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PROCEEDINGS OF THE NUTRITION SOCIETY

ABSTRACTS OF COMMUNICATIONS

The Three Hundred and Sixty-seventh Meeting of the Nutrition Society was held in the Royal Society of Medicine, London, on Thursday, 3 December, 1981, *when the following papers were read:*

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Dietary survey during pregnancy in a low socio-economic group. By WENDY DOYLE, M. A. CRAWFORD and B. M. LAURANCE, *Nuffield Laboratories of Comparative Medicine, Zoological Society of London, Regent's Park NW1*

There are different requirements for early development in different species. These differences are reflected in the relationship between milk composition and the rate of postnatal body growth. For example, the protein content in human milk is 7·5% and in cow's milk 20·3% of the dietary energy (Paul & Southgate, 1978). We have therefore examined the relative importance of protein, dietary fats and energy in relation to foetal development and low birth weight (LBW).

Maternal food intakes were studied in seventy-six mothers, in a low socio-economic group, in the City and East End of London where 9·6% of births are below 2500 g compared with the national average of 7·2% (Office of Population Census and Surveys, 1980). Diet was assessed by weighed food intakes during one week in each trimester.

The mean birth weight of our sample was 3025 g with 11·8% below 2500 g which is considered to be the demarcation point for LBW. Chamberlain *et al.* (1975) suggest that because the incidence of perinatal mortality commences to climb at just under 3000 g a more realistic definition would be 3000 g at term. The babies of 50% of the mothers surveyed were at or below this latter weight.

The mean energy intake over the three weeks was 7·1 MJ (1689 kcal) with only 6% of the mothers meeting the RDA in any one trimester. The mean protein intake was 66·9 g and was above the RDA in each trimester. Comparisons of the intakes of mothers with infants born above and below 2500 g, show a significant difference in energy, fat and pyridoxine intakes but none in protein intake (see Table).

	<2500 g (*n* 9)		>2500 g (*n* 62)		Statistical significance of difference: *P*
	Mean	SE	Mean	SE	
Energy (MJ (kcal)/d)	6·0 (1446)	95	7·2 (1723)	40	<0·001
Protein (g/d)	61·7	5·2	67·8	1·7	
Fat (g/d)	62·1	5	72·6	1·7	<0·025

Our finding that the major nutritional deficit in the LBW group was in dietary energy and fats whilst the mean protein intakes were in excess of the RDA is of interest in view of the report by Rush *et al.* (1980). They observed that high protein supplementation in pregnancy was associated with excess premature deliveries, and a consequent excess of neonatal deaths as well as intrauterine growth retardation. The results of these studies point to the importance of the nutrient ratio. Our general data also suggest that there is a nutritional problem associated with poor families.

Chamberlain, R., Chamberlain, G., Howlett, B. & Claireaux, A. (1975). *British Births* (1970), vol. 1. London: W. Heinemann Medical Books Ltd.

Office of Population Census and Surveys (1980). *OPCS Monitor* DH3 80/2.

Paul, A. A. & Southgate, D. A. T. (1978). *McCance & Widdowson's The Composition of Foods*. London: HM Stationery Office.

Rush, D., Stein, Z. & Susser, M. (1980). *Pediatrics, Springfield* **65**, 683.

Changing dietary patterns among Hong Kong Chinese families now settled in London. By SWEE POH TAN and ERICA WHEELER, *Department of Human Nutrition, London School of Hygiene and Tropical Medicine, Keppel Street, London WC1E 7HT*

Between March 1980 and September 1981 a longitudinal survey of food intake, food behaviour and nutritional status was carried out among ethnic Chinese families, settled permanently in London but originating from Hong Kong. The objective of four successive visits was achieved in thirty-one families out of an initial sample of fifty. At each visit, the height, weight and triceps skinfold thickness of pre-school children were measured, a dietary recall was taken; the mother was questioned about some aspect of food behaviour. Detailed information has thus been obtained on the adaptation of the Chinese family food pattern to life in London, explanations given by families for their choice of food and cooking methods, and the way in which this fits into the traditional Chinese health system. In this communication we present some anthropometric measurements and some aspects of the families' dietary pattern.

The weights and heights of most pre-school children (forty boys and thirty-four girls aged 0–5 years) were within the range of the Tanner 3rd–97th percentiles for age.

The dietary pattern is based on what would be eaten in Hong Kong. All the families purchase and prepare characteristically Chinese foods, especially for the evening meal. Incorporation of British foods into the diet has come (1) for reasons of convenience and (2) through requests from children who attend British schools. The 'convenience' factor operates strongly in the breakfast meal. In Hong Kong, fresh-cooked breakfast foods and snacks are purchased from street vendors. These have been replaced in London by bread, breakfast cereals (including porridge) and Chinese snack foods, suitable for purchase in shops and storage at home.

