ABSTRACTS OF COMMUNICATIONS

The Sixtieth Meeting of The Nutrition Society (Twenty-eighth of the Scottish Group) was held at Strathcona House, Rowett Research Institute, Bucksburn, Aberdeenshire, on Saturday, 22 April 1950, at 11.30 a.m., when the following papers were read:

Nutrition in Relation to the Shape and Size of the Human Pelvis.

By R. M. BERNARD, *Department of Midwifery, University of Aberdeen*

In the female, four normal growth variants in the basic shape of the brim of the true pelvis are described as being due to genetic and hormonal influences. These are the round or feminine, the long oval, the flat, and the triangular or male (Caldwell, Moloy & Swenson, 1939).

The flat and triangular shapes are commonly associated with difficulties in labour due to disproportion between the size of the foetus and that of the pelvis. This in itself suggests that they are not normal but abnormal growth variants. Data collected in Aberdeen suggest that the normal pelvic brim is round or slightly oval in shape. The flat and triangular shapes are abnormal, and are associated with impairment of growth, being found in small and poorly nourished women. The flattening appears to be analogous to that found in rickets, but is of a less severe degree. This chiefly affects the posterior part of the pelvic curve lying behind the widest transverse diameter.

In the higher social classes of Aberdeen only 5 % of the women are under 5 ft. 1 in. in height whilst many are over 5 ft. 5 in. In the lower social classes at least 25 % are under 5 ft. 1 in. whilst few are over 5 ft. 5 in. in height (Baird, 1949). Difficulties in labour due to disproportion at the pelvic brim are confined to women of small stature, and are therefore much more common in the lower-income groups. The social differentiation suggests that many of the small women are small because of poor nutrition during growth rather than because of genetic influences. At the same time, they frequently have a flat or triangular-shaped pelvic brim of small measurements, and hence difficulties in labour due to disproportion occur.

Two groups of women attending Aberdeen Maternity Hospital were examined, ninety over 5 ft. 5 in. and ninety under 5 ft. in height. Each patient was physically assessed early in pregnancy and graded 1 or 2 according to her apparent state of nutrition. In general terms a grade 1 patient had a healthy appearance and good colour, was well proportioned and neither under nor overweight for her height, her skin had a healthy bloom, and her teeth, gums, hair and nails were in good condition. If she failed to reach these standards she was placed in grade 2.

Eighty-four patients were found to be grade 1 and of these 72·2 % were tall. Ninety-six patients were found to be grade 2 and of these 78·9 % were small.

Tables 1 and 2 summarize the data obtained from the results of X-ray pelvimetry carried out on each patient.

Tables 1 and 2 show that small women have smaller pelves which are more frequently

Table 1

	Grade 1	Grade 2	All grades	Difference
	Size of pelvic brim—mean brim area (sq.cm.)			
Tall	139·08	136·96	138·49	31·55 ± 1·69
Small	110·52	105·99	106·94	
All heights	124·80	121·48	—	—
Difference	3·32 ± 1·97		—	—
	Size of pelvic brim—mean true conjugate diameter (cm.)			
Tall	12·80	12·54	12·73	1·99 ± 0·14
Small	11·10	10·65	10·74	
All heights	11·95	11·60	—	—
Difference	0·35 ± 0·16		—	—
	Flattening of posterior segment—mean sagittal indices (%)			
Tall	39·68	38·12	39·24	1·29 ± 0·57
Small	40·23	37·34	37·95	
All heights	39·96	37·73	—	—
Difference	2·23 ± 0·66		—	—

Table 2. *Shape of pelvic brim—percentage incidence* (Nicholson & Allen, 1946)

	Round		Long oval		Flat		Triangular		All shapes
Tall	86·7		5·5		7·8		Nil		100
Small	64·4		Nil		34·5		1·1		100
	By grades								
	Grade 1	Grade 2	Grade 1	Grade 2	Grade 1	Grade 2	Grade 1	Grade 2	
Tall	87·8	—	6·1	—	6·1	—	Nil	—	100
	—	84·0	—	4·0	—	12·0	—	Nil	100
Small	78·9	—	Nil	—	21·1	—	Nil	—	100
	—	60·5	—	Nil	—	38·0	—	1·5	100

flat, than tall women, and that within each height group the same holds for the poorly nourished women as compared with the well nourished. The differences shown in the tables conceal an even wider difference due to degrees of flattening. In grade 2 women the flattening was much more severe than among grade 1 women; among the latter, the flattening was minimal. It is possible that grade 1 women with slightly flat pelves had been somewhat malnourished during growth, but were adequately nourished at the time of examination.

The triangular pelvic brim, in the female, has frequently been described as masculine. This shape, however, is by no means characteristic of the male, in fact the different shapes seen in the female are found in the male in somewhat similar proportions (Thoms & Greulich, 1940). It is probably only a modification of the flat. An investigation of males, now in progress, supports the view that the flat or triangular pelvis is more commonly found in men of small stature and is therefore nutritional and not hormonal in origin.

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Experimental Cobalt Deficiency in the Sheep. By A. T. PHILLIPSON and R. L. MITCHELL, *Rowett Research Institute, Bucksburn, Aberdeenshire and Macaulay Institute for Soil Research, Craigiebuckler, Aberdeenshire*

Stewart (1947) produced cobalt deficiency in lambs by feeding a ration containing 0·068 mg. cobalt daily. We have fed a similar ration consisting of hay 150–200 g., flaked maize and maize-gluten meal in the proportions of 10:1 with 12 g. steamed bone-flour, cod-liver oil and salt. This ration provided a maximum of 0·055 mg. cobalt daily. Lambs raised on cobalt-deficient pastures ultimately died when maintained on this ration. Oral administration of 0·1 mg. cobalt daily was sufficient to allow body-weight increases of 1–1·5 lb./week, but administration of the same dose intravenously had no effect.

