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PROCEEDINGS OF THE NUTRITION SOCIETY

ABSTRACTS OF COMMUNICATIONS

The Three Hundred and Eightieth Meeting of the Nutrition Society was held in the Tower Lecture Theatre, Guy's Hospital Medical School, London, on Friday, 10 December 1982, when the following papers were read:

Trials of Lycasins[®] in the diet of caries-active laboratory rats. By T. H. GRENBY and M. G. SALDANHA, *Department of Oral Medicine and Pathology, Guy's Hospital, London SE1 9RT*

Lycasins[®] are hydrogenated derivatives of glucose syrups developed for use as sweeteners and bulking agents in place of customary food carbohydrates. One of their applications is in the replacement of sucrose, which may improve dental health. However, more experimental results are needed on the effects of Lycasins on the incidence of dental caries.

In a series of five experiments, Lycasins were incorporated in the diets given to caries-active Osborne–Mendel rats and compared with sucrose, starch and sorbitol. With a set experimental period of 8 weeks from weaning, measurements were made of dental caries attack, food and water intake, weight gains and whole-body lipid content.

Lycasin 80/55 was included at five different levels in powdered diets, and was found to be tolerated satisfactorily at 160 g/kg and below. There were significant differences in the caries scores, with the Lycasin less cariogenic than sucrose and sorbitol less cariogenic than the Lycasin (Table 1).

Table 1. *Results from matched groups of sixteen female Osborne–Mendel rats fed on powdered diets containing 160 g sucrose, Lycasin 80/55 or sorbitol per kg diet for 8 weeks*

	Sucrose		Lycasin		Sorbitol	
	Mean	SEM	Mean	SEM	Mean	SEM
Food intake (g/rat per d)	11.2	—	11.8	—	10.4	—
Water intake (ml/rat per d)	17.0	—	17.2	—	16.0	—
Total weight gain in 8 weeks (g/rat)	107	3	99	2	80 ^{***}	4
Dental caries score	7.5 [*]	2.9	2.1 [*]	0.5	0.8 [*]	0.2
Number of carious lesions/rat	3.9 [*]	0.8	1.7 [*]	0.3	0.8 [*]	0.2
Average score/lesion	1.4	0.2	1.2	0.1	1.0	0

^{*}Significantly different between groups ($P < 0.05$).

^{***}Significantly below sucrose and Lycasin values ($P < 0.001$).

When the diets were pelleted instead of powdered the rats were able to tolerate up to 250 g/kg of two different types of Lycasins. Weight gains, body-lipid stores and the weight of fat deposited per kJ of food consumed were all higher on 250 g maize starch/kg and 250 g sucrose/kg than on the Lycasin regimens. The levels of dental caries attack on the Lycasin and starch regimens were closely similar and significantly lower than on the sucrose regimen (Table 2).

Table 2. *Dental caries in groups of fifteen rats fed for 8 weeks on pelleted diets*

	Maize starch		Sucrose		Lycasin 80/55		Lycasin 05/60	
	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM
Caries score	1.7 ^{**}	0.4	5.7	1.0	1.3 ^{**}	0.5	2.5 ^{**}	0.8
Number of lesions/rat	1.7 ^{**}	0.3	3.7	0.5	1.1 ^{**}	0.4	1.5 ^{**}	0.3
Average score/lesion	1.0 [*]	0	1.4	0.1	1.1 ^{**}	0.1	1.3	0.1

Significance of difference from sucrose-group values: ^{*} $P < 0.05$, ^{**} $P < 0.01$.

In summary, the Lycasins were (i) tolerated by the rats better than pure sorbitol, (ii) less lipogenic than either sucrose or starch and (iii) not cariogenic compared with sucrose.

Energetic efficiency during pregnancy. By D. J. NAISMITH and RUTH H. BROOKES, *Department of Nutrition, Queen Elizabeth College, University of London, London W8 7AH*

From a critical review of the most reliable results on dietary behaviour during pregnancy, Naismith (1981) concluded that women, on average, do not increase their food intakes during pregnancy. Therefore, they must meet the high energy cost of pregnancy, estimated to be 250 MJ (Hyttén & Leitch, 1971), by the suppression of energy-wasteful processes such as thermogenesis.

In the present study evidence was sought for an improvement in energetic efficiency during pregnancy using the laboratory rat.

Six groups of three rats selected on the basis of similarity in food consumption, growth rate and body-weight (approximately 230 g) were given *ad lib.* a nutritionally adequate diet containing 160 g protein/kg. One from each triplet was mated (P) and one acted as a non-pregnant control (C21). Food consumption was measured and all faeces were collected for 20 d. The animals were then killed, and the pups and placentas and the maternal carcasses were analysed for protein and fat. Values for the energy content of rat protein and fat (22.7 and 38.5 kJ/g) were used to estimate carcass energy. The third (unmated) rat was killed on day 1 of pregnancy (C1) and analysed in order to calculate the gains in carcass energy by the other members of the triplet. The energy contents of the diet and faeces were determined using a ballistic bomb calorimeter, and the metabolizable energy (ME) intake was calculated from the values for the gross energy, faecal energy and an estimate of energy lost in the urine (nitrogen % $\times 0.31$ kJ/g diet consumed). The results are shown in the Table.

Group	Carcass			Energy gain (kJ)	ME intake (kJ)	Gross energetic efficiency (kJ/kJ)
	Fat (g)	Protein (g)	Energy (kJ)			
P	67.8	45.6	3738*	1738	7368	0.236
C21	46.3	44.9	2806	806	6422	0.126
C1	31.4	34.7	2000	—	—	—

*Includes contribution from foetuses and placentas.

Most of the energy (89%) gained by the pregnant rats, compared with their unmated controls, was accounted for by the increase in body fat; 9% only was found in the product of conception. Energy expenditure (ME intake – gain in carcass energy) was similar in the two groups (P, 5632 kJ; C21, 5619 kJ).

The gross energetic efficiency (carcass energy gain/unit energy intake) was increased by 89% in the pregnant rats ($P < 0.01$).

Hyttén, F. E. & Leitch, I. (1971). *The Physiology of Human Pregnancy*, 2nd ed. Oxford: Blackwell Scientific Publications.

Naismith, D. J. (1981). In *Material Nutrition in Pregnancy: Eating for Two?*, p. 21 [J. Dobbing, editor]. London: Academic Press.

Effect of adrenalectomy on energy balance and brown fat activity in lean and genetically obese Zucker rats. By D. MARCHINGTON, N. J. ROTHWELL*, M. J. STOCK* and D. A. YORK, *Department of Nutrition, University of Southampton, Southampton SO9 3TU* and **Department of Physiology, St George's Hospital Medical School, Tooting, London SW17 0RE.*

The excessive accumulation of lipid in genetically obese rodents can be almost completely prevented by adrenalectomy (Yukimura & Bray, 1978), although the mechanism of this effect is unknown. The obesity in these rodents can develop without hyperphagia and is due to a high energetic efficiency, which may result from defective brown adipose tissue (BAT) thermogenesis. In the present study we have investigated the effects of adrenalectomy (ADX) on energy balance and BAT function in 5-week-old male lean (+/?) and obese (fa/fa) Zucker rats.