Foods which children have encountered at school and demand at home include Italian pastas, fish fingers, hamburgers, sausages, crisps, cheese, chips, cakes and bread. These foods may be prepared for midday meals when children are at home in the holidays, or eaten as snacks. There is a conflict for the mother between supplying food which her children enjoy, and her belief that Western processed, pre-cooked foods are less health-promoting than fresh ones (this conflict also occurs in infant feeding). Some mothers regard school meals as not very nourishing, and the custom is developing of providing a meal (called 'tea') for children on return from school. This consists of cold or milky drinks, bread, Chinese snack foods and cakes, and is a new addition to the Hong Kong dietary pattern. Some mothers also prepare special herbal drinks for school-aged children, to counterbalance the school meal which, in their view, is 'unbalanced'.

The study is supported by a grant from the Ministry of Agriculture, Fisheries and Food.

Persistent nausea and other variables in pregnancy—a possible association with cow's milk allergy in infants. By JUDITH M. BAYLIS and ANTHONY R. LEEDS, *Department of Nutrition, Queen Elizabeth College, London, W8 7AH* and DAVID N. CHALLACOMBE, *Childrens Research Unit, Musgrove Park Hospital, Taunton*

Feeding problems in infancy have been associated for many years with the ingestion of cow's milk. A characteristic profile of cow's milk allergy is recognized and the presence of a family history of atopy is a common feature. Early introduction of cow's milk is considered to increase the likelihood of sensitization. Recent work has suggested that sensitization may occur during lactation (Matsumura *et al.* 1975; Jakobsson & Lindberg, 1978) and *in utero* (Dannaeus *et al.* 1978; Matsumura *et al.* 1975). It is suggested in this study that sensitization may occur *in utero* in some women and that this may be indicated by vomiting in pregnancy.

To test this hypothesis, twenty-one children under 5 years of age, who had well defined cow's milk allergy were matched with an equal number of controls. The mothers were questioned on their diet and health during pregnancy, on their method of infant feeding and on the development of allergic signs in their children.

It was found that the milk-allergic infants were breast fed for longer and had cow's milk introduced later than the control group. An increased incidence of persistent nausea during pregnancy was found in the mothers of the allergic children although the incidence of vomiting was the same in both groups. Significantly more mothers of allergic children were found to have nausea in pregnancy and a personal history of atopy ($P<0.05$; Wilcoxon's matched pairs signed ranks test). Examination of the maternal diet showed that cravings in pregnancy were more common among mothers of the non-allergic children. However aversions to various foods were more prevalent among the mothers of the allergic infants, particularly to coffee and dairy produce.

These findings indicate that a larger prospective study is needed to investigate further the relationship between nausea and vomiting in pregnant atopic women and the development of food allergies in their infants.

Dannaeus, A., Johansson, S. G. O. & Foucard, T. (1978). *Acta Paediat. Scand.* **67**, 497.
Jakobsson, I. & Lindberg, T. (1978). *Lancet* ii, 437.
Matsumura, T., Kuroume, T., Oguri, M., Iwasaki, I., Kanbe, Y., Yamada, T., Kawabe, S. & Negishi, K. (1975). *Ann. Allergy* **35**, 221.

Serum glucose and insulin responses in man, after varying the viscosity of starch. By CELIA A. WILLIAMS and IAN MACDONALD, *Department of Physiology, Guy's Hospital Medical School, London SE1 9RT*

To investigate the effect of the viscosity of a carbohydrate meal on serum glucose and insulin responses ten healthy volunteers, five male and five female, were given four test meals in randomized order, blood samples were taken at intervals and serum assayed for glucose and insulin. The carbohydrates used were glucose (Glc), starch as a gel (Gel S), starch as a fluid (Flu S) and the fluid starch to which guar (2 g/10 g starch) had been added (Flu S + guar). All meals contained 0·75 g carbohydrate/kg body-weight in 5·4 ml water/kg body-weight flavoured with lemon essence and aspartame. Glucose was given as a solution, the three starch meals were cooked in a consistent manner to develop their viscous nature and water losses were corrected. The Gel S and Flu S + guar were of similar viscosity (1800 and 2026 Biabender units respectively) whereas the Flu S was less viscous (540 Biabender units).

There was no sex difference in the serum glucose and insulin responses to the test meals. The Glc, Gel S and Flu S meals resulted in similar mean serum glucose response curves, whereas after Flu S + guar the initial rise in the mean serum glucose concentration was less. However, at 60 and 90 min the mean serum glucose response to Flu S + guar was higher than after the other three meals. The mean areas under the glucose response curves to the four meals were not significantly different from each other. The maximum mean serum insulin response was seen after the glucose meal, however, the mean area under the insulin curve after Flu S and Glc were not significantly different. The mean area under the insulin response curve to Gel S was significantly lower than after glucose ($P<0·05$). The mean area under the insulin response to Flu S + guar was significantly less than after the other three meals ($P<0·01$).

These results suggest that the viscosity of a carbohydrate meal, present as a property of the polymer length of the starch, can alter the serum insulin but not the serum glucose response, the more viscous meal eliciting a smaller insulin response. When the viscosity of the meal is increased by the addition of guar the glucose would appear to be absorbed at a slower rate. It is possible that this is due to the guar-containing meal maintaining its viscosity in the duodenum and jejunum whereas the viscosity of the starch would be expected to be diminished by the hydrolytic action of amylase.

