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ABSTRACTS OF COMMUNICATIONS

The One Hundred and Fifty-fourth Meeting of The Nutrition Society was held at the Medical School, St. Mary's Hospital, London, W.2, on Saturday, 1 December 1962, at 10.30 a.m., when the following papers were read :

Dietary values from a 24 h recall compared to a 7-day survey on elderly people. By ELAINE C. BLAKE and J. V. G. A. DURNIN, *Institute of Physiology, University of Glasgow, Glasgow, W.2*

Several comparisons have been made of the results obtained by the 24 h recall method of dietary study and those from weighed food records which have been measured over a period of several days (Bransby, Daubney & King, 1948–9; Young, Hagan, Tucker & Foster, 1952; Thomson, 1958).

Since no such studies have been made in Britain on elderly men and women, dietary information was collected by the 24 h recall method on the twenty-six men and ten women whose 7-day weighed food intake and energy expenditure were also measured.

The mean age of the men was 56 years and that of seven of the women was 59; three young women (daughters of some of the elderly women) of mean age 25, were included in the total number.

The mean intakes of protein, calcium, iron and energy obtained by the two methods showed very good agreement (cf. table).

However, the correlation coefficients varied widely so that the present results support those of most previous investigators, that the two values for the individual subjects frequently showed much discrepancy.

Mean daily intake of protein, calcium, iron and energy obtained by a 24 h recall and a 7-day weighed survey on twenty-six elderly men and ten women

	Calories (kcal)		Protein (g)		Calcium (mg)		Iron (mg)	
	24 h	7-day	24 h	7-day	24 h	7-day	24 h	7-day
Men	2735	2713	85	88	1018	1012	16·0	16·0
Women	2084	2120	69	73	658	733	13·3	13·6

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The effects of low magnesium intake on lactating ewes. By J. L. L'ESTRANGE and R. F. E. AXFORD, *Department of Biochemistry and Soil Science, University College of North Wales, Bangor*

Lactating cows offered a diet very low in magnesium, showed a sudden drop in serum Mg levels (Rook, 1961). Ritchie, Hemingway, Inglis & Peacock (1962)

showed that low intakes of dietary Mg produced a slow decline in serum Mg levels in adult non-lactating ewes.

The present investigation concerns the formulation and feeding to lactating ewes of a diet low in Mg but otherwise nutritionally adequate to maintain normal milk production.

Percentage composition of diet

Milled wheat straw	30	Sucrose	11
Starch	30	Casein	16
Glucose	10	Minerals and vitamin mixture	3

Diet (a) was pelleted and contained 0·0164% Mg. Diet (b) was not pelleted and contained 0·0280% Mg.

When a normal dietary supply of Mg was provided by supplementation with daily magnesium acetate drenches, five ewes on diet (a) and three on diet (b) remained normal. A sudden withdrawal of supplementary Mg resulted in a sharp drop in serum Mg concentration to approximately 0·7 mg/100 ml within 2–3 days. This was accompanied by general restlessness, inappetence, and a fall in serum calcium concentration. Clinical tetany occurred in one animal. Loss of appetite was specific for the diet as normal foods were still acceptable. Diet (a) was also fed to four lactating ewes with a daily supply of supplementary Mg decreasing from 1200 mg Mg to reach zero after 28 days. Observations were made on changes in serum Ca and Mg levels and on faecal, urinary and milk outputs of these minerals throughout the experiment. As supplementation decreased serum Mg levels declined in each ewe at rates dependent on efficiency of 'apparent' absorption of dietary Mg. At intakes of 200–500 mg Mg daily inappetence and restlessness occurred and falls in serum Ca concentration were recorded.

Appetite, and serum Ca and Mg levels were restored in both experiments by drenching with 2000 mg Mg. Results indicate the absolute dependence of the lactating ewe on a normal and continuous supply of dietary Mg and suggest that hypomagnesaemia occurring in natural conditions is due to a sharp drop in the rate of intake or absorption of dietary Mg.

J.L.L. gratefully acknowledges a research scholarship from the Agricultural Institute, Eire. The work was supported financially by the Agricultural Research Council.

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Some effects of various dietary carbohydrates on liver and depot lipids.