Metabolizable energy intake and body-weight gain over 21 d were slightly elevated in the sham-operated obese compared with the sham-operated lean rats, but body energy gain was dramatically increased (mean \pm SE: lean 900 \pm 45, obese 1855 \pm 125 kJ, $P<0.001$). Adrenalectomy did not significantly affect energy balance in lean rats but in obese rats caused slight decreases in energy intake and weight gain, and a marked reduction in body energy gain (lean ADX 615 \pm 70, obese ADX 565 \pm 95 kJ, not significant (NS)). Energy expenditure was slightly lower in the sham-operated and ADX obese rats than in the lean groups, but net energetic efficiency was significantly higher in obese rats and was completely normalized after adrenalectomy (lean 46.5 \pm 2.4, obese 62.2 \pm 5.1%, $P<0.001$; lean ADX 38.8 \pm 2.0, obese ADX 31.9 \pm 3.5%, NS).

Resting oxygen-consumption was similar for all rats but the response to a single intragastric meal (Complan[®]; Glaxo, Plymouth, Devon) was reduced in obese compared with lean rats (percentage increase: lean 19.1 \pm 1.3, obese 9.7 \pm 1.6, $P<0.001$) and was restored to normal by adrenalectomy (lean ADX 13.6 \pm 1.5, obese ADX 17.2 \pm 1.6, NS).

BAT protein content and mitochondrial protein were lower in the obese rats but were similar in obese ADX and lean animals. The activity of the mitochondrial proton conductance pathway, assessed from GDP binding, was 50% lower in obese (67 \pm 6 pmol/mg protein) compared with lean rats (145 \pm 12, $P<0.001$), but was similar for both ADX groups (lean ADX 145 \pm 16, obese ADX 155 \pm 16, NS).

Thus, adrenalectomy completely prevented the deposition of excess energy in the obese Zucker rats, and this was partly due to a reduction in energy intake but also to a large decrease in efficiency, associated with increases in BAT activity.

Yukimura, Y. & Bray, G. A. (1978). *Endocr. Res. Commun.* 5, 189.

Effect of ambient temperature and energy intake on the onset of vaginal opening in the rat. By N. J. ROTHWELL, M. J. STOCK and C. A. WILSON*,
*Departments of Physiology and *Obstetrics and Gynaecology, St George's Hospital Medical School, Tooting, London SW17 0RE*

The onset of puberty is largely determined by age, but Frisch & McArthur (1974) have suggested that the precise age of onset and maintenance of menstruation in women is determined by body-weight or fat content. In the present work we have attempted to manipulate body-weight, fat content and metabolic rate in young female rats and study their effects on the age of onset of vaginal opening.

In the first experiment, groups of 21-d-old female Sprague Dawley rats ($n=6$) were housed at environmental temperatures of 5, 22 or 30° for up to 18 d. Body-weight was slightly, but not significantly, reduced in rats housed at 5 and 30° compared with controls. Rectal temperature was unaltered by ambient temperature, but rose by 0.35° on the day of vaginal opening in all rats. Resting oxygen consumption ($\dot{V}O_2$) measured at thermoneutrality (29°) was elevated in the group maintained at 5° (15% above the 22° group) and was depressed by 11% in those housed at 30°. The onset of vaginal opening was slightly later in the 5° group (mean \pm SE: 35.5 \pm 0.8 d of age) than the 22° group (33.0 \pm 0.4 d) and earlier in the rats housed at 30° (32.0 \pm 0.5 d).

Separate groups of rats of the same age, sex and strain were maintained at 24° and given either a pelleted stock diet or a highly palatable cafeteria diet, known to stimulate food intake and metabolic rate.

Body-weight gain was reduced and the age of vaginal opening delayed in cafeteria-fed rats (age (d): control 33.9 \pm 0.2, cafeteria 35.0 \pm 0.4); however body-weight on the day of opening was almost identical for both groups (control 106.7 \pm 1.8, cafeteria 107.7 \pm 2.0 g). Rectal temperature was unaffected by diet, but was elevated by 0.35° on the day of vaginal opening compared with the previous morning in both groups. Resting $\dot{V}O_2$ was increased in cafeteria-fed rats (21.58 \pm 0.29 ml/min per kg $W^{0.75}$) compared with controls (16.93 \pm 0.33) and had risen by 8 and 12% respectively on the day of vaginal opening. Body-fat content was greater in cafeteria-fed rats killed before (control 5.48 \pm 33, cafeteria 6.80 \pm 0.44% body-weight) or after (control 5.52 \pm 0.27, cafeteria 7.38 \pm 0.50% body-weight) vaginal opening but did not differ significantly between rats killed before or after vaginal opening.

These results fail to show any consistent relationships between body-weight, fat content, metabolic rate or body temperature and the age of vaginal opening, although the latter was influenced by ambient temperature and the level of food intake. A rise in metabolic rate and body temperature was seen in all rats on the day of vaginal opening, but it is not known if this is causal, or an effect of hormonal changes associated with puberty.

Frisch, R. E. & McArthur, J. W. (1974). *Science* **185**, 949.

Disappearance of the thermogenic effect of noradrenaline in cafeteria-fed rats. By A. MANDENOFF and M. APFELBAUM, *Laboratoire de Nutrition Humaine, Faculte X. Bichat, 16, Rue H. Huchard, 75018 Paris, France*

It has been reported (Rothwell & Stock, 1979) that rats, offered a varied and highly palatable 'cafeteria' diet for three weeks, consume more oxygen in resting conditions at 29°, and have a greater increase in O₂ consumption ($\dot{V}O_2$) in response to noradrenaline (NA), than their siblings given unlimited access to stock diet (controls).

Fifty rats were given a cafeteria diet as described previously (Mandenoff *et al.* 1982). After four weeks the fourteen fattest (FC) and the fourteen leanest (LC) rats of the group were retained for $\dot{V}O_2$ tests (see Table). The tests were performed at 24°.

	Control (n14)		LC (n14)		FC (n14)	
	Mean	SEM	Mean	SEM	Mean	SEM
Body-weight (g)	515.71	13.30	592.07	8.97	780.36	18.27
Resting $\dot{V}O_2$ †	1626	71	1965	79	2257	67
NA-activated $\dot{V}O_2$ †	2270	54	2792	84	2420	63
Resting $\dot{V}O_2$ v. NA-activated $\dot{V}O_2$ †	***		***		NS	
% increase of $\dot{V}O_2$ ‡	4230	553	4570	873	797	499

NS, not significant; *** $P < 0.001$.
 † $\dot{V}O_2$, oxygen consumption, expressed in J/m² surface area per h.
 ‡The % is the mean of individual increases.

The resting $\dot{V}O_2$ of the FC and LC groups were greater than that of the controls ($P < 0.005$), and the FC rats consumed more food than the LC rats ($P < 0.005$). When the $\dot{V}O_2$ was measured over 15 min following an injection of NA (0.4 mg/kg intraperitoneal), the classical increase of $\dot{V}O_2$ occurred in the controls and the LC group, but no significant effect was observed in the FC rats.

