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PROCEEDINGS OF THE NUTRITION SOCIETY

ABSTRACTS OF COMMUNICATIONS

The Three Hundred and Eleventh Meeting of the Nutrition Society was held in the Tower Lecture Theatre, Guy's Hospital Medical School, St Thomas Street, London SE1 9RT on Thursday, 15 *December,* 1977, *when the following papers were read:*

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The nutritional status of patients in a surgical unit. By M. H. JOURDAN, *Department of Surgery, Guy's Hospital, London SE1*

There has been much concern recently that patients entering hospital, and during their stay in hospital, may become undernourished (Bistrian *et al.* 1974). A recent report in the United Kingdom (Hill *et al.* 1977) suggested that up to 60% of patients undergoing major surgery, studied over a short period in a single unit, became undernourished while in hospital.

Over a 12 month period all patients admitted to the Surgical Unit at Guy's Hospital have been subjected to a broad nutritional screening process. In addition, all patients undergoing major surgery i.e. all procedures including, and more extensive than, a cholecystectomy, were assessed again at the time of their discharge. Those factors measured were body-weight, height, mid-upper arm circumference, skinfold thickness over the biceps and triceps and haemoglobin, plasma urea and plasma albumin concentrations. The values obtained were compared with the 'expected' ranges and regarded as abnormal if they were ± 2 SD away from the respective mean for age and sex. During the 12 month period 152 patients underwent major surgery while 442 underwent 'minor' surgical procedures, involving only a short stay in hospital. Of the 'major' surgical group, 103 had full information available. On admission sixteen of these (15·5%) had one or more factors of undernutrition, ten (9·7%) had two or more factors and five (4·8%) had three or more factors. The presence of undernutrition seemed to be primarily related to the patient's disease rather than to age or social circumstances.

Although 40% of the patients undergoing major surgery lost weight while in hospital, only 5% of these who did not previously have a factor indicating undernutrition developed one or more factors during their stay in hospital.

It is concluded that although undernutrition is, and can become a problem in general surgical practice, it is primarily related to the patient's underlying disease. There are therefore likely to be regional differences in the incidence of undernutrition according to the types of illnesses treated in any one surgical practice.

Bistrian, B. R., Blackburn, G. L., Hallowell, E. & Heddle, R. (1974). *J. Am. med. Ass.* **230**, 858.

Hill, G. L., Blackett, R. L., Pickford, I, Burkenshaw, L., Young, G. A., Warren, J. V., Schorah, C. J. & Morgan, D. B. (1977). *Lancet* i, 689.

Survey of nutritional knowledge and interest of students. By JANET P. LOWELL, *Robert Gordon's Institute of Technology, Queens Road, Aberdeen AB9 2PG*

A survey was carried out to investigate nutritional knowledge and interest amongst students, and to determine factors which might affect their knowledge. Students, most of whom are having complete freedon over their choice of food intake for the first time, need to be able to select foods that will give them a reasonably balanced nutrient intake at low cost. Questionnaires were completed by 254 first-year students from eight departments of Robert Gordon's Institute of Technology under the supervision of lecturers to ensure there was no collaboration. Each group of students completed the questionnaire in 15–20 min which involved considerably less time than the normal survey method of one to one interviews. All questions involved putting the appropriate number in a box, and the answers obtained were analysed by computer.

The questionnaire was divided into five sections. Sections A and B contained social questions such as their age, sex, number of siblings, father's and mother's occupation and the subjects they had studied at school. Section C was to assess interest in nutrition and required 'yes', 'no' or 'don't know' answers. Sections D and E were designed to assess nutritional knowledge and consisted of 'true' and 'false' statements and multiple choice questions. To decrease the chance of correct answers being given by guesswork, students could answer 'don't know' to all questions in sections C, D and E.

Female students had more correct answers than male students ($P<0.0001$). Those who had studied home economics at school had the most correct answers and those who had studied food or biologically related subjects knew more than those who had not ($P<0.0001$). 57% of the students had been taught something about nutrition at school, 64% learnt something about it at home and 56% read articles on nutrition. Those who had gained knowledge from any of these sources obtained better scores than those who had not done so ($P<0.0001$). Those who claimed to know enough about nutrition did know more than those who thought they did not ($P<0.001$). Age, number of siblings and father's and mother's occupation made no significant difference to the number of correct answers. These and other results will be discussed.

I am grateful for the assistance of Mr Kevin Walsh, Computer Services Unit, Mr Alex Wilson, School of Mathematics, and lecturers in the School of Social Studies.

Can nitrates in the diet suppress dental caries? By T. H. GRENBY and J. M. BULL, *Department of Oral Medicine and Pathology, Guy's Hospital, London SE1 9RT*

Among the most effective anti-caries agents that can be added to sugary foods to reduce dental caries in laboratory animals are the glycerophosphates. It was observed in rat nutritional studies that calcium glycerophosphate was consistently more caries-inhibitory than sodium glycerophosphate. This led to trials of sodium glycerophosphate supplemented with a range of calcium salts, but only calcium nitrate significantly improved its anti-caries activity. Finally, calcium nitrate alone also showed a caries-protective effect (Grenby & Bull, 1975).

Two further trials have now been completed: (1) to establish whether calcium nitrate is effective in the presence of calcium glycerophosphate; (2) to compare other nitrates with calcium nitrate for anti-caries activity.

Matched groups of caries-susceptible Osborne-Mendel rats received high-sucrose diets for 8 weeks from weaning. In trial 1 the basic 46% sucrose diet was supplemented with 2% calcium glycerophosphate or 1% calcium nitrate or both. In trial 2 the basic diet was supplemented with calcium, magnesium and sodium nitrates at levels calculated to provide the same intake of the nitrate ion as 1% of calcium nitrate.

The weight gains of the animals were recorded week by week. At the end of the 8-week period the mandibular molar teeth were examined for dental plaque and for dental caries by the occlusal grinding technique (Shaw *et al.* 1944).

The main findings were: (A) as before, calcium glycerophosphate exerted a strong protective action against dental caries. (B) Calcium nitrate alone was also caries-inhibitory, but the results were not as clear-cut as with calcium glycerophosphate. (C) the effect of the two agents administered together was cumulative. (D) all three nitrates proved equally effective in inhibiting caries. Thus although the original rationale for the use of calcium nitrate was that its calcium content would improve the low activity of sodium glycerophosphate, its mechanism of action is revealed as dependent on the nitrate anion rather than the calcium cation.

Grenby, T. H. & Bull, J. M. (1975). *Arch oral Biol.* **20**, 717.
Shaw, J. H., Schweigert, B. S., McIntyre, J. M., Elvehjem, C. A. & Phillips, P. H. (1944). *J. Nutr.* **28**, 333.

Transfer of linoleic acid to the foetal and neonatal sheep. By W. M. F. LEAT, F. A. HARRISON and S. R. JUDGE, *ARC Institute of Animal Physiology, Babraham, Cambridge CB2 4AT*

At birth the plasma and tissue lipids of the lamb contain low concentrations of linoleic acid (C18:2) and a high ratio (>0·4), eicosatrienoic acid (C20:3): eicosatetraenoic acid (C20:4), which suggests that the transfer of linoleic acid across the placenta may be limiting the supply of essential fatty acids to the foetus (Leat, 1966).

We have now studied the transfer of [1-^{14}C]linoleic acid from the ewe to the foetus in four experiments in three Clun Forest ewes during late gestation. Catheters were inserted into the foetal and maternal circulations 10 d before experiment. 50 μCi [1-^{14}C]linoleic acid were infused continuously into the ewe for 2–3 h establishing a plateau of radioactivity of about 25 nCi/100 ml plasma (specific activity 90 nCi/mg C18:2). Samples of foetal plasma obtained at this time contained negligible radioactivity above background. The concentration of free fatty acids (FFA) in foetal plasma (<50 μEquiv./l) was, like the linoleic acid fraction of FFA (<1%), at the limit of accurate estimation.

