CONFERENCE ON RUMEN FUNCTION
held at
Midland Hotel, Chicago, Illinois
December 3 - 4, 1969

This was the tenth biennial Conference on Rumen Function. Chairman of the conference was C. R. Richards, Cooperative State Research Service, USDA.

For the purpose of discussion, the program was divided in five panels which are listed below together with the respective panel chairmen.

(a)	Microbiology	M. P. Bryant
(b)	Nutrition	J. T. Huber
(c)	Physiopathology	R. W. Dougherty
(d)	Agronomic	J. C. Burns
(e)	Physiology	A. D. McGilliard

MICROBIOLOGY PANEL

Direct Measurements of the Yield of Microbial Protein from the Rumen Fermentation - I. D. Hume, University of Kentucky, Lexington

Direct measurements were made of the yield of microbial protein (g protein/100 g organic matter fermented) in the rumen. Sheep were fed constant daily amounts of purified diets containing either no protein (experiments 1 and 2) or one of several isolated proteins (experiment 3) at two hourly intervals by automatic feeder. Under this regime the rumen fermentation approached a "steady state".

The rate of flow of digesta from the rumen was estimated with either polyethylene glycol injected into the rumen as single doses on each consecutive day of collection, or with ^{51}Cr-EDTA infused continuously into the rumen throughout the collection period. The digesta flowing out of the rumen was sampled through permanent fistulae in the omasum, and analyzed for protein and organic matter (OM). The daily production of microbial protein in the rumen was then the product of the rate of flow of digesta and the concentration of microbial protein in the digesta leaving the rumen. The quantity of OM digested in the rumen daily was the difference between the amount fed and the amount flowing out of the rumen daily (with a correction for the microbial OM leaving the rumen).

The lowest protein yield (9.1) was obtained when nitrogen was clearly limiting further microbial growth, and the highest (23.3)

when energy was probably the limiting factor. This latter yield is considerably higher than the maximum theoretical yield (16.8) calculated on the basis of published values for molar growth yields (g dry wt. cells/ATP) of pure bacterial cultures and for estimates of the amount of ATP produced in the rumen fermentation. It is suggested that the average growth yield of the mixed ruminal population may, under favorable conditions, exceed the values reported for pure cultures of individual bacterial species.

Quantitative Aspects of Nucleic Acid Purine Synthesis Within the Alimentary Tract of Sheep - William C. Ellis, Texas A&M University, College Station.

A previous report (Ellis and Pfander, Nature 205:4975, 1965) has pointed out that, based upon nucleic acid phosphorus determinations, as much as 13-18% of ruminal microbial nitrogen may be in the form of nucleic acid nitrogen. If, upon subsequent digestion, these purines and pyrimidines are metabolized by expected pathways leading to excretion, then this nitrogen would be innutritious. Two additional experiments have been conducted to more specifically determine the nucleic acid purine-pyrimidine content of digesta within various segments of the ruminant's digestive tract and estimate the amounts digested. In experiment 1, sheep were fed semi-purified diets of 60% alkali extracted cottonseed hulls supplemented with urea or zein. In the second experiment, sheep were fed four times daily semi-purified diets containing 57-90% cottonseed hulls in which urea supplied approximately 85% of the total nitrogen. Nucleic acid adenine to chromic oxide ratios in the second experiment confirmed synthesis in the reticulorumen and caecum with progressive digestion in the upper and lower small intestines with no post-caecal digestion. Total nucleic acid nitrogen represented 6.02% of the 70% ethanol insoluble nitrogen of rumen digesta (N=7) in the first experiment. In experiment 2, this value was 3.4, 3.1, 4.6, 2.2, 1.6, 3.1 and 3.1, respectively for digesta in the reticulum, rumen, abomasum, upper small intestines, lower small intestines, caecum and feces. These results, more specific for nucleic acid base nitrogen than determinations based on phosphorus, indicate nucleic acid nitrogen represented from 3.1 to 6.0% of the microbial ethanol insoluble nitrogen - about one-fourth lower than that previously reported.

Relationships Between Rumen Ammonia Levels, Microbial Population and Volatile Fatty Acid Proportions in Faunated and Defaunated Sheep - J. R. Males and D. B. Purser, Michigan State University, East Lansing.

Twelve, two-year old Cheviot wethers, were incorporated into a metabolism study consisting of four treatment combinations: urea

infusion in the presence and absence of protozoa, and water infusion in the presence and absence of protozoa. Dioctyl sodium sulfosuccinate was used as the defaunation agent. Urea was infused to provide 2.87% of the daily total N intake. Defaunation resulted in higher rumen dry matter at all sampling times; however, the difference was significant ($P < .01$) only at the TO sampling time (16.52 vs. 12.22). Rumen pH was consistently higher in faunated sheep and in the urea infused animals. Defaunation resulted in an increase in the molar percentage of propionate and decrease in acetate and butyrate, with no significant changes being observed in the total volatile fatty acid concentrations. This trend was observed at all sampling times. The following values, obtained at TO or feeding time are quite typical of the differences observed. The molar percent C_3 was 29.94 for defaunated sheep and 19.18 for faunated sheep ($P < .05$), C_2 was 57.26 and 61.66 respectively and C_4 was 7.02 and 13.24 respectively ($P < .05$). In defaunated sheep as compared to faunated sheep, apparent nitrogen digestibility (70.63 and 69.90), nitrogen utilization (73.54 and 43.57) ($P < .01$), and nitrogen balance (6.59 and 4.14) ($P < .05$), were all significantly higher. Urea infusion into faunated animals resulted in lower apparent nitrogen digestibilities (68.04 and 71.75) ($P < .05$), nitrogen utilization (33.86 and 53.28) and nitrogen balance (3.08 and 5.20) but did not affect these nitrogen metabolism parameters in defaunated sheep. Rumen ammonia-N levels in defaunated sheep were lower than those observed in faunated animals. Urea infusion into faunated animals increased rumen ammonia-N 3.44 mg. per 100 ml., while urea infusion into defaunated sheep increased rumen ammonia-N level by only 1.88 mg.per 100 ml. Rumen ammonia-N and C_2/C_3 ratios, C_2/C_4 ratios and C_3/C_4 ratios were fitted to regression equations. Significant correlations were shown between rumen ammonia-N level and C_2/C_3 ratio ($r = 0.91$), C_2/C_4 ratio ($R = 0.89$) and C_3/C_4 ratio ($R = 0.81$).

Measurement of Change in Ruminal Microbes Following Changes in Diet - M. J. Allison, I. M. Robinson, P. F. Pollock, and J. A. Bucklin, National Animal Disease Laboratory, ADP, ARS, USDA, Ames.

Experiments were conducted to develop a method for evaluation of the fit or adaptation of the ruminal microbial population to the diet that is fed to the animal. Such a method might be useful in studies of the effect of various treatments (i.e. antibiotics) upon the rate of microbial adaptation to changed rations. An *in vitro* fermentation system similar to that described by el-Shazly and Hungate (Appl. Microbiol. 13:62, 1965) was used. Ruminal fluid was diluted with 3 volumes of buffered mineral solution and incubated in the presence of excess substrate (ground hay, concentrate ration (90% corn) or sugar) and the rate of gas production was measured as pressure increase with pressure transducers. Simultaneous gas production rates after 20 min. *in vitro* incubation with the various substrates were compared.

The rate of gas production by microorganisms in ruminal fluid from sheep fed hay was usually 2 to 5 times greater with hay as substrate than with the concentrate substrate. When ruminal fluid from sheep fed a concentrate ration was used, the gas production rates with hay or concentrate substrates were about the same. This suggested the method might be useful for following microbial adaptation or changes during changeover from hay to grain rations or vice versa.

