Metabolism of the nucleic acids of rumen bacteria by preruminant and ruminant lambs

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1. A rumen bacterial culture containing specifically labelled nucleic acids was prepared using [8-^{14}C]adenine.

2. The labelled preparation was given in a liquid diet to two preruminant lambs and via a rumen tube to two ruminant lambs. The radioactivity excreted in exhaled gases, faeces and urine and that incorporated into tissues was determined.

3 The preruminant lambs absorbed 58·3% of the total radioactivity measured after 24 h and the ruminant lambs 66·6% of the total activity measured after 48 h.

4. Of the total radioactivity absorbed the preruminant lambs exhaled 38%, excreted 34% in urine and retained 29% in tissues. The corresponding values for the ruminant lambs were 12, 41 and 47% respectively.

5. There was a close relationship between total nucleic acid content and radioactivity per g of tissues of both preruminant and ruminant lambs.

6. Of the radioactivity in the urine, the ruminant and one preruminant lamb excreted most in the fraction containing allantoin, while the other lamb excreted most activity in the uric acid fraction.

7. The salvaging of the breakdown products of bacterial nucleic acids to make tissue nucleic acids appears to be an important synthesis in preruminant and ruminant lambs and of the likely precursors the purine base may be more important than the nucleoside.

The nucleic acids consumed by ruminant animals in their natural diets (Smith & McAllan, 1970; Coelho da Silva *et al.* 1972; Razzaque, 1973) are extensively degraded in the reticulo-rumen. As a result the nucleic acids entering the abomasum and passing to the duodenum are mainly of microbial origin. Smith & McAllan (1971) and McAllan (1980) found that these nucleic acids are well digested in the small intestine of calves and steers respectively and the results reported by Jackson *et al.* (1976) and those of McAllan (1980) indicate that nearly all the purines released are absorbed before the digesta reaches the ileum.

Ellis & Bleichner (1969) were the first to suggest that some of the purines are used for synthesis of nucleic acids in the tissues when they found that a large fraction of those absorbed were not immediately excreted in the urine. Unlike monogastric animals, ruminants appear to make little or no use of glycine, a normal precursor of purines, for nucleic acid synthesis (Condon *et al.* 1970).

Smith *et al.* (1974) attempted to measure the utilization of the nucleic acids of rumen bacteria by sheep and their results indicate that at least 5% was incorporated into the liver, spleen and kidney and another 20% at least may appear in muscle. The present experiment has been conducted to study further the absorption, tissue deposition and excretion of purines derived from bacterial nucleic acids in ruminant lambs and compare the values obtained with those in preruminant lambs.

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EXPERIMENTAL

Preparation of ^{14}C-labelled nucleic acids

[8-^{14}C]adenine (Radiochemical Centre, Amersham, Bucks) was incorporated into rumen bacteria in vitro using the method of Smith & Mathur (1973). Either 50 or 125 μCi [8-^{14}C]adenine were dissolved in 2 ml 0·02 M-sodium hydroxide and added to a growing bacterial culture under anaerobic conditions. The culture contained 27 ml clarified rumen fluid and 67 ml buffer (Baumgardt *et al.* 1962). Optimum growth of bacteria was obtained within 24 h. The whole culture was transferred to tubes and centrifuged at 40000 *g* for 20 min. The supernatant clear fluid was removed and counted for ^{14}C activity. The bacterial pellet was resuspended in 25 ml of the buffer. The incorporation of the ^{14}C activity into the rumen bacteria was 88%. This crude bacterial preparation was used as the source of ^{14}C nucleic acids in the subsequent metabolism trials.

Animals

Four male lambs (Suffolk × Finn-Dorset) were used. They were separated from their dams 3 d after birth and trained to bottle feeding. They received increasing amounts (400–1200 ml) of ewe-milk substitute (Scottish Agricultural Industries Ltd, Edinburgh) daily, divided into four meals.