One ewe lambed 5 h after the infusion of [1-^{14}C]linoleic acid, and the radioactivity in the plasma of the newborn lamb increased rapidly after suckling, particularly in the phospholipid fraction. Radioactivity in milk reached a maximum (0·2 μCi/100 ml) on day 2 *post partum* and declined over the next 20 days of lactation; 94% of the radioactivity was in milk triglycerides. Assuming an average daily secretion of 1500 ml milk it was calculated that more than 50% of the infused radioactivity could have been secreted in milk during the first month of lactation.

Analysis of the liver lipids of sheep foetuses of varying gestational age showed that low levels of C18:2 and high ratios, C20:3: C20:4 were apparent throughout foetal life (Table 1). Appreciable amounts of docosapentaenoic (C22:5) and docosahexaenoic acids (C22:6) were also present in foetal liver lipids which were provisionally identified as derivatives of α-linolenic acid (C18:3ω3).

It is concluded that transfer of linoleic acid via milk is quantitatively much more important than via the placenta.

Table 1. *Percentage polyunsaturated fatty acids in total liver lipids of sheep foetuses of varying gestational age*

Gestational age (d)	Fatty acid (% by wt)						
	18:2	18:3	20:3	20:4	22:5	22:6	C20:3: C20:4
45	1.0	0	5·5	5·7	n.d.	n.d.	0.96
62	0·8	0·1	4·7	5·2	3·6	8·0	0·90
93	1·0	0·3	2·9	7·9	4·2	8·9	0·37
132	0·8	0·6	0·3	4·9	5·2	7·6	0·61

n.d., not determined

Leat, W. M. F. (1966). *Biochem. J.* **98**, 598.

Overnutrition and hypervitaminosis A in the tree shrew ***(Lyongale tana).*** By J. P. W. RIVERS, F. D'SOUZA and C. M. HAWKEY, *Institute of Zoology, Zoological Society of London, Regent's Park, London NW1 4RY*

Although primatologists are generally aware of the risk of nutrient deficiencies in captive colonies of exotic species, the risks of over-feeding are not widely appreciated. Between September 1973 and February 1974, ten animals in two separate collections of the tree shrew, *Lyongale tana,* at the Zoological Society of London, died in an outbreak of disease, the clinical and pathological details of which suggest overnutrition as its cause.

Males and females, some of them imported and some bred in captivity died in the epizootic. The spatial and temporal distribution of deaths suggested that the cause was not an outbreak of infectious disease. All ten animals were in the normal weight range for field-caught animals, but had extensive subcutaneous and omental fat deposits. In four animals this fat was markedly orange-yellow in colour. In nine animals there was evidence of haemorrhage, and in six the extent or position of this suggested it could have been the cause of death. Blood counts performed just before death on two animals revealed a severe normochromic microcytic anaemia; platelets were numerous. Coagulation tests on two other animals showed grossly prolonged one-stage prothrombin times with markedly reduced levels of factors II and X relative to normal primate levels. Since factor V levels were normal, the results were compatible with a diagnosis of hypovitaminosis K. An investigation of what the animals had been fed revealed that dietary deficiency was unlikely since the calculated intakes of vitamin K were 2·5 mg/d (mostly as phylloquinone). However, vitamin A intakes were excessively high: the daily intake over the 2 years since the colony was founded was 6·5 mg retinol equivalent (RE) preformed vitamin A and 45 mg total carotenoids. Liver vitamin A was determined in post mortem samples from seven animals, elevated values, up to 29 mg RE/g, were found in six. Sufficient retinol and carotenoids were present in adipose tissue samples to account for the observed yellow discolouration. The diagnosis of hypervitaminosis A was confirmed when the only animal born during this period showed similar deformities to those described in rats overdosed with vitamin A (Moore, 1957). We concluded that, as has been shown in rats, overdosing with vitamin A blocked utilization of vitamin K and precipitated a secondary vitamin K deficiency.

Three factors led to the overdosage: the use of vitamin A-rich catfoods instead of meat, the addition of vitamin supplements providing vitamin A but not K, and the overconsumption by the animals of the diet (mean daily food intake was approximately 850 kJ/$W^{0.75}$).

A new colony of animals has been established and the level of vitamin A and the energy density of the diets fed have been limited. There has been no recurrence over 2 years of the symptoms described here. However, reports continue to reach us of analogous problems in primate colonies elsewhere.

Moore, T. (1957). *Vitamin A.* New York: Elsevier.

Gluconeogenesis from threonine in adult sheep. By J. L. MORTON[1], D. B. LINDSAY[2] and P. J. BUTTERY[1], [1]*Department of Applied Biochemistry and Nutrition, University of Nottingham School of Agriculture, Sutton Bonington, Loughborough, Leics LE12 5RD;* [2]*ARC Institute of Animal Physiology, Babraham, Cambridge CB2 4AT*

Gluconeogenesis from amino acids in the adult sheep has been examined previously, e.g. Wolff & Bergman (1972), and is generally assumed to play a relatively minor part in the total glucose turnover of the animal. Ash & Pogson (1977) reported that isolated sheep liver cells did not produce glucose at all from extracellular amino acids. However, an earlier report from this laboratory (Morton, Buttery & Lindsay, 1977) showed that isolated sheep liver cells increased their glucose production in response to extracellular amino acids, and that threonine was one of the more gluconeogenic of the amino acids tested. Subsequent experiments using 1 mM-[U-^{14}C]threonine specific activity (166 μCi/mmol) showed that during incubation approximately 0·09% of the label was incorporated into glucose/mg dry weight cells per h.

In order to estimate the importance of gluconeogenesis from threonine in vivo further experiments were undertaken. Three adult Clun wethers were given a daily ration of 1 kg grass nuts in hourly portions. 80 μCi [U-^{14}C]threonine were infused via a jugular catheter, and the specific activity of threonine and glucose in the plasma monitored over a 3 h infusion period. As a very low rate of incorporation was expected phloridzin was also infused continually at the rate of 1 mg/min. A preliminary experiment had shown that the infusion of phloridzin at this ratio caused a rapid and sustained release of glucose into the urine without seriously lowering the plasma glucose concentration.

During the infusion period the threonine specific activity approached a plateau, and rose to approximately 8 nCi/μmol after 3 h. The plasma glucose specific activity was very low during the infusion and the period immediately following, never rising above 22 pCi/μmol. Assuming that both of these figures are close to their plateau values these results would indicate that less than 1% of the available threonine is being converted into glucose.

Determination of the specific activities of threonine and glucose in the pooled urine over 24 h enabled a more accurate estimate of glucose production from threonine to be made. This showed that the flux of threonine through the sheep (total dose of threonine injected÷threonine specific activity in urine) was approximately 3·1 g/24 h which, when multiplied by the percentage of the label which appeared as glucose in the urine over 24 h (0·9%) gives the rate of threonine conversion to glucose as 0·02 g/24 h. In one sheep $^{14}CO_2$ output was recorded and results indicated that 20% of the label infused was recovered as CO_2.

J. L. M. acknowledges receipt of a SRC CASE Studentship.

Ash, R & Pogson, C. I. (1977). *Biochem. biophys. Acta* **496**, 475.
Morton, J. L., Buttery, P. J. & Lindsay, D. B. (1977). *Proc. Nutr. Soc.* **36**, 20A.
Wolff, J. E. & Bergmann E. N. (1972). *Am. J. Physiol.* **223**, 445.