By I. MACDONALD, *Department of Physiology, Guy's Hospital Medical School, London, S.E.1*

The influence of dietary carbohydrate on liver and depot lipids seems to depend not only on the amount of carbohydrate consumed but on the type of dietary

carbohydrate. This has been shown in experimental animals on low but constant protein intakes where the amount and type of dietary carbohydrate was varied (Macdonald, 1962). Where sucrose was the dietary carbohydrate more lipid was found in the liver than when the same amount of maize starch was consumed. Liquid glucose (B.P.C.) in the diet led to liver lipid accumulation whose extent was intermediate between that in sucrose-fed and starch-fed animals.

The proportions of palmitic and linoleic acids in the liver lipid seem to vary according to the type of carbohydrate eaten. The fall in the percentage of linoleic acid in the lipid is greatest with sucrose and least with starch.

Evidence that a similar effect may occur in children has been found in the study of the amount of linoleic acid in the liver lipid of children with kwashiorkor from Nigeria and Jamaica. The increase in liver linoleic acid in the livers of Nigerian malnourished children is very similar to that found in a control group of Nigerian and Jamaican children, whereas there was no significant increase in the amount of liver linoleic acid in the malnourished Jamaican children. An important aetiological factor in the accumulation of liver lipid in kwashiorkor is a relative excess of dietary carbohydrate, which in Nigeria is mainly starch whereas in Jamaica there is a greater consumption of sucrose.

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The influence of dietary carbohydrates on serum protein levels in rabbits on low-protein diets. By Betty L. Coles, *Department of Physiology, Royal Free Hospital Medical School, London, W.C.*1, and I. Macdonald, *Department of Physiology, Guy's Hospital Medical School, London, S.E.*1

The role of carbohydrate as a sparer of protein was investigated in rabbits maintained on a low-protein diet with different types and amounts of carbohydrate added. The carbohydrates used were maize starch, dried liquid glucose (B.P.C.) and sucrose. The animals were pair fed so that one rabbit in each pair received only half the carbohydrate calories of the other, the protein intake being kept the same. Serum albumin levels were used as a measure of the degree of protein sparing. With daily carbohydrate intakes of up to 14 g/kg body-weight increases in carbohydrate intake led to an increase in the rate of fall of serum albumin regardless of the type of carbohydrate fed. When the daily carbohydrate intake exceeded 14 g/kg body-weight the rate of fall of serum albumin was less rapid with increased levels of carbohydrate intake. This suggests that carbohydrate may have two roles in protein metabolism when dietary protein is inadequate. At low levels of carbohydrate intake, increasing the carbohydrate may lead to an increase in the basal metabolic rate with subsequent increases in protein requirements which, in the absence of an increase in the dietary protein, can only be met by further depletion of the animal's protein stores. Above the critical level of 14 g/kg body-weight the basal needs are satisfied and increasing the intake leads to protein sparing with a less rapid fall in serum albumin.

The influence of dietary carbohydrate on food intake of adult cats. By J. P. GREAVES and PATRICIA P. SCOTT, *Department of Physiology, Royal Free Hospital School of Medicine, London, W.C.*1

Purified diets based on casein have been used at this laboratory for some years in feeding experiments involving cats. The carbohydrate source routinely used has been sucrose, but prompted by reports of the beneficial effects on food intake of carbohydrates of high molecular weight (Harper & Spivey, 1958; Schwartzbaum & Ward, 1958; I. Macdonald, 1962, personal communication) dextrin has recently been substituted for sucrose.

Seven adult cats, of both sexes, which had been maintained on a purified diet containing 35% casein and 37% sucrose for many months, were caged individually. Food was offered, *ad lib.*, mixed with water as a gruel; uneaten remnants were weighed back after drying and individual food intakes determined. After 3 weeks on the sucrose diet (period A) the animals were fed an identical diet except that the carbohydrate was provided as dextrin (Hopkins & Williams): after a week, food intakes were recorded for a further 3 weeks (period B), and then a subsequent 4 weeks (period C). The animals were then returned to the sucrose diet for 2 weeks (period D), and then back again to the dextrin diet for 3 weeks (period E). The mean daily dry-food intake of each cat for each period was calculated; the mean intakes for the seven cats for the successive periods were (in g, with standard error in parentheses): A, 31·4 (2·5); B, 36·3 (2·0); C, 33·1 (1·4); D, 24·3 (2·4); E, 28·5 (2·1). The only statistically significant change (at 1%) was found in comparing periods C and D; however, when individual responses were considered (including that of a cat which had received a supplement of 100 g wet raw meat a day, and consequently ate little of the purified diet), out of a total of twenty-four 'cat–carbohydrate changes' only three were not associated with the general trend of an increased consumption on changing from a sucrose-containing diet to one containing dextrin, and vice versa.