The first metabolism trial was made with two preruminant lambs, previously trained to confinement in a metabolism cage. The lambs were fed the bacterial ^{14}C-labelled nucleic acid preparation mixed with 60 ml milk by bottle as a single dose. The lambs were immediately placed in an open-circuit respiration chamber connected to an ion chamber and gas analysis apparatus (Brockway *et al.* 1977). The oxygen consumption, production of carbon dioxide and methane and calculated heat production were recorded. While in the chamber the animals were given either 210 or 300 ml milk at 6 h intervals. Faeces were collected in a polyethylene bag attached over the tail and urine was collected in a tray containing hydrochloric acid as preservative. The radioactivity exhaled by the lambs was continuously recorded. The metabolism trial lasted for 24 h. The lambs and experimental treatments are described in Table 1.

The second trial was made with two trained ruminant lambs. They were weaned at 4–5 weeks of age and given *ad lib.* a pelleted concentrate diet, the composition of which is given in Table 1. The bacterial nucleic acid preparation was administered by rumen tube and the lambs were immediately placed in the respiration chamber as described previously and remained there for 48 h. Faeces and urine were collected on a 24 h basis. The radioactivity in exhaled gases was measured continuously and gaseous exchanges were recorded. The animals were removed from the chamber briefly after 24 h to allow faeces and urine to be removed and they were fed twice daily (see Table 1).

At the end of the metabolism trials the lambs were taken out of the respiration chamber, anaesthetized and bled completely. They were dissected and the viscera and certain glands and digestive organs were separated from the rest of the carcase. These organs and the carcase were immediately frozen and subsequently were minced and homogenized for analysis of nucleic acid and measurement of radioactivity.

Analysis of excreta and tissues

A representative 100 g homogenized sample was re-homogenized in an Ultraturax homogenizer for 2 min and a 2 g subsample was fractionated into perchloric acid-soluble, RNA and DNA fractions by the method of Munro & Fleck (1967). Some subsamples needed to be diluted. Each fraction was made to 20 ml and a 1 ml portion was transferred to a

Table 1. *Characteristics of the lambs and treatments at the time of the metabolism trial*

Sheep no.	Body-wt (kg)	Age (d)	Diet (g/24 h)	Activity of nucleic acids administered (μCi)	Duration of metabolism trial (h)
2226	5·4	26	840*	37·5	24
2230	7·4	26	1200*	36·5	24
2181	18·0	59	300†	111·5	48
2184	19·0	59	350†	110·0	48

* Milk substitute containing 200 g dry matter/kg.
† Concentrate containing 150 g crude protein (nitrogen × 6·25), 39 g crude fibre, 32 g ether extract and 81 g ash/kg dry matter.

scintillation vial and 10 ml scintillation fluid added (Liquid Scintillator ELS 294; Koch Light Laboratories). The sample was left standing for 1 week and counted in a liquid-scintillation counter (Beckman LS150).

Nucleic acid analysis. The tissues and organs fractionated as described previously were analysed for RNA by the method of Munro & Fleck (1967) and for DNA by the method of Burton (1956).

Fractionation of urine for purines. The distribution of radioactivity in the urine and in urinary purine derivatives was measured. The urinary purines were fractionated into hypoxanthine plus xanthine, uric acid and other compounds by the method of Razzaque & Topps (1978).

RESULTS

Absorption and excretion of bacterial ^{14}C-labelled nucleic acids

Total recovery of radioactivity from the preruminant and ruminant lambs exceeded that given by 4·9 and 2·8 μCi, 13·2 and 2·5% of the doses administered respectively. These differences are probably due to some error in accounting for the effect of quenching of activity in the diverse samples examined. All values given subsequently as a fraction of total activity are expressed as a percentage of that totally recovered. The distribution of radioactivity in various sections of gastrointestinal tract, faeces and tissues of the lambs are given in Table 2. All the values given are means for the two animals. Individual values differed from the mean by 26% or less, except for the activity found in the faeces of the preruminant lambs where a threefold difference between animals occurred. In preruminant and ruminant lambs 38·8 and 26·4% respectively of the total activity recovered was found in the digestive tract plus its contents. The preruminant lambs retained a smaller proportion of the dose in the stomach and a larger proportion in the intestines than the ruminant lambs. Only a small proportion of the radioactivity was excreted in the faeces during the 24 or 48 h duration of trials.