Measurements made 24 hours after changing the rations of sheep from hay to concentrate or concentrate to hay, however, were typical of measurements made after extended feeding on these rations. This indicates that the microbial population changes measured with this method occur rapidly after a change in ration. It, however, seems doubtful that microbial adaptation to the new ration was complete in this short a time.

Natural Antibiotic Resistance of Bovine Rumen and Liver Abscess Isolates - Mary Bromel and Beverly Baldwin, North Dakota State University, Fargo.

Natural resistance or sensitivity to oxytetracycline and sulfamethiazine of seven bovine rumen or liver abscess isolates was determined by both tube dilution and disc assay methods. Organisms chosen for assay included: a Clostridium sp., Streptococcus bovis, and two Klebsiella sp. from the rumen of a fistulated heifer with no previous exposure to antibacterial compounds. A Sphaerophorus sp. tested was isolated from a bovine liver abscess obtained from a commercially slaughtered steer.

The two Klebsiella species were extremely resistant to both oxytetracycline and sulfamethiazine with no inhibition of growth up to the 200 ug/ml level in the tube dilutions. The Clostridium species, although quite sensitive to oxytetracycline (minimal inhibitory concentration was 1.0 ug/ml), consistently exhibited an Arndt-Schultz reaction to this antibiotic and showed definite and consistent growth stimulation with sulfamethiazine above a concentration of 1.0 ug/ml.

The Sphaerophorus isolate, while sensitive to 1.0 ug/ml of oxytetracycline, was not inhibited by 10 ug/ml dilutions of sulfamethiazine.

Streptococcus bovis showed definite Arndt-Shultz reaction at the periphery of the inhibition zones on disc assay with 30 ug/ml oxtetracyline and was completely resistant to all tube concentrations of sulfamethiazine.

This work demonstrates the presence of naturally resistant strains of bacteria in the rumen with the potential ability to transfer this resistance to pathogens. In addition, growth of possible pathogens was shown to be stimulated by moderate levels of chemotherapeutic agents.

Synergistic Effect Between Pure Cultures of Rumen Bacteria in the Digestion of Intact Forage Hemicellulose - Judith Coen and B. A. Dehority, Ohio Agricultural Research and Development Center, Wooster.

Several pure strains of rumen bacteria have previously been shown to degrade isolated hemicelluloses from an 80% acidified ethanol insoluble form to a soluble form, regardless of the organism's eventual ability to utilize the end products as energy sources. This study was undertaken to determine whether similar hemicellulose degradation or utilization, or both, occurs from intact forages. Fermentations by pure cultures were run to completion using three stages of alfalfa and two stages of bromegrass as individual substrates at the .5% level. Organisms capable of utilizing xylan or isolated hemicelluloses could degrade and utilize intact forage hemicellulose, with the exception of two strains of Bacteroides ruminicola using a grass hay substrate. In addition, hemicellulose was extensively degraded by three cellulolytic strains that were unable to use the end products. In general, the cellulolytic strains degraded a considerably greater proportion of the forage hemicelluloses than the hemicellulolytics. Definite synergism was observed when a degrading non-utilizer was combined with either one or both of the hemicellulolytic strains on the bromegrass substrates. Those hemicellulolytic strains which could not degrade or utilize any of the hemicellulose,or could do both to a limited extent, almost completely utilized the end products solublized by the non-utilizer. Similar synergism, although of much smaller magnitude, was observed when alfalfa was used as a substrate. For a specific organism, considerable variation occurred in hemicellulose degradation or utilization, or both, between different types of forages. In general, values obtained with alfalfa were lower than those from brome. These data strongly suggest that marked differences exist between grasses and legumes with regard to the availability of the hemicellulose fraction to rumen bacteria. Hemicellulose degradation or utilization, or both, from a given intact forage varied markedly between species and strains, but in all cases decreased as the forage matured.

Degradation of Rutin and Related Bioflavonoid Compounds by Anaerobic Rumen Bacteria - G. A. Jones, K. J. Cheng and F. J. Simpson, University of Saskatchewan, and National Research Council of Canada, Prairie Regional Laboratory, Saskatoon.

Under anaerobic conditions, the mixed rumen microflora rapidly degraded quercetin (3,3',4',5,7-pentahydroxyflavone), quercitrin (quercetin-3-L-rhamnoside) and rutin (quercetin-3-rutinoside) to water-soluble products. Fifteen strains of bacteria capable of degrading rutin anaerobically were isolated from high dilutions of bovine rumen contents and assigned to the genus Butyrivibrio on the basis of morphological and biochemical evidence. The products of rutin degradation by one strain, C_3, were rutinose, phloroglucinol, 3,4-dihydroxyphenylacetic acid and 3,4-dihydroxy-benzaldehyde; fermentation of rutin specifically labelled with carbon-14 showed that carbon-4 of the substrate was released as carbon dioxide. The organism also degraded quercitrin but quercetin was not attacked, even in the presence of free rutinose, glucose or rhamnose; the phenolic products of quercitrin degradation were phloroglucinol and 3,4-dihydroxyphenylacetic acid. The results are consistent with the operation of a degradative pathway for rutin and quercitrin which involves initial removal of the carbohydrate moiety by a glycosidase, followed by hydrolytic cleavage of the heterocyclic ring of the aglycone.

Quantitative Studies on the Carbon Dioxide Requirement of Various Species of Rumen Bacteria - B. A. Dehority, Ohio Agricultural Research and Development Center, Wooster.

The CO_2 requirement of 32 strains of rumen bacteria, representing 11 different species, was studied in detail. Increasing concentrations of CO_2 were added, as $NaHCO_3$, to a specially prepared CO_2-free medium which was tubed and inoculated under nitrogen. Prior depletion of CO_2 in the inoculum was found to affect the level of requirement; however, the complexity and buffering capacity of the medium did not appear to be involved. An absolute requirement for CO_2 was observed for all strains of B. ruminicola (8 strains), B. succinogenes (3), R. flavefaciens (4), L. multiparus (2), S. amylolytica (1) and 2 strains of B. fibrisolvens. Inconsistent growth responses were obtained in CO_2-free media with 1 strain of B. fibrisolvens, B. albus (1) and S. ruminantium (1). Growth of 6 additional strains of B. fibrisolvens, and one strain each of E. ruminantium and S. dextrinosolvens was markedly increased or stimulated by increasing concentrations of CO_2. Peptostreptococcus elsdenii B159 was the only organism tested which appeared to have no requirement, either absolute or partial, for CO_2. Higher concentrations of CO_2 were required for the initiation of growth as well as for optimal growth, by those species which produce succinic acid as one of their primary end products.

Bacteriophages of the Rumen - A. E. Ritchie, M. J. Allison, and I. M. Robinson, National Disease Laboratory, ADP,ARS, USDA, Ames.

Although the rumen microbial flora has been the subject of intensive research, little is known of its phage population. The purpose of this work was to characterize the morphology of as many phage-like entities as were recognizable. Samples of bovine and ovine ruminal contents were examined in potassium phosphotungstate negative stain of the supernatant fluid after the larger and more dense particles had "settled out", and also after differential centrifugation. Phage-like entities numerically exceeded the bacteria in random samples. The ratio of phage to bacteria appeared to be in the range 2-10 to 1. More than 30 morphologically distinct phage-like entities have been observed in a single sample. Structures which appear to be precursors of phage have also been detected with relative ease by the sampling method used. Some bacteria have attached phage allowing preliminary host identification. The most striking feature of the phages was their variety of attachment apparatus. The complexity of these structures probably represents a comparable complexity in the surface of the host. The largest phage was ca. 0.4 micron (overall length) while the smallest was ca. 0.05 micron. It is suggested that phage-bacteria relationships may be important in ruminal microbial ecology.