Cobalt introduced into the duodenum of 5-month-old lambs did not cure the deficiency although one lamb appeared to derive some benefit from this procedure. All methods of administering cobalt led to the deposition of a considerable amount of cobalt in the liver so evidently the amount of cobalt in the liver, *per se*, is not a physiological measure of the cobalt status of the animal (see Table 1).

Table 1. *Cobalt in liver of lambs*

Treatment	Concentration in liver ash (p.p.m.)	Total cobalt in liver (μg.)
No cobalt (9 lambs)	<0·2–0·71	<1·0–<2·5
0·1 mg. cobalt by mouth	14·0	79
0·1 mg. cobalt by mouth (died in 13 days)	<0·26	<1
0·1 mg. cobalt by mouth	15·0	86
1 mg. cobalt by mouth	3·0	12·0
1 mg. cobalt by mouth	1·5	9·7
1 mg. cobalt by mouth	22·0	80·0
0·1 mg. cobalt intravenously	18·0	67
0·1 mg. cobalt intravenously	39·0	89
0·1 mg. cobalt by duodenum	6·0	22
0·1 mg. cobalt by duodenum	7·0	30

Table 2. *Change in weight of lambs 8–12 months old during 20 weeks (lb.)*

Control group, no cobalt	Cobalt administration by		
	Duodenum	Abomasum	Mouth
− 2·0 (R.A.)	+ 9·0 (R.D.)	+20·5 (R.A.)	+28·5 (R.A.)
+11·5 (A.)	+19·5 (R.D.)	+19·0 (R.A.)	+16·5 (A.)
+ 8·0 (R.D.)	+17·0 (D.)	+15·5 (A.)	+18·0 (R.D.)

R. = rumen cannula; A. = abomasal cannula; D. = duodenal cannula.

Administration of cobalt by mouth, abomasum and duodenum to older lambs (8–12 months) led to weight increases in both oral and abomasal groups, which were significantly greater than those of the control group receiving no cobalt. Duodenal administration led to variable responses (see Table 2). The rumen liquor, however, in all animals dosed by any route contained more cobalt than that of the controls.

These experiments support the suggestions of Marston & Lee (1949), but do not exclude the possibility that free cobalt is necessary in the abomasum.

We wish to thank Dr A. B. Stewart and Dr J. Stewart for much advice and for their help in obtaining a supply of cobalt-deficient lambs.

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The Influence of the Ovaries on Bone Repair after Skeletal Depletion during Lactation. By GABRIELLE M. ELLINGER and J. DUCKWORTH, *Rowett Research Institute, Bucksburn, Aberdeenshire*

Warnock & Duckworth (1944) demonstrated that during lactation rats lose bone substance from the spongiosa of the long bones. When a diet adequate in calcium is fed the loss is repaired during the 3 weeks following lactation. Pregnancy during this period does not interfere with the recovery. Later work showed that skeletal depletion occurs in the lactating rat, irrespective of the level of dietary calcium. However, in severe calcium deficiency the compact bone of the shaft, which is normally only slightly affected, may be depleted to about the same degree as the spongiosa (Ellinger, Duckworth, Dalgarno & Quenouille, 1950).

It has been established for the pigeon that the skeletal changes associated with the egg-laying cycle are related to ovarian function (Kyes & Potter, 1934).

In the present experiment rats were fed a diet severely deficient in calcium throughout pregnancy and lactation. The effect of ovarian hormones on the recovery of calcium reserves was then studied during the 3 weeks following lactation. The average daily calcium retention per g. body-weight was 0·131, 0·091 and 0·031 mg. during the 1st, 2nd and 3rd weeks, respectively.

Ovariectomy did not affect this rate of repair. Nor did the daily injection of physiological doses of oestrone and/or progesterone alter the calcium retention of the ovariectomized rats.

It is interesting to compare the rate of repair with the daily calcium retention per g. body-weight calculated for growing rats from the data of Lanford, Campbell & Sherman (1941). Between the ages of 28 and 60 days rats retained 0·316 mg. calcium daily, between 60 and 90 days of age 0·096 mg. and between 90 and 180 days of age 0·030 mg. The intensity of bone anabolism during the 1st week of the recovery period is approximately the same as that of a rat about 60 days of age.

We thank Dr A. T. Phillipson for performing the operations.

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The Nutritional Significance of Microbial Digestion of Starch in the Pig Caecum. By H. NASR (introduced by J. W. HOWIE), *Rowett Research Institute, Bucksburn, Aberdeenshire*

In the pig maize starch is broken down by digestive secretions in the small gut whereas raw potato starch is broken down in the caecum by micro-organisms, chiefly *Clostridium butyricum* (Baker & Nasr, 1947). The object of this work was to examine the phenomena of bacterial digestion of raw potato starch in the pig caecum and to assess its nutritional consequences for the pig. The structural features of microbial breakdown of the raw potato-starch granule include swelling, formation of enzymatic cavities, disappearance of amylose and, lastly, digestion of the amylopectin residues (Baker, Nasr & Morrice, 1949). A strain of *Cl. butyricum* isolated from the pig caecum in pure culture produced an α-amylase in cell-free filtrates when grown in starch medium. Detailed study of this enzyme has been carried out by Whelan & Nasr (1950). The mechanism of polysaccharide synthesis by the *Clostridium* has been shown to involve a phosphorylating mechanism (Nasr & Baker, 1949). *Cl. butyricum* when provided with *p*-aminobenzoic acid and biotin was found capable of synthesizing in vitro at least six members of the vitamin B complex, namely riboflavin, nicotinic acid, aneurin, pantothenic acid, pyridoxin, and folic acid. Others were not tested (Nasr, 1949).

During this work refection was established in the pig. Two pigs fed raw potato starch were able to grow at almost a normal rate for 14 and 22 weeks on a vitamin B-free diet, whereas, within 5 weeks, two pigs died and two pigs were gravely ill when fed the same diet but with the raw potato starch replaced by either boiled potato starch or maize starch (Nasr, 1949). The pigs fed raw potato starch made good progress until the onset of cold weather when they also became ill and died.