We are grateful to the volunteers and to Roquette and Nestlé for the starch and advice on the method of preparation.

Effect of guar gum on glucose absorption from isolated loops of jejunum in conscious growing pigs. By ANNA L. RAINBIRD, A. G. LOW and TERESA ZEBROWSKA, *National Institute for Research in Dairying, Shinfield, Reading RG2 9AT*

The beneficial effects of guar gum on glucose tolerance in normal and diabetic man are well established but its mode of action is unclear. It has been shown that guar gum reduces glucose absorption (Johnson & Gee, 1981). The aim of this experiment was to establish if this occurred in the pig which has been shown to be a suitable model of man (Leeds *et al.* 1980).

Four 35 kg pigs were surgically prepared with two re-entrant cannulas in the jejunum 1·5 m apart. This allowed an isolated loop of jejunum to be formed through which solutions could be perfused.

For 4 weeks pigs were perfused with solutions containing glucose or maltose, without or with guar gum, in a new Ringer solution of similar mineral content to pig jejunal digesta. Solutions kept at 40° were perfused through the loop, using a peristaltic pump, for 6 h a day. The solutions were marked with ^{51}Cr-EDTA to measure net secretion or absorption in the loop.

The effect of guar gum on the mean net absorption (%) of glucose and water from perfusates containing glucose or maltose is shown in the Table.

	Glucose (20 g/l)		Maltose (20 g/l)	
Perfusate . . .	Glucose	Water	Glucose	Water
Without guar gum	74·2	42·7	71·1	49·2
With guar gum (6·7 g/l)	41·0	7·9	35·0	5·1

Guar gum significantly ($P<0·001$) reduced the net absorption of both glucose and water from perfusates with glucose and maltose, perhaps because of slower diffusion of glucose from the gut lumen to the epithelium, or slower uptake. There were no significant differences between maltose and glucose suggesting that guar gum does not inhibit maltase activity.

We thank R. M. W. Hopkins of the Meyhall Chemical Company for the gift of guar gum.

A.L.R. acknowledges receipt of an ARC research studentship.

Johnson, I. T. & Gee, J. M. (1981). *Gut* **22**, 398.
Leeds, A. R., Kang, S. S., Low, A. G. & Sambrook, I. E. (1980). *Proc. Nutr. Soc.* **39**, 44A.

The effects of legumes on mucosal cell turnover in rats. By SUSAN J. FAIRWEATHER-TAIT, JENNIFER M. GEE, IAN T. JOHNSON and WENDY E. NELSON, *Agricultural Research Council, Food Research Institute, Colney Lane, Norwich, Norfolk NR4 7UA*

The protein in legumes has a low digestibility when measured by conventional techniques (Burr, 1975). Bender & Mohammadiha (1981) have suggested however that, in the rat, part of the faecal N is endogenous, and results from what they described as a massive increase in mucosal cell turnover. We have used the technique of pulse-labelling of mucosal cells with [^{3}H]thymidine to compare the cell loss in rats fed on a diet containing beans with that in animals fed on a control diet.

Twenty-six immature male Wistar rats were randomly divided into two groups. One group was fed on a diet containing 400 g/kg white kidney beans (*Phaseolus vulgaris*) which had been cooked, dried and ground. The control group consumed a semi-synthetic diet of similar protein and energy content. After 10 d both groups were given [^{3}H]thymidine (50 μCi) by intra-peritoreal injection. Half of each group were killed 3 d post-injection and the remainder 5 d post-injection. Segments of jejunum, ileum and colon were removed for ^{3}H counting, and 'mucosal scrapes' were prepared for measurement of DNA and protein content, and for estimations of mucosal disaccharidase activity.

Slight morphological differences in the small intestines of the two groups were observed. The bean-fed animals had slightly longer intestines ($P<0.02$) than the controls, and showed a small decrease in the dry weight/unit length. The DNA and protein contents (mg/g dry weight tissue) of mucosa of animals killed 5 d post-injection were also higher in the bean than in the control group, though the DNA:protein values were similar. Disaccharidase activities did not differ between the two groups.

The ^{3}H content (counts/min per mg dry tissue) of all the intestinal samples in both groups declined significantly between 3 d and 5 d post-injection, indicating a loss of cells from the labelled mucosal pool. However, there were no significant differences in the ^{3}H content of any of the samples between the two groups, and hence no evidence for increased cell turnover in either the small intestines or the colons of the bean-fed animals.

Our results are not consistent with the proposal that the elevated faecal-N in bean-fed rats is an indication of a much increased proliferation and loss of intestinal mucosal cells and we suggest that its likely origin is either undigested protein or bacterial or both. However, since beans cause changes in the morphology of the gut further work is required before we can definitely identify the origin of the increased faecal-N.

Bender, A. E. & Mohammadiha, H. (1981). *Proc. Nutr. Soc.* **40**, 66A

Burr, H. K. (1975). In *Protein Nutritional Quality of Foods and Feeds* part 2, p. 117 [M. Friedman, editor]. New York: Dekker.