Characterization of the Lipids of Rumen Bacteria - Butyrivibrio fibrisolvens Strain D-1 - J. E. Kunsman, University of Wyoming, Laramie.

Butyrivibrio fibrisolvens Strain D-1 was grown on a lipid free chemically defined medium. The lipids were extracted with chloroform-methanol and separated into non-polar fractions by silicic acid column chromatography. Further separations were made on preparative thin layer chromatography. The lipid fractions were identified by specific staining reactions and RF values, by phosphorus and nitrogen determinations, by chromatography of hydrolysis products and by the use of infrared spectroscopy. The major non-polar lipid was free fatty acid. Four major polar lipids were identified: phosphatidyl ethanolamine, phosphatidyl glycerol, lipoaminoacid and glycolipid. The lipoaminoacid contained alanine, leucine and isoleucine. The glycolipid contained galactose. The major fatty acids identified were C:16:0 and C:18:1. The significance of the presence of lipoaminoacid is discussed in relation to membrane function and amino acid synthesis. It is suggested that the radioactive carbon from labeled volatile fatty acids which has been reported to enter the lipid portion of the cells of B. fibrisolvens resides in the amino acid moiety of the lipoaminoacids.

The glycolipid isolated from B. fibrisolvens grown on a lipid free chemically defined media suggests rumen bacteria synthesize their own glycolipid rather than using the plant glycolipid available in the rumen.

NUTRITION PANEL

The Syringe-Type Rumen Fistula Mechanism - R. S. Hinkson, Jr., University of Rhode Island, Kingston.

Various types of rumen fistula mechanisms have been described in the literature. This report describes one of three syringe-type fistula mechanisms for which only abstract information is available. It was originally used as a replacement for a dislodged, permanent rumen fistula mechanism. It has been modified considerably and is now employed as a permanent as well as a replacement rumen cannula.

The fistula mechanism is self-made and economical to construct. The only materials necessary for its preparation are: (1) a disposable plastic syringe (20, 30, or 50 cc capacity); (2) a small sheet of clear, semiflexible, vinyl plastic; and (3) two lengths of braided nylon twine.

The tools used to make this fistula mechanism were an electric drill with a 3/32 inch bit and a hole cutter, an emery wheel, an electric eraser adapted for use with a carborundum disk (a hacksaw, a coping saw and a flat file have been used in place of the modified electric eraser), a small steel rod with a conical end, and a small knife.

The syringe barrel and its plunger have been modified to serve as the cannula and cannula plug. The sheet of vinyl plastic was altered to serve as both the internal and external washers. The lengths of braided nylon twine are used to adjust for tissue pressure and to secure the internal washer and cannula in the rumen. The surgical technique described by R. W. Dougherty (Cornell Vet. 45: 331, 1955) was followed when it was installed as the original and permanent fistula mechanism.

Besides being simple and economical to construct, it can be installed in a matter of minutes. It fits snug against the abdominal wall. It weighs approximately 40 grams. The washers do not crack or break in the presence of rumen contraction or physical obstructions. It can also be completely removed and replaced in the rumen without prior surgery. All fistulation attempts using four sheep, a goat, and a deer have been successful.

Metabolic Effects of Zearalanol - Duane Sharp and I. A. Dyer, Washington State University, Pullman.

Zearalanol, a lactone of resorcylic acid, has hormone properties similar to stilbestrol. Studies were conducted on 90 heifers, 108 steers and 20 lambs to estimate the effect of Zearalanol on rate and efficiency of gain; carcass grade and composition; blood glucose, amino acid and insulin level; and, distribution and excretion of tritiated Zearalanol.

Rate of gain was increased 15% and efficiency of feed utilization was increased 8% by 36 mg Zearalanol implants for steers and heifers. Zearalanol was effective in increasing performance with different grains and at different protein levels. It did appear, however, that there might be a Zearalanol - dietary energy density interrelationship. In lambs gain was increased 13% and feed efficiency by 16% by 12 mg Zearalanol implants. Plasma glucose and amino acids levels did not reflect well defined changes due to Zearalanol. Total plasma insulin, however, was increased in both cattle and lambs due to Zearalanol implantation.

Carcass grades were increased slightly by Zearalanol. Carcass water and protein were increased while carcass fat was slightly reduced by Zearalanol administration. Zearalanol was not detected in tissue (except in the bile) at 65 days. Its primary route of excretion is via the bile into the feces.

Milk Production Response to Supplementation with Encapsulated Methionine per os or Casein Per Abomasum - G. A. Broderick, T. Kowalczyk, and L. D. Satter, University of Wisconsin, Madison.

Experiment 1

Encapsulated methionine, a product containing kaolin, tristearin, and DL-methionine, and formulated to protect the amino acid from rumen degradation, was fed to provide either 45, 15 or 5 gm. per day of methionine to lactating dairy cows. Eight cows at least six weeks postpartum, being fed a ration of concentrate and urea supplemented corn silage ad libitum (overall ration contained 15-16% crude protein), were divided into two groups of equal production, and used in a switchback design experiment. The length of treatment cycles at each level of encapsulated methionine was 24 days. One group of cows received encapsulated methionine during the first 12-day period of each cycle, while the other group received equivalent amounts of kaolin and tristearin, followed by a reversal of treatments during

the second 12-day period. Milk composition was determined from three-day composite milk samples, and production data calculated from the last nine days of each period. No statistically significant effects due to encapsulated methionine were noted on any of the three levels of methionine. Though not determined at the 45 gm. per day level, plasma methionine ($P < .10$) and methionine per valine ratio ($P < .01$) increased significantly in all cows from samples taken on the last day of each period at the 15 gm. per day level. At 5 gm. per day, only plasma methionine per valine ratio in the highest producing cows was significantly elevated ($P < .01$).

Experiment II

The same ration and experimental design used in Experiment I was used with three abomasally fistulated cows averaging 31 kg. milk per day. The treatment solution, which was infused via abomasal fistulae 24 hours per day, consisted of 800 gm. per day casein plus 2.4 gm. per day methionine. Saline or glucose-urea (isocaloric-isonitrogenous with casein infusion) was infused as a control. Significant effects noted with casein infusion were a 6.2% increase ($P < .10$) in milk protein content (NX625), a 13.0% increase ($P < .05$ in protein production, and a 10% decrease ($P < .05$) in grain intake. Fifteen different free amino acids were determined in plasma, and significant effects observed with casein infusion were decreased glycine ($P < .10$) and decreased total nonessential amino acids ($P < .05$), increased isoleucine ($P < .05$), leucine ($P < .05$), valine ($P < .10$), phenylalanine ($P < .05$) and increased total essential amino acids.

Frequent Feeding of a Corn Silage and Urea Complete Ration to Lactating Dairy Cows - L. R. Williams, F. A. Martz, J. R. Campbell, J. D. Sikes, and E. S. Hilderbrand, University of Missouri, Columbia.