The debated problem of the relative merits of cooked and raw potatoes in pig feeding was also re-examined. By adding them gradually and carefully to the diet it was possible to feed to fattening pigs up to 15 lb. of raw potatoes along with $2\frac{1}{2}$ lb. of pig meal a day. Four pigs so fed required on an average 13 days longer to reach bacon weight than a group fed the same amount of boiled potatoes. There was no marked difference in carcass measurement or bacon quality between the groups. Under some conditions of farming raw potatoes may have to be fed, and this work shows that such a situation need not inevitably be regarded as unfavourable in every respect. The economic factors involved do not permit of generalizations at this stage; but it may be emphasized that the earlier attainment of bacon weight is not by any means the only consideration of importance. Different results may be expected with pigs at different ages and from feeding a smaller proportion of the diet as raw potatoes. These points will be raised for discussion.

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The Influence of Ascorbic Acid on the Vascularization of the Cornea subsequent to Injury. By F. W. CAMPBELL and I. D. FERGUSON (introduced by R. C. GARRY), *Institute of Physiology, University of Glasgow*

We recently studied the influence of scurvy on the rate of healing of deep corneal heat injuries in guinea-pigs and found a significant delay in the time of healing and a structural weakness of the wound in the scorbutic animals (Campbell, Ferguson & Garry, 1950).

We now find that an invasion of the cornea with new vessels from the corneosclerotic junction occurs with significantly greater frequency in the scorbutic group. This result might be due to the longer time required for healing in the deficient animals, but on examination of the results no conclusive evidence could be found to substantiate this belief.

It may be that repair of a corneal injury makes additional metabolic demands which cannot be met in a state of ascorbic-acid deficiency. As a result, metabolites might accumulate and evoke by some means, not yet fully understood, a vascular invasion of the corneal stroma.

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The Biological Value of Dietary Nitrogen in the Calf. By K. L. BLAXTER and W. A. WOOD, *Hannah Dairy Research Institute, Kirkhill, Ayr*

When adult ruminants are fed proteins of different amino-acid composition, nitrogen metabolism and hence the biological value of the dietary proteins remains almost constant. This is taken as evidence that the ingested proteins are altered by the degradative and synthetic action of the rumen micro-organisms before they reach the small intestine. It is probable, however, that in the young calf in which no ruminal fermentation occurs, the biological value of the dietary proteins will vary according to their composition. A study of this aspect of calf nutrition has therefore been begun.

In the first experiments the proteins of dried skim milk, commercial light casein, and gelatin of good quality were compared in nitrogen metabolism studies with four Ayrshire bull calves, each of which received each ration. The proteins were fed as constituents of semi-synthetic diets in which they were the sole source of nitrogen. Except that only 9 % of the energy of the diets was supplied in the form of protein, and that they were therefore deficient in protein, the diets were otherwise nutritionally adequate. Biological values were calculated according to the Thomas-Mitchell method.

Urinary nitrogen excretion increased when both the casein and particularly the gelatin diets were fed. Over 90 % of the increase was due to excretion of urea, ammonia and amino nitrogen. There was a small increase in creatine excretion, but no change occurred in the excretion of creatinine and total purine nitrogen, although the distribution of purine nitrogen between purine bases, uric acid and allantoin was slightly modified.

The mean daily body-weight gains, nitrogen balances and biological values were as follows:

	Gain in weight (g./day)	Nitrogen balance (g./day)	Biological value of the proteins: As found	Biological value of the proteins: Taking the value of dried skim milk protein as 100
Dried skim milk proteins	+268	+5·55	92·3	100
Casein	+241	+3·64	78·8	85
Gelatin	−271	−2·70	29·5	32

The values in the last column for calves are very similar to those of 100, 82 and 30 found for the rat. It is concluded therefore that before rumen fermentation develops in the young calf, this animal is just as dependent on its diet for amino-acids as is man, the dog or the rat.

The Design and Statistical Analysis of Growth Experiments with Chicks.

By A. W. Boyne, K. J. Carpenter and J. Duckworth, *Rowett Research Institute, Bucksburn, Aberdeenshire*

This paper discusses some aspects of experiments testing the effects of different protein or vitamin diets on chick growth. In experiments carried out at this Institute three types of cages have been used, housing groups of twelve to sixteen chicks, groups of four, and individual chicks.

The first question considered is whether the different types of housing allow valid estimates to be made of dietary effects. There is a tendency for individually caged chicks to be smaller than those housed in groups, and it is possible that the slower growth rate might alter dietary effects. This, however, has not been observed. For instance, the following table gives the results from an experiment in which all three types of caging were used. Six diets were tested and the results given are the mean weight gain during the experiment, from 4 days until 5 weeks. The weight gains are expressed as a percentage of the overall mean weight gain for each type of caging.

Table 1. *Mean weight gains expressed as percentages of overall mean weight gain*

No. in group	Diet A	B	C	D	E	F	Standard error of differences between means	Overall mean weight gain (g.)
16	93	124	132	104	85	63	± 4·0	212
4	98	121	123	101	97	59	± 15·0	210
1	89	127	119	103	88	73	± 10·2	184
Mean	93	124	125	103	90	65	± 6·2	—

Table 1 shows that, in all arrangements, the diets are in the same order, with the exception of B and C, which are reversed in individual caging. This reversal is not important since B and C are not significantly different in any arrangement.

The next point considered is the interpretation of differences between dietary or treatment means. When birds are caged in groups the estimate of error mean square between groups is larger than that among birds of the same group, sometimes by a factor of four or five. Thus it is incorrect to test differences between diet means, which are between group comparisons, with estimates of error calculated from the within-group variability. More than one group should receive each treatment to provide an estimate of the between-group error.