Throughout the periods the animals maintained their body-weight, with slight fluctuations, tending to show increased weight with increased food consumption. The relatively minor effects observed may have been due to the necessarily comparatively small proportion of the diet accounted for as carbohydrate. It is concluded that the use of dextrin rather than sucrose is to be preferred.

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A co–relation between the osmotic pressure of dietary carbohydrate and food intake. By I. MACDONALD, *Department of Physiology, Guy's Hospital Medical School, London, S.E.*1

During the course of experiments in adult rabbits on the comparative physiology of dietary carbohydrates, it was noticed that starch-fed animals ate more than those

fed sucrose. The diet, which consisted of 25 parts 'green food', 68 parts carbohydrate, 2 parts dried yeast and 5 parts of a salt mixture, was offered *ad lib.* The carbohydrates that were used included maize starch, liquid glucose B.P.C., sucrose and dextrose. The mean daily consumption of food per kg body-weight for each carbohydrate together with the osmotic pressure of the dietary carbohydrate are given in the table. The slope of the line for food intake plotted against osmotic pressure of the dietary carbohydrate was highly significant ($P<0.001$).

Carbohydrate	Mean daily food intake (g/kg body-weight)	SD	No. of animals	Osmotic pressure (atm. at 37°) of a 16% (w/v) solution
Starch	29·9	±4·9	5	0·0
Liquid glucose B.P.C.	19·0	±2·2	4	10·8
Sucrose	18·8	±4·0	8	14·0
Dextrose	15·6	±5·1	3	28·1

Thus in adult rabbits on a high-carbohydrate diet (68%) there is a correlation between the amount of food eaten and the osmotic pressure of the carbohydrate in the food.

Carbohydrate digestion in the small intestine of the young steer. By M. J. Henschel, W. B. Hill and J. W. G. Porter, *National Institute for Research in Dairying, Shinfield, Reading*

Steers, 4–6 months old, fitted with duodenal cannulas and intestinal re-entrant cannulas and given diets low in starch were used. In each experiment a solution or suspension containing 10 or 30 g carbohydrate in 200 ml water, in which were dissolved 2 g polyethylene glycol as marker, was introduced and the effluent from the proximal end of the re-entrant cannula was collected during the ensuing 8 h. One-tenth of each sample collected during each 1 h period was taken for determination of its carbohydrate and polyethylene glycol content and the remainder was returned into the distal end of the re-entrant cannula. The percentage recoveries of 10 g doses of the various carbohydrates showed wide ranges; mean values (with number of experiments in parentheses) were: raw wheat starch 59 (2), soluble starch 28 (11), maltose 30 (6), lactose 14 (5), sucrose 62 (5) and glucose 0 (2). The addition of amyloglucosidase to test suspensions of starch reduced the recovery of both raw wheat starch and soluble starch to 7% (6) and 2% (3) respectively. Mean recoveries from 30 g doses were: raw wheat starch 25 (2) and soluble starch 40 (4).

The carbohydrate-splitting enzyme content of the effluent was determined in fourteen experiments. The mean amylase activity of that collected during the 2–3 h that polyethylene glycol was present was sufficient to hydrolyse 120 g starch. It is possible that this activity is partly of pancreatic origin and partly from amylolytic bacteria in the intestine. The maltase and lactase activities of the effluent were sufficient to hydrolyse only about 2 g of maltose or lactose. The effluent contained no sucrase.

In nine experiments samples of jugular blood were taken through an indwelling plastic cannula at intervals during 2·5 h after the carbohydrate had been introduced

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into the duodenum. Marked increases were observed in the blood glucose concentrations when solutions of glucose, lactose or maltose were introduced, and a small increase after soluble starch, but none was found with sucrose.

These results show that there is appreciable digestion of starch, maltose and lactose in the small intestine of the 4–6 months old ruminant; part of this digestion is due to the action of the digestive enzymes, but part is probably the result of bacterial fermentation.

We are grateful to Dr A. T. Cowie for inserting the cannulas and to Glaxo Laboratories Ltd for the gift of amyloglucosidase.

