

Results in the table show that a supplement of white fish meal supported about 20% higher egg production than a supplement of GN2. Addition of 0.1% DL-methionine (L. Light & Co.) can raise egg production on the GN2 diet by about 10% while 0.1% L-lysine (as monohydrochloride, E. I. du Pont) in addition to the methionine can bring production up to that with white fish meal as supplement. 0.1% L-lysine alone did not improve egg production on the GN2 diet.

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The One Hundred and Forty-second Meeting of The Nutrition Society was held at the Royal Society of Medicine, 1 Wimpole Street, London, W.1, on Friday, 26 May 1961, at 1.30 p.m., when the following papers were read:

The copper content of the liver and hair in kwashiorkor. By I. MACDONALD and P. J. WARREN, *Departments of Physiology and Chemical Pathology, Guy's Hospital Medical School, London, S.E.1*

It has been suggested that changes in the blood and pigmentation in kwashiorkor may be related to a copper deficiency and a marked hypocupraemia has been found (Lahey, Behar, Viteri & Scrimshaw, 1958; Edozien & Udeozo, 1960). In view of this the copper content of liver and hair in kwashiorkor was studied to determine whether the copper concentration in these tissues is altered.

The results showed a significant reduction in the copper concentration in both liver and hair (Table). The results also show that no copper was present in the liver lipid in the cases studied.

Mean values and standard deviations for the copper concentration ($\mu\text{g Cu/g tissue}$) in liver and hair

	Kwashiorkor	Control	Comparison between kwashiorkor and control P
Dry liver	6.7 \pm 1.2	20.4 \pm 8.2	0.005
Dry fat-free liver	17.3 \pm 3.9	24.4 \pm 7.3	0.05-0.025
Hair	13.9 \pm 2.7	18.5 \pm 4.2	0.05-0.025

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 Lahey, M. E., Behar, M., Viteri, F. & Scrimshaw, N. S. (1958). *Pediatrics, Springfield*, **22**, 72.

The influence of iodine supplementation on the incidence of thyroid enlargement in schoolchildren. By R. KILPATRICK, *Department of Pharmacology and Therapeutics, Sheffield University, Sheffield*, W. T. C. BERRY, *Ministry of Health, Savile Row, London, W.1* and J. N. HORNE, *Ministry of Education, Curzon Street, London, W.1*

Salt, iodized at a level between 1:60 000 and 1:45 000 is used as table salt in schools in Oxfordshire and, as cooking salt also, in Wiltshire schools. The incidence of thyroid enlargement was compared in children not taking lunches with those taking the lunches and iodine supplementation.

In Oxfordshire 948 children, 13 years old and over were examined in March 1960, when iodized table salt had been used for about 15 months in all schools. In Wiltshire, 862 girls between 13 and 15 years were examined in September 1960 when all schools had had iodized salt for two full terms or more. One lunch from each of the ten schools visited in Wiltshire was pooled; the average iodine content of each meal was 120 μ g. The iodine provided by table salt in Oxfordshire and Wiltshire was probably small.

In Oxfordshire 4.3% of girls and 1.5% of boys examined had visible thyroid glands, and a further 13.9% of girls and 2.9% of boys had palpable glands. Of those who took school lunch 17.5% had visible or palpable glands and of those who did not, 14.7% (this difference is not significant); of those who said they took salt with school lunch 22.6% had palpable glands, and of those who did not, 13.3% ($P < 0.05$).

In Wiltshire 2.6% of 862 girls had visible thyroid glands, 8.8% had palpable but not visible glands, and in 11.5% the thyroid isthmus alone was palpable. School lunches were taken by 58% of these children, and the incidence of visible thyroid glands was 2.2% in those taking school lunches and 3.1% in those not. Palpable glands, not visible, were found in 8.6% of takers and 9.2% of non-takers of school lunches. None of the differences between girls taking school lunch or not were significant, nor were there consistent differences in individual schools between 'school lunchers' and others. One of the schools taking iodized salt for the longest period of time showed the highest incidence of visible glands recorded in the 'school lunchers'.

Either thyroid enlargement in these schoolchildren was independent of iodine supplements, or some other factor related to the taking of school lunches overcame the effect of added iodine.

A dental malocclusion associated with rickets in growing lambs. By MILTON R. McROBERTS, *Rowett Research Institute, Bucksburn, Aberdeen*

Blackface ewe hogs were fed a diet low in phosphorus and vitamin D for 12 months (average daily intake, 0.38 g phosphorus). In addition to poorly mineralized skeletons, severe indications of rickets were evident both clinically and radiologically at this time. At 9 months an altered dental occlusion rapidly developed in

which the incisor teeth failed to meet the maxillary pad. When the diet was supplemented with phosphorus and vitamin D, recovery from this malocclusion was rapid, until the incisor teeth once again met the maxillary pad in the normal position.