The error mean square is larger when birds are housed in groups than when they are individually caged. Table 2 illustrates this effect.

Table 2. *Estimates of error mean square in growth for different group sizes*

Mean square up to	Size of group 12–16	4	1
4 weeks	1436	1425	433
5 weeks	2481	4804	1122
6 weeks	8505	—	2163

This table was compiled from the results of ten experiments, all of which gave comparable results. It shows that the mean square when large groups are used is about three times as great as with individually caged birds. Thus when a limited number of birds can be used, or where the dietary material under test is scarce, it is better to cage birds individually. If there is no such limitation, the experimenter must decide whether the threefold increase in accuracy obtained from individual caging justifies the additional work involved in handling each chick individually.

It has been observed at this Institute that initially larger chicks tend to be heavier throughout the experiment. It is thus suggested that when birds are individually caged they should be stratified according to initial weight before allocation to diets. In this way the most economical use is achieved of the limited numbers available. Whatever size of group is used, balancing of initial weight between groups is advantageous.

Phosphatase and Ester-Phosphorus in Human Milk. By R. CHANDA and E. C. OWEN, *Hannah Dairy Research Institute, Kirkhill, Ayr* and B. CRAMOND, *Royal Infirmary, Aberdeen*

Microscopic Studies of the Alimentary Micro-organisms of the Sheep. By MARJORIE MASSON (introduced by A. T. PHILLIPSON), *Rowett Research Institute, Bucksburn, Aberdeenshire*

In a sheep given hay and concentrates: (1) The micro-organisms of the rumen are largely disintegrated in the abomasum. (2) Spore-forming rods predominate in the lower small gut. (3) The food particles show a characteristic distribution of size-frequencies for particular regions of the gut. (4) A proportion of the starch grains

ingested by the protozoa in the rumen appears to be liberated in the abomasum, where these protozoa are broken down.

In this and other sheep it was found that: (5) In the omasum many of the larger rumen organisms undergo changes which may be a first step towards their digestion in the abomasum. (6) Changes in the rumen microbial population may result from changes in diet. Thus: (*a*) In sheep fed hay alone the bacterial types are few, the bacteria and protozoa are small in size, and the number of organisms in stained smears is relatively low. (*b*) In sheep fed hay and moderate amounts of concentrates the population is rich in starch-digesting sarcinae, diplococci, and streptococci; the protozoa are larger; and more bacterial types are represented. (*c*) In sheep fed a large proportion of flaked maize, protozoa and yeasts were absent and Gram-positive sporing rods were predominant. These proved to be *Clostridium butyricum*. Lactobacilli were also isolated. (*d*) From Dr R. L. M. Synge I received the rumen contents of a sheep into whose rumen casein was inserted in amounts up to 300 g. daily. Numerous streptococcal forms were observed around the casein. On culture a streptococcus was isolated which clotted milk and later digested the clot. So far it has been grown only under anaerobic conditions: it survives 60° for 30 min., grows on McConkey's medium, and liquefies gelatin.

These results form the point of departure for a systematic investigation of the microbial populations of the alimentary tract of the sheep. Ultimately, the changes in microorganisms will have to be considered in relation to the growth and welfare of the animal.

Some Observations on the Utilization of Protein-Rich Supplements by Sheep. By MARGARET I. CHALMERS and R. L. M. SYNGE, *Rowett Research Institute, Bucksburn, Aberdeenshire*

We are trying to assess the nutritional significance of the considerable evolution of ammonia from proteins occurring in the rumen. McDonald (1948*a*) observed the time course of ammonia production after feeding proteins and showed (McDonald, 1948*b*) that this ammonia is absorbed by the blood draining the rumen. We have confirmed these observations and Cuthbertson & Chalmers (1950), after introducing casein directly into the duodenum, found by nitrogen-balance experiments that it was better utilized than when it had passed through the rumen.

In Table 1 are shown the results of similar nitrogen-balance experiments in which two specimens of casein and two specimens of herring meal were fed as supplements to nutritionally depleted sheep on a basal diet of hay and mixed meals. The faecal-nitrogen figures indicated complete net absorption of the supplementary nitrogen. Fig. 1 shows the time course of ammonia concentration in the rumen of sheep fed in this way.

It seems reasonable to connect the lower rumen-ammonia figures with the better retentions of nitrogen for the herring meal as against the casein. We have also observed differences of this kind between caseins before and after heat processing. We are hoping to extend the work to include growth experiments and to study the utilization of the

Table 1. *Retention of nitrogen of casein and herring-meal supplements fed to 6-year-old Cheviot ewes on a diet of mixed meals and hay*

(The ewes received a basal diet of 400 g. hay (4·37 g. nitrogen) and 150 g. stock mixed meals (3·44 g. nitrogen)/24 hr. Supplements (6·3–6·6 g. nitrogen) were fed mixed with the meals. Urinary and faecal nitrogen output was measured over a period of 9 days on the basal diet, followed by four successive 12-day periods in which each of the four supplements was fed (in different sequences) to each animal, followed by a 9-day period on the basal diet. Since the daily faecal nitrogen outputs remained constant throughout the experiment, no correction for faecal carry-over was needed, and the retentions are calculated with reference to the excess of daily nitrogen output during the supplemented period over the mean daily nitrogen output during the basal periods for each animal)

	Percentage of supplementary nitrogen retained				Wt. (lb.)	
	Casein		Herring meal			
Animal	Sample 1	Sample 2	Sample 1	Sample 2	Initial	Final
T	17	27	30	44	100	97
V	9	9	38	23	88	85·5
W	29	20	36	39	90	92·5
X	32	18	45	36	97·5	92