Dietary manipulation of the composition of milk. By J. L. CLAPPERTON, MORAG E. KELLY and J. A. F. ROOK, *The Hannah Research Institute, Ayr KA6 5HL*

With the current medical concern regarding the high intake of saturated fat, there could be a market for specialized milks in which there was a lower proportion of fat rich in unsaturated acids and a high protein content. Feeding the cow a low fibre–flaked maize ration is known to cause the desired type of change in milk composition (Rook & Balch, 1961) and this ration was therefore used in the present work. Cracked, unextracted soya beans and protected soya-bean oil were offered in small amounts as supplements in order to investigate the possibility of mitigating the extreme decrease in fat content sometimes observed with this type of diet.

Four Ayrshire heifers in the third month of lactation were selected. After an initial period of 4 weeks during which they were offered a normal ration of long hay, molassed sugar beet pulp and dairy concentrates, they were gradually changed over a period of about 5 weeks onto a basal low-roughage ration of 48% cubed dried grass, 48% flaked maize and 4% soya-bean meal. During the next 12 weeks, a 4×4 Latin Square experiment was carried out in which the four diets used were basal low roughage, or additions of 1 or 2 kg cracked unextracted soya beans/d or 0·27 kg protected soya-bean meal containing 67% soya-bean oil/d. The diets were both isoenergetic and isonitrogenous. Finally, the animals were returned to the normal high-roughage diets for a further period of 4 weeks. The results are shown in the table.

	High roughage	Low roughage	SE
Conventional composition			
Milk fat (%)	4·08	2·30	0·25
Crude protein (%)	3·38	3·72	0·14
Lactose (%)	4·84	4·93	0·05
Fatty acid			
6:0 to 14:1	24·2	21·0	2·8
16:0+16:1	35·1	26·9	3·0
18:0	9·6	7·2	1·1
18:1	27·5	34·4	1·8
18:2+18:3	3·6	10·7	1·5

Relative to the high-roughage control, the dried grass–flaked maize diet produced the desired changes: decreased fat and increased protein. However, the addition of soya-bean oil, in the form of the cracked bean or as a protected, spray-dried powder, to the low-roughage diet did not affect the yield or composition of the milk fat. This difference from published results (Storry *et al.* 1974) is probably due to the small amount of supplemented oil fed in the present case. The proportion of (18:2+18:3) increased on feeding the low-roughage diet and the ratio, saturated:unsaturated acids decreased from approximately 2:1 in the high-roughage treatment to 1:1 in the low-roughage treatment.

Rook, J. A. F. & Balch, C. C. (1961). *Br. J. Nutr.* 15, 361.

Effect of abomasal infusions of casein, arginine, methionine or phenylalanine on growth hormone, insulin, prolactin, thyroxine and some metabolites in blood from lactating goats. By J. D. OLDHAM, I. C. HART and J. A. BINES, *National Institute for Research in Dairying, Shinfield, Reading RG2 9AT*

There have been many reports that abomasal infusions of casein can increase milk nutrient yield in ruminants (Clark, 1975). Sometimes it has been suggested that changes in release of hormones which stimulate milk production could account for part of the responses (Ranawana & Kellaway, 1977) but there is no direct evidence. The aim of this work was to measure changes which might occur in blood hormone and metabolite concentrations following short-term abomasal infusions of casein, arginine, methionine or phenylalanine in lactating goats.

Three British Saanen goats were used. Each was fitted with an abomasal catheter and jugular venous catheter for the experiment. They were fed 1·25 kg hay+1·25 kg concentrates/d (total 279 g crude protein (N×6·25) in 2·11 kg dry matter).

The treatments were: 24 h abomasal infusion of either L-arginine (5·7 mmol/h), DL-methionine (5·2 mmol/h), L-phenylalanine (5·4 mmol/h) or calcium caseinate (2·62 g/h). Blood samples were withdrawn hourly during the 8 h immediately before infusion (control period, C) and again during the last 8 h of infusion (treatment period, T). The samples were assayed for growth hormone (GH), insulin, prolactin, thyroxine (T_4), glucose, 3-hydroxybutyrate (3HBA), non-esterified fatty acids (NEFA) and urea.

		GH (ng/ml)	Insulin (μU/ml)	Prolactin (ng/ml)	T_4 (ng/ml)	Urea (mmol/l)	3HBA (mmol/l)	NEFA (mg/ml)	Glucose (mmol/l)
Arginine	C	13·4	25·0	708	40·5	4·8	0·38	159	3·6
	T	11·8	35·7	592	40·0	5·5	0·58***	125	3·6
Methionine	C	11·9	29·4	507	36·9	4·8	0·77	125	3·7
	T	9·5	23·6	464	33·2	5·7	0·59	175	3·6
Phenylalanine	C	10·1	20·2	520	25·2	5·8	0·58	175	3·9
	T	9·9	27·0	411	21·9	4·3	0·70	126	3·7
Casein	C	9·1	18·1	496	18·8	5·5	0·62	118	3·8
	T	14·0*	24·4	346	19·1	6·8	0·69	119	3·8

T differs significantly from C: *$P<0·05$, ***$P<0·001$.

Casein raised GH concentration ($P<0·05$), but had no significant effect on insulin or prolactin. Arginine prompted a big rise in 3HBA ($P<0·001$), but otherwise the amino acids caused only small changes. That phenylalanine was the only one to cause a drop in urea concentration may suggest it was limiting in this case.

These results suggest that part of the milk production responses reported for abomasal infusions of casein may be linked to changes in GH release but the stimulus for this has yet to be identified. Two possibilities are that there is a response to the influx of extra α-amino nitrogen or to an apparent energy deficit resulting from increased milk synthesis.

Clark, J. H. (1975). *J. Dairy Sci.* **58**, 1178.
Ranawana, S. S. E. & Kellaway, R. C. (1977). *Br. J. Nutr.* **37**, 67.

Effect of marginal protein malnutrition on repeated nematode infection of small intestine. By A. M. TOMKINS, K. MADI and B. M. OGILVIE, *Clinical Nutrition & Metabolism Unit, Hospital for Tropical Diseases, Department of Human Nutrition, London School of Hygiene & Tropical Medicine, and National Institute for Medical Research, Mill Hill, London*

Intestinal parasites are commonly associated with mucosal lesions, malabsorption and protein-energy malnutrition (PEM) among pre-school children in developing countries. However, it is difficult in clinical situations to ascribe a particular role to many intestinal parasites as they may be present within the intestine but unaccompanied by mucosal damage (Tomkins *et al.* 1976). It seems likely that intestinal lesions are, at least in part, the result of host self-cure rejection mechanisms mounted by immunocompetent cells within the mucosa (Ferguson & Jarrett, 1975). Such antigen-antibody interactions may be impaired by marginal PEM during initial infection (Tomkins *et al.* 1977) but the effects on subsequent infections are unknown.

Male Wistar rats were weaned on a cubed diet with NDPE 0·10 (control) or 0·068 (deficient) (Stewart *et al.* 1975). A mucosal lesion (measured by ocular micrometry and results expressed as villus:crypt ratio) developed 7 d after subcutaneous infection by 500 larvae of *Nippostrongylus brasiliensis* but significantly ($P<0·01$) less atrophy occurred in malnourished animals than controls (Table 1). A further infection given 14 d after the first resulted in a marked rejection response with a clearance of worms in controls, but this was less marked in the malnourished animals in whom mucosal lesions were also less marked ($P<0·05$).

Table 1.

		7 d after initial infection	7 d after second infection
Mucosal morphology (villus:crypt (V:C))	Controls	1·05± 0·26	2·9 ± 0·29
	Malnourished	1·89± 0·6	2·16± 0·27
Mast cell numbers (per 10 V:C units)	Controls	33·5 ± 9·8	410±62·4
	Malnourished	14·6±11·3	107±43·3

The second infection produced a significant increase in mucosal mast cell numbers ($P<0·01$) (Table 1) and circulating immunoglobulin E antibodies were demonstrable in control animals but marked impairment of these increases occurred in the malnourished animals. This suggests that marginal PEM produces a decrease in immunological rejection mechanisms impairing worm clearance. It may also limit the mucosal damage produced in response to the parasite.

