	Mean	22·6	67·7	1·813	10·3	7384	10710
	SD	2·88	7·04	0·0117	2·59	727	544
Small eaters	Mean	21·2	67·9	1·745	13·9	7195	10586
	SD	0·84	5·93	0·0460	4·09	418	1180

Activity diaries kept at the same time as the weighed intake records were used to calculate the proportion of each day spent in different activities, and values for the physical activity index (PAI) for each subject were calculated from the cost of activity: BMR ratios given by the Food and Agriculture Organization/World Health Organization/United Nations University (1985). The values for the large eaters (mean 1·53 (SD 0·12)) were significantly higher than those for the small eaters (mean 1·38 (SD 0·04)) ($P<0·05$). 20% of the difference in energy intake can therefore be accounted for by differences in time spent in voluntary physical activity, but the majority of the difference must be due to the fact that even the most careful 7 d dietary records do not accurately reflect the long-term energy requirements of individuals. We suggest that the inter-individual variation in energy requirements of normal-weight subjects may be considerably less than that inferred from short-term measurements of energy intake.

Food and Agriculture Organization/World Health Organization/United Nations University (1985). *Energy and Protein Requirements*. Geneva: WHO.

Body temperature and metabolic rate following typhoid vaccination in human subjects.

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Fever is commonly associated with infection and may be generated by either reduced heat loss or increased heat production. Studies on laboratory rodents using endotoxin have revealed significant increases in metabolic rate, but experimentally induced fevers are more difficult to achieve in man. Recently Ximenes *et al.* (1987) reported a significant (25%) increase in resting energy expenditure in five 'reactive' volunteers within 6 h after subcutaneous injection of typhoid vaccine. In view of the possible value of this protocol for studies on fever and infection in man, we have attempted to repeat this experiment. We now present results from two separate studies performed in London and Manchester which differ from the results of Ximenes *et al.* (1987).

Both studies were performed on healthy young male and female volunteers (23–32 years of age), injected subcutaneously with either saline (9 g sodium chloride/l) or typhoid vaccine (Wellcome Laboratory, 0·5 ml or TAB, David Evans Laboratory, 0·1 ml). In the experiments undertaken in Manchester, most of the subjects (6/8) had not previously received typhoid vaccine, and all showed a significant increase in white blood cell count within 6 h after vaccination (mean values (with SEM)) (5 h: 13·0 (1·3) $\times 10^3$ cells/ml) but not saline injection (7·2 (0·6), $P<0·01$, n 6). Oxygen consumption (V_{O_2}), heart rate and metabolic rate (calculated from V_{O_2} and carbon dioxide production) did not alter significantly within the 6 h period after either saline or typhoid injection. Average post-injection values (0–6 h) for V_{O_2} were: saline 210 (9), vaccine 213 (11) ml/min; and for heart rate: saline 57 (1), vaccine 61 (3) beats/min (not significant). Oral and skin temperatures were comparable up to 6 h after injection of either saline (36·4 (0·05)°) or typhoid (36·7 (0·14)°, not significant), but increased significantly in the evening after vaccination (peak at 16 h post-injection: saline 36·7 (0·1), typhoid 37·5 (0·2), $P<0·05$).

Subjects studied in London were injected with vaccine (TAB) on two occasions, 6 weeks apart in order to enhance the response. Measurements were performed at the second treatment. Oral and aural temperatures were similar, and not affected by vaccine within 6 h of injection (saline 36·3 (0·1), vaccine 36·5 (0·1)°, not significant, n 7). V_{O_2} was measured in three subjects during this 6 h period and was slightly, but not significantly, greater after vaccine (281 (44) ml/min) than after saline (234 (31)). Oral temperature increased during the evening (peak 14 h) after vaccine (1·14 (0·1)°) but not saline injection.

The results of the present study have not confirmed those of Ximenes *et al.* (1987) since we found no change in body temperature or metabolic rate in any of the subjects within the 6 h post-vaccination period. However, typhoid vaccination did cause a significant but delayed rise in body temperature, and may therefore be of value in the study of fever in man.

Ximenes, R., Cox, M., Tomkins, A. M. & Collins, K. (1987). *Proceedings of the Nutrition Society* **46**, 16A.

The effect of vitamin E deficiency in rats on the link between muscle glutamine and protein synthesis during the catabolic response to the *Escherichia coli* endotoxin. By ASMA B. OMER, P. C. BATES and D. J. MILLWARD, *Nutrition Research Unit, London School of Hygiene and Tropical Medicine, 4 St Pancras Way, London NW1 2PE*

It has been suggested that muscle glutamine may play an important regulatory role in mediating catabolic responses to a variety of insults as a result of both the unique properties of its transporter (Rennie *et al.* 1986), as well as its direct regulatory influence on the rate of muscle protein synthesis (MacLennan *et al.* 1987). Because vitamin E may be associated with membrane changes in muscle that could influence the ability to maintain the glutamine gradient, particularly during infection, this could modify the catabolic response of muscle in infection which, in turn, could influence the provision of amino acids for the hepatic acute-phase response. We report here measurements of the changes in muscle glutamine concentrations and protein synthesis in response to the *E. coli* endotoxin in rats which were both protein and vitamin E deficient.

The dietary treatment was as previously described (Omer *et al.* 1988). Weanling rats (body-weight 50 (SE 3) g) were given the following diets with (+E) and without (−E) vitamin E: (A) 200 g protein/kg for 16 d; (B) as (A) plus 16 d on a diet of 30 g protein/kg; (C) as (A) plus 16 d on a diet of 5 g protein/kg. These groups were then treated with the *E. coli* endotoxin (LPS: strain 0127:B8) at 1, 2, 3 and 4 mg/kg body-weight and measurements made of muscle glutamine concentration by ion-exchange chromatography and protein synthesis in vivo, as previously described (Jepson *et al.* 1986).

Vitamin E deficiency did not significantly influence the striking linear relation between muscle glutamine and protein synthesis in the three dietary groups (r 0·93, n 5, +E; r 0·887, n 34, −E). In response to the endotoxin there were significant reductions in glutamine in all three dietary groups which was not influenced by vitamin E deficiency. However, the apparent regulatory link between muscle glutamine and protein synthesis was significantly altered by vitamin E deficiency in that the changes in muscle glutamine were associated with diminished changes in muscle protein synthesis. In the very-low-protein group vitamin E deficiency abolished completely the depression of muscle protein synthesis in response to the endotoxin.

These results suggest that vitamin E deficiency may impair the regulatory link between muscle glutamine and protein synthesis, which could in turn impair the ability of muscle to release amino acids during the acute-phase response of infection.

Jepson, M. M., Pell, J. M., Bates, P. C. & Millward, D. J. (1986). *Biochemical Journal* **235**, 329–336.
MacLennan, P. A., Brown, R. A. & Rennie, M. J. (1987). *FEBS Letters* **215** (1), 187–191.
Omer, A. B., Bates, P. C. & Millward, D. J. (1988). *Proceedings of the Nutrition Society* **47**, 10A.
Rennie, M. J., Hundal, H., Babij, P., MacLennan, P., Taylor, P. M., Watt, P. W., Jepson, M. M. & Millward, D. J. (1986). *Lancet* **i**, 1008–1012.