Ten lactating Holstein cows were randomly assigned to treatment groups in an 120 day continuous study. The study was to compare the effects of frequent feeding a complete ration containing a pelleted urea-alfalfa combination. The cows were fed individually in a tie-stall barn twice daily (2X) and four times (4X) daily. Average daily fat-corrected-milk (FCM) production, milk fat, solids-not-fat (SNF), milk protein, body weight and ration intake by treatments were: 2X) 19.21 kg, 3.49%, 10.11%, 3.56%, 608.0 kg, 4X) 17.56 kg, 3.60%, 9.80%, 3.41%, 621.2 kg, 15.11 kg, respectively. Analysis of covariance indicated no significant differences ($P < .05$) for daily FCM production, milk composition, body weight and ration intake.

No significant differences ($P < .05$) were found in blood urea nitrogen, blood ammonia, urinary urea nitrogen, urine volume, urinary nitrogen, creatinine and urinary amino acids. These results indicate that 4X daily feeding has no additional benefit over 2X feeding when a complete corn silage concentrate ration is fed which contains a pelleted urea - alfalfa supplement.

Use of Fibrous Feeds for Ruminal Urea Utilization in Dairy Cows - H. R. Conrad, R. W. Wallenius and J. S. Mugerwa, Department of Dairy Science, O.A.R.D.C., Wooster.

Initial studies have indicated that rations high in fiber can be used effectively to support urea utilization by lactating cows. Four animals consumed an average of 222 g urea or diammonium phosphate N/day and produced an average of 19.5 kg FCM/day. The greatest production was 26.8 kg/day for a two month period. Three of the cows completed their lactations. The ration given to the four cows included 1) a pellet composed of 50% soybran flakes, 21% solka floc, 12% dehydrated alfalfa meal, 2% dical., 1.1% diam. phos., 6% urea, 6% fat, 1% hydan, 0.5% sodium propionate, 0.3% salt and 30,000 units vitamin A; 2) beet pulp and 3) hay in an approximate ratio of 50:35:15. When a similar pellet was fed alone bloating was frequent. Bloat froth harvested from an animal receiving the high fiber-urea pellet contained 40% crude protein (Nx 6.25) and 14.8% ether extract. These values compare with values found in froth harvested from animals on alfalfa pasture or receiving high grain-soybean meal rations. A second pellet composed of 37.5% soybran flakes, 20.8% beet pulp, 19.5% solka floc, 12.5% dehydrated alfalfa meal, 2.5% dical., 4.2% urea, 2.5% fat, 0.2% hydan, 0.2% salt and 0.1% vitamin A has been fed to four cows and made up 85% of the ration, hay making up the difference. Maximum production over a 16 day period has been 28.9 kg FCM/day (range 14.3-28.9 kg).

Effect of Dehydrated Alfalfa, Molasses and Pelleting on Utilization of Urea Rations - F. G. Owen and E. L. Fisher, University of Nebraska, Lincoln.

Four digestion trials were conducted, using eight Hereford steers which were randomly assigned to two 4x4 quasi-Latin squares to determine the value of dehydrated alfalfa meal, molasses and pelleting and all possible combinations of these factors on utilization

of urea-containing rations. Consequently, eight rations, one-half meal and one-half pelleted, were used. The urea (1%) was mixed in a supplement which contained dicalcium phosphate, limestone, salt, trace minerals, vitamins A and D, corn (for pelleting qualities), and the variables (5% dehydrated alfalfa or 5% molasses, or both). This supplement was fed with 57% ground corn and 25% ground corn cobs.

During each digestion trial, all steers were restricted to the same near-maintenance level of nutrients. Feed, urine, and feces samples were collected for six days.

The results of the trial did not favor pelleting. Pelleting significantly decreased digestibility of dry matter and crude protein and also tended to depress nitrogen-free extract digestibility, but had no effect on nitrogen retention.

Dehydrated alfalfa did not improve or detract from digestion of ration components or affect nitrogen retention. Some of the steers in this trial tended to select out and leave the dehydrated alfalfa meal. This indicates the need to cover this undesirable characteristic of dehydrated alfalfa meal in some manner. Molasses appeared to improve acceptance of the dehydrated alfalfa, but pelleting did not. This suggests that the adverse effect is probably related to qualities other than its texture. Molasses tended to increase dry matter and ether extract digestibility, but had no apparent effect on digestion of other components or nitrogen retention.

From these data it appears that none of the treatments used in these trials improved the utilization of urea rations. Consequently, based on these results, neither addition of dehydrated alfalfa, molasses or pelleting of the supplement or any combination of these factors appears recommendable for increasing the utilization of urea nitrogen.

Relationship Between Production Level and Response of Dairy Cows to High Urea or Low Protein Rations - J. T. Huber, P. W. Spike and R. E. Erickson, Michigan State University, East Lansing.

In order to establish whether cows of different production levels reacted differently to urea or low-protein stress, milk yield data from several studies were analyzed to test the significance of differences between regression coefficients determined for treatments within a given experiment.

One study involved 70 cows which received urea in the grain at 0, 178 and 327 g/day. Milk persistencies significantly decreased as urea increased (91,83 and 72%). The regression coefficients for treatment yields (Y) on pre-treatment yields (X) were 1.01, .673 and .475, respectively, and demonstrated that the higher producers in the groups receiving urea were more greatly depressed in milk persistencies than the lower producers; however, this trend was not shown for the control group.

Another study involved four treatments (0, 100, 192, 260 g urea/day) with 32 cows. Milk yields were significantly depressed at the two highest urea levels. Again the high producing cows were more severely affected by the high-urea rations than the low producers and regression coefficients for the respective treatments were .916, .742, .541 and .490.

Low protein rations (10 cows/group) resulted in a significant depression in milk yields and showed a pattern similar to that observed for high urea. At 13.5, 10.5 and 8.0% ration protein, milk persistencies averaged 88, 81 and 67% and regression coefficients were .947, .447 and .405, respectively.

The data suggest that cows on high corn silage rations producing below about 50 lb/day can be fed urea as the only nitrogen supplement without depressing milk yields. However, natural protein supplement is needed above this level. Moreover, 10 to 11% crude protein in the total ration is probably sufficient for cows under 50 lb/day, but this level needs to be increased with higher production.

PHYSIOPATHOLOGY PANEL

The Effects of Potassium Deficiency on the Acid-Base Status of Cattle - G. D. Phillips, Department of Animal Science, University of Manitoba, Winnipeg, Canada.

Venous blood samples, from steers receiving various levels of dietary potassium, were analysed for plasma standard bicarbonate and chloride contents. The basal diet consisting mainly of dried brewers grains and corn starch had an inherent potassium content of about 0.1%. Supplementary potassium as K_2CO_3 was added to give a dietary level of 0.67% K and all 24 steers were adjusted to the diet for 23 days. The steers were randomly allotted to 4 groups of six steers each, and the same basal diet but containing 0.36, 0.50, 0.67 and 0.77% of K

respectively fed for 105 days. Blood samples were taken on the last day of adjustment and on 4 subsequent occasions at approximately monthly intervals. The effects of the various dietary levels of potassium on feed consumption, rate of gain, serum Na & K levels etc. have been published (1). It was judged that the dietary potassium requirement was about 0.70% of dry matter.

Standard bicarbonate content of the plasma was significantly decreased in steers on the 0.50% K diet and there was a further decrease in the steers on 0.36% K. This acidosis was unexpected as alkalosis has usually been observed in monogastric animals in potassium deficiency states (2). Alkalosis is said to arise because of the distal renal tubular mechanism whereby sodium reabsorption is dependent on tubular secretion of H^+ or K^+. In states where potassium is being conserved H^+ are excreted thus causing systemic alkalosis.

The present results in cattle suggest that the Na^+ and K^+/H^+ exchange mechanism may be functioning somewhat differently than in monogastric animals.