Automatic dispensing at frequent regular intervals of liquid diet for piglets. By A. G. CHAMBERLAIN and W. B. HILL, *National Institute for Research in Dairying, Shinfield, Reading*

The nursing sow normally feeds her piglets approximately hourly (Barber, Braude & Mitchell, 1955). Piglets taken from the sow and reared artificially have been fed by a variety of systems, many of which involve the continual presence of diet before the animal. This allows the piglets to toy with the diet and may often lead to extensive wastage. In metabolic studies the resulting contamination of the excreta is a serious inconvenience.

A machine has been constructed to simulate the feeding pattern of the sow. A series of cam-operated micro-switches directs current to magnetic valves each hour. The opening of these valves permits diet to flow into the feeding troughs. The volume of diet admitted to the troughs can be controlled by allowing the rising level of the milk to touch electrodes positioned at the required height above the base of the troughs, thus actuating a relay that shuts off the valves. These electrodes also serve as a safety device that prevents repeated additions to the trough should the piglets fail to drink their rations. To prevent the piglets from drinking while the trough is being replenished, an electric fencer connected to the cage is automatically switched on. Piglets attempting to drink touch the earthed trough and receive a slight, harmless shock which keeps them away. An alternative, but less accurate method of replenishing the trough is by altering the cam profile (a simple matter for the type of cam used).

The use of the machine has proved successful in reducing wastage. Piglets eagerly consume their small hourly allowances, leaving the troughs empty until the following hour. In a trial involving five pairs of piglets given equal volumes of homogenized cow's milk with supplementary vitamin D_3 for up to 2 weeks, one member of each pair was fed twice daily and the other mechanically. Wastages of milk were estimated by measuring the milk-fat content of the urine collected over the experimental periods. The mechanically fed piglets wasted not more than 1% of the milk supplied, compared with up to 9% by the animals fed twice daily. The mechanically fed piglets grew appreciably faster than the piglets given the same amount of milk twice daily.

This appeared to be due to reduced wastage and possibly to improved utilization of the diet.

We wish to thank Dr R. Braude, Mr R. T. Budd and Dr J. W. G. Porter for suggesting the investigation and for their help throughout.

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The effect of dietary fat on the production of volatile fatty acids in the rumen of the cow. By M. C. NOTTLE* and J. A. F. ROOK, *National Institute for Research in Dairying, Shinfield, Reading*

The following daily diets were given to each of two dry cows over successive periods of 14 days: a basal diet of hay (11 lb dry matter), barley (2 lb dry matter) and extracted linseed cake (1 lb dry matter) (Expt 1); the basal diet with the extracted linseed cake replaced by linseed meal (1·60 lb, containing 270 g oil) (Expt 2); and the basal diet with the addition, through a fistula, of 270 g linseed oil (Expt 3), of cod-liver oil (Expt 4), or of beef tallow (Expt 5). The effects of these diets on the production of volatile fatty acids in the rumen and on the digestibility of dietary constituents were determined.

The results are given in the table. The replacement of the linseed cake by linseed meal and the supplement of linseed oil were without effect. The cod-liver oil caused a pronounced fall in the molar proportion of acetic acid and a complementary increase in propionic acid (cf. Shaw & Ensor, 1959) whereas tallow tended to give the reverse changes. There was a slight decrease in the digestibility of crude fibre and of the fat-free dry matter in the diet during the period of addition of tallow.

Cow	Expt no.	Total volatile fatty acids in rumen liquor (m-equiv./100 ml)	Individual fatty acids in rumen liquor, molar percentages of total volatile fatty acids*				Digestibility (%)†		
			Acetic	Propionic	Butyric	Valeric	Fat-free dry matter	Crude fibre	Ether-extractable material
A	1	8·50	67·2	17·4	12·4	3·1	67·9	61·6	45·9
	2	8·43	66·2	19·3	11·1	3·5	65·4	63·5	88·1
	3	9·50	66·6	18·4	12·0	3·0	69·3	61·5	88·4
	4	7·87	64·5	20·8	11·4	3·4	67·0	65·0	90·0
	5	8·81	69·7	16·4	11·4	2·6	64·6	59·5	87·7
B	1	8·62	66·6	18·1	12·3	3·0	70·2	65·6	48·7
	2	8·65	67·5	17·9	10·3	3·7	67·8	65·4	89·1
	3	9·31	67·0	18·5	11·1	3·4	69·7	63·7	88·4
	4	9·35	60·3	23·8	12·2	3·7	71·1	65·8	90·0
	5	9·36	68·4	17·0	11·8	3·0	64·6	61·5	87·2

*Mean values for a 12 h sampling period on the last day of each experiment.
†Mean values for the last 5 days of each experiment.