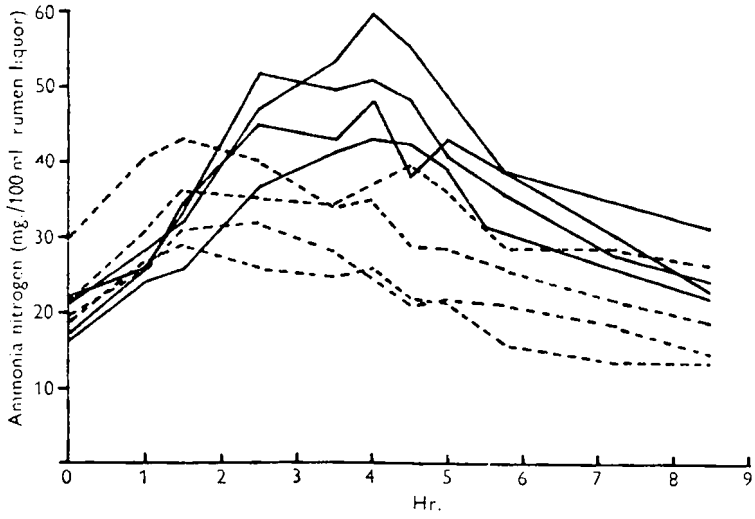

Fig. 1. Ammonia in rumen liquor on feeding casein and herring meal to Cheviot ewes with rumen fistulas. Samples of rumen liquor were strained, diluted to 10 vol. with 0·02 N-HCl and filtered (cf. McDonald, 1948*a*); NH_3 in filtrates was determined according to Conway & O'Malley (1942) using K_2CO_3. Zero-time samples were taken immediately before feeding 150–200 g. mixed meals with 50 g. supplement; after 4 hr., 300 g. hay was fed. ——— —, supplement: casein; - - - - - -, supplement: herring meal.

nitrogen of grass products as well as of concentrates. Measurement of ammonia concentration in the rumen of a fistulated animal is a rapid and simple procedure that may prove helpful in selecting diets for more detailed study.

We thank Dr A. T. Phillipson for doing the surgery involved in this work.

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The Sixty-first Meeting of The Nutrition Society was held at the London School of Hygiene and Tropical Medicine, London, W.C. 1 *on Saturday,* 27 *May* 1950, *at* 10.30 *a.m., when the following papers were read:*

Variables Influencing the Response of Chicks to Animal Protein Factors in the Ration.

By K. J. CARPENTER and J. DUCKWORTH, *Rowett Research Institute, Bucksburn, Aberdeenshire*

American workers report that poultry rations containing largely soya-bean and maize meals, when supplemented with vitamin B_{12} or 'animal protein factor' (A.P.F.) concentrates, are equal to rations containing animal protein.

We have been investigating whether satisfactory all-vegetable rations, with similar supplements, could be formulated with materials available in this country.

Rations with groundnut meal, dried yeast, grass meal, mixed cereals and miller's offals as the protein sources were almost equal to regulation 'animal protein' mashes for commercial chicks; and a vitamin B_{12} concentrate* did not improve either growth or feed-conversion efficiency.

The progeny of hens fed a similar ration and kept on either wire screens or folded across winter grass were also tested. They grew slowly on this U.K. all-vegetable ration and vitamin B_{12} improved growth only slightly. Parallel groups fed a U.S.A. (soya-yeast-alfalfa-maize) ration grew even more slowly, but vitamin B_{12} restored growth completely.

The U.K. ration appears less deficient than the U.S.A. ration in vitamin B_{12} but more deficient in a second dietary factor transmittable from hen to chick. Microbiological assays with *Lactobacillus lactis* Dorner† did not indicate any difference in the vitamin B_{12} content of the two rations.

Children's Growth.

By E. R. BRANSBY and W. H. HAMMOND, *Ministry of Health, Whitehall, London, S.W.* 1

The paper discussed problems connected with the assessment of nutritional status from children's measurements and outlined the methods on which we were working.

* 'Cytamen' prepared as a by-product of the manufacture of streptomycin and kindly supplied by Glaxo Laboratories Ltd.

† These assays were kindly carried out for us by Mr G. E. Shaw of the Evans Biological Institute.

Groups were compared in respect of socio-economic status and clinical nutritional categories and the 'good' groups in each case showed quite different characteristics. Thus the good socio-economic group excelled mainly in length measurements but had less fat, whilst the clinically good groups excelled in girths and fat. Physical type evidently needed to be taken into account within the social and clinical groups.

For individuals the situation is complicated by hereditary and environmental effects and also past and present conditions. By considering growth and allowing for attained size we can eliminate many of the past conditions. Variability of growth has not yet, however, been reduced sufficiently to make it of much practical use. Comparisons of actual and predicted weight, together with fat measurements, are promising, but we believe that no one method offers a real solution. The safest approach is to use all available methods in conjunction. It may finally be necessary to appeal to the procedure of test feeding to solve the problems, difficult though that may be.

Changes in the Pancreatic Islets in Guinea-pigs on a Vitamin P-Deficient and a Stiffness-Producing Diet. By G. H. BOURNE, *Department of Histology, London Hospital Medical College, London, E.* 1

A small percentage of guinea-pigs on a vitamin P-deficient diet (Bourne, 1943) for 6 weeks or more show changes in the islets of Langerhans in the pancreas which vary from almost complete cytological degeneration to pyknosis of the nuclei. Guinea-pigs on a vitamin P-deficient diet also show a greater variation in the blood sugar than normal guinea-pigs. The usual tendency was for the blood sugar to be raised. In three cases out of twenty-one animals it was raised more than 60 % above normal. There was no correlation between blood-sugar level and the level of capillary resistance which suggests that the missing factor may be something other than vitamin P. Crude sugar-cane wax was found to have some vitamin P activity and three guinea-pigs of eight on a diet said to produce joint stiffness (van Wagtendonk, 1944) (which is prevented by sugar-cane wax) showed greatly enlarged islets of Langerhans. It is of interest that Banting (see Stevenson, 1947) commented that the incidence of diabetes in the tropics was negligible in poorer classes who ate raw sugar-cane and higher in classes who ate refined sugar.