A small additional experiment with some of the cattle suggested that the acidosis could be partly alleviated by giving the cattle additional H^+ acceptor in the diet in the form of $NaHCO^3$.

Does Blood Flow Affect Absorption from the Rumen? - A. Dobson, A. F. Sellers, and S. O. Thorlacius, New York Veterinary College, Cornell University, Ithaca.

The exchange of materials between the blood and a solution placed in the temporarily isolated ventral sac of the rumen of the conscious cow (1) has been observed. Blood flow to the rumen was stimulated by substituting carbon dioxide for nitrogen in the stirring gas, or butyric acid for saline (2). The equilibration of tritiated water between sac contents and blood was markedly increased by blood flow stimulation. The effect on ethanol equilibration was similar, but slightly smaller while the effect was on antipyrine, though still present, was much reduced. These observations are consistent with the idea that blood flow limits the passage of these substances across the epithelium. The influence of blood flow is greatest on tritiated water, which penetrates the most rapidly and least on antipyrine, which penetrates the least rapidly. Since the change in the plasma clearance of tritiated water is similar in magnitude to the change in blood flow in the right ruminal artery when the gas is changed from 100% N_2 to 100% CO_2, the clearance of tritiated water may well be an index of mucosal blood flow under our experimental conditions.

The Appearance of Urea and Ammonia in the Rumen of the Cow - S. O. Thorlacius, A. F. Sellers, and A. Dobson, New York State Veterinary College, Cornell University, Ithaca.

The appearance of urea and ammonia in the washed ventral sac of the conscious cow was measured using the temporarily isolated ventral sac preparation described by Dobson, Sellers, and Shaw (1). Gassing the experimental solutions in the rumen with carbon dioxide for as little as five minutes caused a several fold increase in the rate of appearance of urea plus ammonia. This increase was not detectable until 20-30 minutes after gassing with carbon dioxide was begun and thus could occur long after the partial pressure of carbon dioxide in the experimental solution had returned to the initial level. The effect appears to be localized to the region of the rumen to which carbon dioxide is administered. Following gassing with carbon dioxide, changes in flux of acetamide in either direction across the rumen epithelium closely paralleled changes in rate of urea plus ammonia appearance. Acetamide is an analogue of urea which is foreign to the body and is not hydrolyzed by urease.

The similarity between the effects of carbon dioxide on diffusion of acetamide and rate of appearance of urea plus ammonia suggests that carbon dioxide produces an increase in permeability of the rumen epithelium to urea. The production of an unknown substance in the epithelium is postulated to account for the delay between carbon dioxide administration and its effects.

Stimulation of "Glucoreceptors" in the Central Nervous System of Ruminants with 2-Deoxy-D-Glucose: Food Intake and the Hyperglycemic Response - T. R. Houpt and H. E. Hance, University of Pennsylvania, Philadelphia.

Deprivation of the central nervous system of adequate amounts of glucose can lead to several consequences including an increase in food intake and activation of the sympathetic nervous system. Sympathetic stimulation of the adrenal medulla causes a release of catecholamines causing in turn, among other things, an hyperglycemia. The integrative areas for food intake control and the sympathetic nervous system lie in the hypothalamous and cells located there appear to be especially sensitive to lack of glucose ("glucoreceptors"). The glucose analogue 2-deoxy-D-glucose(2-DG) is a competitive inhibitor of glucose metabolism within cells and can cause the CNS effects of glucoprivation. The stimulation of food intake by 2-DG can be used as a test for the presence of a glucostatic control of food intake. This

was done on goats, and a small increase in the intake of feed concentrates was found. This suggests that the glucostatic mechanism for the control of food intake exists in ruminants, perhaps as an evolutionary vestige.

Glucose plasma concentration is much lower and dependence upon glucose for energy needs is smaller in ruminants as compared to non-ruminants. However, CNS cells are generally particular in their need for glucose. Are the cells of the CNS of the ruminant more sensitive or less sensitive to glucose lack than those of non-ruminants? To evaluate the sensitivity of ruminant CNS cells to glucoprivation, 2-DG was injected intravenously as a continuous infusion at different rates, and the effects on plasma glucose and on behavior were followed. The lowest (threshold) level of plasma 2-DG necessary to activate the sympathetic nervous system, initiating an hyperglycemia, was determined and compared with similar measurements on dogs. Incomplete results indicate that the ruminant CNS "glucoreceptors" are about as sensitive as canine ones. Higer levels of 2-DG caused a graded hyperglycemic response. Adrenalectomy prevented this response. Finally, depression, muscular twitching, brief periods of voracious eating, ataxia and convulsions appeared at high 2-DG concentrations. Brain deprivation of glucose appears to be as serious in the ruminant as in other animals.

Rumen Pathological Alterations in Sheep Ingesting Radioactive Sand Particles - L. B. Sasser, J. L. West and M. C. Bell, UT-AEC Agricultural Research Laboratory, Oak Ridge, Tennessee.

The response of the ruminal tissues of sheep exposed to beta irradiation from ingested ^{90}Y-labeled sand particles was studied. Diarrhea, anorexia, and pyrexia developed approximately one week after ingesting 2.4 mCi/kg body weight. At necropsy, major damage was usually confined to the ventral and lateral areas of the rumen and abomasum. The involved mucosal surface of the rumen was characterized by large (up to 12 cm) elevated areas consisting of polyp- or cauliflower-like masses of fibrino-necrotic exudate. Pathologic changes in rumen tissue were apparent 4 to 5 days after dosing. The fibrino-necrotic masses were friable and began to detach in 3 to 4 weeks synchronous with healing of the underlying tissue. Scars with superficial erosions, and some covered with necrotic exudate, have been observed several months after treatment. Histopathologic examination revealed relatively minor hemorrhagic involvement which was not grossly conspicuous.

Abomasal changes consisted of generalized edema and hyperemia with a large area of hemorrhagic necrosis involving the laminae in the caudal fundus and usually extending into the cephalic pylorus. In many cases, serosal adhesions had developed over abomasal as well as ruminal lesions. Relatively minor lesions have been observed in the reticulum and omasum. Intestinal alterations were limited to minor congestion and edema, usually of the duodenum. (Work supported by the Office of Civil Defense under work order No. DAHC20-69-C-0109 and the Atomic Energy Commission under contract No. AT-40-1-GEN-242.)

Motility of the Llama Stomach - Augusto Vallenas, New York State Veterinary College, Cornell University, Ithaca.

The motility of the llama stomach was studied for comparison to the forestomach of the advanced ruminant (cow and sheep). For comparative purposes the three distinctive compartments between the cardia and duodenum were numbered one, two, and three. The first two compartments of the llama stomach undergo cyclic motility. This includes a single rapid contraction of compartment two, which initiates the cycle and is followed by contractions of the caudal and then cranial sacs of compartment one. The contractions involving compartment one are repeated six or seven times. A pause follows the last caudal sac contraction of the cycle. Eructation, occurs at the peak of caudal sac contractions, and in a single motility cycle may occur three to four times. Regurgitation is not related to contractions of compartment two, but is always preceded by contraction of the cranial sac of compartment one. A single motility cycle may include three complete rumination cycles.