The nature of niacin in sorghum. By BAHIELDIN I. MAGBOUL and DAVID A. BENDER, *Courtauld Institute of Biochemistry, The Middlesex Hospital Medical School, London W1P 7PN*

The niacin of most cereals is known to be largely chemically bound, and therefore presumably biologically unavailable. However, Belavady & Gopalan (1966) have claimed that in *Sorghum vulgare* the niacin is present as free nicotinic acid. By contrast, Ghosh *et al.* (1963) showed only about 15% of the niacin of sorghum to be free, while Carter & Carpenter (1980) were unable to demonstrate any free nicotinic acid, although approximately 35% of the total niacin content of sorghum was biologically available. This discrepancy has been investigated using samples of two varieties of sorghum commonly eaten in the Sudan.

Samples of sorghum meal were extracted with water, 0·1 M-hydrochloric acid or 0·1 M-sodium hydroxide for 45 min at room temperature, or with 0·5 M-sulphuric acid for 90 min at 100°. The extracts were adjusted to pH 6·5, mixed with an excess of acetone and centrifuged to remove denatured proteins, then extracted with chloroform. The nicotinic acid in the aqueous phase was determined by the colorimetric method of Carlson (1966).

Sorghum variety	Nicotinic acid (mg/kg meal) extracted by:			
	Water	0·1 M-HCl	0·1 M-NaOH	0·5 M-H_2SO_4
Feterita	6·4	8·7	16·9	16·0
Mayo	6·5	8·1	23·6	23·0

These results confirm that the majority of the niacin of sorghum is chemically bound and therefore presumably unavailable. Belavady & Gopalan (1966) used 0·5 M-H_2SO_4 or $Ca(OH)_2$ solution as extraction medium, and it must be assumed that they hydrolysed much of the bound niacin of their samples prior to chemical or microbiological estimation.

The increase in free nicotinic acid after extraction with 0·1 M-HCl, compared with water extraction, suggests some degree of hydrolysis of the bound material even under such mild conditions. If this also occurred in vivo, as a result of the action of gastric acid, it would explain the apparent partial availability of bound niacin reported by Carter & Carpenter (1980).

Belavady, B. & Gopalan, C. (1966). *Ind. J. Biochem.* **3**, 44.
Carlson, D. A. (1966). *Clin. Chim. Acta* **13**, 349.
Carter, E. G. A. & Carpenter, K. J. (1980). *Fedn Proc. Fedn Am. Socs exp. Biol.* **39**, 557.
Ghosh, H. P., Sarkar, P. K. & Guha, N. C. (1963). *J. Nutr.* **79**, 451.

Dietary fibre, sodium, hypertension and C-reactive protein. By P. M. DODSON, B. SHINE, D. J. GALTON and J. LANDON, *Departments of Medicine and Chemical Pathology, St. Bartholomew's Hospital, London*

C-reactive protein (CRP) is an acute phase reactant which rises in response to tissue injury, chronic inflammatory disorders, malignant neoplasia and infective states. We now report that serum CRP levels are elevated in patients with essential hypertension and the significant changes in serum CRP levels of hypertensive patients on a dietary regimen of high-fibre, low-fat and low-salt.

Thirty-two outpatients with essential hypertension were treated with a high-dietary-fibre (40 g/d), low-fat (15% of total energy), low-sodium (40–50 mmol/d), high-potassium (80–90 mmol/d (Na–K, 1:2)) dietary regimen which provided 6·5–7·5 MJ/d. On the initial visit and after 3 months on the dietary regimen, blood pressure and weight were recorded. Fasting levels of serum CRP were determined in twenty-five of the hypertensive patients and in fifty healthy volunteers (*n* 50), by single antibody radioimmunoassay with a sensitivity of 70 ng/ml.

There was a significant reduction in supine diastolic blood pressure (mean ± SD:98·2±8·2 to 86·1±9·0 mm Hg:$P<0·001$) and weight (77·6±11·9 to 73·9±10 kg:$P<0·001$) in the hypertensive patients on the dietary regimen as previously reported (Dodson & Humphreys, 1981).

	At entry		3 months on dietary regimen		Statistical significance of difference between values:
	Mean	SD	Mean	SD	*P*
C-reactive protein (mg/l)	4·99	1·2	3·77	1·2	—
Log CRP (mg/l)	3·5	0·40	3·29	0·45	<0·01
Serum globulin (g/l)	34·3	0·93	32·1	0·7	<0·05
Serum total protein (g/l)	76·9	1·1	74·9	1·0	NS

NS, not significant.

Serum CRP levels were significantly elevated in the hypertensive patients on the initial visit compared to the healthy volunteers (4·99±1·2 *v.* 1·40±2·52 mg/l: $P<0·001$). However, as the Table shows, after 3 months on the dietary regimen, the hypertensive patients showed a significant reduction in serum CRP levels ($P<0·01$) and in serum globulin concentration ($P<0·05$) while serum total protein levels were not significantly different.

We conclude that patients with essential hypertension have elevated levels of serum CRP which together with serum globulin levels, weight and blood pressure may be lowered by a high-fibre, low-fat and low-salt dietary regimen.

Dodson, P. M. & Humphreys, D. (1981). *Western Diseases: their emergence and treatment.* Chap. 24. [Trowell and Burkitt, editors]. London: Arnold.