The radioactivity unaccounted for in the digestive tract plus contents and faeces represented 58·3 and 66·5% of the total recovered in the preruminant and ruminant lambs respectively.

Fate of absorbed radioactivity

The ^{14}C-labelled bacterial nucleic acid derivatives that were absorbed were either exhaled, excreted in the urine or deposited in the lamb's tissues.

Table 2 shows that the preruminant lambs exhaled approximately three times more radioactivity in 24 h than ruminant lambs did in 48 h. The patterns of excretion of gases

Table 2. *Distribution of activity (μCi) in guts+contents, faeces, exhaled gases and urine*
(Mean values for two lambs; values in parentheses are percentage of total absorbed)

	Preruminant lambs (24 h trial)		Ruminant lambs (48 h trial)	
	Activity	% of total recovered	Activity	% of total recovered
Forestomach	5·37	12·8	18·59	16·4
Abomasum	1·87	4·5	1·46	1·3
Small intestine	4·40	10·5	4·00	3·5
Large intestine	4·64	11·1	5·87	5·2
Faeces	1·24	3·0	8·03	7·1
Other tissues*	7·02	16·7 (28·7)	35·5	31·3 (46·9)
Exhaled gases:				
0–24 h	9·24	22·0 (37·8)	6·23	5·5 (8·2)
24–48 h	—	—	2·87	2·5 (3·8)
Urine:				
0–24 h	8·21	19·6 (33·6)	16·16	14·2 (21·4)
24–48 h	—	—	14·90	13·1 (19·7)

* See total value in Table 3.

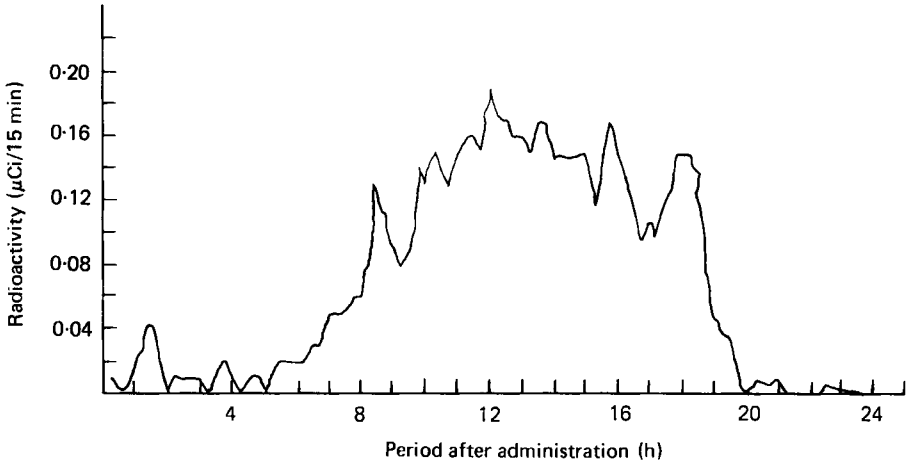

Fig. 1. Radioactivity (μCi) exhaled by preruminant lamb.

by one of each of the two pairs of lambs are shown in Figs. 1 and 2. Large amounts of activity were exhaled during the first 24 h of the metabolism trial. This presumably comprised both eructated gas from the reticulo-rumen and expired pulmonary CO_2 derived from tissue metabolism.

Preruminant and ruminant lambs excreted in their urine 34 and 41% of the radioactivity lost from the digestive tract in 24 and 48 h respectively (Table 2). The proportions excreted by the two pairs of lambs were clearly influenced by the difference in the duration of the experiment as well as by the mode of digestion.