From these motility studies, it is tempting to consider the compartment two analogous to the reticulum of the commonly known ruminants (cow and sheep), because it presents a rapid contraction and initiates the cycle. Also compartment one could be considered analogous to the rumen. However, these analogies fail in several respects; 1) the reticular contraction which initiates the ruminoreticular cycle is double in the cow and biphasic in sheep, while in the llama it is single, 2) in the cow and sheep this is followed by primary, and sometimes, secondary rumen contractions, whereas in llama it is followed by six to seven secondary contractions of compartment one, 3) regurgitation in the cow and sheep is always related to an extra-reticular contraction and there is one cycle of rumination per ruminoreticular cycle. In llama, there is no relationship between regurgitation and contraction of compartment two, and each motility cycle may include three cycles of rumination.

A Multiplexed Radiosonde for Measuring Reticular Pressure and Temperature in Cattle - G. E. Smith, R. W. Weeks, J. J. Cupal and G. A. Mooney, University of Wyoming, Laramie.

A radiotelemetry system for measuring ruminoreticular pressures in free-feeding cattle has been designed and tested. This radiotelemetry system is sensitive and stable and has been used to monitor ruminoreticular pressure changes in free-roaming cattle maintained in 7 x 15 m. corrals. The transmitting radiosonde passes down the esophagus of 340 kg. cattle and self-implants in the reticulum without surgery. The well known diphasic contractions of the reticulum have been recorded for the pre-feeding and feeding states of cattle fed baled alfalfa hay. The magnitude and frequency of contractions increased significantly during eating. When either pelleted feeds or a purified diet were fed, the amplitude of contractions was significantly reduced and frequency of contractions was increased. The triphasic contractions associated with rumination have been observed while steers were fed baled alfalfa hay. The visual absence of rumination, when steers were fed the purified diets and pelleted feed, was verified by the absence of rumination pressure changes. The radiotelemetry system designed to simultaneously measure temperature and pressure consists of a two channel pulsed carrier telemetry system. The time between the narrowest pair of pulses is directly proportional to pressure. The time between the widest pair of pulses is directly proportional to temperature. Full scale pressure is 100 mm. Hg with 1 mm Hg resolution. Full scale temperature is 10°F (95°F to 105°F) with 0.1°F resolution.

Sequential Biochemical Changes in Carotid and Portal Blood of Sheep Experimentally Engorged on Ground Barley - R. H. Dunlop, E. B. Edwards, W. E. Roe, and J. G. Manns, Department of Veterinary Physiology, Western College of Veterinary Medicine, University of Saskatchewan, Saskatoon.

An intensive study was conducted on four sheep experimentally engorged with ground barley at a dose of 40 g/kg. In each sheep a carotid arterial loop was prepared surgically and a plastic catheter was introduced to the portal vein. Prior to each experiment a catheter was inserted into the carotid arterial loop. Carotid arterial (C) and portal venous (P) blood samples were taken every two hours throughout a control period of 24 hours and a post-engorgement period of 48 or 72 hours. Analyses were made for pH, P_{CO_2}, total lactate, L-lactate, pyruvate, glucose, insulin, hemoglobin and hematocrit. Although the responses varied greatly among the individuals, some consistent changes were observed. In all animals hemoglobin concentration and hematocrit increased following engorgement but the (P-C) differences were not marked.

Total lactate increased from < 1 mM/l to 6-11 mM/l and (P-C) became clearly positive after engorgement. D-lactate appeared in the blood after loading and reached peak levels of 3-10 mM/l. L-lactate increased but never exceeded 3.8 mM/l. Pyruvate rose from < 0.10 to a peak of 0.16-0.24 mM/l. pH was always lower and P_{CO2} much higher in P than C. After barley loading a distinct increase in P_{CO2} occurred preceding a large rise in (H^{+}). The peak for the latter also preceded the peak in (lactate). In both sheep in which the (H^{+}) returned to baseline prior to termination of the experiment, it fell to subnormal levels that were accompanied by an elevated (HCO_3-) indicating the presence of metabolic alkalosis. Glucose tended to show a positive (C-P) in the control period but this was reversed during part of the experimental period. Glucose increased from 60-70 mg/100 ml to a peak of 94-127 mg/100 ml after the grain dose. Plasma insulin increased several fold after loading and the concentration tended to vary in parallel with the glucose concentration. (Supported by Canada Department of Agriculture Operating Grant No. 9134).

AGRONOMIC PANEL

Progress Through Interfacial Associations - J. C. Burns, North Carolina State University, Raleigh.

Participants in the Rumen Function Conference have represented and continue to represent, very diverse disciplines. Scientists from the areas of Biology, Physiology, Nutrition, Microbiology, Dairy Science, Animal Science, Veterinary Medicine and Agronomy have met jointly in an attempt to understand better the area of animal response. This common goal has served as a thread among these disciplines and is responsible for the continued interest and resulting growth from the initial bloat conference to its current form.

Understanding the relationships between the soil, plant and animal systems as altered by environment and management is very complex, and it is in this particular area that cooperative research can play a vital role. Complete knowledge of the system with which one is experimenting permits proper measurements of the major variables and experimental designs that provide adequate control such that true differences are measured.

Attempts to broaden a researcher's view of a particular area by retraining him in another discipline may result in considerable losses in time and money; more importantly, loss of association with his original discipline and lack of time to keep himself current in several disciplines.

A more tenable arrangement is the development of what I term "interfacial contacts". This can occur when discipline boundaries are eroded to the extent that scientists of different disciplines having similar objectives can associate. Arrangements may be developed whereby each depends on the other's expertise in a specific area, and upon considering all aspects, finally make joint decisions. In this manner, each cooperating scientist retains identity with his own discipline, at the same time acquiring an appreciation for approaches and problems confronting others in their particular areas of research.

The merit of cooperative research is the progress that can be achieved when seeking relationships among complex systems. These data may further stimulate experimentation in specific areas resulting in information which can be used in future cooperative studies. In addition, it enables each scientist to capitalize on the stimulation that is generally associated with the exchange of ideas and approaches among cooperators.

Breeding for Improved In Vitro Digestibility - B. R. Christie, Ontario Agricultural College, University of Guelph, Guelph, Ontario.

The development of techniques for the measurement of dry matter digestibility *in vitro* has provided the plant breeder with another selection criteria. In our breeding program, selection for *in vitro* dry matter digestibility (I.V.D.) has been receiving increased emphasis.

Significant differences among varieties have been found at every cut. The range in I.V.D. has been of the order of 10-15 I.V.D. units. Differences among varieties can be altered considerably by stage of cutting. In our trials, each variety is cut at the same stage of maturity, either just after heading or at pollination.

Within a variety or strain, individual plants have been found to differ significantly in I.V.D. In bromegrass, within any one year, significant differences have been found for the I.V.D. of leaves, stems, and of the whole plant. Over a two year period, however, only differences in the I.V.D. of the stems were statistically significant. Breeders would be advised to select on the basis of differences in the I.V.D. of stems, and to evaluate their materials for at least two years.

Out of 450 genotypes in bromegrass, 10 were found to have leaves and stems of equal digestibility.

There appears to be no relationship between I.V.D. and such morphological traits as plant color, leaf width, erectness of leaves or stems, or stem size.

In bromegrass and orchardgrass, estimates of percent genotypic variance for I.V.D. ranged from 60-73%. It is concluded that there is ample genetic variance in both species for improvement in I.V.D. through breeding.