Ferguson, A. & Jarrett, E. E. (1975). *Gut* **16**, 114.
Stewart, R. J. C., Preece, R. F. & Sheppard, H. G. (1975). *Br. J. Nutr.* **33**, 233.
Tomkins, A. M., Madi, K. & Ogilvie, B. M. (1977). *Gut* (In the Press).
Tomkins, A. M., Wright, S. G., Drasar, B. S. & James, W. P. T. (1976). *Gut* **17**, 397.

Physiological effects of a high soya-bean protein diet in man. By P. VAN STRATUM, M. RUDRUM and F. TEN HOOR, *Unilever Research, Vlaardingen, The Netherlands* and R. WILSON, *Unilever Research, Colworth, England* and N. A. PIKAAR, *Central Institute for Nutrition and Food Research, TNO, Zeist, The Netherlands*

Although edible soya-bean protein has been available for many years, the physiological consequences of eating a daily diet rich in soya-bean protein are not fully known. Therefore, we performed an experiment giving maximum chance for detecting effects from a 4-week load of soya-bean protein materials in a normal Dutch diet under normal living conditions.

One group of forty-six healthy volunteers received a test diet, in which a wide variety of refined soya-bean protein products replaced 25% of the conventional proteins. A second group of forty-six subjects was given the control diet, i.e. the same menu, but prepared with conventional proteins only. After 4 weeks both groups changed diets, and another 4-week dietary period started. Blood, urine and faeces were analysed at the end of each dietary period, and general health was monitored throughout.

Most of the more than one hundred factors investigated did not show any systematic change. All statistically significant changes were small and well within normal limits. In conclusion, no major physiological effects are to be expected from the introduction of novel soya-bean protein materials into a normal diet. This confirms the prevailing view that soya-bean protein materials are acceptable ingredients in our daily food.

Effect of casein compared with soya-bean protein isolate on plasma cholesterol in the rabbit. By ELIZABETH A. BELTON and A. S. TRUSWELL, *Department of Nutrition, Queen Elizabeth College, London W8 7AH*

Dietary protein has not been generally regarded as an important influence on plasma cholesterol in man, although Sirtori *et al.* (1977) reported that a textured soya-bean protein had a cholesterol-lowering effect in patients with Type II hyperlipidaemia. In rabbits, fed on cholesterol-free, semi-synthetic diets, Carroll & Hamilton (1975) found that plasma cholesterols were higher when the defatted protein came from various animal sources.

In an attempt to confirm these interesting findings, two groups of 14-week-old male New Zealand White rabbits were fed *ad lib.* for 28 d on isonitrogenous (26% crude protein–energy, isoenergetic (15·4 MJ/kg), low fat, low cholesterol, semi-synthetic diets. The dietary variable, protein, was given either as sodium caseinate (Casumen) or soya-bean protein isolate (Purina Protein 610) and mixed into the basal diet which contained (g/kg): glucose 600, cellulose (Solka-floc) 50, corn oil 10, together with vitamin and mineral mixtures.

Both groups gained weight, the casein group more slowly with smaller food intake. Non-fasting blood samples were taken before gradual introduction of the diets and again on days 14 and 28 of the full experimental diets. Plasma cholesterol results, determined by an enzymatic-colorimetric method (Boehringer Mannheim) are shown in the table.

Plasma total cholesterol levels (mmol/l)

(Mean values with the range in parentheses)

	Casein (*n* 8)	Soya-bean protein isolate (*n* 9)
before	1·30 (0·67–1·81)	1·66 (1·24–1·99)
after	3·03 (2·18–5·18)	1·86 (0·88–5·67)

Plasma cholesterol levels rose in all the casein-fed animals (P=0·002). They fell in seven of the rabbits eating soya-bean protein isolate but not in the two in this group that became ill. Our results confirm Carroll & Hamilton's (1975) report. A cholesterol-elevating effect of casein in rabbits (not fed cholesterol) was clearly demonstrated as early as 1941 (Meeker & Kesten, 1941). This phenomenon deserves re-examination in a variety of species, including man.

The soya-bean protein isolate was kindly supplied by McAuley Edwards Ltd, Baldock, Herts.

Carroll, K. K. & Hamilton, R. M. G. (1975). *J. Fd. Sci.* **40**, 18.
Meeker, D. R. & Kesten, H. D. (1941). *Archs. Path.* **31**, 147.
Sirtori, C. R., Agradi, E., Conti, F., Mantero, O. & Gatti, E. (1977). *Lancet* **i**, 275.

Dietary fibre and asymptomatic diverticular disease of the colon. By J. S. S. GEAR, A. C. WARE, D. J. NOLAN, P. S. FURSDON, A. J. M. BRODRIBB and J. I. MANN, *Department of Social and Community Medicine, University of Oxford; Departments of Radiology and General Surgery, Radcliffe Infirmary, Oxford*

The hypothesis that dietary fibre intake protects against the development of many Western diseases, for example, ischaemic heart disease, varicose veins, obesity and disorders of the large bowel, is based on the paucity of such cases in rural communities of the Third World. The diets in these societies are rich in roughage (Trowell *et al.* 1974).

In this study three groups of 45–70 year old people, volunteers from local industry, long-standing members of the Vegetarian Society of the United Kingdom and those on a central Oxford general practice register, have been investigated for asymptomatic diverticular disease of the colon in relation to dietary fibre consumption. Only asymptomatic people were accepted, as the onset of bowel symptoms may produce a change in diet.

After each subject had completed a self-administered postal 'fibre questionnaire' a barium follow through was performed. A subsample were also interviewed by a nutritionist or doctor to expand upon and validate the information obtained from the first questionnaire. Dietary fibre intake was calculated from fibre tables (Southgate *et al.* 1976).

The mean total dietary fibre consumption in the general practice group was 19 g fibre/d and in the vegetarians 31 g fibre/d. The two groups also had a different prevalence of diverticular disease, 32% (76/235) in the general practice population and only 13% (6/46) in the vegetarians ($P<0.02$).

These two observations suggest that dietary fibre may be important prophylactically as well as therapeutically in diverticular disease. However, when positive and negative individuals were paired matching for age, sex and population source (i.e. vegetarian female with female) there was no difference in the dietary fibre intake of cases and controls. This was based on the analysis of 61 pairs.

The most feasible explanation for this finding is that all members of the general practice and volunteer populations, who contributed 55 of the 61 pairs, eat too little fibre for a protective effect to be observed. In fact, they may all be susceptible to the condition. Another possible explanation is that some factor other than dietary fibre is responsible for the lower prevalence in the vegetarians.

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Trowell, H. C., Painter, N. S. & Burkitt, D. P. (1974). *Am. J. Dig. Dis.* **19**, 864.

The effect of dietary lipid supplementation on digestion and synthesis in the stomach of sheep. By R. KNIGHT, J. D. SUTTON, A. B. MCALLAN and R. H. SMITH, *National Institute for Research in Dairying, Shinfield, Reading RG2 9AT*

In an experiment designed to examine the effects of dietary lipid supplementation on lipid digestion in the sheep (Knight *et al.* 1977) the effects of the supplements on digestion and microbial protein synthesis in the stomach were also investigated.