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*On leave from the Department of Agriculture, Western Australia.

The free lysine and amino-nitrogen content of liver, muscle and serum in normal and protein-depleted rats. By J. C. WATERLOW and JOAN M. L. STEPHEN, *Medical Research Council Tropical Metabolism Research Unit, Department of Chemical Pathology, St. Mary's Hospital, London, W.2*

The free lysine content of rat tissues has been measured as part of a study of protein turnover, using radioactive lysine. Weanling rats were fed a diet containing 6–7% casein for 5–10 weeks. Litter-mate controls were fed a stock diet. At the time of killing the depleted animals were one-third to one-half the weight of the controls. The tissues were extracted with 1% picric acid, the amino acids isolated on a cation-exchange resin column, eluted, evaporated to dryness, and taken up in a small quantity of phosphate buffer. The lysine content of the extracts was measured with lysine decarboxylase (Sigma Chemical Co.) in the Cartesian diver microrespirometer (Waterlow & Borrow, 1949). For each measurement 0·005–0·01 μmole lysine was necessary. Total amino nitrogen was measured in the picric acid extract by the ninhydrin colorimetric method.

Lysine and amino nitrogen content of liver, muscle and serum in normal and protein-depleted rats

	Normal	Depleted
Liver:		
lysine (μmole/g)	0·66±0·06	0·47±0·053
amino nitrogen (μmole/g)	18·8 ±0·34	22·2 ±0·90
Muscle:		
lysine (μmole/g)	0·82±0·14	0·86±0·04
amino nitrogen (μmole/g)	17·3 ±1·5	21·9 ±0·64
Serum:		
lysine (μmole/ml)	0·49±0·02	0·54±0·07
amino nitrogen (μmole/ml)	4·2 ±0·19	4·9 ±0·33

The results are shown in the table. In the protein-depleted animals the free lysine content of liver was significantly lower than in the controls. There was no significant difference in the lysine content of muscle or serum. Total amino nitrogen was significantly higher in both muscle and liver in the low-protein animals, and it was slightly, but not significantly, higher in the serum. These results are surprising, in view of the low levels of plasma amino acids, particularly of essential amino acids, that have been found in kwashiorkor (Arroyave, 1962).

The concentration ratio (concentration in intracellular water : concentration in extracellular water) was calculated on the assumption that all chloride is extracellular. Lysine concentration within the cells was relatively much less than that of total amino nitrogen. The average values of the concentration ratio in the normal animals were as follows: liver, lysine 2, amino nitrogen 10; muscle, lysine 2·3, amino nitrogen 5·8, and in the depleted animals the values were very similar. The figures for the concentration ratio of total amino nitrogen are in general agreement with those of Christensen (1955). We have no explanation for the anomalous behaviour of lysine.

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Nutritional attitudes of some London housewives. By ANN M. BROWN, J. C. MCKENZIE and JOHN YUDKIN, *Department of Nutrition, Queen Elizabeth College, University of London, Campden Hill, London, W.8*

One of the factors determining food choice may be ideas concerning nutritional values. We report on a small survey, carried out in September 1962, aimed at finding out something of these ideas amongst housewives in a London suburb.

Of 100 housewives selected at random, eighty-one agreed to answer a short questionnaire. They were asked to mention two foods which were rich sources of protein, iron, carbohydrate, calcium or vitamin C. They had a reasonably good knowledge of foods which contain protein or vitamin C but less of foods which contain iron or calcium. Nearly one-half of the housewives could not mention any food containing carbohydrate. The second question asked the housewives to say 'true' or 'false' to each of several statements about nutrition. Most gave some replies which were either correct or at least plausible, such as that iron is needed to prevent anaemia, that sweets help cause tooth decay, or that brown bread is better than white. But a large number also believed that lemon juice is good for slimming or that an apple a day really does keep the doctor away.

More than half the housewives knew that fluorine is added to water to reduce tooth decay, though some believed that it was to make the water soft or to stop the pipes from corroding. When asked which foods give energy, the majority mentioned foods which are rich in carbohydrate. When asked to suggest foods to avoid in order to reduce weight, they mentioned carbohydrate-rich foods 185 times, but fat-rich foods only fourteen times.