Distribution of activity in tissues

Table 3 shows the distribution of radioactivity in various tissues of the lambs. The activity was divided into perchloric acid-soluble, RNA and DNA fractions. Mean values are given for each pair of animals, the individual values differing from the mean by 27% or less except

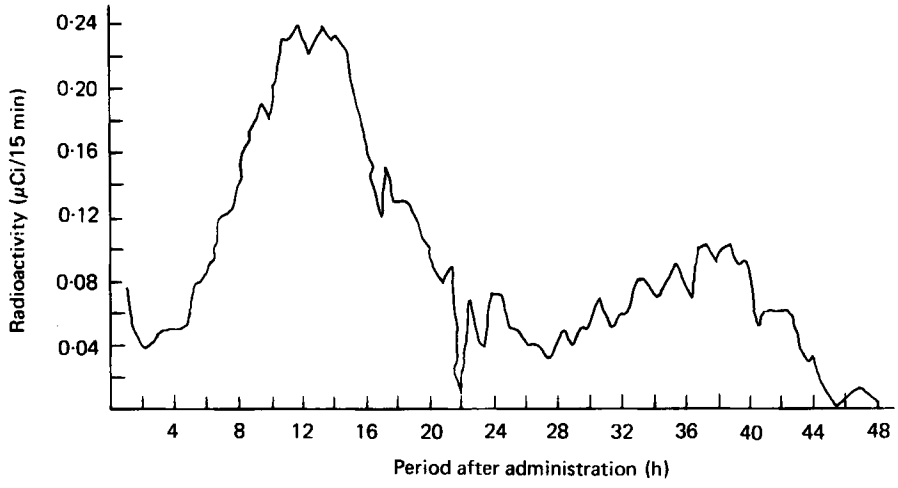

Fig. 2. Radioactivity (μCi) exhaled by ruminant lamb.

Table 3. *Distribution of activity (μCi) in tissues*
(Mean values for two lambs)

	Preruminant lambs				Ruminant lambs			
	Perchloric acid-soluble	Fractions		Total	Perchloric acid-soluble	Fractions		Total
		RNA	DNA			RNA	DNA	
Liver	0·53	0·14	0·30	0·97	1·08	0·24	0·76	2·08
Spleen	0·07	0·03	0·07	0·17	0·09	0·03	0·15	0·27
Heart	0·06	0·05	0·05	0·16	0·09	0·03	0·15	0·27
Lungs	0·14	0·07	0·22	0·43	0·50	0·09	0·98	1·57
Thymus	0·03	0·04	0·12	0·19	0·12	0·03	0·33	0·48
Kidney	0·07	0·02	0·10	0·19	0·21	0·04	0·10	0·35
Pancreas	0·03	0·03	0·03	0·09	0·07	0·01	0·09	0·17
Blood	0·06	0·04	0·41	0·51	0·17	0·03	1·37	1·57
Carcase	1·76	0·89	1·60	4·25	6·48	1·71	19·2	27·4
All viscera, blood and carcase				7·02				35·5

for some of the very low values, e.g. the activity of the RNA fractions from the thymus in ruminant lambs. In these instances differences between animals were approximately two- to fivefold in extent and were probably due to errors associated with counting very low levels of activity in such tissues. The liver, thymus and pancreas were found to have a higher activity (6·3, 10·5 and 15·0 μCi/kg respectively for preruminant and 6·3, 12·4 and 9·0 μCi/kg respectively for ruminant lambs) than the carcase as a whole (1·0 and 2·3 μCi/kg for preruminant and ruminant lambs respectively) and the activity in these organs was related to the concentration of nucleic acids. Fig. 3 shows that there was a close relationship between total nucleic acid (mg/g tissue) and activity (disintegrations/min per g tissue). The viscera, blood and carcase incorporated 29% of the total absorbed activity in the preruminant lambs and 47% in the ruminant lambs. Considerable quantities of activity appeared in the perchloric acid-soluble fractions of all organs. This fraction contains free purines, nucleosides, mononucleotides, dinucleotides and their coenzymes.