Five sheep, fitted with rumen and re-entrant duodenal cannulas were given a basal ration of 200 g hay and 400 g concentrates daily, providing 5·6 MJ metabolizable energy and 11·28 g nitrogen/d, alone or with supplements of 40 g/d of linseed oil (LSO) or coconut oil (CCO), either protected or unprotected. Flow of duodenal digesta was measured by spot sampling using chromic oxide paper as the marker. Samples of rumen fluid taken 0, 3 and 5 h post-feeding were centrifuged to yield a bacterial preparation. Some results are given in the table:

	Basal	LSO	Protected LSO	CCO	Protected CCO
Proportion of organic matter digested (DOM): total	0·76	0·73	0·76	0·72	0·76
Proportion of DOM digested in stomach: Apparent	0·63	0·40	0·50	0·40	0·58
True	0·82	0·71	0·72	0·68	0·76
N flow to duodenum (g/24 h)	15·41	18·81	16·50	19·90	14·68
Microbial N:					
Flow to duodenum (g/24 h)	7·07	12·75	9·18	11·38	8·42
g/kg Apparent DOM stomach	30	85	46	74	37
g/kg True DOM stomach	23	46	31	31	37

With free oil supplementation the proportion of organic matter (OM) apparently digested in the stomach was depressed by about 40% due mainly to the intestinal absorption of the oil supplements and a large shift in the digestion of fibre from the stomach to the intestines. Differences between treatments in OM digested in the stomach were less when based on true digestion than apparent digestion because of increased microbial OM flow on the supplemented diets. With free oil supplementation the flow of microbial N to the duodenum and the efficiency of microbial protein synthesis were considerably increased possibly due to the large reduction in rumen protozoal numbers caused by the oil supplements. Protection of the oils reduced the effects on OM digestion and protein synthesis in the rumen. Values for microbial synthesis in the table were based on the use of diaminopimelic acid (DAPA) as the microbial marker, they were similar to values based on RNA, but with greater differences between treatments when the oil supplements were given, probably because of differences in the protozoal contribution.

R.K. acknowledges receipt of an ARC studentship.

Knight, R., Sutton, J. D. & Storry, J. E. (1977). *Proc. Nutr. Soc.* 36, 71A.

The contribution of threonine to the glucose economy of hill sheep. By A. R. EGAN, *The Waite Agricultural Research Institute, University of Adelaide, South Australia* and J. C. MACRAE, *Hill Farming Research Organisation, Bush Estate, Penicuik, Midlothian EH26 0PY*

Threonine, a significant contributor to glucose production by isolated liver cells from sheep (Morton *et al.* 1977), is probably, after methionine, the second most limiting essential amino acid (EAA) for protein synthesis in the whole animal. It was considered possible, therefore, that threonine might provide a useful metabolite through which to evaluate the relative importance of EAA in protein synthesis of gluconeogenesis and energy metabolism during pregnancy and lactation in hill ewes.

A simple three pool model calculated from the irreversible losses (IL) and transfers of ^{14}C label between plasma, threonine-, glucose- and CO_2-C in four Scottish Blackface wethers given 650 g dry matter/d of freeze-stored *Agrostis festuca* by continuous feeders is given in Fig. 1 (*a*). Compared with considerable metabolism of glucose-C to CO_2 and fixation of CO_2-C back into glucose, there was very little appearance of threonine-C in glucose. However, appearance of threonine-C in CO_2 was greater (10% of IL of threonine), indicating some catabolism of EAA.

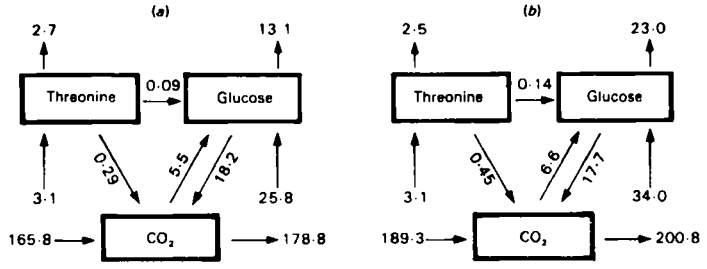

Fig. 1. Transfers (g C/d) of plasma threonine-, glucose- and CO_2-C in sheep given *Agrostis festuca* (650 g DM/d) (*a*) before and (*b*) during infusions of phloridzin (20 mg/h).

In order to impose a 'glucose sink' on the non-pregnant, non-lactating animals used in the experiment, infusions of phloridzin (20 mg/h) (to block resorption of glucose across the kidney tubules) were made immediately following the measurements used for Fig. 1 (*a*). The effects of phloridzin can be seen in Fig. 1 (*b*). The infusion caused a urinary excretion of 22–28 g glucose/24 h and stimulated increases in the IL of both glucose (30%) and CO_2 (13%). Although transfer of threonine-C into glucose increased by 50%, the rate was still slow. Appearance of threonine-C in CO_2 increased by 56%, to 15% of the IL of threonine. If threonine was a limiting amino acid in these animals, this catabolism could impair protein synthesis by as much as 30–40 g/d.

The low appearance of threonine-C in glucose relative to CO_2 probably indicates that threonine (and possible other EAA) entering the TCA cycle does not contribute in any direct major way to net glucose synthesis, but does spare from oxidation equivalent amounts of TCA intermediates otherwise derived from glucose or its precursors.

Morton, J. L., Buttery, P. J. & Lindsay, D. B. (1977). *Proc. Nutr. Soc.* **36**, 20A.

Microbial and host-animal components of energy metabolism in hill sheep. By J. C. MACRAE, S. WILSON and J. A. MILNE, *Hill Farming Research Organisation Bush Estate, Penicuik, Midlothian EH26 0PY*

In recent studies on the nutritive value of poor quality *Agrostis Festuca* herbage an attempt was made to partition energy-yielding processes into those occurring in the rumen and those associated with metabolism of absorbed nutrients and endogenous substrates (MacRae *et al.* 1976). However, in the light of recently identified technical inaccuracies associated with the radioassay of $NaH^{14}CO_3$ and $Ba^{14}CO_3$ (MacRae & Wilson, 1977) revised results are presented in Fig. 1, which includes additional observations from other animals prepared with caecal cannulas (MacRae *et al.* 1973) to incorporate a third pool of caecal bicarbonate into the model. Results were obtained in a three-phase experiment in which $NaH^{14}CO_3$ was continuously infused for 20 h into (a) the rumen, (b) the jugular vein and (c) the caecum of four sheep. Bicarbonate-C radiospecific activities were measured over the 12–20 h 'plateau periods' in the primary (infused) and in both secondary metabolite pools. The results shown in Fig. 1 were then calculated as described in the appendix to Nolan *et al.* (1976).

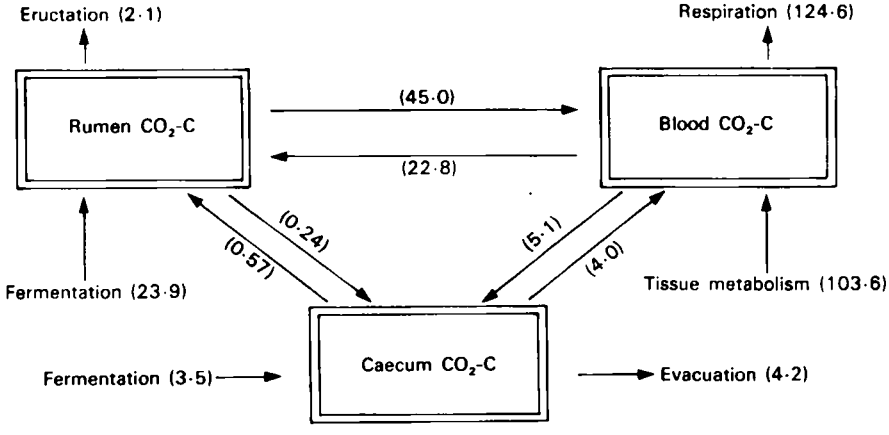

Fig. 1. A three-pool model illustrating the movement of bicarbonate-C (g/24 h) in sheep given *Agrostis-Festuca* herbage (450 g OM/d).