Influence of High Levels of Nitrogen Fertilization of Pastures on Animal Response - J. P. Fontenot, R. E. Blaser and R. E. O'Kelley, Virginia Polytechnic Institute, Blacksburg

An experiment was conducted during 3 years to study the effect of a high level of nitrogen fertilization with and without a low level of magnesium fertilization of native pasture on magnesium metabolism of lactating beef cows. Procedures were similar for each of the 3 years. Three 2.9 ha. plots were used. The average levels of fertilizers applied each year, 17 to 29 days prior to the beginning of the grazing season, were: Plot 1-none; Plot 2-346 kg. nitrogen per ha.; Plot 3-336 kg. nitrogen and 53 kg. magnesium per ha. Liquid nitrogen and magnesium oxide were used as fertilizers. Blood and urine samples were obtained from the cows prior to the beginning of the grazing season and at intervals until approximately July 1. The high rates of nitrogen fertilization resulted in a lower dry matter content and higher crude protein and magnesium contents, dry basis, of the herbage. Blood urea level was higher for the cows grazing the nitrogen fertilized pastures. During the second and third years the use of the high levels of nitrogen usually resulted in lowered blood serum magnesium. During each year urinary magnesium per unit of creatinine was lower for the cows grazing the nitrogen fertilized plots.

A 3-year experiment was conducted to study the effect of nitrogen fertilization of native bluegrass pastures on performance of continuously grazed cattle. The source of nitrogen fertilizer was ammonium nitrate. Applying 168 kg. nitrogen per hectare did not affect rate of gain. Carrying capacity and average gain per hectare were increased substantially by nitrogen fertilization.

The Meadow Vole as a Bioassay of Forage Quality - R. F. Barnes, USDA, ARS, Purdue University, Lafayette.

The meadow vole (Microtus pennsylvanicus) has been suggested as a bioassay organism for estimating forage quality. The meadow vole is a short-tailed herbivore with an enlarged caecum which allows microbal degradation of ingested feed. Thus, the vole is able to utilize fibrous diets in a manner similar to the horse.

Also the vole contains an esophageal pouch which temporarily stores ingested feed prior to its passage into the fundic portion of the stomach. This pouch allows direct absorbtion of certain metabolically active compounds which would ordinarily undergo acid hydrolysis in the stomach and thereby be rendered inactive. For example, this may be particularly true in a case of ingestion of alkaloids.

Diets high in fiber may be fed to such animals and the growth response of weanling voles on experimental diets may be compared to those on a standard purified diet. The direct application of such growth response data toward the prediction of ruminant digestibility or intake results does not appear to be feasible across all forage species and harvesting conditions. However, the results appear to be applicable within a given grass species and growth period.

Shenk and Elliott (J. Ani. Sci. 27:1518. 1968) and Shenk (Agronomy Abstracts, p 63. 1969) have reported that nutritive balance and maximum predicted daily gains of approximately 1.0 grams per day was obtained with voles fed diets having a protein: energy ratio of 0.086 (Carbohydrate energy: protein ratio of 11.7) and a fiber level not exceeding 50%. Diets fed with deviations from this balanced relationship resulted in growth depression due to either energy or protein deficiencies. Diets resulting in growth depression when fed at the recommended protein: energy ratio should be examined for possible antimetabolites influencing growth response.

The Central Nervous System and the Control of Feed Intake of Ruminants - Clifton A. Baile, Dept. of Nutrition, Harvard School of Public Health, Boston.

Many areas of the CNS function in controlling feed intake, including transmission of motor neuron signals and signals from peripheral receptors, but the hypothalamus probably has the most

specialized and studied functions. The ventromedial area of the hypothalamus (VMH) which is only about 10/(1 in volume in sheep is important in long term control of feed intake or the input side of energy balance regulation. Electrolytic lesions in the VMH cause hyperphagia and an increased level of energy balance in most laboratory animals and in goats; the response has not been shown in sheep or cattle. The VMH may be the memory center for energy balance regulation. The VMH probably acts on feeding by inhibiting the feeding activating system found especially in the lateral hypothalamus (LA). Stimulation of the VMH suppresses feeding in goats. Electrical stimulation of the LA causes immediate feeding in satiated sheep and goats as well as most laboratory animals. Electrolytic lesions in the LA cause transitory aphagia and adipsia in goats and sheep. In the hypothalamus there are temperature, osmotic, and possible glucose receptors, none of which under our laboratory conditions, appears to be acting in the hunger-satiety controlling system of goats and sheep. We have found no evidence for receptors in the hypothalamus for acetate or propionate, although there are probably receptors for these metabolites in the ruminal area which can act to depress feeding. Short term feed intake of ruminants is probably controlled by peripheral feedback signals acting on hypothalamic areas. Little is known about signals or receptor areas for long term control of feed intake or the input for energy balance regulation, but the VMH is intimately involved.

Fraction I (18S) Protein, Bloat and Mineral Interrelationships - J. E. Miltimore, J. M. McArthur and J. L. Mason Research Station, C. D. A., Summerland, British Columbia

Cattle did not bloat below 1.8% Fraction I protein but bloat increased logarithmically up to 6.1%. The range in bloat was from 2% to 35%. The relationship could be expressed as log bloat incidence %=0.329 Fraction I protein % - 0.238 with a standard error of 0.027. Lipids, tannins and magnesium were not significantly related to bloat but lipids and tannins were correlated with Fraction I protein (P = 0.05).

Calcium, Ni and Zn were significantly related to bloat but only calcium was significantly associated with Fraction I protein.

Of the variables studied, only Fraction I protein had a threshold level below which bloat did not occur. There was an increase in bloat of 33% over the bloating range of Fraction I protein. Comparable increases in bloat over the observed range of Ca, Ni and Zn were 10, 10 and 8.5% respectively.

PHYSIOLOGY PANEL

Developments on a Theoretical Model of Fiber Digestion in Relation to Lignification and Unresolved Problems - D. R. Waldo and L. W. Smith, Animal Husbandry Research Division, USDA, and E. L. Cox, Biometrical Services, OA, USDA.

The lignin concentration in fiber seems to influence the extent of *in vivo* digestion, but the increasing lignin content during digestion does not appear to slow the rate of digestion. The digestion of lignified fiber proceeds as if the cellulose is of two definable components - potentially digestible and completely indigestible. Disappearance of the indigestible cellulose is by passage only. Passage is proportional to that present and may be expressed as a linear semilog function of time. The potentially digestible cellulose disappears by the sum of both passage and digestion. These two simultaneous rates appear as one rate sum which is proportional to that present and may be expressed as a linear semilog function of time. The fractional digestion of the potentially digestible component in the rumen is given by the digestion rate over the sum of digestion rate and passage rate.

Utilization of Ruminal Propionate for Glucose Synthesis in the Lactating and Nonlactating Cow - David W. Wiltrout and Larry D. Satter, University of Wisconsin, Madison.

A primed constant infusion technique using acetate-1-C^{14}, propionate-2-C^{14}, butyrate-1-C^{14} and glucose-U-C^{14} was employed to measure ruminal volatile fatty acid production, plasma glucose entry and the extent to which propionate was used to synthesize glucose. The experiments were conducted with two Holstein cows fed hourly to assure constant rumen fermentation. The cows consumed 10.1 and 18.4 kg. of a hay-concentrate ration per day during the nonlactating and lactating periods, respectively, and were producing about 30 kg. milk daily during the lactating phase. One set of infusions was performed when the cows were lactating, the other when they were dry. The mean net ruminal production of acetate and butyrate during the nonlactating period was 42.1 and 8.1 moles per day, respectively, and 76.8 and 5.8 moles per day during the lactating period. The production values for propionate were discarded because of an error in the infusion rate. The mean glucose entry rates during the nonlactating and lactating periods were 7.6 and 14.0 moles per day, respectively. The percent of glucose derived from propionate increased from 32.4% when the cows were nonlactating to 45.2% when they were lactating. The percent of glucose carbon derived from acetate and butyrate during the nonlactating period was 11.4 and 7.6%, respectively, and 20.7 and 4.1% during the lactating period. It was

concluded that lactating cows fed liberal concentrate derive less than 50% of their blood glucose from propionate. The balance of glucose must be coming from direct absorption from the gastrointestinal tract, or from alternate glucogenic sources. Cows consuming 60% concentrate, as these experimental cows were, would appear to have more than an adequate supply of glucose in view of the poor utilization they made of propionate for glucose synthesis.