Our results for resting $\dot{V}O_2$ are consistent with those of Rothwell & Stock (1979); those concerning NA are not. such a discrepancy may be related to one or more of the three differences between the two experiments: (a) the temperature of testing, (b) the duration of the diet, (c) the selection of food and bad responders to the cafeteria diet. Concerning the latter point, our hypothesis is that the decrease in responsiveness to NA could occur when a ponderal threshold is reached, this threshold being reached later by the leanest rats. Further investigations are needed to document such a hypothesis.

Mandenoff, A., Fumeron, F., Apfelbaum, M. & Margules, D. L. (1982). *Science*, **215**, 1536.
 Rothwell, N. J. & Stock, M. J. (1979). *Nature, Lond.* **281**, 31.

The influence of dietary obesity on milk production in the rat. By B. A. ROLLS, JASMINE B. BARLEY and M. I. GURR, *National Institute for Research in Dairying, Shinfield, Reading RG2 9AT*

When obesity has been induced in rats by the consumption of palatable foods, these rats do not exhibit the usual hyperphagia during lactation and their young grow less well and have a higher mortality as compared with the litters of lean controls (Rolls & Rowe, 1982).

We have recently shown that the milk from obese rats contained slightly less carbohydrate and markedly more fat than did that from lean dams and that this fat had significantly more long-chain and fewer medium-chain fatty acids than were found in the milk of lean controls (Rolls *et al.* 1981). The work reported here was designed to investigate whether the quantity as well as the quality of the milk consumed by the litter was affected by dietary obesity.

Two groups of female Lister hooded rats were given laboratory chow alone (control group) or chow supplemented with a palatable high-energy liquid diet (obese group). After parturition litter size was adjusted to eight. The milk consumption of each pup was measured on the eighth day of lactation using the tritiated water technique of Godbole *et al.* (1981). The dam was injected intraperitoneally with 500 μ Ci tritiated water and was subsequently given 3 H-labelled drinking water (125 μ Ci/100 ml). After 24 h, blood samples were taken from the dam and all young and their radioactivity was measured. The milk production of the lean controls (48.7 ± 2.5 ml/d; 5.9 ± 0.2 ml/pup per d) was higher than many estimates, but similar to measurements made by Hanwell & Linzell (1972) and C. H. Knight (personal communication). The amount of milk consumed by the young of obese dams (36.1 ± 4.5 ml/d; 4.3 ml/pup per d) was rather lower ($P < 0.05$ for dams; $P < 0.001$ for pups).

It is possible that obesity renders the mother less capable of secreting sufficient milk, although these observations are open to different interpretations. Other possible explanations include an inability on the part of the young to consume sufficient of the high-energy milk or to digest the altered fat, a reluctance on the part of the dam to permit adequate nursing and innate defects in the young that reduce its capacity for normal development.

Godbole, V. Y., Grundleger, M. L., Pasquine, T. A. & Thenen, S. W. (1981). *J. Nutr.* **111**, 480.

Hanwell, A. & Linzell, J. L. (1972). *Comp. Biochem. Physiol.* **43A**, 259.

Rolls, B. A., Edwards-Webb, J. D., Gurr, M. I., Rolls, B. J. & Rowe, E. A. (1981). *Proc. Nutr. Soc.* **40**, 60A.

Rolls, B. J. & Rowe, E. A. (1982). *Physiol. Behav.* **28**, 393.

Some aspects of lipid metabolism in riboflavin-deficient lactating rats and their litters. By JULIA M. DUERDEN and C. J. BATES, *MRC Dunn Nutrition Unit, Cambridge CB4 1XJ*

Sucrose-based diets containing 200 g casein/kg, 30 g arachis oil/kg and 0.12 mg riboflavin/kg were given to 150 g female rats for 4 weeks before mating, throughout pregnancy and for 15 d of lactation. Pair-fed controls received the same diet with 15 mg riboflavin/kg; coprography was prevented by collars.

Riboflavin deficiency was assessed by the activation coefficient of the erythrocyte glutathione reductase (*EC* 1.6.4.2) (EGRAC) test and by maternal and pups' hepatic flavin levels at 15 d post partum. Samples of milk were collected from the dams by suction just before killing. Mitochondrial β -oxidation was measured in 15-d-old pups with a Yellow Springs Instruments model 53 oxygen monitor using palmitoyl-L-carnitine as substrate (see Table for results).

(Mean values with their standard errors; numbers of animals or pooled litters in parentheses)

	Deficient		Pair-fed controls	
	Mean	SEM	Mean	SEM
EGRAC				
Dams	2.04* (4)	0.03	1.28 (4)	0.03
Pups	1.78* (4)	0.07	1.21 (5)	0.03
FAD (μ g/g liver)				
Dams	8.15* (4)	0.61	17.13 (5)	0.58
Pups	3.98* (4)	0.21	14.34 (5)	0.73
Milk riboflavin (μ g/g)	0.61* (4)	0.15	7.96 (4)	0.69
Oxygen consumption by brown adipose tissue mitochondria†				
A: Initial	23.24* (4)	0.89	57.38 (5)	4.70
B: With added GDP (1 mM)	21.00 (4)	3.25	28.41 (5)	4.01
A/B	1.13* (4)	0.13	2.27 (5)	0.11

*Significantly different from pair-fed controls: $P < 0.001$.

†Expressed as n atoms of oxygen consumed/mg mitochondrial protein per min at 24°.

Biochemical evidence of riboflavin deficiency was clear-cut. Brown adipose tissue mitochondrial fatty acid oxidation was reduced in the deficient pups, and the inhibition by GDP was also diminished, suggesting a possible impairment in non-shivering thermogenesis.

Thus a maternal diet containing 0.12 mg riboflavin/kg produced functional and biochemical alterations in suckling rats, without severely impairing reproductive performance. These observations may be of relevance to human populations where riboflavin deficiency is endemic, especially since efficient thermal control is of crucial importance to young infants.

J.M.D. acknowledges receipt of an MRC training award.

Some longitudinal observations of the weight, height and nutrient intake of 405, 11–13 year old Northumbrian children. By A. F. HACKETT,* J. M. PARKIN,† D. R. APPLETON,‡ A. J. RUGG-GUNN,* and J. E. EASTOE,*
*Departments of *Oral Biology, †Child Health and ‡Medical Statistics, University of Newcastle upon Tyne, Newcastle upon Tyne NE2 4BW*

This paper describes the relationship between weight, height and their 2-year increments, and the mean nutrient intake of 193 boys and 212 girls initially aged, on average, 11½ years. Intake was measured on five separate occasions between September 1979 and July 1981 using a 3 d diary and interview method previously described (Hackett, Pearce *et al.* 1982) and already reported in part (Hackett, Rugg-Gunn *et al.* 1982). Height and weight (in school clothes minus jackets and shoes) were measured under standardized conditions in October 1979 and October 1981 (see Table).

Social class	n	Baseline height (m)		Baseline weight (kg)		Height increment (mm)		Weight increment (kg)		Energy intake (kJ)	
		Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Boys											
I±II	46	1.48	0.010	39.95	1.03	140	6	10.56	0.69	9440	192
III	86	1.46	0.007	39.74	0.96	142	4	10.68	0.51	9359	162
IV±V	52	1.44	0.009	37.64	0.90	126	6	9.29	0.60	9491	197
Girls											
I±II	39	1.49	0.011	41.42	1.01	116	6	9.87	0.61	8593	243
III	86	1.46	0.008	38.54	0.78	117	4	9.20	0.42	8272	146
IV±V	66	1.47	0.009	40.81	1.21	114	5	9.63	0.53	8632	185

Classifications VI, VII and VIII (*n* 30) have been omitted.