Digestive tract fermentation and host-animal metabolism contributed 21 and 79% respectively to the over-all CO_2 production of the sheep (246 l/d). The technique of compartmental modelling of CO_2 kinetics provides a means of evaluating the contributions of the numerous constituent reactions involved in over-all host-animal energy metabolism. In addition it provides information on rumen and caecal fermentation CO_2 productions which together with volatile fatty acid and methane productions and the amounts of hexose digested in the respective organs allows a critical evaluation of the stoicheiometry of fermentation.

MacRae, J. C., Reid, C. S. W., Dellow, D. W. & Wyburn, R. S. (1973). *Res. Vet. Sci.* **14**, 78.
MacRae, J. C. & Wilson, S. (1978). *Int. J. Appl. Radiat. Isotopes* (In the Press).
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A new approach to the question of the cause of differences between high-concentrate and high-forage diets in the efficiency of utilization of metabolizable energy for fattening. By M. R. STOKES* and P. C. THOMAS, *The Hannah Research Institute, Ayr KA6 5HL*

There are a large number of experiments to describe the effects of diet on the composition of the mixture of end-products of digestion in the sheep and to determine the calorimetric efficiency of utilization of individual end-products given in the diet or as enteral infusions (Thomas & Rook, 1977). Nonetheless there is no clear explanation for the increase between high-forage and high-concentrate diets in the efficiency of utilization of metabolizable energy (ME) for fattening (k_f)

An experiment was therefore conducted with four diets designed to provide a wide range of ratios, starch:fibre and to limit differences between diets in the passage of unfermented dietary protein and lipid to the small intestine. The diets contained ground barley straw, maize starch and molasses in proportions 80:10:10; 60:30:10; 40:50:10 and 20:70:10. Urea (29 g/kg) and sodium caseinate (42–55 g/kg) were added to make the diets 13·8% crude protein (nitrogen × 6·25) together with soya-bean oil (35 g/kg), minerals, trace nutrients and vitamins (94 g/kg).

In the first part of the experiment, the ME contents and k_f values for the diets were estimated in two mature rumen-cannulated wether sheep using a respiration chamber (Wainman & Blaxter, 1958). Both ME and k_f increased linearly with the proportion of starch in the diet and there was a significant relationship (r v 0·77; $P<0·01$) between k_f and the metabolizability (Q) of the gross energy.

At the same time, determination (n 3) were made for each diet of the digestion of gross energy, α-linked glucose polymers, total lipid and total and ammonia nitrogen in the rumen, small intestine and caecum and colon using sheep fitted with ruminal cannulae and simple cannulae in the duodenum and terminal ileum. Chromic oxide was used as an indigestible marker. Rumen fluid was analysed for short-chain fatty acids. Using the results of these determinations and those for methane production (part 1) the contribution of acetic acid, propionic acid, butyric acid, glucose, lipid and protein to the digested energy was calculated. For only two substrates, glucose and butyric acid did the proportion in the digested energy increase systematically with Q, and thus k_f.

There is indirect evidence from other experiments that k_f is not dependent on the proportion of butyric acid absorbed (Nicholson & Sutton, 1969). Thus the results indicate that the increase in k_f between the high-forage and high-concentrate diets studied here was linked with an enhanced uptake of glucose from the small intestine.

Nicholson, J. W. G. & Sutton, J. D. (1969). *Br. J. Nutr.* **23**, 585.
Thomas, P. C. & Rook, J. A. F. (1977). *Proc. 11th Univ. Notts Feed Man. Conf.* (In the Press).
Wainman, F. W. & Blaxter, K. L. (1958). *Proc. 1st Symp. on Energy Met.* EAAP Publ. No. 8, p. 85.

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The inadequacy of urinary 3-methylhistidine excretion as an index of muscle protein degradations in the pig. By G. MILNE and C. I. HARRIS (Introduced by G. E. LOBLEY), *Rowett Research Institute, Bucksburn, Aberdeen AB2 9SB*

The amino acid 3-methylhistidine occurs only in the myosin and actin of the total muscle protein. It is not reutilized during protein turnover and in rat, man and the adult rabbit it is rapidly and quantitatively excreted in the urine (Harris *et al.* 1977). In these species, determination of the urinary excretion of 3-methylhistidine provides a non-destructive measure of in vivo muscle protein degradation. However, this method may not be generally applicable since Harris & Milne (1977) have shown that it is not valid for sheep. This work describes similar studies with pigs.

Intravenous injections of 3-[Me-^{14}C]methylhistidine in 25–60 kg male pigs [Large White×(Land Race×Large White)] and subsequent quantitative collections of urine resulted in recoveries of less than 25% of the radioactivity in 7 d. Although the muscle pool of free 3-methylhistidine appeared low (approximately 10 nmol/g), acid hydrolysis of perchloric acid extracts of muscle resulted in an enormous increase in free 3-methylhistidine (up to 10 μmol 3-methylhistidine/g muscle). The magnitude of the increase was greater in older pigs. Levels of 3-methylhistidine in blood did not change appreciably after hydrolysis.

An animal (33 kg) slaughtered 10 d after injection of 3-methylhistidine had significant levels of radioactivity in perchloric acid extracts of muscle. Ion-exchange chromatography of these extracts showed that 99·4% of the total radioactivity was associated with a single component which appeared chromatographically similar to the unidentified component reported to occur in sheep muscle (Harris & Milne, 1977). Rangley & Lawrie (1976) have also reported that 3-methylhistidine occurs in pig muscle as a non-protein bound component which they identified as a dipeptide and which increased in concentration with age.

A 27 kg pig injected with radioactive 3-methylhistidine excreted 7–8 μmol 3-methylhistidine/d in urine, equivalent to a fractional degradation rate of 0·07%/d (assuming protein-bound 3-methylhistidine = 1 μmol/g muscle and muscle tissue = 0·4×body mass). Less than half the radioactivity excreted was as 3-methylhistidine, showing that metabolism of 3-methylhistidine was extensive. The large body pool of non-protein 3-methylhistidine which increased with age and the extensive metabolism of administered 3-methylhistidine suggests that urinary excretion of 3-methylhistidine cannot be used to quantitate muscle protein degradation in the pig.

Harris, C. I., Milne, G., Lobley, G. E. & Nicholas, G. A. (1977). *Biochem. Soc. Trans.* **5**, 706.
Harris, C. I. & Milne, G. (1977). *Proc. Nutr. Soc.* **36**, 138A.
Rangley, W. R. D. & Lawrie, R. A. (1976). *J. Fd Technol.* **11**, 143.

Muscle growth and protein turnover in a fast growing rat strain. By P. C. BATES and D. J. MILLWARD, *Clinical Nutrition & Metabolism Unit, Department of Human Nutrition, London School of Hygiene & Tropical Medicine, 4 St Pancras Way, London NW1 2PE*

Measurements of developmental changes in muscle protein turnover in a hooded rat strain showed a clear positive correlation between the growth rate of skeletal muscle protein mass and the rate of protein breakdown (Millward *et al.* 1975). Because rates of muscle protein breakdown are increased in several conditions when muscle growth is accelerated, we have argued that increased protein breakdown might be a necessary accompaniment to muscle growth. We have now extended these studies to include a fast growing albino strain (CFY). Measurement of rates of protein synthesis and breakdown throughout development (by means of the [^{14}C]tyrosine constant-infusion technique: (Garlick *et al.* 1974; Millward *et al.* 1975) show that (Table 1) although there are developmental changes in protein turnover in muscle, in this strain the relationship between growth rate and protein breakdown rate is less obvious.

