ADSA 2019. Cincinnati, OH. June 23 – 26, 2019. ***J. Dairy Sci.*** Individual paper listed by abstract number in summary statements. **113 dairy-calf pertinent abstracts.**

Summary statements (each research paper in "two lines"), segregated by topic. More complete analysis, with statistics and details, later in this paper:

Abbreviations: BW = Body weight; d = days; GIT = gastro-intestinal tract; g = gallon or g = gram, depending on obvious context; wk=week; m = minutes; cfu = colony forming units; fdg = feedings; NSD = no significant difference; MC=maternal colostrum. Assume water always offered (didn't repeat it to save space). If grain is mentioned assume ad lib feeding unless different protocol mentioned. Typically, I only mention differences (P<0.05 or better) and trends (P<0.10) and if something obvious like ADG is not mentioned, that means no statistical difference.

Alternative proteins in CMR (3 Abstracts)

1. 12.5% of CP from hydrolyzed wheat protein (25:19 CMR) noted same ADG, no diff in health prewean, but ↓ADG post wean both (d 49 – 78) and d 1 – 78. Mapleview. W48.
2. Replacing 50% of WPC CP with Hamlet HP100 soy resulted in comparable true ileal digestibility of protein. 29 d old calves fed 2.8 lbs/d CMR. U of Ill. Nouriche. LB4 (JDS '20)
3. 56 d ADG, 680 g/d: 20:20 all-milk, animal fat (AF), 1.34 lbs ADG; 25:20 AM, AF, 1.5#; 25:20 plasma/wheat/soy (PWS) w/AF, 1.32; PWS w/AF+coco oil 1.43 UM Waseca, M163.

Additives in milk replacer or starter grain (16 abstracts):

1. Supplementing butyrate at 1% of DMI during 2 wk wean transition increased starter intake +39% & decreased rumen pH from 6.4 to 5.83. U of ID. Nutriad. M16.
2. Na-butyrate fed at either 15, 30, or 45 g/d improved d 60 ADG +10 – 11%. G/F ↑ for 15 & 45 g/d. Rumen pH d 14 ↓linearly with Na-butyrate fdg rate. China. The OSU. M147
3. Linear increase in ADG as supplementation of *Schizochytrium* (a marine algae) increased from 0, 5, 10, 20, and 40 g/d in whole milk. Chinese Academy Ag Sci. OSU. M148.
4. Fdg yucca improved F/G and reduced scour score but did not improve ADG or body dimensions. Chinese Acad. Ag Sci. OSU – Columbus. M159.
5. Gram-negative lipopolysaccharides (LPS) and/or Na butyrate were fed daily. LPS ↑ ADG vs. butyrate. Combo of both ↑stomach & reticulorumen weight. VA Tech. 33, oral.
6. A review of microbial based solutions in calf production. Gut microbial colonization in early life plays a role in immune and metabolic development in calves. U Guelph. 246.
7. A literature review across 5 electronic databases found 97 milk fed calf studies examining probiotics. Lactobacillus (37), bacillus (10) and yeast (11). UC-Davis. T122.
8. Probisan (metabolites of lactobacillus & yeast) fed birth to 18 weeks noted no effect on diarrhea but noted ↓infection from 42 d dehorning, SDSU. U in Barcelona, Spain. T123.
9. PMI Nutrition "Surmount" in CMR and "Victant" in grain improved 91 d body weight and reduced morbidity compared to neg. control or DFM. U of Ill. Land O'Lakes. T165.

10. Supplementing 3 L colostrum with 1:1 mix fish & flax oil ↑ omega-3 FA content of colostrum but no effect on health, growth, or oxidant status. Mich State U. 358.
11. Follow-up abstract: fish & flax oil + vit E noted in colostrum noted no affect on ADG, STP, or diarrhea, but ↓oxidant stress week 1, ↑plasma omega 3 FA +90%. Mich State W24.
12. Tributyrin at 0.3% DM in CMR noted NSD ADG in full growth potential fed calves. Blood GLP-2 concentrations ↑, NSD BHA or glucose in tributyrin calves. ZEN-RAKU-REN. W49.
13. 60 mL blend of 1:1 blend flax & fish oil w/200 mg vit E added to colostrum ↓ oxidant status index for 14 d w/o effecting serum IgG. ↓nasal discharge. MSU. 34.
14. 5% plasma noted ↓severity of scours compared to all-milk (AM) or AM w/Na Butyrate + Bacillus subtilis. AM+ additives noted ↑risk of mortality. Mapleview. Animix. W45.
15. Supplementing Jerseys CMR & grain w/ NeoTec5g noted ↑digestibility regardless if fdg 1 lb/d or 1.5 lbs/d CMR. Post-wean nutrient digestibility ↑w/1#/d CMR. Provimi. W46.
16. Lallemand yeast mix (YANG) fed 90 d ↑veal calf ADG & ↓morbidity and ↓numbers of chronic sick calves; ↑serum IgG d 47 & 118. NSD Hg. U Bologna, Italy. Lallemand. 298.