Lipid concentrations in rabbits given atherogenic diets. By A. N. HOWARD* and G. A. GRESHAM, *Department of Pathology, University of Cambridge*

Previous studies in the rat showed that certain fats such as butter, and beef fat produced thrombosis and other fats such as arachis and corn oil produced atherosclerosis when fed together with hypercholesterolaemic agents, such as cholesterol, cholic acid and thiouracil (Gresham & Howard, 1961). The present investigation concerns the feeding of thrombogenic and atherogenic fats in the rabbit, a species more susceptible to experimentally induced arterial disease. Groups of rabbits, given a semi-synthetic diet containing 10–40% butter, beef fat, corn or arachis oil, with and without supplements of 1% cholesterol, were compared with control rabbits receiving a commercial pellet diet (Bruce & Parkes, 1947).

All animals given the semisynthetic diet without cholesterol developed fibrous atherosclerosis of the proximal aorta and coronary arteries similar to that seen in man, but no lesions were seen in the controls. The liver and spleen did not contain histologically demonstrable lipid. All the dietary fats were atherogenic and thrombosis was not seen. Lipid analyses were carried out on the plasma and liver with the cholesterol-free semisynthetic diet, plasma cholesterol was increased four- to ten-fold and liver cholesterol two- to four-fold compared with the controls. The increase in the plasma was due to both free and esterified forms but in the liver only the esterified form was increased. Glyceride concentration in the plasma was unchanged but in the liver there was a two- to three-fold increase. Phospholipids were doubled in the plasma but unchanged in the liver.

Those animals given the diets containing cholesterol produced typical 'cholesterol arteriosclerosis' with large numbers of intimal fat-filled macrophages in the aorta and coronary arteries. Thrombosis likewise did not occur but the liver and spleen were intensely fatty. The lipid pattern was also different from that described above. The concentration of cholesterol was increased fifty times in the plasma and ten times in the liver compared with the controls; both the free and esterified forms were increased. Although the glycerides concentration in the plasma was doubled, there was only a 50% increase in the liver. Phospholipids were unchanged in both the plasma and liver.

It was concluded that the disease produced by the semisynthetic diet without cholesterol bore a closer relationship to that seen in man.

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Gresham, G. A. & Howard, A. N. (1961). *Brit. J. exp. Path.* **42**, 166.

*Member of the External Scientific Staff of the Medical Research Council,

A technique of carrying out individual weighed diet surveys. By JEAN W. MARR, *Social Medicine Research Unit of the Medical Research Council, London Hospital, London, E.1*

Any survey inevitably focuses attention on the matter under investigation. In dietary surveys the effect such unusual attention might have on the customary pattern of eating cannot be assessed. A technique which, we hope, will allow the subjects to follow their usual routine was designed for use by bank officers carrying out weighed diet surveys for 7 consecutive days.

The following equipment is provided: a spring-balance weighing up to 2 lb graduated in $\frac{1}{4}$ oz and readable to $\frac{1}{8}$ oz; a Pyrex dish for spreading fat; a light-weight plate; a log-book and a detailed instruction sheet, worded without undue emphasis on any particular food. Items of food ready for eating are weighed by addition on the plate provided. Thus: first weight=empty plate; second weight=plate + first item of food; third weight=plate + first and second items of food; etc. It is hoped that helpings will be the usual size. Items used several times a day (milk, sugar and spreading fats) are kept in separate containers and weighed at the beginning and end of the day. This enables the men to help themselves as they would from a family dish on the table.

The items of food and their weights are recorded in the log-book which is ruled for the purpose but has no heading for meals. Plate waste is also weighed and recorded. A small note-book is provided for entering unweighed foods, e.g. mid-morning and afternoon snacks at the bank, sweets and any meals taken out; these have been described in detail. Sample meals have been weighed by the dietitian in office canteens. Holidays and other special periods have been avoided.

Co-operation of the men is sought at a group meeting and individual visits are arranged to bank or home, whichever is preferred. These visits have been kept to a minimum to avoid influencing behaviour and in fact only a small minority were seen at home. During this first visit the equipment is left and instructions given. At the end of the week the log-book is examined in the presence of the subject to make sure sufficient details have been given and to check apparent anomalies. A letter of thanks is sent to each man.

The dietitian who conducts the survey is responsible for classifying the foods and preparing this information for calculation of nutrients using modified standard tables.