The work presented suggests that there may be a dietary factor responsible for the maintenance of the integrity of the islets of Langerhans in the pancreas and that this dietary factor may be vitamin P or a related substance.

I am indebted to Dr F. Bergel and Mr M. W. Parkes of Roche Products Ltd. for a supply of animals on a stiffness-producing diet and for some of the blood-sugar estimations and to Dr C. J. O. R. Morris of the London Hospital for other blood-sugar estimations.

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Lesions of the Muco-cutaneous Junctions in Pyridoxin Deficiency in Albino Rats. By V. RAMALINGASWAMI and H. M. SINCLAIR, *Laboratory of Human Nutrition, University of Oxford*

Definite pathological changes in the cutaneous, haemopoietic and nervous systems have been described in various laboratory animals in pyridoxin deficiency. Recently Mueller & Vilter (1949) produced acute pyridoxin deficiency in man by injecting deoxypyridoxin and observed mainly lesions about the eyes, nose and lips.

During studies of pyridoxin deficiency in adult albino rats, we were impressed by the frequency and severity of lesions of the nose, lips and angles of the mouth and less frequently of the ano-genital region. The rats were kept in individual cages with raised mesh floors, were pair-fed, and the relevant vitamin supplements were given by mouth independent of the basal diet. Changes in the skin and muco-cutaneous junctions were followed by naked-eye inspection, slit-lamp microscopy, and finally by histological examination in those not used for therapeutic trial. The nose and mouth were involved, in ten out of twelve deficient rats, within about 16 weeks of deficiency, after the characteristic lesions of the paws had developed. The severity of the muco-cutaneous lesions ran parallel to that of the lesions of the paws. The earliest observed change was erythema and oedema, followed by hyperkeratosis and fissuring of the affected parts. The lesions around the mouth closely resembled cheilosis and angular stomatitis in man. Complete reversal of the changes has been observed on administration of pyridoxin to those rats not autopsied. None of the control rats exhibited similar lesions.

It is concluded that pyridoxin is essential for the integrity of the muco-cutaneous junctions in the rat as may well be the case also in man (Smith & Martin, 1940; Machella, 1942).

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Quantitative Studies and Dose-Response Curves in Nicotinamide Deficiency in Rats. By L. J. HARRIS and E. KODICEK, *Dunn Nutritional Laboratory, University of Cambridge and Medical Research Council*

It used to be thought that rats could not be used for the experimental study of nicotinamide deficiency, since they remained healthy on diets which produced pellagra-like disorders in dogs, pigs, monkeys and other species. However, Krehl, Teply & Elvehjem (1945), by feeding rats on a diet containing 40% maize, found that a retardation in their growth rate could be demonstrated which was remediable by administration of nicotinic acid. Later papers by Krehl and other American workers have discussed the possible influence of other factors (including amino-acid intake and imbalance) in producing this growth retardation. Our present observations arose from the desire to produce in rats signs of a regular deficiency disease, leading to fatal consequences, such

as can be obtained with other vitamin deficiencies, and to explore the possibilities of quantitative methods of assay.

Various dietary combinations and modifications were studied, in tests involving over 300 rats. Additions of sulphonamide and gelatin to the diet were not found to be necessary. Young male rats weighing about 55–60 g., given a low-protein, maize diet (consisting of casein 3·5, sucrose 51·4, maize meal 40, salt mixture 3, cottonseed oil 2, cystine 0·1 %, supplemented with aneurin, riboflavin, pyridoxin, calcium pantothenate, biotin, choline chloride, and vitamins A, D, E and K) cease gaining weight within about a fortnight and begin to succumb to the deficiency within about 40–60 days. In repeated series of curative and preventive tests (involving about 400 rats), graded doses of nicotinic acid, nicotinamide, L-tryptophan, and of mixtures of these substances (*per os* and intraperitoneally), and of certain foods (*per os*), were given; and well-graded, reproducible dose-response curves were obtained. In the conditions of the test, 1 mg. L-tryptophan was biologically equivalent to approx. 25 μg. of nicotinamide (or acid). Because of interaction between different factors (L-tryptophan, nicotinamide, protein level) it is possible only to compare the overall 'anti-pellagric' activity of a food preparation, for the rat, and at a given specified level of dosage.

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Some Experimental Observations on the Dietary Selection of the Rat. By D. E. TRIBE and J. G. GORDON, *Rowett Research Institute, Bucksburn, Aberdeenshire* and J. W. WHITFIELD, *Psychological Laboratory, University of Cambridge*

An experiment was carried out to determine whether rats given a straightforward unlimited choice between two diets, identical in all respects except their vitamin B-complex content, would select that containing the necessary quantities of the vitamin B complex in preference to the one containing none. The diets used were as follows:

No. 16 (Adequate in all respects except the vitamin B-complex content)		No. 37 (Adequate in all respects including the vitamin B-complex content) The same as no. 16 plus:	mg./100 g.
Casein (vitamin-free)	230 g.	Aneurin	0·3
Glucose	330 g.	Pyridoxin hydrochloride	0·3
Maize starch	400 g.	Riboflavin	0·3
Margarine	150 g.	Calcium pantothenate	2
McCollum salts	50 g.	Nicotinic acid	4
Radiostoleum	3 ml.	*i*-Inositol	10
		p-Aminobenzoic acid	10

Six litters each of six hooded Lister rats were divided into six groups in such a way that the groups were of comparable sex and litter-mate distribution.