At baseline the boys from the upper and lower social classes (I+II and IV+V respectively) were, on average, lighter than the girls but approximately the same height. However, their height and weight increments were greater than those of the girls which probably results from the boys beginning puberty later than the girls; i.e. during, rather than before, the experimental period.

Mean energy intake averaged over the 2 years was not significantly correlated to baseline weight and was correlated to baseline height for the girls only ($r +0.181$, $P < 0.01$). Energy intake was not correlated to either weight or height increment.

The lower social class boys were 'smaller' and 'grew' less well despite eating a similar amount of energy to the other boys. The lower social class girls were shorter than the higher social class girls but had similar body-weights. However, the lower social class girls grew less in height but increased their body-weight by a similar amount to that of the higher social class girls, despite a similar energy intake.

Hackett, A. F., Pearce, J., Twist, A. Rugg-Gunn, A. J. & Eastoe, J. E. (1982). *Proc. Nutr. Soc.* **41**, 92A.

Hackett, A. F., Rugg-Gunn, A. J., Appleton, D. R. & Eastoe, J. E. (1982). *Proc. Nutr. Soc.* **41**, 144A.

Maternal sucrose preferences in infant foods in the London Borough of Ealing: A pilot study, 1982. By BRENDA M. SMITH and ANTHONY R. LEEDS, *Department of Nutrition, Queen Elizabeth College, University of London, London W8 7AH*

There is evidence that sucrose in the diet is harmful to health but some of the evidence is equivocal. However, from the purely nutritional point of view sucrose is not an essential dietary component and could be removed from the diet without ill effects, though preference for foods with reduced sucrose content might not be large. Some manufactured foods for babies contain relatively high concentrations of sucrose. This study was designed to answer the questions 'are mothers of young infants concerned about sucrose in baby foods?' and, 'are such mothers able to detect reduced concentrations of sucrose in dessert foods for babies?'

200 Mothers with babies under 2 years of age, a social-class distribution bias towards the upper classes, of different ethnic origins, and attending Health Clinics and Mother and Toddler groups in the London Borough of Ealing, were interviewed about their infant-feeding practices. Using a portable tasting booth, 100 of the mothers were asked to distinguish between laboratory-made apple desserts with 0, 5 and 10% added sucrose, and 100 mothers between manufactured apple desserts with 7.8 and 11% added sucrose. Bengtsson's (1943) Triangle Test was used and specific questions were then asked about other properties of the foods.

Of the mothers, 171 and 172 thought that a low level of salt and sugar respectively in baby food was important or very important, and 15 and 36% of mothers used mainly manufactured and about equal amounts of manufactured and home-made foods respectively. Of those who used manufactured baby desserts none added extra sugar to the product.

When tasting baby-food samples, mothers were unable to distinguish between samples with 7.8 and 11%, and 5 and 10% added sucrose. 0 and 5%, and 0 and 10% sucrose were readily distinguished by twenty-one out of thirty-four and thirty out of thirty-three mothers, and the fifty-one mothers with correct answers showed a preference trend towards the less sweet product.

If the preference for low sugar levels in baby foods shown by this group of mothers and their inability to detect some reductions of added sucrose in baby desserts is a reflection of national preferences and tastes, then baby desserts with lower levels of sucrose would be attractive to mothers and, in any case, considerable reduction of sucrose levels could be achieved without being detectable to consumers.

We are grateful to Drs Briggs, Bentley and Harvey and Mrs Smith for arranging access to clinics and toddler groups. Drs Macleod and Watson, Messrs George and McFarlane and Miss Craske gave valuable assistance. H. J. Heinz Company Ltd, Middlesex, kindly provided samples of standard and sucrose-reduced baby desserts.

Bengtsson, K. (1943). Quoted in: Amerine, M. A., Pangborn, R. M. & Roessler, E. B. (1965). *Principle of Sensory Evaluation of Food*, p. 285. London and New York: Academic Press.

Use of nutritional supplements by students of nursing. By J. R. KEMM,
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About £25 million are spent annually on the purchase of over-the-counter vitamin and other nutritional supplements. Although the use of these supplements may have a profound effect on an individual's intake of micronutrients, very little is known about the consumption of these supplements. Some fragmentary and out of date information may be gleaned from surveys of medicine consumption (Kohn & White, 1976; Office of Population Census and Surveys, 1976).

This communication reports a study of the consumption of nutritional supplements by female students entering Nottingham Schools of Nursing. Fifty out of 321 students answered yes to the question 'have you taken any tablet, pill, medicine or tonic which contains vitamins, or iron or other mineral in the previous 7 d?' Older students were higher users than younger students (age < 20 years, 12% of 188; age 20–24 years, 18% of sixty; age 25–34 years, 21% of fifty-three; age ≥ 35 years, 30% of twenty).

Married students were higher users than single students (fifteen out of sixty-one *v.* thirty-three out of 253 respectively) and student health visitors were higher users than pupil nurses or student nurses (nine out of forty *v.* sixteen out of ninety-two and twenty-five out of 189). Both these differences could be accounted for by age.

Thirty-eight out of the fifty users took only one preparation, while twelve took two or more. The most commonly-taken preparations were multivitamins, taken by twenty-three users. The main constituent of other types of preparation taken were (*n* in parentheses): vitamin C (nine), iron (nine), B complex (six), yeast (six), cod liver oil (six), vitamins A, C and D (three), garlic (three) and ginseng (two). Only two users obtained their preparation on prescription. The majority (forty-four) of users purchased their preparations from conventional pharmaceutical outlets and only four obtained them from health-food stores.

Users were asked why they took these supplements and forty-three gave one or more reasons. Poor diet was mentioned by ten users, tiredness and feeling run down by nine, anaemia or menorrhagia by nine, prevention of colds by seven, a general view that vitamins were good for you by seven and miscellaneous other reasons by nine.

The user rate seems rather higher than that reported in comparable populations and the proportion obtained on prescription was lower. Most users did not hold clear views as to the benefits they expected from the use of supplements and there was no evidence that the speculations on vitamin requirements in the medical and nutritional literature had influenced this group.

The author thanks Mrs Bradley and the staff and students of the Nottingham School of Nursing for their co-operation in this study.

Kohn, R. & White, K. L. (1976). *Health Care; an International Study*. London: Oxford University Press.

Office of Population Census and Surveys (1976). *The General Household Survey 1973*. London: HMSO.

Effect of various types of dietary fibre on gastric emptying in pigs. By ANNA L. RAINBIRD and A. G. LOW, *National Institute for Research in Dairying, Shinfield, Reading RG2 9AT*

Several types of dietary fibre decrease the rate of glucose absorption and it has been suggested that this is partly the result of delayed gastric emptying, particularly following the consumption of viscous meals (Jenkins *et al.* 1978). We have recently shown that guar gum does not markedly decrease the rate of gastric emptying of a meal in pigs (Rainbird *et al.* 1983) although it does decrease postprandial hyperglycaemia (Leeds *et al.* 1980).