The choice of diets of differing caloric density by normal and hyperphagic rats. By MELEK KHAIRY, *Medical Research Council Unit for the Experimental Investigation of Behaviour, Department of Psychology, University College, London, W.C.1.*, and T. B. MORGAN and JOHN YUDKIN, *Department of Nutrition, Queen Elizabeth College, University of London, W.8*

Adult hooded rats were given a choice between two purified diets, one undiluted and the other diluted by 15% or 30% cellulose. The rats, between 40 and 60 days of age, were housed in individual cages constructed so as to obliterate cues as to the

positions of the food pots, which were interchanged at random. The intakes of both diets were measured daily for about 50 days. Each animal was then operated upon so as to produce bilateral lesions in the region of the ventro-medial nuclei of the hypothalamus. This was done by electrodes inserted with the aid of a stereotactic apparatus. Controls were sham-operated to the extent of being anaesthetized and having an incision of the scalp.

Before operation, the animals showed somewhat variable and fluctuating choice between the concentrated and the diluted diets. With the 30% cellulose diets most animals ate more of the concentrated diet; this choice was less evident with the 15% cellulose diets.

After operation, several of the animals developed hyperphagia and became obese to a degree which on the whole was related to the accuracy and extent of the lesion in the ventro-medial nuclei. During hyperphagia, the animals ate appreciably less of the diluted diets and more of the concentrated diet, the extent of the discrimination depending on the extent of hyperphagia. When the weight increase ceased, the obese animals reduced their caloric intake to about that of the pre-operation period. In doing this, they increased the proportion of the diluted diet which they consumed so that it was often higher than the proportion consumed before operation.

Adolph (1947) has shown that normal rats eat an amount of a given diet depending on their caloric needs. According to Kennedy (1953), rats with hypothalamic lesions, particularly when they have become obese, are more than usually sensitive to the palatability of the diet and eat less of an unpalatable (diluted) diet than normal rats. Our results with rats offered a choice of diets suggest that, at least in some situations, discrimination is for calories rather than for palatability.

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Kennedy, G. C. (1953). *Proc. Nutr. Soc.* **12**, 160.

The development of proteolytic enzymes in the abomasum of the young calf. By M. J. HENSCHEL, W. B. HILL and J. W. G. PORTER, *National Institute for Research in Dairying, Shinfield, Reading*

The young calf, and possibly other young ruminants, differ from other young mammals in that they secrete two proteolytic enzymes in the abomasum or true stomach. It has generally been accepted, since the findings of Berridge, Davis, Kon, Kon & Spratling (1943-4), that the young milk-fed calf secretes only rennin and that the secretion of pepsin only becomes pronounced when the ingestion of solid food begins.

We have measured the proteolytic activity of samples of abomasal contents, collected through a cannula inserted into the abomasum, just before and at intervals during a 5 h period after a normal feed of milk. The three calves used were fistulated when about 4 days old and were kept muzzled to prevent their eating roughage. The proteolytic activity of the samples was determined by estimating the tyrosine released

by the action of a suitable dilution of the sample on a 2% solution of freshly prepared casein in the pH range 1.5–5. The measured proteolytic activities were plotted against pH and the resulting pH-activity curves were compared with those for crystalline rennin and crystalline pepsin. The results for samples of abomasal contents taken when the calves were 1–2 weeks old showed that at this stage two of the calves were secreting predominantly rennin but the third was secreting some pepsin also, at 4 weeks of age two of the calves were secreting both rennin and pepsin and the third only rennin, and at 6–8 weeks of age one calf was secreting predominantly pepsin and the others both pepsin and rennin. There was no indication of any marked change with age in the total amount of enzyme secreted.

The results for samples taken immediately before feeding were generally similar though it was noteworthy that the ratio of pepsin to rennin was apparently greater than in the samples taken after feeding. This was probably because pepsin was more resistant to proteolysis by rennin than rennin to proteolysis by pepsin.

It seems probable, therefore, that the young calf may secrete both rennin and pepsin and we are not able to confirm the finding of Berridge *et al.* (1943–4) that pepsin secretion was initiated when the animal ate roughage.

REFERENCE

Berridge, N. J., Davis, J. G., Kon, P. M., Kon, S. K. & Spratling, F. R. (1943–4). *J. Dairy Res.* **13**, 145.