Group 1 was given a choice between diets nos. 16 and 37 and care was taken to alter at frequent intervals the position of the diet in the cage and to prevent the association between a particular pot and a particular diet. In this way it was ensured that the

rats responded to the diets and not to the non-nutritional conditions of the environment. Group 2 was given a choice between diets nos. 37 and 37 in order to compare the reaction of rats to two pots containing identical diets with that of those in group 1 which were offered two pots containing different diets. Group 3 was given a choice between diets nos. 16 and 16 until they showed obvious clinical symptoms of vitamin B deficiency. They were then given the choice between diets nos. 16 and 37 and thus given the opportunity to remedy the deficiency. Groups 4 and 5 were each given the choice between diets nos. 16 and 37. In group 4, however, the positions of the food pots in the cage were kept permanent while the positions of the diets were altered, and in group 5 the positions of the diets in the cage were kept permanent while the positions of the food pots were frequently changed. Group 6 was fed diet no. 37 only in order to use the body-weight of those rats as a check of the efficiency of mixing the small quantities of the vitamins in the large quantities of diet when making diet no. 37 for the other groups.

It was found that non-deficient rats did not discriminate between the diets while deficient animals, when given the opportunity, showed a preference for diet no. 37. The reason for this is at present unknown. A test involving twenty-four people showed that it was impossible for human beings to distinguish between the two diets. In this experiment there was no evidence that the animals preferred to eat their food either from a particular pot or from a particular part of the cage.

Haemoglobin in Women before and after Labour.

By H. E. Magee and E. H. M. Milligan, *Ministry of Health, Whitehall, London, S.W.* 1

We have already given a preliminary account of haemoglobin levels in some 1000 pregnant women from the area round Manchester (Magee & Milligan, 1949). The observations have been continued and extended to women after labour, the total examined amounting to 1985. Some of the haemoglobin determinations were made in the same women before and after labour.

Table 1. *Mean haemoglobin (% Haldane) in pregnancy: all women*

	1st trimester			2nd trimester			3rd trimester		
		Haemoglobin			Haemoglobin			Haemoglobin	
	No.	%	S.E.	No.	%	S.E.	No.	%	S.E.
Manchester area 1947–50	109	92	0·69	482	87	0·35	653	84	0·31
Great Britain M.R.C. 1943	105	89	--	209	86	--	376	82	--
London East-end 1943–6	—	95	--	—	90	--	—	85	--

The antenatal figures (Table 1) agree closely with the earlier ones and show a decline of the same order between the 1st and 3rd trimesters and the same favourable comparison with observations made in earlier years (Committee on Haemoglobin Surveys, 1945; Hoch, Marrack, Rusc & Hoch, 1948). The postnatal values (Table 2) show a gradual but slow rise from 85·5 % at a mean point of 6 weeks after labour to 89·2 % at 52 weeks

Table 2. *Mean haemoglobin after birth*

	0–12 weeks	13–25 weeks	26–38 weeks	39–51 weeks	52+ weeks
Mean	85·5	86·2	88·1	89·2	89·2
No.	222	203	152	91	156
S.E.	±0·64	±0·67	±0·88	±1·06	±0·59

or more after labour. This last value is appreciably below the mean (93·7) for all women and also for parous married women over 50 (93·5) in the M.R.C. 1943 survey (Committee on Haemoglobin Surveys, 1945). The reason for this is not clear. Those taking iron (generally gr. iii t.d.s. of ferrous iron) for 3 weeks or more before the sample was taken had significantly higher values than those not taking iron (Table 3). The effect was

Table 3. *Mean haemoglobin: difference between women taking and those not taking iron**

	Antenatal					
	1st trimester		2nd trimester		3rd trimester	
	No.	Hb (%)	No.	Hb (%)	No.	Hb (%)
Iron (1)	17	95·1	215	88·3	479	84·3
No iron (2)	92	91·5	267	86·6	174	81·3
Difference (1–2)		+3·62 S		+1·62 S		+2·97 S

	Postnatal							
	0–12 weeks		13–25 weeks		26–51 weeks		52+ weeks	
	No.	Hb (%)	No.	Hb (%)	No.	Hb (%)	No.	Hb (%)
Iron (1)	184	86·6	164	87·1	220	88·8	137	89·9
No iron (2)	38	80·1	39	82·5	23	85·3	19	84·5
Difference (1–2)		+6·54 S		+4·60 S		+3·46		+5·42 S

* For at least 3 weeks before blood taken; usually gr. iii t.d.s. Fe″.
S = significant.

even greater in the postnatal than in the antenatal period. All the differences are in favour of the iron group and all are significant except the one at the 26th–51st week after labour.

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Histological Changes in Rats on Nicotinic Acid-Deficient Diets. By G. H. BOURNE, *Department of Histology, London Hospital Medical College, London, E.* 1 and L. J. HARRIS, *Dunn Nutritional Laboratory, University of Cambridge and Medical Research Council*

Rats placed on a 'pellagragenic diet' (40 % maize, 3·5 % casein, 51·4 % sucrose and supplements described by Harris & Kodicek (1950)) show histological changes in a number of organs. The mucosa of the stomach is reduced in thickness apparently

mainly at the expense of the oxyntic cells although in some cases there is a decrease of the peptic cells as well. There are only slight degenerative changes in the rest of the gastro-intestinal tract. There is a loss of staining ability and possibly a decrease in number of the acidophil cells of the anterior-pituitary gland; there is also cessation of bone formation at costo-chondral junctions, of spermatogenesis in the testes, and a reduction in the size of the adrenal cortex.

The spleen is greatly reduced in size—it shows increased fibrosis and reduction of red pulp. The epithelium of the trachea shows degeneration.

The above changes are prevented by the addition of nicotinic acid (250 μg./rat/day) to the diet.

Severe tubular degeneration of the kidneys is also present in the deficient animals and while it is lessened in most animals treated with nicotinic acid in some it is still severe.

In order to ascertain how far the changes recorded are specifically due to nicotinamide deficiency and to check which of them may be due to mere inanition, controls are being examined (*a*) in paired-feeding experiments and (*b*) in animals receiving yeast or liver extracts (normal controls) in place of nicotinamide (positive controls).