The effect of zinc supplementation on plasma levels of vitamin A and retinol-binding protein (RBP) in children recovering from protein–energy malnutrition (PEM). By P. M. MATHIAS*, *Tropical Metabolism Research Unit, University of the West Indies, Jamaica*

Studies suggest that zinc plays a role in the transport of vitamin A in plasma (Solomons & Russell, 1980). At the T.M.R.U. oral Zn supplements are given to some children during their treatment for PEM. The present study examines the effect of Zn on the plasma levels of vitamin A and its carrier, RBP, in these children.

Twenty-two children with PEM, aged 4–34 months (mean 13·6), were studied. Eleven were given a supplement of 2 mg Zn/kg body-weight per d during their treatment (Zn^+ group). the other eleven (Zn^- group) only received Zn present in the feeds (80 μg/kg body-weight per d for the maintenance diet and 0·55 mg/kg body-weight per d for the rapid growth diet). There were no differences between the groups in the mean intakes of vitamin A, protein and energy during maintenance (585 μg, 0·6 g/kg body-weight and 400 kJ/kg body-weight per d respectively) or during rapid growth (1134 μg, 3–4 g/kg body-weight and 600–800 kJ/kg body-weight per d respectively). The mixed diet provided normal intakes of nutrients. Vitamin A and RBP were measured in plasma on admission, at the end of maintenance, at intervals into rapid growth, and after a period on mixed diet, immediately before discharge. The results are shown in the Table.

		Days		Days on Zn			Vitamin A (μg/l)		RBP (μg/ml)	
Group	Period	Mean	SE	Mean	SE	No. of samples	Mean	SE	Mean	SE
Zn^+	Admission	—	—	—	—	11	157	26^a	23·1	$4·1^a$
	Maintenance	17	3	10	3	7*	399	53^{bc}	54·8	$6·8^b$
	Rapid growth	38	6	30	3	22	441	39^{bc}	51·7	$5·5^b$
	Mixed diet	10	2	—	—	11	373	47^{bd}	33·4	$2·5^c$
Zn^-	Admission	—	—	—	—	11	231	53^{ae}	26·9	$5·2^a$
	Maintenance	8	1	—	—	11	517	65^b	49·6	$3·6^b$
	Rapid growth	28	4	—	—	18	381	26^c	44·5	$4·4^b$
	Mixed diet	8	1	—	—	11	269	34^{de}	25·4	$1·6^d$

a,b,c,d,e, Values in the same column that do not have common superscripts are significantly different ($P<0·05$).

*Four children commenced oral Zn during rapid growth.

The highly significant increases in vitamin A and RBP during maintenance ($P<0·005$) appeared to be independent of Zn supplementation. However, the raised vitamin A and, to a lesser extent RBP values, were thereafter sustained throughout recovery in Zn^+ group, whereas those in the Zn^- group decreased to admission values before discharge.

It is not clear from these results whether the effect of Zn on plasma vitamin A is mediated through an effect on plasma RBP.

Solomons, N. W. & Russell, R. M. (1980). *Am. J. clin. Nutr.* **33**, 2031.

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Effect of zinc deficiency on the conversion of β-carotene to retinol as indicated by liver stores. By H. R. H. TAKRURI and D. I. THURNHAM, *Department of Human Nutrition, London School of Hygiene and Tropical Medicine, Keppel Street (Gower Street), London WC1E 7HT*

Zinc plays a role in vitamin A metabolism by affecting the synthesis of retinol-binding protein and by being essential for some enzymes involved in vitamin A metabolism. Zn may also influence the conversion of β-carotene to retinol through retinal reductase, which is Zn dependant. In this study the conversion of β-carotene to vitamin A was investigated in Zn deficient rats already depleted of vitamin A.

Weanling Sprague-Dawley rats (twenty-eight) raised with minimal liver vitamin A reserves (Takahashi *et al.* 1975) were randomly divided into four dietary groups and housed individually in stainless steel cages. All rats were fed on a vitamin A-free diet for 18 d to completely deplete liver stores. In addition, the Zn-deficient group (ZD) received marginal Zn supplies (9·0 mg/kg diet) from day 10 to day 16 and 2·5 mg/kg till the end of the experiment. The other three groups (*ad lib.* control, C; pair-fed, PF; weight-matched, WM) received 30 mg Zn/kg diet throughout the experiment.

On depletion of liver stores (day 18) 500 μg β-carotene in 0·5 ml cotton-seed oil was given intragastrically to each rat for 10 d. Rats were killed and liver and serum were analysed for Zn and vitamin A. The Table shows the concentrations of retinol.

		Expt. 1				Expt. 2			
		μg/100 ml serum		μg/g liver		μg/100 ml serum		μg/g liver	
Group (n 5)	Zn (μg/kg diet)	Mean	SE	Mean	SE	Mean	SE	Mean	SE
ZD	$2{\cdot}5^{I}$ $1{\cdot}4^{II}$	29·0	2·9	8·1	0·8	19·6	0·9	15·1	2·1
C	30	39·0	3·1*	11·7	0·7*	30·0	3·8*	16·1	0·9
PF	30	32·2	2·1	20·5	3·3*	22·3	1·7	38·7	3·0*
WM	30	23·8	2·1	20·8	2·8*	22·3	1·5	39·3	3·2*

*Significant difference ($P<0{\cdot}05$) from ZD group.