The distribution of RNA, DNA and total nucleic acids in different organs are presented

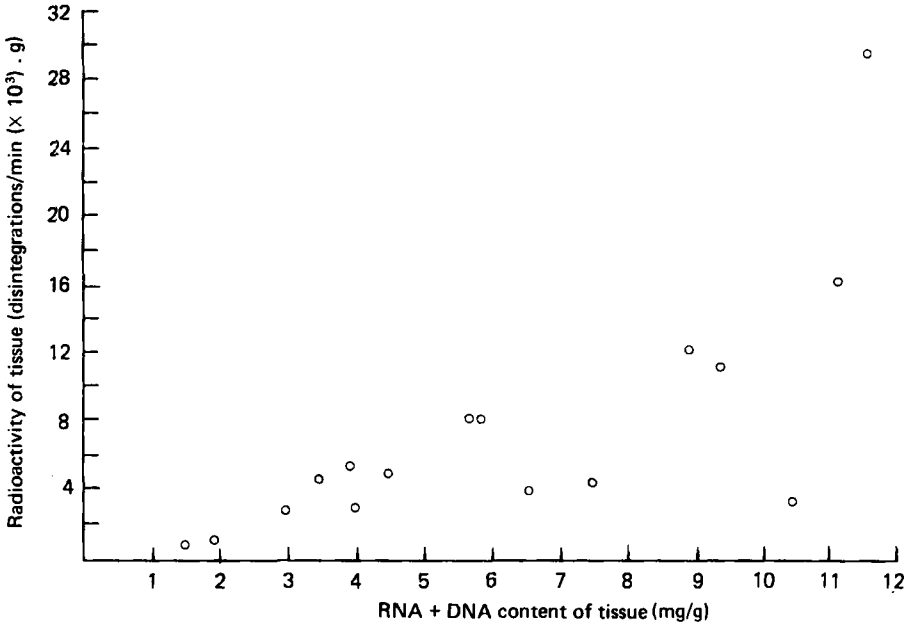

Fig. 3. Relationship between radioactivity (disintegrations/min ($\times 10^3$) per g) and total nucleic acid content (mg/g) of tissues of ruminant lambs.

Table 4. *Nucleic acid concentrations in viscera, blood and carcase (mg/g tissue) of preruminant and ruminant lambs*

(Mean values for two lambs)

	Preruminant lambs			Ruminant lambs		
Organ	RNA	DNA	Total	RNA	DNA	Total
Liver	4·15	1·49	5·64	3·96	1·13	5·10
Spleen	3·42	5·27	8·69	3·91	6·13	10·04
Heart	2·07	2·03	4·10	0·97	2·39	3·36
Lungs	3·22	5·57	8·79	3·72	3·85	7·57
Thymus gland	6·70	15·38	22·08	7·80	18·00	25·80
Kidney	3·02	3·10	6·12	3·40	3·59	6·99
Pancreas	10·71	2·22	12·93	7·36	3·68	11·04
Blood	0·21	0·38	0·59	0·45	1·33	1·78
Carcase	1·26	1·83	3·09	0·95	2·83	3·78

in Table 4. Mean values are given for each pair of animals, the individual values differing from the mean by 21% or less. The thymus gland had the highest concentration of nucleic acids, followed by pancreas, spleen and lungs. There was no marked difference in concentration of nucleic acid between the two types of lambs.

The RNA:DNA value differed greatly among the tissues. The thymus gland contained three times more DNA than RNA whereas the pancreas contained two to five times more RNA than DNA.