Proteolysis of milk and synthetic milks in the abomasum of the young calf. By M. J. HENSCHEL, W. B. HILL and J. W. G. PORTER, *National Institute for Research in Dairying, Shinfield, Reading*

Samples of calf abomasal contents (see Henschel, Hill & Porter, 1961) were taken just before and at intervals during a 5 h period after a feed of milk or synthetic milk compounded from casein or α -protein (an isolated soya protein, Glidden Company, Chicago) with glucose, margarine, salts and vitamins. The pH of the samples was measured. Before feeding the pH of the abomasal contents was about 2, immediately after feeding with any of the diets it rose to about 5 and it then gradually fell towards the initial pH during the next 5 h. The extent of proteolysis in the samples taken at $\frac{1}{2}$, 2 and 5 h after feeding was measured by estimating by the micro-Kjeldahl procedure their content of soluble nitrogenous compounds. The results showed that there was little difference in the amount of nitrogenous compounds soluble in 5% (w/v) trichloroacetic acid, but that the content of nitrogenous compounds insoluble in 5% (w/v) trichloroacetic acid in the 2 h samples from the animals receiving the synthetic-milk diets was markedly lower than that from the calves receiving raw milk. This finding presumably reflects the absence from these samples of the whey protein fraction.

In parallel studies we investigated the extent of proteolysis brought about by pepsin and rennin acting on these same diets, using the same concentrations of enzymes as those found to be present in the abomasum of the calf and adjusting the

pH to conform with the values found in the abomasum. Samples of such digests were taken at intervals of 1 h and digestion was stopped by the addition of trichloroacetic acid to give final concentrations of 5% and 15%. The total amount of nitrogenous compounds in the trichloroacetic-acid filtrates was measured by the micro-Kjeldahl procedure. There was little difference between the results with pepsin and rennin for the digestion of raw milk and the synthetic milk containing casein. However, with the α -protein-containing diet pepsin caused the release of more nitrogenous material soluble in 5% trichloroacetic acid than rennin, although there was little difference in the amounts of material soluble in 15% trichloroacetic acid that were released. It may be, therefore, that pepsin is more effective than rennin in breaking down the larger peptide fragments deriving from α -protein.

REFERENCE

Henschel, M. J., Hill, W. B. & Porter, J. W. G. (1961). *Proc. Nutr. Soc.* **20**, xl.

Preliminary experiments with a roughage-free diet for beef cattle. By
T. R. PRESTON, F. G. WHITELAW, A. MACDEARMID, N. A. MACLEOD and
EUPHEMIA B. CHARLESON, *Rowett Research Institute, Bucksburn, Aberdeen*

In studies on the formulation of purified diets for lambs Matrone, Ramsey & Wise (1959) found that the addition of the sodium and potassium salts of bicarbonate, or of the steam-volatile fatty acids, increased the appetite and rate of live-weight gain of lambs given diets which did not contain fibre.

Twenty Friesian male calves were used. They had been weaned from milk replacement at 3 weeks of age and thereafter given *ad lib.* an early weaning concentrate containing 10% grass meal. This diet (Table 1) was given *ad lib.* from a self-feeding hopper. After a period of 10 weeks, 2.5% of sodium bicarbonate was added to the diet. Throughout the experiment the animals were bedded on sawdust. The performance of the steers is shown in Table 2 and is compared with that of similar

Table 1. *Composition of diets (kg)*

	Roughage-free diet (100% concentrate)	Standard diet (65% concentrate, 35% roughage)
Maize meal	—	336
Bruised oats	—	168
Bruised barley	980	—
Molassine meal*	—	112
Milled dried grass	—	112
Oat dust	—	280
Groundnut meal	—	112
Soya-bean meal	84	—
Fish meal	28	—
NaCl	5	5
CaCO ₃	5	5
Vitamin A and D supplement†	5	5

*75% molasses, 25% sphagnum moss (Molassine Co. Ltd, Greenwich, London, S.E.10).

†Contained 1 000 000 i.u. vitamin A and 200 000 i.u. vitamin D/kg.

Table 2. *Performance of Friesian steers on roughage-free diets*

	100%	100%	65% concentrate 35% roughage	
	concentrate	concentrate (including 2.5% NaHCO ₃)	20	20
No. of animals	20	20	20	20
Age at start (days)	137	207	122	189
Initial weight (kg)	113	176	108	176
Final weight (kg)	176	248	176	250
Daily gain (kg)	0.89 ± 0.055	1.47 ± 0.062	1.00 ± 0.045	0.98 ± 0.070
Air-dry feed/100 kg live weight day	2.50	2.80	3.20 ± 0.108	2.89 ± 0.120
Feed-conversion efficiency (live-weight gain/starch equivalent consumed)	0.350	0.360	0.380 ± 0.017	0.27 ± 0.012

animals given our standard intensive beef diet of 65% concentrate and 35% roughage. In the first stage of the experiment daily live-weight gain and feed-conversion efficiency were similar for steers given the 100% concentrate diet and for those given the standard diet containing roughage; this was because the steers given the latter diet ate more air-dry feed than those given 100% concentrates. When 2.5% of sodium bicarbonate was added to the 100% concentrate diet there was more than a 50% increase in daily live-weight gain compared with the performance of the same animals in the preceding period and also when compared with similar animals on the standard mixture containing roughage, over the same weight range.