The results showed that serum retinol in the ZD group was not significantly different from that in the PF and WM groups but liver reserves (μg/g) were much lower ($P<0{\cdot}01$). The difference between liver reserves (μg/g) in the ZD and C rats was not so apparent as that in the PF and WM groups. The explanation for the low concentration of retinol in livers of the C group may be due to the more rapid growth and higher vitamin A requirements of this group than that in the PF and WM groups. The results therefore suggest that Zn deficiency impairs the efficiency of β-carotene utilization in the rat.

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Takahashi, Y. I., Smith, J. E., Winick, M. & Goodman, D. S. (1975). *J. Nutr.* **105**, 1299.

Iron absorption from chicken meat. By F. BOGUNJOKO, R. J. NEALE and D. A. LEDWARD, *Department of Applied Biochemistry & Nutrition, University of Nottingham School of Agriculture, Sutton Bonington, Loughborough, Leics. LE12 5RD*

The use of rats as animal models to study the absorption and availability to humans of iron from food still requires clarification. In particular, haem-Fe absorption (the predominant form of Fe in beef) is reported to be much lower in rats than humans (Weintraub *et al.* 1965) although other studies suggest a high absorption of haem-Fe in rats, both as haemoglobin (Bannerman, 1965) or as ^{59}Fe-labelled meat (Amine & Hegsted, 1971). We have studied the absorption of Fe from ^{59}Fe-labelled chicken meat fed as a slurry to rats by stomach tube. Fe absorption was measured over short time intervals as the difference between the ^{59}Fe given and that present in gut lumen and gut wall after killing the rats. Absorption over a 7 d period was the difference between ^{59}Fe fed and that recovered in urine and faeces. Results using three different forms of chicken meat in Fe-replete rats are shown in the Table.

	Absorption of ^{59}Fe (%)				
Time . . .	30 min	60 min	120 min	240 min	7 d
Water-soluble meat extract	16·9	22·4	13·4	14·5	14·0
Whole chicken meat	—	25·4	18·3	—	18·7
Water insoluble meat residue	—	—	6·7	—	5·8

With the water-soluble meat extract (containing 45% total meat-Fe and approximately 33 μg total Fe) Fe absorption followed a biphasic pattern with maximal absorption at 60 min which then dropped to a lower constant level at 120 and 240 min. The 7 d result agreed closely with the values obtained after 120 and 240 min. The whole chicken meat slurry (33 μg Fe) showed the highest absorption the high value at 60 min falling off again at 120 min, this value agreeing well with the 7 d result.

The water insoluble meat residue (33 μg) gave the lowest absorption, the Fe being presumably in a poorly available form.

The results show a varying pattern of availability of the various forms of meat Fe the absorption of the soluble Fe showing a biphasic pattern similar to that shown by Fe salts (Wheby & Crosby, 1963). The availability of the whole chicken meat-Fe was of a similar magnitude to that in human studies (Callender, 1971).

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Bannerman, R. M. (1965). *J. Lab. clin. Med.* **65**, 944.
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Weintraub, L. R., Conrad, M. E. & Crosby, W. H. (1965). *Proc. Soc. exp. Biol. Med.* **120**, 840.
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The release and movement of chromic oxide from a capsule in the rumen of sheep. By F. A. HARRISON, R. H. LABY* and J. L. MANGAN, *ARC Institute of Animal Physiology, Babraham, Cambridge CB2 4AT*

To follow the movements of the soluble and insoluble products of microbial digestion of plant food in ruminant herbivores, inert markers of the two phases have been widely used. In preliminary experiments we have compared the movement of a soluble marker, chromium ethylene diamine tetra-acetate (CrEDTA), infused continuously into the reticulo-rumen, with that of an insoluble marker, chromic oxide (Cr_2O_3), suspended in sucrose mono-stearate (50:50 w/w) and released slowly from a capsule (Harrison *et al.* 1981) placed in the rumen. The Cr_2O_3 was a finely ground preparation before suspension and 94% of the particles were $<10\mu$ and 4·5% between 10 and 23μ. Sheep were surgically prepared, under general anaesthesia, with a cannula in the rumen and, in some cases, with a single re-entrant cannulation of the duodenum. All experiments took place at least one month after any surgery. The sheep were housed in metabolism cages (Harrison, 1974) to enable separate collection of urine and faeces. They were fed once daily on a diet of 500 g lucerne nuts and 600 g chaffed hay with a measured supply of water and a mineral salt lick always available. At the start of observations, a Cr_2O_3 capsule was inserted through the rumen cannula and anchored by attached nylon threads to the cannula. A continuous infusion of CrEDTA solution (2·8 mg Cr/ml) was established using a roller pump delivering 0·085 ml/min. The release of Cr_2O_3 was assessed by daily measurement of the movement of the capsule plunger. CrEDTA was extracted with water from the finely ground dried faeces and the washed residue was digested with perchloric–sulphuric acids to convert Cr_2O_3 to chromate. Cr was estimated in both fractions and in urine by atomic absorption flame spectrophotometry.