Distribution of radioactivity in urinary purine derivatives

The main catabolic endproducts of nucleic acids and their derivatives that are excreted in the urine of ruminants are hypoxanthine, xanthine, uric acid and allantoin, the last being contained in the residual fraction remaining in the procedure adopted. The distribution of

Table 5. *Distribution of activity (μCi and % of total urinary activity) in the purine derivatives excreted by lambs in their urine*

Lamb no.	Hypoxanthine + xanthine		Uric acid		Other compounds	
	Activity	% of total	Activity	% of total	Activity	% of total
Preruminant:						
2226	1·39	17·4	1·34	16·7	5·25	65·6
2230	1·15	13·6	6·46	76·7	0·80	9·5
Ruminant:						
2181						
1st 24 h	2·03	11·6	2·41	13·8	13·00	74·3
2nd 24 h	1·34	9·4	1·47	10·3	11·40	80·2
2184						
1st 24 h	1·88	12·7	1·93	13·0	10·94	73·9
2nd 24 h	1·12	7·1	3·01	19·3	11·44	73·4

Table 6. *Oxygen consumption, production of carbon dioxide and methane (l/24 h) and calculated heat output (kJ/24 h) by lambs*

Lamb no.	O_2 consumption	CO_2 production	CH_4 production	Heat output
2226	108	92	10·5	2180
2230	152	152	10·2	3201
2181				
1st 24 h	181	194	39·2	3810
2nd 24 h	206	233	49·6	4397
2184				
1st 24 h	300	294	40·4	6244
2nd 24 h	142	215	26·8	3317

radioactivity in urinary constituents is shown in Table 5. The unweaned lambs excreted 15·5, 47·5 and 37% of the total urinary activity in hypoxanthine plus xanthine, uric acid and the residual fraction respectively. However, there was considerable variation between these two lambs, lamb no. 2226 excreting most activity in the residual fraction, lamb no. 2230 excreting most activity in uric acid. Lamb no. 2226 was found to have developed its rumen to a slightly greater extent. In this lamb, the weight of reticulo-rumen + omasum together with contents was 642 g and the pH of the rumen contents was 5·6 compared with corresponding values of 618 g and 5·3 for lamb no. 2230 which was heavier by 2 kg. The two ruminant lambs excreted 75% of the total urinary activity in the residual fraction. Table 5 shows that the ruminant lambs excreted 12·1, 13·4 and 74·1% of the total urinary activity in the hypoxanthine plus xanthine, uric acid and residual fractions respectively during the first 24 h of the trial. Corresponding values during the second 24 h were 8·3, 14·8 and 76·7% respectively. There was little difference between the two lambs.

Gaseous exchange and heat production

Table 6 shows that O_2 consumption and production of CO_2 and calculated production of heat differed considerably between the two pairs of lambs. Production of these components was related to body-weight and food consumption. The mean respiratory quotient values for preruminant and ruminant lambs were 1·08 and 0·88 respectively.

The ruminant lambs produced large amounts of methane in relation to the amount of food that was eaten.

DISCUSSION

It was anticipated that there would be a clear-cut difference between the two pairs of lambs in their output of methane with the preruminant animals excreting very little and the ruminant animals producing normal amounts. In the event both of the preruminant lambs excreted substantial amounts of methane. At slaughter it was found that they had partly developed a functional rumen, which might have arisen from the consumption of small amounts of peat moss on which the animals were bedded. The output of methane by the two ruminant lambs was high in relation to their intake of concentrate. No explanation can be given for this finding. However, the indications that substantial rumen development had occurred in the unweaned lambs will influence any comparison of results between the two pairs of animals.