We have now measured in five 45 kg pigs the rate of emptying of meals (semi-purified diet based on casein, maize starch, soya-bean oil, tallow and cellulose, and given at 3% live weight/d) including several types of dietary fibre: bran (40 g/kg), LejGuar[®] (40 g/kg), pectin (60 g/kg) and high viscosity sodium carboxymethylcellulose (CMC) (30 g/kg). The amounts of pectin and CMC used provided meals of similar viscosity to those containing 40 g guar gum/kg in our previous studies (Rainbird *et al.* 1983). LejGuar (Lejus Medical Ab, Sweden), unlike other types of guar gum, does not appreciably increase meal viscosity. Each pig received each diet for 7 d in a Latin-square design. The stomach was evacuated at 0, 0.5, 1, 2 and 4 h after feeding (for details, see Low & Rainbird, 1983).

The only significant differences from the control diet (no added fibre) in the rate of dry matter (DM) emptying from the stomach were for the diets with CMC (faster after 2 h) and bran (slower after 4 h). There was significantly more gastric digesta for the diets with LejGuar (except at 0 and 0.5 h) and CMC (at 2 and 4 h) than for the control diet.

These results suggest that none of the sources of dietary fibre used had a major effect on the pattern of gastric emptying of DM (which contains all of the dietary glucose), particularly in the first hour after the meal, i.e. the period when the hypoglycaemic effects are greatest (except with bran which has not been shown to have such an effect).

We thank Dr J. Buckle of H. P. Bulmer Ltd, Hereford and H. Thomas of Britannia Pharmaceuticals Ltd, Reigate, Surrey, for the gifts of pectin and LejGuar respectively.

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Intestinal glucose and fructose absorption is unimpaired when sucrase is inhibited by acarbose. By R. H. TAYLOR and HELEN M. BARKER, *Department of Gastroenterology and Nutrition, Central Middlesex Hospital, London NW10 7NS*

The complex oligosaccharide acarbose is a potent inhibitor of α -amylase and of many intestinal brush border α -glycoside hydrolases. It has been suggested that as an effective sucrase and amylase inhibitor it may have a role in the management of diabetes mellitus, slowing digestion and, therefore, absorption of dietary carbohydrate. However, the presence of an inhibitor of many intestinal enzymes could be potentially hazardous if all absorption of carbohydrate were blocked. These experiments were designed to measure the effects of acarbose on monosaccharide transport mechanisms by intestinal perfusion *in vivo*.

Young adult female Sprague Dawley rats (160–210 g) were anaesthetized with pentobarbitone (60 μ g/g body-weight) intraperitoneally. At laparotomy the proximal jejunum was identified, a 200 mm segment was cannulated and perfused *in vivo* at a flow rate of 0.27 ml/min. The perfusion solution contained 11.7 mM sucrose (*n*7), glucose (*n*4) or fructose (*n*4), with sodium chloride (147 mmol/l) and 3 g/l PEG 4000 labelled with 1 μ Ci 14 C as a non-absorbable marker. Its osmolality was 290 mosmol/l. Following a 30 min stabilization period, aspirates were collected at 10 min intervals for 180 min. In the second 30 min period the perfused solution also contained acarbose (30 mg/l). Sugars in the aspirate were measured by high pressure liquid chromatography, electrolytes by flame photometry and absorption rates were calculated in the standard manner. The results are summarized in the Table.

Luminal carbohydrate disappearance rates (μ mol/h per 200 mm segment)

	Time from start of perfusion (min)							
	30		60 (Acarbose)		120		180	
	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM
Sucrose (<i>n</i> 7)	71	7	15 ^{***}	4	40 ^{***}	6	47 ^{**}	4
Glucose (<i>n</i> 4)	99	6	93	5	85	6	81	8
Fructose (<i>n</i> 4)	32	4	30	2	23	4	23	3

Significantly different from 30 min value: ** $P < 0.01$, *** $P < 0.001$.

When acarbose inhibited sucrase activity, the luminal sucrose disappearance rate fell to only 21% followed by a gradual recovery after the acarbose perfusion. Luminal concentrations of liberated glucose and fructose followed the same pattern as did sodium and water absorption rates. By contrast, acarbose had no significant effect on glucose or fructose disappearance rates when those sugars were perfused.

We conclude that the absorption of both glucose and fructose is unaffected by brush border enzyme blockade with acarbose in this model. This suggests that it does not inhibit monosaccharide transport mechanisms.

Intestinal uptake of galactose in rats recovering from experimental zinc deficiency. By S. SOUTHON, J. M. GEE and I. T. JOHNSON, *ARC Food Research Institute, Colney Lane, Norwich NR4 7UA*

Despite the poor food utilization and low growth rates associated with experimental zinc deficiency in rats, rates of intestinal sugar transport measured *in vitro* are significantly increased in comparison with those of control animals (Southon *et al.* 1982). The mechanism underlying this effect remains unknown. In recent work we have studied the kinetics of galactose uptake in Zn-deficient animals, following their return to an adequate level of dietary Zn.

Eighteen immature male Wistar rats were divided randomly into groups of six, and given a semi-synthetic diet containing 1 mg Zn/kg. After 30 d the animals had developed signs of Zn deficiency, including poor growth, erratic food intake and skin lesions. The groups were then given diets containing 60 mg Zn/kg for periods of 1, 2 or 5 d prior to being killed. The kinetics of galactose transport were measured using isolated rings of everted jejunum, and estimates of the weight per unit length, and the mucosal DNA content of adjacent samples were obtained. The V_{\max} for galactose transport of the 1-d refed group was found to be close to that characteristic of Zn-deficient animals, but had fallen to a value similar to that observed in control animals in the 2-d and 5-d refed groups (see Table).

Group	K_m (mM)		V_{\max} ($\mu\text{mol/g per min}$)	
	Mean	SEM	Mean	SEM
1-d refed	12.0	1.4	8.0	0.3
2-d refed	4.9	2.7	3.6	0.7
5-d refed	8.7	1.8	4.2	0.3
Pair-fed control	4.1	1.4	3.7	0.3

It is unlikely that the apparent decline in galactose transport rate merely reflected a change in the structure or composition of the gut following refeeding with Zn, as there was no significant difference in the mucosal weight per unit length of intestine between the groups. We suggest that it is the absorptive capacity of the enterocytes themselves which is altered by changes in the Zn status of these animals.