Table 1. *Developmental changes in muscle protein metabolism in CFY rats*

(All values are means and standard deviations of 4–6 determinations)

Age (d)	Body-wt (g)	Protein synthesis (%/d)	RNA activity (g protein synthesis/d per g RNA)	Protein breakdown (%/d)
25	75 (3)	15·6 (1·3)	12·6 (1·3)	9·8 (0·9)
32	129 (10)	15·2 (2·9)	14·7 (2·2)	9·5 (2·7)
52	289 (19)	7·3 (0·6)	10·1 (0·65)	4·4 (0·6)
101	546 (45)	5·2 (0·5)	11·6 (1·3)	4·1 (0·5)
320	716 (59)	4·5 (0·1)	10·9 (1·5)	4·5 (0·01)

In particular, the breakdown rate in the youngest, rapidly growing, rats is less than half the value observed at the same age in hooded rats (described previously in Millward *et al.* 1975). In addition the breakdown rate had fallen to the adult maintenance rate at 52 d of age even though these rats were still growing at 3%/d. Possible rationales for this strain difference in the relationship between muscle growth and protein breakdown during normal development were discussed.

Garlick, P. J., Millward, D. J. & James, W. P. T. (1974). *Biochem. J.* **136**, 935.
Millward, D. J., Garlick, P. J., Stewart, R. J. C., Nnanyelugo, D. O. & Waterlow, J. C. (1975). *Biochem. J.* **150**, 235.

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Protein synthesis in lean and obese Zucker rats. By G. E. LOBLEY, A. J. F. WEBSTER and P. J. REEDS, *Rowett Research Institute, Bucksburn, Aberdeen AB2 9SB*

If congenitally obese (fatty) Zucker rats are restricted during growth to a food intake the same as that of their lean siblings (two-thirds of which may be presumed to be heterozygous with respect to the Fa gene), rats of the fat phenotype deposit less protein/d than their lean counterparts. This paper reports a study of protein metabolism in fatty and lean rats of 200 g body-weight which had been received from weaning either 14 (low) or 18·4 (high) g/d of a highly digestible semi-synthetic diet (Pullar & Webster, 1977).

Male animals were infused via the tail vein with either L-[side-chain 2,3-^{3}H]tyrosine or L-[U-^{14}]tyrosine or L-[1-^{14}C]leucine for periods of 5 or 6 h. The fractional rate of protein synthesis (FSR) was determined as described by Nicholas *et al.* (1977) in muscle, skin, intestine and liver, which together account for over 85% of body protein. FSR was calculated from the ratio of protein bound specific radioactivity (SR) to either intracellular ($k_{s,i}$) or plasma ($k_{s,p}$) free amino acid SR. For each tissue total protein synthesis was derived from FSR×tissue protein content and whole-body synthesis ($A_{s,i}$ or $A_{s,p}$ g/d) from the sum of these for the four tissues.

Mean values for FSR ($k_{s,i}$/d) are shown below:

	Muscle	Liver	Gut	Skin
Fatty rats: low	0·058	0·41	2·24	0·165
high	0·080	0·40	1·59	0·334
Lean rats: low	0·051	0·56	1·37	0·298
high	0·069	0·66	2·10	0·211

Phenotypic differences in $k_{s,i}$ were significant ($P<0·01$) only for liver. Differences with food intake were significant ($P<0·001$) for muscle alone. Values for the gut were extremely variable.

There was a marked difference between phenotypes in derived $A_{s,i}$ values. These were $6·42\pm1$ and $10·98\pm1·2$ g/d for fatty and lean rats respectively, corresponding to fractional synthesis rates for the whole body of 0·225 and 0·223/d. The corresponding $A_{s,p}$ values were 3·15 and 3·21. Values for whole-body protein synthesis based on the plasma flux of leucine and the rate of leucine oxidation were in good agreement with $A_{s,i}$ but not with $A_{s,p}$.

The results suggest that the low protein deposition of the fatty Zucker rat is not due to a decrease in the fractional rate of protein synthesis.

Nicholas, G. A., Lobley, G. E. & Harris, C. I. (1977). *Br. J. Nutr.* **38**, 1.
Pullar, J. D. & Webster, A. J. F. (1977). *Br. J. Nutr.* **37**, 355.

Protein mass, protein synthesis and heat loss in the Zucker rat. By A. J. F. WEBSTER, G. LOBLEY, P. J. REEDS and J. D. PULLAR, *Rowett Research Institute, Bucksburn, Aberdeen AB2 9SB*

Measurements made of energy and nitrogen retention in congenitally obese (fatty) and lean Zucker rats were used by Pullar & Webster (1977) to calculate increments of heat loss associated with net protein and fat deposition. The efficiencies of utilization of metabolizable energy for protein and fat deposition were 0·44 and 0·74 respectively. There remained, however, large residual differences in heat loss between the two phenotypes which correlated with the protein content of the body but might be attributed, in part, to differences in total protein synthesis.

In the present study, estimates of total protein synthesis have been compared with measurements made of total heat loss (Pullar & Webster, 1977) for fatty and lean rats at 200 and 350 g body-weight and given 14·0 or 18·4 g/d of a highly digestible diet. Total body protein synthesis was estimated as described in the previous paper (Lobley *et al.* 1978).

Estimates of total protein synthesis varied from 6·4 g/d for fatty rats at 200 g to 13·4 g/d for lean rats at 350 g body-weight. The mean ratios of protein synthesis to heat loss were 0·046 and 0·055 g/kJ for fatty and lean rats respectively. These values are very close to those reported by Garlick *et al.* (1976) for rats, pigs and humans.

There was, for all rats, a close correlation (r^2 0·90) between heat loss (H, kJ/d) and protein synthesis ($A_{s,i}$, g/d). The regression equation relating the two was

$$H = 11{\cdot}77\,A_{s,i} + 71{\cdot}9 \quad \text{SE of } b = \pm 1{\cdot}51.$$

The correlation between H and body protein mass was markedly lower (r^2 0·72) and that between H and body-weight lower still (r^2 0·59).

Although this close association between protein synthesis and heat loss does not reveal the true energy cost of total protein synthesis, it appears that protein synthesis and those aspects of metabolism associated with it probably account for about 50% of heat production; this is much higher than the value of 17% suggested by Garlick *et al.* (1976) for protein synthesis alone.

Garlick, P. J., Burk, T. L. & Swick, R. W. (1976). *Am. J. Physiol.* **230**, 1108.
Lobley, G. E., Webster, A. J. F. & Reeds, P. J. (1978). *Proc. Nutr. Soc.* **37**, 000.
Pullar, J. D. & Webster, A. J. F. (1977). *Br. J. Nutr.* **37**, 355.

Whole-body protein turnover in obese subjects given a low-energy diet.

By P. J. GARLICK, G. A. CLUGSTON and J. C. WATERLOW, *Department of Human Nutrition, London School of Hygiene & Tropical Medicine, Keppel Street, London WC1E 7HT*

Sender *et al* (1975) measured the rate of whole-body protein turnover in obese human subjects by constant infusion of [U-^{14}C]tyrosine. They showed that after 3 weeks on a diet containing 1·25 MJ/d as carbohydrate, but lacking protein, the rate of protein turnover was reduced by half. We have extended this work by comparing the effects of two weight-reducing diets, both containing 2·1 MJ/d, one including 50 g protein/d (diet P) and the other containing no protein (diet O).

Obese subjects were admitted to the ward and given a normal diet containing 8·4 MJ and 70 g protein/d for 3 d, after which whole-body protein turnover was measured by constant infusion of [1-^{14}C]leucine (O'Keefe *et al.* 1974). A weight-reducing diet (diet P or diet O) was then given for 3 weeks, after which protein turnover was again measured. In a different group of subjects protein turnover was also measured by hourly oral administration of [^{15}N]glycine accompanied by measurements of ^{15}N abundance in urinary NH_3 (Waterlow *et al.* 1977). Both methods of measurement showed little change with diet P and a large decrease in protein synthesis when diet O was given (see table).

Whole-body protein synthesis (Z) and nitrogen excretion (E) in obese patients given low energy diets for 3 weeks

(Rate after 3 weeks on low energy diet as a percentage of rate on normal diet ±SEM. Number of subjects in parentheses).