Absorption of radioactivity

The results of previous workers (Topps & Elliott, 1965; Smith & McAllan, 1971) have indicated that nucleic acids synthesized in the rumen are digested and their products absorbed and metabolized to give rise to large quantities of allantoin in the urine. The results of this study clearly show that both the preruminant and the ruminant lambs largely digested and absorbed the bacterial nucleic acids administered although differences were evident within pairs of lambs in the rate of movement of activity down the digestive tract. The absorptions obtained, 58 and 66% of the total activity recovered for preruminant and ruminant lambs respectively, are probably minimum values. Much of the activity found in the gut and its contents, particularly that in the stomach and small intestine (28 and 21% respectively of recovered activity), would probably have been absorbed if the animals had not been killed and indeed much of that present at slaughter may have been located in the gut tissue rather than in the gut contents. The fraction of activity present in the forestomach of the preruminant lamb 24 h after dosing, however, indicates that the contents may contain substantial amounts of ^{14}C. The amount of activity in this part of the gut of these animals appears to be in excess of that probably taken up by the gut tissues from the blood and it is likely that a part of the dose swallowed passed to the rumen and flowed only slowly onward. The absorption values obtained agree reasonably well with those of Smith & McAllan (1971) who found that the loss of RNA and DNA from microbial nucleic acids was 85 and 75% respectively in the small intestine of ruminating calves. Coelho da Silva *et al.* (1972) and McAllan (1980) found a similar amount of digestion of microbial RNA and DNA in the small intestine of sheep and steers respectively. The high digestibility may be attributed to the pancreas of ruminant animals having a high content of ribonuclease (*EC* 3.1.4.22; Barnard, 1969; Razzaque, 1973). It is likely that young lambs from an early age and before they are fully functional ruminants have high levels of ribonuclease in their pancreas and small intestine. Similarly, Jackson *et al.* (1976) showed that the net absorption of adenine from the small intestine of sheep was close to 100%; such an efficient process may well be present in very young lambs.

Loss of radioactivity in exhaled gases

Both the preruminant and ruminant lambs exhaled an appreciable amount of ^{14}C in the first 24 h following ingestion of the labelled bacterial nucleic acids. Tissue catabolism of [8-^{14}C]adenine or [8-^{14}C]adenosine, the major products of digestion of the labelled nucleic acids in the small intestine, is likely to yield [8-^{14}C]uric acid or radioactive allantoin. Decarboxylation of uric acid occurs at the C-6 position to yield allantoin. It would seem that either further tissue catabolism of some of the allantoin occurs to yield CO_2 or that most of the radioactive gases arise from degradative reactions within the gut. The former seems unlikely since enzymes responsible for the catabolism of allantoin do not appear to

be present in mammalian tissues. Furthermore, the work of Zvilna *et al.* (1975) has shown a clear difference between conventional and germ-free mice in the amount of radioactive CO_2 derived from labelled adenosine given orally. Conventional mice were found to expire 4–8 times more radioactivity in CO_2 than did germ-free mice and the difference could be explained only by the participation of intestinal microflora in the catabolism of adenosine. The entry of some of the milk substitute into the rumen of the preruminant lambs would lead to its rapid fermentation and the likely loss of radioactivity as exhaled gases. A similar but slower breakdown would occur in the ruminant lamb since dietary nucleic acids are known to be extensively degraded in the reticulo-rumen and Jurtshuk *et al.* (1958) found that in an in vitro experiment the rumen micro-organisms decarboxylate purines. It would seem therefore that in both the preruminant and ruminant lambs most of the radioactivity in the exhaled gases arose from microbial degradation in the gut.