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Effects of the ionophoric antibiotic ICI 139603 in lambs. By A. DAVIES and A. W. J. BROOME, *ICI Pharmaceuticals Division, Alderley Park, Maclesfield, Cheshire SK10 4TG*

ICI 139603 is an antibiotic produced by *Streptomyces longisporoflavus* which has been shown to increase average daily live-weight gain and food conversion efficiency in growing beef cattle given good quality concentrate plus roughage (Davies *et al.* 1982). Although structurally dissimilar to, and more potent than, other ionophores studied experimentally in cattle, it seemed likely that it would resemble them in its mode of action and might, therefore, depress animal performance on rations containing high percentages of fibre. To check this hypothesis ninety-six lambs were allocated to two treatment groups on the basis of live weight and fed *ad lib* a diet containing either low or high fibre. The rations for the low- and high-fibre groups respectively were (g/kg); flaked maize 300, 300; maize meal 400, 0; soya-bean meal 50, 50; grass meal 200, 200; barley straw 0, 400; minerals/vitamins 20, 20; urea 10, 10; limestone 10, 10; and salt 10, 10. After 4 weeks of acclimatization to the diets, each group was further divided into four sets of twelve animals and given diets containing respectively 0, 2, 4 and 8 g ICI 139603/tonne. After 4 weeks on the medicated diet, samples of rumen fluid were withdrawn by stomach tube and analysed for volatile fatty acids. Thereafter digestibility measurements were made.

Digestibility	Low-fibre diet ICI 139603 (g/tonne)				High-fibre diet ICI 139603 (g/tonne)			
	0	2	4	8	0	2	4	8
Dry matter	66.4	67.1	66.7	67.1	51.7	50.1	52.1	54.4*
Organic matter	69.2	68.5	68.0	69.5	54.9	53.0	54.1	56.1
Nitrogen	59.8	64.0	63.7	66.7	54.6	51.4	51.5	48.1
P:A+2B	0.29	0.35	0.41	0.33	0.25	0.36*	0.38**	0.42**

* $P=0.05$, ** $P<0.01$.

ICI 139603 significantly increased the percentage of propionic acid in the rumen fluid (in the table this is shown as a ratio of ruminal propionic (P) to acetic (A) acids plus twice the butyric acid (B)) and the dry matter digestibility in lambs on the high-fibre diet. There were also trends toward an increase in organic matter digestibility but a decrease in nitrogen digestibility. The results in the group of animals on the low-fibre diet were much more variable (perhaps due to the relatively high Cu content of this diet) and no statistically significant changes were recorded. However, the trends were for all digestibility measurements and the P:A+2B to increase with increasing amounts of ICI 139603 in the diet. This would indicate some improvements in both energy and protein supply to the lambs on the low-fibre diet, but marked improvement in energy coupled with a marginal decrease in protein supply on the high-fibre diet. The expected growth response is related to protein availability in both cases.

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Catabolism of branched-chain amino acids by ruminant muscle. By E. TELENI and E. F. ANNISON, *Department of Animal Husbandry, University of Sydney, Camden, NSW 2570, Australia*, and D. B. LINDSAY and JEAN MACKENZIE, *ARC Institute of Animal Physiology, Babraham, Cambridge CB2 4AT*

In isolated rat muscle, branched-chain amino acids may affect protein synthesis and degradation (e.g. Tischler *et al.* 1982). Since, unlike other essential amino acids, they can be catabolized by muscle, this could mediate their effects on protein turnover. However, in ruminant muscle these amino acids may not be catabolized (Lindsay & Buttery, 1980) and if this is so, such a mediating effect cannot be generally applicable. By means of a technique employing chronic implantation of catheters (Domanski *et al.* 1974) we have measured, directly, oxidation of branched-chain amino acids in sheep skeletal muscle. [$1-^{14}\text{C}$]leucine or [$1-^{14}\text{C}$]valine were infused intravenously for 3 h at a constant rate. During this period, and for the following 5 h, samples of arterial and venous blood were taken simultaneously and the concentration and specific radioactivities of leucine, or valine, and $^{14}\text{CO}_2$ determined.

Across the muscle there was a significant extraction of radioactivity in amino acids (mean \pm SE: leucine, $26.5 \pm 4.5\%$; valine, $8.5 \pm 0.47\%$). Production of $^{14}\text{CO}_2$ accounted for 9% of the leucine and 20% of the valine taken up. From the true uptake (fractional extraction of radioactivity \times arterial concentration) and net arteriovenous difference, the apparent rate of proteolysis was calculated to be 1.6 (valine) or 6 (leucine) times larger than the rate of oxidation of the corresponding amino acid, calculated from $^{14}\text{CO}_2$ production. If in fasting there is a similar relation of oxidation to amino acids released by proteolysis, approximately 12–35% of the amino acids released are oxidized within the muscle.

In post-absorptive man, up to 60% of the amino-N in circulating alanine may be derived from the branched-chain amino acids (Haymond & Miles, 1982). In fasting sheep, the venous-arterial (V-A) difference for alanine across the muscle is approximately 20 μM , (substantially less than the comparable V-A difference across human muscle). If isoleucine is catabolized like valine and leucine, amino groups from the catabolism of the branched-chain amino acids would account for approximately 30% of the amino-N released as alanine. While catabolism of branched-chain amino acids does occur, it is quantitatively much less in sheep than in human muscle.

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A new compound with anorectic activity in the fowl. By A. H. SYKES,
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During the course of an examination of a compound for possible hypolipidemic activity in the laying hen it was observed that there was a reduction in food intake. This effect was investigated further as follows. The compound, M&B 11008 (*R,S*-(4-methylisothiazol-5-yl)-(4-methylpiperazinyl) phenylmethane) was added to the diet at the level of 1 g/kg and given to a group of eight hens for 21 d; food intake over this period was (mean \pm SE): 88 ± 3 g/bird per d compared with the control of 132 ± 4 g/bird per d. Egg production was reduced (69 ± 5 compared with $85 \pm 4\%$) but pair-feeding trials and trials in which the daily protein intake of treated hens was maintained suggested that the fall in egg production was a result and not a cause of the decreased food intake. Over the same period body-weight fell from 1.71 ± 0.1 to 1.52 ± 0.03 kg. The compound was active when given in aqueous solution by crop tube and when given parenterally. The anorectic activity was dose-related and could be observed following a single daily dose (mean \pm SE; six hens):

Food administered (g/bird per d) for	Dietary concentration of M&B 11008 (g/kg)									
	0		0.25		0.5		1.0		2.0	
	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM
1 d	119	4	98	4	86	6	74	9	62	2
3 d	123	5	113	4	102	3	77	4	50	4

In order to study the response more acutely, and to provide a greater hunger stimulus, laying hens were provided with food for only 6 h/d and, after adjustment to this regimen, the compound was added to the diet (1 g/kg) for single days. Food intake (g/h) was recorded hourly:

Hours...	1		2		3		4		5		6		Total food intake	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Control (n 18)	24.3	1.3	11.5	1.5	12.5	1.4	18.2	1.3	20.3	1.6	16.2	0.9	103.0	2.7
Treated (n 14)	18.6	1.1	6.8	1.0	8.4	1.2	10.1	1.3	10.3	1.2	8.9	1.1	63.1	3.3

The reduction of food intake commenced in the first hour, when less than 20 mg of M&B 11008 had been administered, and persisted throughout the feeding period although some sign of the normal feeding pattern remained. There were no signs of toxicity in the treated hens.

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The detection of antibodies against soya proteins in serum. By JENNIFER M. PITTS, C. R. LOWE and T. G. TAYLOR, *School of Biochemical and Physiological Sciences, University of Southampton, Southampton SO9 5NH*

It is well documented that small amounts of ingested protein can cross the gut-wall intact and stimulate an immune response in normal adult animals (Walker, 1978). The nature of this immune response varies from trace levels of circulating antibodies, with no obvious symptoms, to acute allergic reactions. Soya-bean protein has been implicated in such allergic reactions in both animals (Smith & Sissons, 1975) and man (Ament & Rubin, 1972). In the course of such studies with soya bean in rabbits and man it has become clear that some of the conventional methods of immunological assay are unsuited to soya-bean protein.