REFERENCE

Matrone, G., Ramsey, H. A. & Wise, G. H. (1959). *Proc. Soc. exp. Biol., N.Y.*, **100**, 8.

An improved method for measuring the nutritive value of protein sources in diets for growing chickens. By W. S. MILLER, *Walton Oaks Experimental Station, Vitamins Ltd, Tadworth, Surrey*

The principle of the method is to measure the growth and efficiency of food conversion of chicks fed a protein source at graded levels in a basal cereal diet. From the experimental observations, regression equations are calculated relating live-weight gain and food-conversion ratio to dietary level of supplement. These permit estimation of the live-weight gain and efficiency of food conversion at any dietary level within the range of levels tested.

The equation relating live-weight gain to dietary level of supplement can also be expressed in terms of supplementary value (s.v.) and supplementary protein value (s.p.v.). s.v. and s.p.v. are the ratios of the weight gains of chicks fed a particular dietary level of supplement, and supplementary crude protein respectively, to the weight gains of chicks fed a standard control diet. Relative supplementary value (r.s.v.) and relative supplementary protein value (r.s.p.v.) measure the increase in s.v. and s.p.v. with increasing dietary level of supplement and supplementary crude protein.

The values of different protein sources have been measured, using a basal diet of which cereals, mineral and vitamin supplements comprise 70%. Sucrose and the test supplement make up 100%. True supplementary value is measured when the unsupplemented basal cereal diet is used as a standard control. For routine assay, however, it is preferable to include 5% casein in the control diet. In a typical experiment, the test supplement is fed at three or four levels to different lots of chicks, while other lots receive the standard control diet. Treatments are replicated according to a randomized block experimental design. The chicks receive the experimental diets *ad lib.* from 10 to 24 days of age.

The table gives, for some protein sources, equations relating s.v. to dietary level of supplement. Protein sources can be ranked according to their maximum s.v.s and

Supplementary values of protein sources: Equations relating supplementary value (s.v.) to dietary level (%) of supplement (x)

	Crude protein (%)	Range of dietary level (percentage of diet)	s.v.
Dried skim milk	34.5	5-30	$1.375 + 0.1662x$
Fish meal	70.8	7.5-30	$2.641 + 0.420x - 0.00816x^2$
Meat meal*	61	10-30	$0.732 + 0.1644x$
Soya	47.7	2.5-30	$0.972 + 0.450x - 0.010x^2$

*A.R.C. sample M.M.16 (cf. Anonymous, 1959).

classified according to their capacity to support a particular rate of growth. It is possible to estimate the dietary level of supplement necessary to support a particular rate of growth and the corresponding amount of total food required to produce unit live-weight gain. The method thus evaluates protein supplements in terms applicable to the least-cost formulation of practical diets, in contrast to methods used hitherto by other investigators.

REFERENCE

Anonymous (1959). *Nature, Lond.*, **183**, 1303.

The nutritional significance of primary bladder stones. By DANIEL ANTHONY ANDERSEN (introduced by A. M. COPPING), *The Evangeline Booth Hospital, Ahmednagar, India, and The University Institute for Experimental Medical Research, University of Oslo*

Observations are presented on a series of 256 primary bladder stones treated at Ahmednagar, India, between 1939 and 1957. More detailed investigations carried out under the auspices of the Indian Council of Medical Research between 1957 to 1960 are described.

The stones are found to occur predominantly in males (97.1%) and most commonly between the ages of 1 and 10, with a peak incidence at 5 years.

Histological studies carried out in thirty cases showed no evidence of specific vitamin A changes in the bladder epithelium and any aetiological relationship between vitamin A and the occurrence of primary bladder stones is, on this and other grounds discounted. Studies of the chemical composition of thirty stones showed that the commonest constituent was calcium oxalate. The nuclei of four stones examined contained more calcium oxalate and less phosphates and urates than the stone as a whole. This fact, if confirmed, suggests a renal origin of the stones. The population group affected is the poor farmer, farm labourer or village artisan (93%) whose diet is almost entirely vegetarian, and based on a hard millet of which 23–24 oz/day are eaten by an adult. This gives an adequate total calorie value and a fairly high protein intake, but there is little or no animal protein, and very low fats and oils.