Amount and distribution of activity in the tissues

Until 1970 there had been assumptions as to the fate of digestion products from microbial nucleic acids after their absorption by ruminants. Ellis & Bleichner (1969) suggested some utilization of such products for synthesis of body tissue. Condon *et al.* (1970) found very little incorporation of glycine into the tissue nucleic acids of lambs, which indicated that preformed purines may be major precursors. Smith *et al.* (1974) obtained supporting evidence for such a biosynthetic route when they found that radioactivity was incorporated into certain organs and muscles of sheep given bacterial nucleic acids labelled with [8-^{14}C]adenine. Using the same technique in this study, the results show a large incorporation of radioactivity into the body tissues of the ruminant lambs, with approximately 47% of the total activity absorbed being found in the tissues after 48 h. This value appears to be higher than that given by Smith *et al.* (1974), but the difference may be partly explained by the earlier workers killing their sheep 24 h after injection of labelled bacteria into the rumen. Our preruminant lambs also incorporated a significant quantity of radioactivity (29% of that absorbed) into their tissues, which indicates that lambs from an early age, possibly from birth, have the ability to utilize preformed purines for tissue synthesis. The close relationship obtained between activity and nucleic acid concentrations per g tissue for different parts of the body indicate that absorbed adenine or adenosine are used for the synthesis of tissue nucleic acids. The thymus gland, pancreas and spleen of both preruminant and ruminant lambs had the highest concentrations of radioactivity and nucleic acids, while the carcase and blood showed the lowest values for both charactertistics. In most tissues, the liver being a notable exception, the majority of the radioactivity was found in the RNA and DNA fractions, mainly in DNA. These results are consistent with the salvaging of the products of bacterial nucleic acids for synthesis of tissue nucleic acids, and they indicate that adenine rather than adenosine which contains ribose may be the more important precursor.

Excretion of activity in the urine

The preruminant and ruminant lambs excreted 34 and 41% of the total activity absorbed in the first 24 and 48 h respectively. These values agree reasonably well with that of Ellis & Bleichner (1969), who reported that in sheep approximately 30% of the purines absorbed from the gut are excreted in the urine. Only approximately 25% of the activity in the urine of the ruminant lambs was in the hypoxanthine plus xanthine and uric acid fractions. This agrees with the findings of Ellis & Pfander (1965) and of Topps & Elliott (1965) that in ruminants the main excretion product of purines is allantoin which would have been contained in the residual fraction. Although the amount of urea in the residual fraction would be greater than that of allantoin, it seems unlikely that much of the radioactivity was present in urea. Any tissue catabolism of allantoin, which is improbable, may yield some

radioactive urea but any urea formed in the gut of the lambs would be rapidly degraded and not excreted as such in the urine. Zvilna *et al.* (1975) found in their work that most of the radioactivity excreted in the urine of conventional mice given labelled adenine or adenosine was in the form of allantoin. A part of the urinary activity may have been the product of microbial metabolism of adenine before absorption rather than that of subsequent catabolism in the lamb's tissues. However, this part was probably small for recovery of 88% of the activity of the adenine substrate in the bacterial pellet that was prepared indicates that most was present in nucleic acid, as found by Smith & Mathur (1973). These authors concluded that rumen bacteria can efficiently use radioactive adenine for the synthesis of nucleic acids and that very little of the adenine appears to be degraded and used in other ways. However, they did find substantial amounts of radioactivity incorporated into guanine of rumen nucleic acids (approximately 40% of that in adenine), but both these purines are converted to xanthine and then to allantoin when they are degraded. One of the preruminant lambs, which had less rumen development than the other, excreted most of the activity in the uric acid fraction which suggests that catabolism of adenine in the tissues of this animal might have differed from that of the other three.

Nucleic acid content of different parts of the body

The results of the nucleic acid analysis of the tissues are of some interest since there is a lack of comprehensive information for sheep. As expected, the organs with a high metabolic activity have a high content of nucleic acids, the thymus glands, pancreas and spleen being particularly high. On the other hand the entire carcase and blood are very low. The relative amounts of RNA and DNA which differ between different organs are compatible with the physiological function. The lymphoid organs, the thymus gland and spleen, which are concerned with cell division and body immunity, are richer in DNA than RNA. Conversely, the liver and pancreas, which are active sites of protein synthesis, have higher contents of RNA and DNA.

It may be concluded that these results provide additional evidence for the utilization of bacterial nucleic acids for synthesis of tissue nucleic acids. Sheep may depend heavily on this salvage pathway to produce their own nucleic acids. Further work is needed to measure the turnover rate of tissue nucleic acids, the amounts of pancreatic ribonuclease in very young ruminants and whether these animals have very little of the enzyme uricase in their tissues.

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