Amylase Secretion by Ruminants Fed Grain - G. E. Mitchell, Jr., C. O. Little, J. J. Clary and J. L. Call, University of Kentucky, Lexington.

Evidence that substantial quantities of starch escape fermentation in the rumen of cattle and sheep fed high levels of grain led to investigation of the availability of pancreatic amylase to digest this starch in the small intestine. Apparent limitation of the ability of steers to digest starch in the small intestine was demonstrated by infusing starch into the abomasum. It was then demonstrated that pancreatic tissue of steers fed grain contained significantly more amylase than tissue from steers on pasture. The amylase activity of pancreatic secretions from sheep was also shown to increase as grain was added to the diet. Attempts to induce increased amylase secretion by intravenous infusion of glucose have resulted in either reduced amylase secretion or no change in amylase secretion.

Further Studies on an Implantable Hydraulic Needle for Sampling Portal Blood in Calves - A. Dare McGilliard, Iowa State University, Ames.

Catheters, which have been surgically implanted in the portal vein of calves for obtaining blood samples, do not generally remain functional for long periods of time. Their failure usually results from sheath or thrombus formation at the tip of the catheter. Therefore, a hydraulic needle has been designed which can be implanted on the wall of the portal vein and can be actuated externally. It consists of a cylinder which is precision bored to form a hydraulic chamber with inlet and outlet ports. The needle (18 ga) is centered in a piston milled to precisely fit within the hydraulic chamber. The chamber is sealed at each end by threaded discs which seat tightly on silicone rubber O-rings and contain centered teflon bushings. The shaft of the needle rides within these teflon bushings and the 15 ga. blood withdrawal port. The length of the chamber is such that there is a

maximum travel of the needle of 12.7 mm. The travel of the needle can be limited. When the needle is retracted, it is contained entirely within the cylinder. A perforated metal disc is attached to the cylinder to facilitate its attachment to the vein. The inlet and outlet port of the hydraulic chamber and the blood withdrawal port are exteriorized by polyvinyl tubing and are closed exteriorly by two-way valves. Heparinized saline serves as the hydraulic fluid and calibrated 5 cc disposable syringes are used for driving or retracting the needle.

To date, the needle has been tested in 6 animals. In the first two animals, the needles were functional (could withdraw blood) 21 and 45 days. During this period the needles were injected 46 and 22 times, respectively. Upon failure to withdraw blood, the animals were sacrificed. In both cases, failure was due to the needle having been pulled away from the vein wall. In the subsequent 4 animals the procedure for attachment of the needle to the vein wall and support of the needle by the liver was changed. Two of the needles are still functional after 12 and 18 weeks. One animal, in which the needle was functional after 20 weeks, was sacrificed for other reasons. Autopsy confirmed that the needle was functionally in excellent condition. In the fourth animal the needle functionally failed after 17 weeks. The needle operated mechanically but blood could not be withdrawn. On autopsy of this animal it was found that the vein wall had thickened and the travel of the needle was overextended.

Lymph Flow and Composition in Calves - D. R. Romsos and A. Dare McGilliard, Iowa State University, Ames.

Development of surgical techniques for collecting lymph has advanced rapidly in recent years. To maintain body fluid equilibrium lymph has been returned to the animal. One of the main problems in maintaining these lymph shunts is in establishing a return catheter that will remain patent for extended periods of time. Due to the difficulties encountered in maintaining lymph shunts there is a paucity of information on lymph flow and composition in young calves.

The thoracic or intestinal lymph duct was successfully cannulated in 10 calves. Lymph was returned directly to the duct cannulated, to the jugular vein, or to the posterior vena cava. The most satisfactory route for lymph return was via the vena cava because a minimum of tubing was exteriorized, clotting in the venous end of the vena cava catheter was never a serious problem, and there was a good aspiratory action in the vena cava catheter.

Lymph flow from the thoracic (TDM) and intestinal (IDM) ducts of calves fed whole milk twice daily averaged 695 and 429 ml/hr, respectively, while lymph flow from the thoracic (TDHG) and intestinal (IDHG) of calves fed hay and grain ad libitum averaged 899 and 517 ml/hr, respectively. Average lymph flows were derived from a series of 13-hr total lymph collections with simultaneous infusion of the collected lymph at a rate approximately equal to the flow.

Lymph lipid concentration averaged 1.45, 3.14, 0.50, and 0.79 g/100 ml in the TDM, IDM, TDHG, and IDHG calves, respectively. Lymph flow and lipid output were significantly correlated ($r = 0.49$). Lymph protein concentration averaged 4.04, 4.62, 3.66, and 4.89 g/100 ml for the TDM, IDM, TDHG, and IDHG calves, respectively. Lymph flow and protein concentration were inversely correlated ($r = -0.49$) while flow and protein output were positively correlated ($r = 0.49$).

UNITED STATES DEPARTMENT OF AGRICULTURE
COOPERATIVE STATE RESEARCH SERVICE
WASHINGTON, D.C. 20250

February 2, 1970

SUBJECT: Business Meeting of Tenth Conference on Rumen Function

TO: Participants in Tenth Conference on Rumen Function

C. R. Richards was asked and agreed to continue as conference chairman with a request to set up another conference (eleventh) at the same time in 1971.

The panel chairmen have also been asked to continue in 1971.

There was no request for further steps to set up a "Society of Ruminologists". Dr. E. E. Bartley has made some preliminary study but was not at this year's conference.

Dr. R. W. Dougherty suggested that a new name for the conference would be in order since the scope goes beyond that of "rumen function". Suggestions would be welcome.

A meeting room has been reserved at the Midland for December 1 and 2, 1971.

C. R. Richards

C. R. Richards
Conference Chairman

TENTH CONFERENCE ON RUMEN FUNCTION
held at
Midland Hotel, Chicago, Illinois
December 3 and 4, 1969

The following persons were in attendance:

NAME	ORGANIZATION
Allison, M. J.	National Animal Disease Laboratory, Ames, Iowa 50010
Anthony, W. B.	Department of Animal Science, Auburn University, Auburn, Alabama 36830
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Baile, C. A.	Department of Nutrition, Harvard School of Public Health, 665 Huntington Avenue, Boston, Massachusetts 02115
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Bergen, W. G.	Department of Animal Husbandry, Michigan State University, East Lansing, Michigan 48823
Blake, J. T.	Department of Veterinary Science, Utah State University, Logan, Utah 84321
Borchers, R. L.	Department of Biochemistry and Nutrition, University of Nebraska, Lincoln, Nebraska 68503
Bray, R. W.	Department of Meat and Animal Science, University of Wisconsin, Madison, Wisconsin 53706
Broderick, G. A.	Department of Dairy Science, University of Wisconsin, Madison, Wisconsin 53706
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Condon, R. J.	Animal Science Department, University of Illinois, Urbana, Illinois 61801
Cook, R. M.	Department of Dairy Science, Michigan State University, East Lansing, Michigan 48823
Cunningham, M. D.	Animal Science Department, Purdue University, West Lafayette, Indiana 47907

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