There was linear release of Cr_2O_3 for up to 20 d at an average rate equivalent to 111 mg Cr/d. Daily excretion of Cr_2O_3 in faeces reached a plateau 5–6 d after inserting the capsule into the rumen and was similar to the daily release of Cr_2O_3. CrEDTA excretion peaked 3–4 d after starting an infusion and up to 5% of soluble Cr was excreted in urine. Hourly collections of faeces over 24 h revealed differential movements of the two markers.

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Flavomycin as a ruminant growth promoter—investigation of the mode of action. By J. B. ROWE, J. S. W. MORRELL and A. W. J. BROOME, *ICI Pharmaceuticals Division, Alderley Park, Macclesfield, Cheshire SK10 4TG*

Flavomycin is a phosphorus containing glycolipid antibiotic. Recently, its use in cattle diets was claimed to improve growth rates and feed conversion (Hoechst, unpublished).

The aim of this study was to examine the action of flavomycin in the rumen. In the first experiment the effect of flavomycin and monensin on the role of cellulose degradation in the rumen were measured using the dacron bag technique (chopped hay). Nine ruminally-cannulated cattle, divided into three groups, received a diet consisting of concentrate (g/kg; 800 barley, 170 soya bean, 30 minerals) at 8 g/kg live weight per d and pelleted straw *ad lib.* The concentrate given to two groups contained either monensin or flavomycin to provide 0·5 and 0·2 mg active ingredient/kg live weight per d respectively. During the 3 week period when the medicated diets were fed, six measurements were made of cellulose degradation and the concentrations of rumen volatile fatty acids and ammonia. No significant differences in rumen fermentation due to flavomycin were observed in this experiment. The rate of degradation of chopped hay was reduced ($P<0·05$) and the molar proportion of propionate increased ($P<0·05$) by monensin.

The second experiment was designed to measure post-ruminal antibacterial activity of flavomycin. Four sheep fitted with permanent cannulas in the rumen, duodenum and ileum were fed on a pelleted diet containing 220 mg flavomycin/kg from a continuously moving belt feeder. The rate of fluid flow through the digestive tract was measured relative to Cr-[^{14}C]EDTA (infused intraruminally). The concentration of flavomycin was measured by a zone inhibition bioassay using agar gel seeded with spores of *Bacillus subtilis*. There appeared to be no loss of antibacterial activity of flavomycin in the digestive tract.

These observations suggest that flavomycin may act as a post-ruminal growth promoter by controlling intestinal microflora. It therefore seems possible that other antibiotics, currently used as growth promoters in monogastrics may be used in the same way as flavomycin. Protection of these antibiotics (e.g. with lipid, protein and formaldehyde) against rumen microbial action may be necessary.

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The effect of Durabolin on protein metabolism in the female rat. By NICOLA W. DUMELOW, J. T. PEARSON, CHRISTINE P. ESSEX and PETER J. BUTTERY, *University of Nottingham School of Agriculture, Department of Applied Biochemistry and Nutrition, Sutton Bonington, Loughborough, Leics. LE12 5RD*

Trenbolone acetate (TBA) is a growth promoter with androgenic properties, its mode of action involving a decrease in both protein synthesis and degradation (Vernon & Buttery, 1976). The following results show the effect of Durabolin (nandrolone phenylpropionate, a testosterone analogue—an anabolic agent used in clinical practice) on the protein metabolism of female rats.

Twelve entire female rats were injected daily for 14 d with either a placebo or Durabolin (4 mg/kg body-weight). They were individually housed and fed on a powdered diet containing 160 g casein/kg. The results are shown in the Table.

	Fractional† synthetic rate (d)		Urinary 3-methylhistidine: creatinine (μmol/mg)		Body-weight gain over 14 d (g)		Food conversion ratio (g food consumed/g weight gain)	
Group	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Control (placebo injection: six animals)	0·044	0·004	1·97	0·39	36·5	4·8	5·86	0·46
Experimental (4 mg Durabolin/kg body-weight per d; six animals)	0·075	0·010*	3·10	0·25*	50·0	3·1*	4·24	0·18*

Significant differences between test and control groups *$P<0.05$.
†See Vernon & Buttery (1976).

Durabolin increased the rate of muscle protein synthesis, in contrast to the effect of TBA. The 3-methylhistidine results indicate an accelerated rate of protein breakdown in the treated rats, again contrasting with TBA (Vernon & Buttery, 1978). In a second growth trial, when animals were given a conventional rat diet, cathepsin D activity was measured (Barrett, 1972). The weight gains (means ± SEM) over 12 d were significantly different ($P<0.001$): controls 31·8±0·4 g, tests 43·7±2·0 g. The free Cathepsin D activity (counts/min per mg protein) was also significantly different ($P<0.05$) at 2·47±0·19 and 3·19±0·17 for control and test rats respectively. This is consistent with the 3-methylhistidine results, and contrasts with the effect of TBA (Vernon & Buttery, 1980).