New Zealand White rabbits were parenterally immunized with a soya-protein isolate (Promine D) and the immune sera used in the evaluation of the following three methods of immunoassay of anti-soy IgG: immunodiffusion, haemagglutination and enzyme-linked immunosorbent assay (ELISA).

In the immunodiffusion method, precipitates were formed between immune serum and Promine D using the Ouchterlony double diffusion method. However, a precipitate was also formed when control serum from a non-immune animal was used. Both these precipitates were soluble in saline indicating that they were not true immune precipitates. Counter-current immunoelectrophoresis against Promine D produced two precipitates with immune sera, one of which was soluble. Under similar conditions control sera produced a single soluble precipitate with Promine D. Both soluble precipitates could be stained for calcium and Ca (0.5 mM CaCl₂) was found to precipitate Promine D in free solution. Since the two main storage proteins of soya, glycinin and β -conglycinin are precipitated by Ca salts, it is thus likely that Ca is the serum factor causing non-immune precipitation of Promine D.

The passive haemagglutination technique was also found to be unsuitable. Both sheep and chicken tanned-erythrocytes, when coated with Promine D, freely agglutinated in the absence of serum. This arises from the presence of an agglutinating lectin in soya bean. The Promine D extract used to coat the erythrocytes contained 265 ng agglutinin/mg protein.

A method in which the soya antigen is attached to a solid-phase support not itself affected by the antigen is therefore necessary. An ELISA was developed. Polystyrene cuvettes coated with Promine D were incubated with suitably diluted test serum. The cuvettes were then incubated with an anti-rabbit IgG (raised in goat)-peroxidase conjugate. The amount of specific antibody present is proportional to the enzyme activity bound to the cuvettes. By this method anti-soya IgG could be detected in the test serum diluted in the range 1.5×10^4 to $1.6 \cdot 4 \times 10^6$. The assay was simple, reproducible and gave low background readings for control samples.

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The effect of maternal dietary protein on specific antibody and antigen content of human cord blood and breast milk. By JENNIFER M. PITTS, JANE B. MORGAN, P. J. GALLAGHER and M. J. GIBNEY, *School of Biochemical and Physiological Sciences, University of Southampton, Southampton SO9 5NH*

The human infant receives passive immunity from its mother entirely by the transplacental transmission of antibodies. Circulating maternal antibodies against food proteins will therefore be transmitted to the foetus from cord blood. Human milk, particularly colostrum, is rich in secretory IgA with antibody activity against micro-organisms and food proteins. The specific immune response in the mammary gland appears to reflect the mother's intestinal experience (Cruz *et al.* 1981). Food antigens ingested by the mother may be absorbed and may then enter the breast milk causing allergic reactions in susceptible infants (Gerrard, 1979).

The quantitative relationship between dietary egg- and soya-protein intake and specific antibodies and antigens in cord blood and milk were investigated. Twenty-six women in the third trimester of pregnancy weighed and recorded their daily food intake for 7 consecutive days. Thirteen of them continued this regimen for a further 7 d during which time they consumed three meals containing soya protein. Cord blood was collected at delivery and colostrum and mature breast milk samples were collected within 48 h and 28 d of delivery respectively. Enzyme-linked immunosorbent assays were used to measure anti-ovalbumin and anti-soya IgG in cord blood and anti-ovalbumin and anti-soya IgA, ovalbumin and soya antigen levels in colostrum and milk.

The mean daily egg-protein intake ranged from 1.0 to 9.0 g/d (mean 5.1 g/d) which was 1.1–13.9% of the total daily protein intake. The comparable range for soya protein was 3.6–15.4% of the total daily protein intake.

Linear regression analysis was used to determine any significant relationship between the criteria measured.

Specific antibodies and soya and egg antigens were detected in many of the samples measured. There was a very large variation in the levels of antibody and antigen between subjects. Protein intake did not affect specific antibody levels, but mature milk levels of soya antigen ($P < 0.05$) and ovalbumin ($P < 0.02$) increased with increasing antigen intake. There was no significant relationship between antibody levels in cord blood and colostrum or milk antibodies. There was, however, a highly significant relationship between the anti-ovalbumin IgA levels in colostrum and milk ($P < 0.001$).

It appears from these results that maternal diet does influence the antibody and antigenic experience of the newborn human infant.

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Effect of experimental hookworm infection on some biochemical criteria of nutritional status. By S. VAN BEERS, A. L. VAN LAERE, H. J. NORDBECK, R. LUYKEN and B. REP, *Subdepartments of Parasitology and Nutrition, Royal Tropical Institute, Amsterdam*

Young adult Beagle dogs were infected with 2000–5000 *Ancylostoma caninum* larvae. Because of limited accommodation a series of experiments were carried out on small groups of dogs. After infection the animals were monitored for up to 70 to 160 d and blood samples were drawn once or twice a week. The results of each series of experiments were comparable. A typical result is summarized in the Table.

Group	Extent of infection	Serum protein (g/100 ml)			Serum albumin (g/100 ml)	Serum cholesterol (mmol/l)
		n	Day 30	Day 65	Day 45	Day 45
I	None (control)	4	6.0	5.7	3.4	4.06
II	Slight	4	4.8	7.0	2.6	3.21
III	Heavy	4	5.7	7.0	2.6	3.26

Because of the small number of animals in each series, the significance of individual change was calculated from individual regression lines.

The results indicated that serum protein decreased slightly during days 20–40 after infection but increased significantly during days 40–90. Recovery from infection was spontaneous on days 80–100. After day 100 all values normalized.

Serum albumin decreased significantly and again normalized after infection. Serum cholesterol decreased significantly after infection. Erythrocyte transketolase (*EC* 2.2.1.1) activity and glutathion reductase (*EC* 1.6.4.2) activity showed a tendency to increase in infected animals. The stimulation of both enzymes by thiamin pyrophosphate and FAD respectively seemed to decrease after infection. These tendencies were not significant. A serious anaemia developed in the infected animals.

These studies show that the presence of intestinal parasites may interfere with biochemical measurements of nutritional status. In tropical areas nutritional surveys must include a parasitological survey.

Effect of intravenous sodium D-L-3-hydroxybutyrate on post-cholecystectomy urinary nitrogen output in man. By W. G. A. WOODS*, G. L. S. PAWAN†, S. J. G. SEMPLE†, D. N. L. RALPHS*, and L. P. LEQUESNE*, *Departments of *Surgical Studies and †Medicine, The Middlesex Hospital, London W1N 8AA*

Both intravenously and orally-administered sodium D-L-3-hydroxybutyrate (3HB) have been shown to produce a significant reduction in net protein loss in obese patients on very low-energy diets (Pawan & Semple, 1980). Ketone bodies may replace glucose as a metabolic fuel for the brain (Owen *et al.* 1967) and, in certain conditions, may themselves inhibit gluconeogenesis from protein (Sherwin *et al.* 1975). Since net protein loss has, for many years, been recognized as one of the major components of the metabolic response to injury (Cuthbertson, 1942), we have investigated the effects of administering 3HB intravenously to patients following cholecystectomy.