In Europe 100 years ago primary stones in the bladder were common, both in children and adults. They were found most frequently in England in Norfolk, which was a poor agricultural area, where the food at that time showed a marked resemblance to the diet described at Ahmednagar. The incidence of primary bladder stones was found to diminish in the second half of last century, and reached vanishing point in England between 1920 and 1930, and in Scandinavia between 1910 and 1920. There was simultaneously in Scandinavia a great increase in the recorded occurrence of renal stones and a preliminary observation is presented regarding this.

A working hypothesis that primary bladder stones are basically due to a diet consisting almost exclusively of one cereal is presented, and other possible aetiological factors considered.

A brief review of recent experimental work is given which indicates that there is a theoretical possibility of stone formation in the renal tract due to an imbalance, whether excess or shortage, of the individual amino acids associated with a deficiency, whether primary or secondary, in a constituent of the vitamin B group, possibly vitamin B₆, concerned in intermediate protein metabolism.

The use of the ballistic bomb calorimeter for the determination of fat. By

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The calorific value of diets has generally been calculated from analytical data for carbohydrate and fibre, fat, protein and ash, but a fair approximation can be made for human dietaries which are normally of low ash and fibre contents by using the percentage fat only; conversely if the total calorific value were known the fat percentage could be calculated. A simple, rapid and direct determination of calorie values is now possible using the bomb calorimeter of Miller & Payne (1959), and from the data obtained the percentage of the fat in dried meals can be calculated. The values obtained for 127 meals, with fat contents ranging from 2% to 50% on a dry-weight basis, have been examined for fat content by light-petroleum extraction and from the total calorific value. The correlation coefficient between gross energy (G.E.) in kcal/g and percentage fat (F) was found to be 0.94, slightly greater than

that found (0.92) when the total fat and the metabolizable energy (M.E.) were compared. This was surprising since the calculated metabolizable energy includes a correction for the incomplete oxidation by animals of nitrogenous compounds (Miller & Payne, 1959). The best straight line was calculated using the method of least squares and this was found to be:

$$\text{G.E.} = 0.051F + 4.32.$$

The mean value of the constant found by the combustion in the bomb of samples from which the fat had been extracted was 4.25.

The results for percentage fat obtained by calculation from the above equation are shown in the table with the result obtained by light petroleum extraction, the samples being selected at random.

Comparison of percentage fat values found by calculation from the gross energy with those found by light-petroleum extraction

G.E.	Fat calculated (%)	Fat extracted (%)	G.E.	Fat calculated (%)	Fat extracted (%)
4.70	7.5	8.5	5.29	19.1	19.6
4.72	7.9	9.6	5.36	20.5	17.0
4.86	10.6	9.3	5.37	21.1	19.4
4.89	11.2	9.3	5.43	21.9	23.6
4.93	12.0	12.8	5.46	22.5	21.5
4.97	12.8	11.2	5.46	22.5	23.8
5.00	13.4	12.2	5.75	28.2	27.2
5.06	14.6	16.0	5.91	31.2	29.7
5.09	15.2	15.6	6.08	34.7	37.8
5.25	18.3	19.3	6.11	35.3	34.4
5.26	18.5	16.0	6.30	39.0	37.0

The accuracy of prediction is not particularly high but considering that the comparison is between the material extracted with light petroleum and not necessarily with the true content of lipid and that no allowance is made for a variable ash content, the agreement is reasonable.

Thus a single rapid determination gives an acceptable value for calorific value together with an approximate value for the percentage fat sufficiently accurate to provide a basis for a calculation of the percentage of calories supplied by fat. It should be emphasized that the equation only applies to diets of low fibre and ash contents but other equations could be obtained for other diets whose main variable is the content of fat.

REFERENCE

Miller, D. S. & Payne, P. R. (1959). *Brit. J. Nutr.* **13**, 501.

Dietary protein deficiency and the growth and mineralization of the bones of the pig. By R. J. C. STEWART and B. S. PLATT, *Human Nutrition Research Unit, National Institute for Medical Research, The Ridgeway, Mill Hill, London, N.W.7*

Changes in the bone are a feature of protein-calorie deficiency produced experimentally in young pigs (for diets see Heard, Platt & Stewart, 1958). Radiographs of

the bones of such animals show the epiphysial cartilages to be thin and, varying with the severity of the disease, a single well-marked or a series of less well-marked transverse trabeculae or arrested growth lines within the rarefied metaphysis (Stewart & Platt, 1958).