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Gum Pallor as a Sign of Anaemia. By W. T. C. Berry and P. J. Cowin, *Ministry of Health, Whitehall, London, S.W.* 1

The detection of moderate degrees of anaemia is an important function of routine school medical inspections. In its detection, some degree of reliance is put upon the colour of the mucous membrane. The aim of this study was to assess the reliability of this procedure.

The colour of the mucosa was matched against plastic plates of different degrees of redness. It was found impracticable to obtain direct matching against the mucous membrane of the eye, whilst on the lip the handling needed to obtain matching led to blanching. The gum has neither of these drawbacks.

Pieces of plastic conforming with the contour of the gums were constructed in two shades of redness. With these, five degrees of gum redness could be recorded, ranging from no. 1, which was redder than the reddest plastic, to no. 5, which was paler than the palest. Preliminary trials showed that two clinicians working independently differed by one shade in just under 20 % of subjects, but never by more than one shade.

Examinations were made on 281 boys aged 10–11 years whose gums were free from disease. The haemoglobin value was determined within a few minutes of the assessment of redness of the gum by an independent observer. Figures are expressed in terms of the Haldane scale (100 % = 14·8 g. Hb/100 ml.).

Relations between haemoglobin levels measured by grey-wedge photometer and

tint of mucous membrane of the gum, in schoolchildren, as measured by plastic plates, are shown below:

Shade of redness measured by plastic ...	1	2	3	4	5
Mean haemoglobin level (% Haldane)	91·45	92·07	91·80	88·18	86·5
Range	57–102	81–107	52–104	80–95	86–87
No. examined	36	146	81	16	2

It is clear from these findings that the colour of the gums cannot be regarded as a reliable index of haemoglobin level.

Dental Depigmentation in Albino and Piebald Rats. By T. MOORE, *Dunn Nutritional Laboratory, University of Cambridge and Medical Research Council*

Irregularities in the incidence of dental depigmentation in rats deficient in vitamin E (Moore, 1943) suggested that albino rats were more susceptible to this abnormality than piebalds. In two experiments, groups of young female Wistar albino and piebald rats of Dr Hartley's strain, bred under substantially the same conditions, were kept on a diet deficient in vitamin E. In the first experiment the upper incisor teeth of the albinos were bleached after about 6 weeks, the teeth of the piebalds were still brown after 9 months. In a second experiment the teeth of the albinos were usually bleached after 10 weeks, whereas in the piebalds only slight mottling of the brown layer could be seen in some of the animals, both at this time or after a further 5 weeks. The teeth of piebald rats, however, are not immune from depigmentation. Almost complete bleaching was seen in animals kept for 4 months on a diet deficient in vitamin E, followed by 4 months on a diet both deficient in vitamin E and low in protein. Slight mottling of the brown layer was frequently seen in piebald rats kept for 7 weeks on a diet deficient in both vitamins E and A.

The brown layer which is responsible for the normal colour of the front surfaces of the incisor teeth contains iron, as indicated by staining methods (Dam & Granados, 1945). The greater resistance of piebalds to depigmentation therefore recalls the observation of Bacharach, Cuthbertson & Thornton (1949) that they are more resistant to anaemia induced by iron deficiency. The omission of the iron salt usually included in the basal diet, however, did not cause a degree of deprivation sufficient to influence the persistence of pigmentation in either albinos or piebalds.

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The Protection of the Newborn Calf against Fatal Scours by Small Quantities of Colostral Proteins. By R. ASCHAFFENBURG, S. BARTLETT, S. K. KON, J. H. B. ROY and D. M. WALKER, *National Institute for Research in Dairying, University of Reading*, and C. BRIGGS and R. LOVELL, *Research Institute in Animal Pathology, Royal Veterinary College, Camden Town, London, N.W.* 10

Following successful protection of newborn calves by small quantities (80–400 ml.) of fat-free colostrum (Aschaffenburg, Bartlett, Kon, Walker, Briggs, Cotchin & Lovell,

1949), the comparative protective value of colostral whey, dialysed whey, and 'immune lactoglobulins' isolated by a modification of the method of Smith (1946), was tested in two experiments with Shorthorn bull calves. In both, the calves were reared on the 'synthetic milk' of Aschaffenburg, Bartlett, Kon, Terry, Thompson, Walker, Briggs, Cotchin & Lovell (1949) and each block of calves contained one animal deprived of colostrum. The remaining three calves in each of eight blocks of the first experiment received in their first feed small quantities of fat-free colostrum, whey or dialysed whey, each dose containing *c.* 13 g. of whey proteins. In the eight blocks of the second experiment, the remaining two calves received fat-free colostrum or the 'immune lactoglobulins', each dose containing *c.* 14 g. of globulin. The results are summarized below.

	Treatment						
	First experiment				Second experiment		
Calves	No colostrum	Fat-free colostrum 150 ml.	Whey 150 ml.	Dialysed whey 200 ml.	No colostrum	Fat-free colostrum 200 ml.	'Immune lactoglobulins' *c.* 14 g. in 155 ml. solution
No. used	8	8	8	8	8	8	8
No. died	8	3	3	3	8	3	3
Mean live-weight gain of surviving calves during first 21 days (lb.)*	—	$-2 \pm 3{\cdot}5$	$-9 \pm 1{\cdot}9$	$-9 \pm 1{\cdot}9$	—	$-3 \pm 2{\cdot}6$	$+1 \pm 1{\cdot}5$

* Values with their standard errors of the mean.

Contrary to the earlier experiments (Aschaffenburg, Bartlett, Kon, Walker, Briggs, Cotchin & Lovell, 1949), not all the calves on colostral treatments survived, but the numbers of deaths on each such treatment were the same. There were no statistically significant differences within each experiment between the mean live-weight gains of surviving calves or the frequency of scouring for the colostral treatments. Progressive steps of our inquiry have thus shown that the 'immune lactoglobulins' contain the factor most essential for the protection of the newborn calf.

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