Amino Acid Nutrition (3 abstracts)

1. Supplementing L-glutamine at 2% of DMI during wean helped calves withstand wean stress. Adding L-glutamine improved ADG and starter intake. ISU, Turkish U. 242.
2. Supplementing isopropyl ester of MHA at 0.16% of methionine equiv. in grain ↑ DMI post-wean. Standard MHA ↓post-wean BW gain, Smartamine no effect. Cornell. 143.
3. Supplementing 4.5 g/d of tryptophan during the weeks around weaning had no effect on calf performance or behavior. Tryptophan is a precursor to serotonin. Spain. W1.

Colostrum, Colostrum Replacers (CR), and feeding Transition Milk (9 abstracts)

1. The heritability of calving ease but not milk production or confirmation were genetic selection traits shown to be associated with calf serum total protein. PSU & U MN. M59.
2. Premolac (Zinpro) CR noted ↑AEA as compared to hi-quality maternal colostrum. Lo-IgG MC +40 g, 150 g and 110 g IgG CR dose, 22.33, 16.9, 12.9 mg IgG/mL. PSU/Zinpro M18.
3. Calves fed pasteurized transition milk or blend of CMR and colostrum replacer at 2 qts, 3x/d for 3 d noted ↑ 55 d ADG (+6.6 lbs.) compared to fdg. CMR alone. MSU. T91.
4. SSCC 100 g IgG colostrum replacer effectively replaced maternal colostrum. ↑feeding rate of MC or CR did not affect serum IgG or 56 d growth. U of Sao Paulo. SSCC. T89.
5. Colostrum replacer fed at 60 g/d for the first 5 days on milk noted +11.4 lbs. body weight (+80 g/d ADG) at 60 d and nearly 50% reduction in scours. Goias, Brazil. T90.
6. Calves fed either transition milk or 50:50 blend CMR:colostrum replacer d 2 – 4 of life noted +60 g/d to d 21 and +5.5 lbs BW at 56-d wean (P=0.06). NSD in health. MSU. T91.
7. Colostrum status and incidence of morbidity & mortality was monitored on 1,631 calves. Poorer colostrum status increased respiratory & ear disease and scours. U of ID. 356..
8. A statistical analyses of colostrum from 1,313 dairy cows determined genetic selection for IgG/IgM might improve colostrum quality. Swedish U of Ag Sci. Wageningen. 361.

9. Supplementing 46 g or 92 g /d of Zinpro Premolac colostrum replacer d 0 to 14 ↑growth and reduced milk refusals in Holstein calves. Zinpro. Dairy Experts. W16.

CMR and Milk Feeding Rates and Strategies (10 abstracts)

1. Meta-analysis 10 studies compared moderate (~58 lbs.) to hi (~96 lbs.)/calf ~49d CMR fdg rates. Hi rate ↑growth. Mod. fdg rate ↑starter & wk 8 digestibility. Provimi. M155.
2. Continuation M155 d 56 – 112 Moderate (1.45#/d) outgained hi (2.2#/d) +4.8 lbs BW. Mod. ↑digestibility. D 1 – 112 Hi fdg rate +5.2 lbs, moderate +3.3% G/F. Provimi M157.
3. Jersey calves fed 4 L/d of either whole milk (30:37) or organic CMR (21:22) noted +17.8% BW gain w/whole milk (1st 3 wks) and +96% starter intake for CMR. U NH. M156.
4. Holsteins fed 24:24 CMR made via components on-farm or from commercial CMR. Component CMR ↑grain intake +22% & ADG +13%, ↓$/lb. gain 29%. United. PDS. W98.
5. 5 calf studies measuring fd intake, ADG, & body retention of protein, fat & energy were analyzed to make new equations predicting fat & protein retention. Cornell. M161.
6. NSD in ADG, wean weight, body dimensions between whole milk and organic CMR fed up to 8 L/d via autofeeder. $/kg BW gain $8.82 for CMR & $6.35 whole milk. U MN. 224.
7. Condensed whey solubles fed at 0, 42, or 84 g/d in 22% CP CMR wk 1 & 2, in grain to 84 d noted ↑grain intake, BW, BHB, ↓ scours, when fed at 42 but not 84 g/d. SDSU. 418.
8. Calves fed 1.5 or 1.74 lbs./d 26:17 either 2x or 3x/d in 2 X 2 factorial during hot Georgia summer. Fdg 3x in summer may ↓heat stress and ↑intake but NSD ADG. U of GA. 520.
9. Calves fed 1.25 20:20 or 26:17 at 1.5 or 1.75 lbs./d compared during hot Georgia summer & ACTH challenge. No affect on cortisol from CMR fdg rate. U of GA. W87.
10. Allowing calf to nurse dam 21 d improved ADG compared to assigning calf to nurse cow or feeding CMR (CMR details not provided). Difference carried to 180 d. Czech U. W96.