Three litter-mate pigs of the same age and sex (nos. 92, 93 and 88) were maintained on the LP (low-protein), LP+CH (LP+extra carbohydrate) or 5 CLP (5 g casein replaces 5 g starch in each 100 g of LP) diets respectively. Pig no. 92 (LP) developed small bones with radiographic evidence of a thin epiphysial cartilage, fine transverse trabeculae and general rarefaction. Cytological examination confirmed that the proliferation and maturation of the cartilage was seriously impaired. Osteoblastic activity was substantially reduced but osteoclasts was not affected or may have been slightly increased. Accompanying the impaired chondrogenesis and growth was a reduction in the number and length of the primary trabeculae which were often separated from the epiphysial cartilage by the action of osteoclasts or chondroclasts. The continuing osteoblastosis had produced an excessive lateral interlacing of the trabeculae or trabecula remnants resulting in the transverse lines seen in the radiographs. The combination of reduced chondrogenesis and osteoblastosis with relatively normal osteoclasts had led to the osteoporotic condition. Similar but more severe changes were found in the bones of pig no. 93 (LP+CH) whilst those of pig no. 88 (5 CLP) were comparatively slight.

The total mineral ash recovered from the femurs of these animals was 2.75 g, 2.53 g and 4.97 g respectively but the A/R ratios (Chick & Roscoe, 1926) of the shafts of the femur did not vary, being related in these experiments to the age of the animal rather than its diet. The addition of 650 mg/day of calcium to a protein-deficient diet did not prevent any of the abnormalities.

In these experiments the pathological changes, including osteoporosis, in the long bones and vertebrae can clearly be attributed to the low protein value (quantity \times quality) of the diet. It is suggested that more attention be given in the study of the pathogenesis of other forms of osteoporosis to the protein element in the diet.

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Studies of body composition in men aged 60 and over. By J. H. FRYER (introduced by B. S. PLATT), *Graduate School of Nutrition, Cornell University, Ithaca, N.Y., U.S.A.*

A study was made of the body composition of sixty men aged 60 or over, all of whom were in good general health. The group was unselected by body habitus but comparison with large samples from the Caucasoid population of the United States showed no bias of height or weight. Determinations were made of body specific

gravity by water densitometry, total body water by *N*-acetyl antipyrine dilution (NAAP space), thiocyanate space, basal oxygen consumption, urinary creatinine excretion and skinfold thickness at selected sites.

Group mean values for selected parameters are shown in the table, together with values from the literature to illustrate the age trend.

	Mean age (years)	Group mean value	Reference
Body sp. gr.	20	1.0766	Brožek & Keys (1951)
	49	1.0554	Brožek & Keys (1951)
	70	1.0359	Present study
Total body water	25	44.1 l. (61% body-weight)	Edelman <i>et al.</i> (1952)
	41	43.8 l. (55% body-weight)	Edelman <i>et al.</i> (1952)
	70	37.4 l. (53% body-weight)	Present study
Basal oxygen consumption	23	250 ml/min	Wedgwood (1953)
	70	232 ml/min	Present study
Urinary creatinine	23	2040 mg/24 h	Miller & Blythe (1952)
	70	1419 mg/24 h	Present study

A synthesis of all the data indicates that ageing produces an inevitable trend in body composition with the loss of lean tissue and total body water and possibly bone mineral, while fat is gained. These changes are irrespective of changes in body-weight and weight may be a very poor indicator of fat content in the older man. Obesity may apparently occur in the 'underweight' individual. The loss of lean tissue is associated with a reduction in basal oxygen requirement and creatinine excretion. The possible relationship of the changes described to 'degenerative' diseases, such as atherosclerosis, should be a matter of interest.

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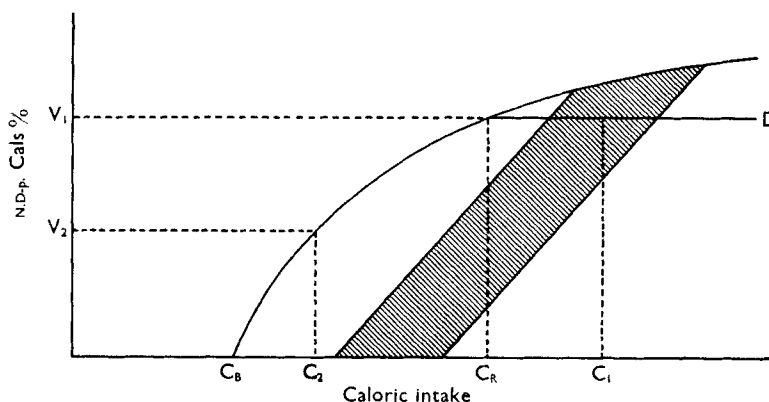
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The effect of caloric intake on net dietary-protein value. By D. S. MILLER and P. R. PAYNE, *Human Nutrition Research Unit, National Institute for Medical Research, The Ridgeway, Mill Hill, London, N.W.7*

Protein malnutrition in man is frequently associated with inadequate caloric intakes; the assessment of the protein value of diets when the food intake is low is clearly important. Experiments with rats indicate that below a certain level of caloric intake as the energy value of the food eaten is reduced an increasing amount of protein is burnt for energy purposes and consequently the efficiency of utilization of nitrogen falls.