In conclusion, these results suggest a diversity in the modes of action of two growth promoters, both with androgenic properties.

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Pyruvate dehydrogenase activity of perirenal adipose tissue from foetal lambs. By J. P. ROBERTSON, ANNE FAULKNER and R. G. VERNON, *Hannah Research Institute, Ayr, Scotland KA6 5HL*

Pyruvate dehydrogenase (PDH), as well as ATP-citrate lyase (ACL), probably has a key role in regulating fatty acid synthesis (FAS) from glucose in ruminant adipose tissue (Robertson *et al.* 1980). As the rate of FAS from glucose is higher in adipocytes from foetal than 8-month-old sheep (Vernon *et al.* 1981), we have compared PDH activities in such animals.

Methods have been described (Robertson *et al.* 1980; Vernon *et al.* 1981) except that for PDH, the pyruvate and Mg^{2+} concentrations were doubled during the assay and 6 mM-pyruvate was added during the activation step.

As shown below, PDH activity, active-state and total, and FAS from glucose, were significantly higher in cells from foetal than adult sheep ($P<0.01$, $P<0.05$ and $P<0.01$ respectively) whereas there was no difference in ACL activity.

	Perirenal adipose tissue					
	30 d pre partum			9 months post partum		
	n	Mean	SEM	*n*	Mean	SEM
Glucose to fatty acid (nmol/2 h per 10^6 cells)	3	45·0	8·5	4	3·0	1·3
PDH (nmol/min per 10^6 cells):						
Active state	4	13·1	1·3	4	5·2	1·3
Total	4	18·9	0·7	4	10·5	3·2
ACL (nmol/min per 10^6 cells)	3	6·4	0·7	4	5·0	1·3

The relatively greater difference between the rates of FAS from glucose at the two ages than the PDH activities at the two ages is probably due to an additional regulatory step during glycolysis as suggested from other studies (Robertson *et al.* 1981) for the rate of glycolysis is likely to be greater in foetal than adult adipocytes.

The results are in agreement with our view that the reaction catalyzed by PDH is one of a series of restrictions which limit FAS from glucose in sheep adipose tissue.

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Testicular lipids of rats given an EFA deficient diet supplemented with linoleate or linolenate. By W. M. F. LEAT, N. G. E. CLARKE, F. A. HARRISON, *ARC Institute of Animal Physiology, Babraham, Cambridge CB2 4AT* and R. W. COX, *Institute of Ophthalmology, Cayton Street, London EC1V 9AT*

Rats fed for 35 weeks or more on an essential fatty acid (EFA) deficient diet alone or supplemented with linolenate (C18:3) develop testicular atrophy whereas rats given linoleate (C18:2) show normal testicular development (Cox *et al.* 1981). Analysis of the total lipids of the testes of these EFA-deficient and C18:3-supplemented rats revealed that, compared with C18:2-fed animals, there were reduced proportions of docosapentaenoic acid (C22:5ω6) and of a polar lipid identified as a sulphogalactosylglyceride, the principal glycolipid of normal rat testis (Ishizuka *et al.* 1973). The distribution of individual phospholipids was similar in all testes, the major components being choline phosphoglycerides (47–48%) and ethanolamine phosphoglycerides (29–32%).

In a second experiment to determine histological changes occurring before 35 weeks of age, eight male rats from two litters born to C18:3-supplemented females were weaned at 4 weeks and reared to 37 weeks of age in four groups: (1) EFA-deficient diet alone (EFA-D), (2) EFA-D + C18:2, (3) EFA-D + C18:3, (4) commercial diet (Labsure, Poole, Dorset). Under pentobarbitone anaesthesia a unilateral orchidectomy was carried out on one rat from each group at 13 weeks and on the second animal at 26 weeks of age. Histological examination showed that the testes from rats of Groups 2 and 4 were normal in appearance, whereas those of Groups 1 and 3 showed well marked atrophy. The fatty acids of the atrophic testes contained reduced proportions of C20:4ω6 and C22:5ω6 (see Table). In one rat of Group 3 where the supplement of C18:3 was replaced with C18:2 from 27 weeks of age, regeneration of some seminiferous tubules had occurred by 35 weeks of age, with the establishment of spermatogenesis. The proportion of C22:5ω6 in the testicular fatty acids of this animal had also increased.

Major polyunsaturated fatty acids (% by weight) of the total lipids of testes removed by unilateral orchidectomy at 13 weeks of age

	Fatty acid								
Diet	18:2 ω6	18:3 ω3	20:3 ω9	20:4 ω6	20:5 ω3	22:4 ω6	22:5 ω6	22:5 ω3	22:6 ω3
EFA-D	0·8	nd	6·6	4·2	nd	0·8	1·9	nd	nd
EFA-D+18:2	2·7	nd	0·7	14·2	nd	1·9	18·7	1·0	1·0
EFA-D+18:3	1·2	0·9	3·5	6·7	2·0	0·5	2·1	0·7	4·7
Commercial	5·7	0·2	0·2	14·7	nd	1·8	18·3	1·2	1·0

nd, not detected.

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