The housewives were asked to give the name of any organization concerned with world food problems. Two-thirds either said they did not know, or gave a wrong answer. Only one person mentioned the Freedom from Hunger Campaign, although its activities began in this country in April 1961.

Any conclusions we may draw from such a small survey must be very tentative and subject to confirmation by more detailed studies. But the present results suggest two possible conclusions. The first is that the knowledge of nutrition amongst London housewives is not extensive and is often wrong. The second is that nutritional beliefs, such as the superiority of brown bread over white, or the inferiority of canned foods over fresh, or the harmfulness of sweets in causing tooth decay, do not seem to have any great effect on food choice, since most people eat white bread, canned foods are used extensively and increasingly, and more sweets are eaten in this country than in any other.

The influence of vitamin A status on the proteolytic activity of lysosomes from the livers and kidneys of rats. By J. T. DINGLE, *Strangeways Research Laboratory, Cambridge*, and I. M. SHARMAN and T. MOORE, *Dunn Nutritional Laboratory, University of Cambridge and Medical Research Council*

Treatment of lysosomes in vitro with vitamin A causes the liberation of their proteolytic enzymes (Dingle, Lucy & Fell, 1961; Dingle, 1961). Release of lysosomal enzymes could explain the loss of mucopolysaccharides, and cellular changes, seen by Fell & Mellanby (1952) in cartilaginous limb-bone rudiments cultured in the presence of excess vitamin A. To investigate whether the proteolytic activity of lysosomes is influenced by vitamin A reaching the cells in vivo by the normal routes of absorption and distribution, studies were made on homogenates and subcellular fractions from groups of rats given (1) no vitamin A, and (2) marginal, (3) adequate, (4) excessive (toxic) supplements of vitamin A. Portions of liver and kidney tissues were homogenized in 0·25 M-sucrose in a Potter homogenizer. Total catheptic activity (μg tyrosine/20 min g wet weight of tissue) was measured in a portion of the original homogenate after lysis by detergent. The homogenate was then spun at 600 ***g*** for 5 min and the pellet rejected. The supernatant was next re-spun at 15 000 ***g*** for 20 min and free activity determined in the resulting supernatant. Lysosomally bound activity was measured after resuspending the pellet and lysing with detergent.

Means of bound activities for liver preparations showed only slight variation between groups in the first experiment. The mean free activity, however, was significantly higher in the group given excessive intakes of vitamin A (200) than in the other groups (39, 72, 65 for the deficient, marginal and adequate groups respectively). The total activity in the excessive group was also higher (1400) than in the other groups (990, 1050, 790, respectively). Catheptic activities in the kidney were little affected by vitamin A status.

To confirm these results on the liver the experiment was repeated with improvements in technique, particularly homogenization, as recommended by Aldridge, Emery & Street (1960), but the 'adequate' group was omitted. Again, free activity was higher in the group given excessive vitamin A (450) than in the other groups (250, 80). Total activity (1460) was also higher in this group, than in the others (1140, 820). An unexpected finding was a higher mean for free activity in the 'deficient' group (250) compared with the 'marginal' group (80). Again, bound activity varied little between groups.

Chemical estimation of vitamin A indicated that the total amounts of vitamin A in the livers were in agreement with the dietary intakes but no evidence was obtained of a higher concentration of vitamin A in the lysosomes compared with other subcellular fractions.

Experiments were also performed in collaboration with M. G. Stanton, to investigate the influence of vitamin E status on proteolytic activities. A pronounced release of lysosomal cathepsin was observed in the kidney, whereas little effect was detectable in the liver.

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Amino acid supplementation of pig diets. By D. W. ROBINSON and D. LEWIS, *University of Nottingham School of Agriculture, Sutton Bonington, Loughborough*

Cereals constitute the major portion of pig diets and contribute not only towards the energy requirements but also a variety of minor constituents and 50–70% of the protein. Cereals fed without supplementation with materials rich in protein are deficient in certain amino acids and there are numerous reports of the growth-depressing effect of such deficiencies.

In the present study a group of sixteen hog pigs were individually fed the diets listed in Table 1. The pigs fed the basal diet grew only slowly and were excessively fat (Table 2). Supplementation of the diet with methionine and lysine resulted in an improved growth rate, food conversion efficiency and carcass quality. Pigs receiving the diets supplemented with five amino acids were in some respects superior to those control pigs receiving a more conventional diet. Most of the advantages could be attributed to the addition of lysine and methionine, but the addition of tryptophan, threonine and isoleucine to correct marginal deficiencies resulted in some improvement.