Thirty-two patients, who had been routinely admitted to hospital for cholecystectomy, were allocated randomly to receive either 3HB or equi-energy-glucose intravenously. For two pre-operative days all patients ate a diet consisting of 60 g protein/d and a minimum of 6.3 MJ (1500 kcal)/d. Urine (24 h) was collected each day and nitrogen output was measured by the Kjeldahl method. Post-operatively, the control group received daily, for 3 d, 2.8 MJ (670 kcal) supplied as glucose, 154 mmol Na and 3500 ml water. The 3HB group received 18 g 3HB dissolved in 3 l glucose solution (50 g/l, 0.93 MJ/l) and 146 mmol Na. Each day urine collections were made and total urinary N was taken as a measure of protein losses. Patients were weighed and their heights measured. Plasma urea was measured on the day of operation and at the conclusion of the study.

There was no significant difference in the post-operative daily N excretion between the control glucose-group (median 8.3 g/d) and the 3HB group (median 8.3 g/d), nor was there any difference when allowances were made for body surface area or blood urea changes during the course of the study.

We conclude that this dose of intravenous 3HB is unlikely to be of benefit in the management of the increased protein catabolism associated with the extent of surgical trauma of cholecystectomy in patients admitted to a general surgical ward.

This investigation was approved by The Middlesex Hospital Ethical Committee.

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Is linolenic acid an essential nutrient for the guinea-pig? By W. M. F. LEAT, CHRISTINE A. NORTHROP and K. DAVIDSON, *ARC Institute of Animal Physiology, Babraham, Cambridge CB2 4AT*

Linoleic acid (18:2 ω 6) is generally regarded as the major essential fatty acid (EFA), but firm evidence for a specific function in mammals of linolenic acid (18:3 ω 3) is sparse (see Tinoco *et al.* 1979; Leat, 1981). Most EFA research has used the rat as an experimental animal, but the guinea-pig may be a better model for man since much of the guinea-pig's brain development occurs *in utero* (see Dobbing, 1974).

Two weanling female guinea-pigs (first generation) were reared on a purified diet, based on that of Reid & Briggs (1953), comprising (g/kg): casein 300, maize starch 200, solkaflor 100, sucrose 80, glucose 70, kaolin 30, arginine 3, mineral mix 90, vitamin mix 27 and sunflower oil 100. This diet contained 61.3 g linoleic acid and 140 mg linolenic acid/kg. Daily intakes of 18:2 and 18:3 fatty acids per animal were approximately 1840 mg and 4 mg respectively. The growth of guinea-pigs on this diet (mean weight at 20 weeks = 679 g) was comparable to that of guinea-pigs reared on a commercial diet (mean weight of two females at 20 weeks = 593 g). The commercial diet contained 12.4 g linoleic acid and 2.0 g linolenic acid/kg. These four guinea-pigs were mated and the offspring were successfully reared on their respective diets.

The growth rates of the second generation animals were again comparable. At 20 weeks of age the mean weight of the two females reared on the purified diet (770 g) was slightly less than that of the two females reared on a commercial diet (839 g).

In the guinea-pigs reared on the purified diet there was a marked reduction in the content of ω 3 fatty acids in the retina (see Table).

Percentage composition of the major polyunsaturated fatty acids of retinal lipids of guinea-pigs reared on a purified diet low in linoleic acid (Diet A) and on a commercial diet (Diet B)

(The number of animals is given in parentheses)

Fatty acid . . .	18:2 ω 6	20:4 ω 6	22:4 ω 6	22:5 ω 6	22:5 ω 3	22:6 ω 3
Diet A						
1st generation (2)	13.8	13.1	2.3	4.8	0.2	1.1
2nd generation (2)	4.6	8.4	2.6	13.8	—	0.8
Diet B						
1st generation (2)	4.1	10.3	1.7	6.2	0.7	7.8
2nd generation (1)	4.6	10.3	1.9	5.8	0.5	6.9

It is concluded that female guinea-pigs grow satisfactorily, show no overt abnormal signs and reproduce through two generations on purified diets containing not more than 140 mg linolenic acid/kg diet.

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Effect of linoleic acid intake on thromboxane and prostacyclin production in rats receiving dietary eicosapentaenoic (20:5 ω 3) and docosahexaenoic (22:6 ω 3) acids. By T. A. B. SANDERS, E. CHUA and N. R. BOLSTER, *Department of Nutrition, Queen Elizabeth College, University of London, London W8 7AH*

The inhibition of platelet function in rats given large amounts of cod-liver oil can be attributed to the displacement of arachidonic acid (20:4 ω 6) from platelet lipids by 20:5 ω 3 and 22:6 ω 3 fatty acids (Hornstra & Hemker, 1979; Hornstra *et al.* 1981). This study reports the influence of varying the intake of linoleic acid (18:2 ω 6) on thromboxane and prostacyclin production in rats receiving modest amounts of dietary 20:5 ω 3 and 22:6 ω 3.

Thirty-two pairs of Sprague Dawley rats (120–160 g) were randomly allocated into four equal groups to receive 2, 6, 10 and 15% energy as 18:2 ω 6 respectively. One of each pair received 1.7% energy each as 20:5 ω 3 and 22:6 ω 3 (MaxEPA oil group), the other (control group) received a similar amount of oleic acid as triglyceride. The animals were pair-fed for 4 weeks. The results are shown in the Table.

% energy as 18:2 ω 6	Group	PGI ₂ (ng/assay)		6-keto-PGF _{1-α} (ng/assay)		Thromboxane B ₂ (ng/10 ⁸ platelets)	
		Mean	SE	Mean	SE	Mean	SE
2	MaxEPA	1.59*	0.33	2.36	0.31	1.56*	0.86
	Control	1.20	0.19	1.99	0.36	7.18	1.85
6	MaxEPA	1.09	0.30	4.49	1.11	9.41*	0.85
	Control	1.18	0.24	4.07	0.90	16.80	2.23
10	MaxEPA	0.83	0.44	1.04*	0.27	6.80*	0.71
	Control	1.39	0.24	2.95	0.62	13.85	2.17
15	MaxEPA	1.01	0.15	1.55*	0.44	2.84*	0.25
	Control	1.33	0.12	3.24	0.55	5.50	0.41

* $P < 0.05$ compared with control; Wilcoxon's test.

Thromboxane B₂ production in platelet-rich plasma, triggered by collagen, was reduced in the MaxEPA groups compared with their controls, but increased with increasing linoleic acid intake. Prostacyclin (PGI₂) production, measured by bioassay and radioimmunoassay of 6-keto-PGF_{1- α} , was greater in the MaxEPA group given 2% energy as 18:2 ω 6 but was lower in MaxEPA groups receiving 10 and 15% energy as 18:2 ω 6 compared with their respective controls.

In conclusion, the intake of linoleic acid appears to determine the extent to which dietary 20:5 ω 3 and 22:6 ω 3 can alter the balance between thromboxane and prostacyclin production.

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