	Z	*E*
From [1-^{14}C]leucine		
Diet P (5)	86·8±3·1	89·4±18·8*
Diet O (4)	62·0±5·6	19·0± 2·5*
From [^{15}N]glycine		
Diet P (3)	104·0±6·4	98·3±19·9
Diet O (4)	61·0±8·0	27·0± 5·8

*Estimated from leucine oxidation rate.

The effects of the two diets on protein turnover could also be detected when the [^{15}N]glycine was given as a single oral dose (Waterlow *et al.* 1977). In several subjects given diet O this technique was repeated at 3 d intervals and a decrease in protein synthesis was demonstrated within the first 3 d.

O'Keefe, S. J. D., Sender, P. M. & James, W. P. T. (1974). *Lancet* ii, 1035.
Sender, P. M., James, W. P. T. & Garlick, P. J. (1975). In *Energy Regulation in Man.* [E. Jequier, editor]. Geneva: Editions Medicine & Hygiene.
Waterlow, J. C., Golden, M. H. N. & Ell, M. S. (1977). *Proc. Nutr. Soc.* **36**, 34A

Pectin and gastric emptying in the dumping syndrome. By A. R. LEEDS[1,2], D. N. RALPHS[3], P. BOULOS[3], F. EBIED[3], G. METZ[2], J. B. DILAWARI[2], A. ELLIOTT[4] and D. J. A. JENKINS[2], [1]*Heinz Research Fellow, Department of Nutrition, Queen Elizabeth College, London W8*; [2]*MRC Gastroenterology Unit, Central Middlesex Hospital, London NW10*; [3]*Department of Surgical Studies,* and [4]*Department of Nuclear Medicine, The Middlesex Hospital, London W1*

Pectin, a partially methoxylated polymer of galacturonic acid has been shown to decrease post-prandial glycaemia after a carbohydrate meal in normal volunteers and diabetic subjects, and to prevent rebound hypoglycaemia after a glucose drink in patients with the dumping syndrome.

In this study six patients, presenting with the dumping syndrome after gastric surgery were studied on 2 d after overnight fasts. Five patients had blood samples taken, all by means of an indwelling venous catheter, and all six patients were semi-recumbent in a dental chair throughout the tests. After two initial blood samples each patient was given a control drink containing 75 g glucose and 150 ml water labelled with 1·5 mCi ^{113}Indium (viscosity: 3·0 cP) or a test drink of the same composition but with 10·5 g high-methoxy pectin added (viscosity: 3000 cP). Further blood samples were taken at 10, 20, 30, 40, 60, 90 and 120 min and were analysed for haematocrit and blood glucose. Gastric emptying was followed by means of a dynamic study on a Nuclear Enterprises Mk V HR gamma camera connected on-line to a Varian computer system. Plasma volume changes were calculated from the haematrocrit results.

Five of the six patients had symptoms after the control meal but these did not occur or were less severe after the pectin meal. The maximum fall of plasma volume was 12±2·4% (mean±SEM) after the control meal and 5±1·6% after the pectin meal ($P<0·002$, n 5). Blood glucose levels at 30 min were 10·1±0·45 mmol/l (control) and 7·8±0·39 mmol/l (pectin) ($P<0·05$, n 5) and at 120 min were 4·1±0·71 mmol/l (control) and 5·7±1·18 mmol/l (pectin). In the five patients in whom gastric emptying was demonstrated to be prolonged the stomach count 20 min after the peak count was 38±7·2% of peak count (control) and 73±5·3% of peak count (pectin) ($P<0·025$). In one patient who had symptomatic improvement, reduction of plasma volume changes and no hypoglycaemia after pectin there was only a minimal change of gastric emptying.

We conclude that pectin slows rapid gastric emptying but such retardation is not essential for prevention of rebound hypoglycaemia. This suggests that changes of gastric emptying are not the only factor responsible for the previously reported effects of pectin and guar gum on postprandial glycaemia. This is supported by the lack of correlation between gastric emptying and postprandial rise of blood glucose in similar studies with pectin in normal volunteers.

Professors L. P. LeQuesne and M. Hobsley kindly allowed their patients to be studied, Dr F. Bonmartini and Mr K. W. Titchell of Hercules Europe S.A. provided the pectin and H. Catlow and M. J. Ellis of H. J. Heinz Co. Ltd made the viscosity measurements.

Some metabolic effects of ingesting galactose, before and after a high-lactose diet. By TANIA PHILLIPS, I. MACDONALD and ANNE KEYSER, *Physiology Department, Guy's Hospital Medical School, London SE1*

From previous studies it seemed that serum glucose levels following a lactose tolerance test were higher after a subject had consumed, for 2 weeks, 2 pints milk/d while on a normal diet. In view of this, eleven students were given, for 2 weeks, 1 g lactose/kg body-weight daily added to their usual diet, and before and at the end of this period the following tolerance tests were carried out: 1 g lactose/kg body-weight, 0·5 g glucose and 0·5 g galactose/kg body-weight, or 0·5 g galactose/kg body-weight, all made up with 4 ml water/kg body-weight. Following an overnight fast venous blood samples were taken at 0, 15, 30, 60 and 90 min after ingestion, and the glucose, galactose, insulin, uric acid and lactate concentrations in each sample determined.

The results did not support those of the preliminary studies carried out with milk, but did confirm that serum galactose levels are much higher when glucose does not accompany ingested galactose (Stenstam, 1946). Conversely, glucose absorption does not apear to be affected by the presence of galactose. Unlike glucose, galactose raises serum levels of uric acid and lactate.

The addition of lactose to the diet lowered the serum glucose response to galactose and tended to raise the serum galactose response. The fasting serum triglyceride level was higher after the addition of lactose to the diet.

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Stenstam, T. (1946). *Acta Med. scand.* 125, suppl. 177.

Effects of dietary carbohydrate on intellectual performance. By G. G. BIRCH, N. D. COWELL and G. A. CHARLES (introduced by I. MACDONALD), *National College of Food Technology, University of Reading, St. George's Avenue, Weybridge, Surrey*

Dietary carbohydrates of different chemical structure are known (Brooke, 1973) to influence work output in different ways in human subjects and some of these differences have been ascribed to effects on the central nervous system. Previous reports from this laboratory (Birch, 1974; Birch & Etheridge, 1976) have described improved intellectual performance, measured by standard intelligence tests, in subjects who have ingested glucose-syrup fractions. Since the results did not rule out the possibility that the different chemical structures of the glucose-syrup fractions might affect the subjects' performance, further work along the same lines has now been carried out.

In six separate experiments a number (of the order of twenty) of human volunteers of comparable age and educational status were divided into three equal groups. After fasting at least 3 h before the experiment the individuals in each group consumed 50 g high- or low-molecular-weight glucose-syrup fraction in 200 ml water or a saccharin solution approximately isosweet. At 15 min after consuming the solution subjects were asked to complete an intelligence test consisting of random triads of verbal, numerical and diagrammatic questions out of material available from the National Foundation for Educational Research. The test lasted about 30 min. Each group in each experiment consumed each carbohydrate or placebo in rotation at 1 week intervals, each experiment beginning at 11.00 hours.

Results showed that within-experiment variance did not differ significantly between the experiments, but the effect of the solution ingested was significant ($P \leqslant 0{\cdot}01$). A more detailed analysis showed that scores for the group given the high-molecular-weight carbohydrate were higher than those for the group given the placebo ($P \leqslant 0{\cdot}01$) in a one-tailed test, and the scores for the low-molecular-weight carbohydrate were also higher ($P \leqslant 0{\cdot}05$).

These results may be related to recent reports (Fernstrom & Wurtman, 1971; Wurtman & Fernstrom, 1974, 1975) that ingested carbohydrate elevates serum tryptophan and hence brain serotonin concentrations.

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