The animal's requirements for energy are met preferentially and the use which can be made of the protein in the diet depends upon the energy available: thus the

protein values of diets when fed in restricted amounts are a function of caloric intake only. The level of energy intake below which this occurs depends upon the net dietary-protein value (Platt & Miller, 1959) of the diets when fed *ad lib.*



The diagram illustrates the effect of caloric intake on protein value expressed as N.D-p. Cals %. When fed *ad lib.* the caloric intake of animals fed diet D has been found to fall within the shaded area (e.g. C_1) and N.D-p. Cals % = V_1 . If the intake is reduced to C_R the N.D-p. Cals % will be V_1 , but if it is further reduced to C_2 the value will have fallen to V_2 . The curve is given by

$$\text{N.D-p. Cals \%} = 17\left(1 - \frac{70}{C}\right),$$

where C = caloric intake measured as kcal/day body-weight $\text{kg}^{0.73}$.

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A calorie paradox? By J. H. FRYER, D. S. MILLER and P. R. PAYNE, *Human Nutrition Research Unit, National Institute for Medical Research, The Ridgeway, Mill Hill, London, N.W.7*

Maintenance of body-weight depends upon a balance between energy intake and energy expenditure; it is commonly accepted that the latter may be divided simply into a requirement for resting metabolism and that required for physical activity. In experiments with rats, two groups were held at constant weight by feeding either (a) a restricted amount of stock diet or (b) *ad lib.* amounts of a diet with a low protein concentration. The difference in caloric intake of the two groups was 33%; this could not be accounted for by differences in the energy content of the faeces or urine, the specific dynamic action of the diets, activity or body composition, indicating that the excess calories were converted directly into heat. This conclusion was confirmed by differences in CO_2 production.

In a second experiment, two pigs (4.5 kg) were also maintained at constant body-weight on the two regimens described above for a period of 40 days. The caloric

intakes were (a) 243 kcal/day and (b) 1185 kcal/day. The energy content of the faeces and urine were (a) 18.5% and (b) 6.1% of the daily intake. Thus the ratio of the calories from the food absorbed was more than 1:5. Activity was estimated to be the same in both cases, whereas CO₂ production was in a ratio of 1:4. The excess calories clearly produce heat alone.

The implication of these experiments on the calculation of calorie requirements, the prescription of diets for weight control and the meaning of basal metabolism and specific dynamic action are far-reaching and suggest the need for further research.

DEMONSTRATION

Clinical, electroencephalographic and pathological changes in the nervous system of experimental animals. By C. R. C. HEARD, A. MEYER, G. PAMPIGLIONE, R. J. C. STEWART and B. S. PLATT, *Human Nutrition Research Unit, National Institute for Medical Research, The Ridgeway, Mill Hill, London, N.W.7*

The demonstration (a film) (a) recalls the effects on the central nervous system of protein-calorie deficiency on normally born young pigs (Platt & Stewart, 1960; Meyer, Stewart & Platt, 1961); (b) assembles some new observations on the offspring of bitches fed on a modified United Kingdom-type diet; (c) suggests that the state of the nutrition of the mother may be a factor in the pathogenesis of some neurological disorders in man.

Five apparently normal growing bitches were given a United Kingdom-pattern diet modified by (1) omitting all the milk solids; (2) including only half the meat; (3) restoring the calcium and most of the vitamins of the B-complex; (4) adding cod-liver oil. Three of these five animals have thrown two litters and another had one litter making a total of forty-one pups. None of these was normal; twenty died before weaning at 6 weeks of age. Twenty-one have shown, even within litters, varying degrees of clinical, electroencephalographic and histological changes. The pups are retarded in development; they have a waddling gait, the hind legs being widely spread. Not only is the gait sometimes ataxic but there are other disorders of movement of the body. Tremors, especially of the head, are common and one animal had an epileptiform fit. The disordered movements are exaggerated in the presence of a strange dog. The electrical activity of the brain was grossly abnormal with an excess of irregular slow activity of large amplitude, multifocal discharges and diminution of rhythmic activity. The abnormality was more obvious during drowsiness and sleep than when the animal was alert.

A preliminary study of the histology of the central nervous system has revealed a widespread nerve-cell degeneration accompanied by fibrous gliosis, including gliosis of the sub-pial cortex, the most severe being in the anterior horns of the spinal cord. The lesions are similar to, but more pronounced than, those reported earlier in the piglet suffering from protein-calorie deficiency.

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