Table 1. *Percentage composition of diets*

	Grower diets				Finisher diets			
	Basal (B)	B2	B5	Control	Basal (B)	B2	B5	Control
Barley meal	95	95	95	60	96	96	96	63
Maize meal	—	—	—	24	—	—	—	30
Fish meal (white)	—	—	—	6	—	—	—	2
Soya-bean meal (extracted)	—	—	—	7	—	—	—	3
Minor supplement	3	3	3	3	3	3	3	2
Glutamic acid	2	0·9	0·2	—	1	0·5	0·1	—
DL-methionine	—	0·6	0·6	—	—	0·2	0·2	—
L-lysine	—	0·5	0·5	—	—	0·3	0·3	—
DL-isoleucine	—	—	0·3	—	—	—	0·2	—
DL-threonine	—	—	0·3	—	—	—	0·1	—
DL-tryptophan	—	—	0·1	—	—	—	0·1	—
Crude protein* (N × 6·25)	16·4	16·4	16·4	16·2	11·6	11·6	11·6	11·5
Digestible energy (kcal/kg) approx.	2950	2950	2950	2950	2950	2950	2950	2950

*Differences in crude protein level were achieved by the use of a high-nitrogen barley in grower diets (2·35% N) and a moderate sample in finisher diets (1·7% N).

Table 2. *Growth and carcass quality*

		Basal	B2	B5	Control	Difference significant at 5% level
Growth (lb/day)	50–120 lb	0·98	1·14	1·26	1·40	0·10
	120–200 lb	1·43	1·44	1·50	1·44	0·08
lb food eaten/lb	50–120 lb	3·80	3·20	2·80	2·70	0·28
live-weight gain	120–200 lb	4·04	4·00	3·76	3·76	0·25
Percentage lean in total carcass		35·9	39·2	42·4	41·1	2·50
Back-fat thickness (mm), mean of five measurements		48·6	41·2	41·8	43·7	5·0

Placental carbohydrate. By A. ST. G. HUGGETT, *Physiology Department, St. Mary's Hospital Medical School, London, W.2*

D. P. A. Alexander & D. A. Nixon (in preparation) have shown the sheep foetal renal tubule absorbs from the glomerular filtrate nearly all the glucose, the vesical urine containing the fructose. Re-assessment with glucose oxidase (Huggett & Nixon, 1962) of the amniotic and allantoic sugars during pregnancy shows averages of 252 and 172 mg/100 ml of fructose and 2·8 and 3·1 mg/100 ml of glucose respectively instead of 60 mg/100 ml as described by me previously (Barklay, Haas, Huggett, King & Rowley, 1949). Wright & Nixon (1961) have shown the foetus actively absorbs amniotic fluid including fructose from its alimentary canal. The allantoic fluid in late pregnancy disappears into the foetal blood.

The total fructose (Table 1) available to the foetus is the intrafoetal plus this extrafoetal, which is computable, average fluid volumes being known (Wallace, 1948) and used with our determinations. It reaches a maximum of 5500 mg at about 115–120 days, that is the end of the second trimester: a similar maximum applies to the placental glycogen of the rabbit (Huggett, 1961). Both carbohydrates are unavailable to the mother, even on demand, but both disappear into the foetus in the third trimester coincident with the terminal period of rapid foetal growth. Apparently the placenta reserves them for the foetus.

The two major points are the placental action in mid-pregnancy in transforming the glucose to form a carbohydrate reserve unavailable to the mother and the foetal gut absorption enabling this reserve of fructose to be increased eightfold.

Table 1. *Fructose content (mg) of sheep foetus*

Foetal age (days)	60	80	90	100	110	120	130	140	147
Total blood	30	60	80	110	140	190	230	250	180
Extracellular fluid	300	460	540	600	650	710	780	800	630
Total intrafoetal	330	520	620	710	790	900	1000	1050	810
Amniotic fluid	1130	1170	1180	1200	2000	2600	1500	700	70
Allantoic fluid	210	230	300	800	1450	2000	1380	580	110
Total extrafoetal	1340	1400	1480	2000	3450	4600	2880	1280	180
Total available fructose	1670	1920	2100	2710	4240	5500	4380	2330	990
Foetal weight (g)	130	420	760	1350	2000	2600	3200	4100	4600

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