Dry Cow Strategies and their Impact on the Calf (12 abstracts)

1. Calves from cows fed lo-starch (14%) in 28-d close-up dry cow diets can clear glucose more effectively than calves from cows fed high starch (26%) diets. Hiroshima. M26.
2. Concurrent to M26. Conversely, hi-starch diets enhanced glucose-lowering action when GLP-2 was injected. Hi-starch diet in gestation enhances calf's organ dev. U of AB. M29.
3. Fdg. added bypass lysine and methionine 21 d prior calving improved calf metabolic and immune status. Comparison between two farms. Ajinomoto. Japan. M145.
4. Supplementing DFM in close-up dry cow TMR had no effect on the calf's IgG status at 24 h, 72 h and no effect on ADG. U of Idaho. Lallemand. Oral 45.
5. Supplementing bypass methionine (Mepron) at 0.09% in dry cow feed didn't affect calf growth but ↑ calf blood methionine foundational growth metabolites. U of Ill. 214.
6. Feeding to calves via CMR non-infectious feces collected from healthy high performing cows noted ↑liver function & trend ↑ADG and ↓ inflammation. Italy, SDSU. 145 & T16.
7. Calves born from low body condition (≤3.25) as compared to hi body condition dams (≥3.75) noted ↑birth weight & maintained difference to wean. NSD ADG. U of Ill. 216.

8. Close-up cows fed DCAD -90 mEq/kg DM with urine pH <6.0 were 2.39x more likely to give birth to a stillborn calf than cows with urine pH ≥6.0. U of GA. Argentina. 217.
9. Newborn heifer calves from close-up cows fed 60g/d bypass choline noted alteration (increase or decrease) of 12 of 305 unique metabolites. Balchem. Argentina. T92.
10. Supplementing biotin, folate & B12 final 26 d gestation increased colostral and calf plasma B-vit content. Folate + B12 ↑calf birthweight. No effect IgG. Ag Canada. T93.
11. In vivo study of calf liver cells exposed to a FA blend mimicking cow's blood at calving noted no change gene expression when C16:0, 18:0 or 18:1 was ↑. UW Mad. T94.
12. Feeding bypass methionine to dam the final 28 d gestation ↑ calf ADG and body dimensions at wean. Some a.a. metabolic pathways upregulated. U of Ill. Evonik. 315.

Fats and Oils Nutrition (5 abstracts)

1. Replacing 15% of animal fat w/ coconut oil ↑G/F and ↓med costs but had no effect on ADG. Fdg 1.9 vs. 1.23 lbs./d 24:24 CMR ↑84d ADG +7.5% & G:F 8.5%. Waseca. M162.
2. 25:20 w/35.6% of CP combo plasma/soy/wheat (AP) w/15% fat from coconut performed comparably to 25:20 all milk and ↑ADG vs. same AP w/100% animal fat. Waseca. M163.
3. Supplementing lysolecithin 4g/d to 6 L/d 14% solids 24:19 CMR for 56d resulted in +45% ↑in ADG (0.62 vs. 0.89 lbs./d), 42% ↑G:F & 49% ↓fecal score. n=32. U Sao Paulo M151.
4. Supplementing flax or soy oil at 80 g/d wk 1 – 12 via whole milk or grain ↓ post-wean pellet intake and ↓ total VFA production while ↑ blood triglycerides. SDSU. 35.
5. There is a greater proportion and total yield of omega-3 and omega-6 fatty acids in colostrum as compared to whole milk, indicative of neonatal requirement. Guelph. 209.
6. Temperature and humidity did not affect serum total protein but a TH index >72 resulted in an increased hazard ratio of diarrhea occurrence. CSU. 442.

Health. Respiratory Disease (Bovine Respiratory Disease, BRD). Toxins. (7 abstract)

1. *Clostridium* ID'd from 14,265 fecal samples from 26 states. *C. perfringens type A* most prevalent (52.6% in cow/38.9% calf). 28 Clostridium species detected. Arm&Ham. M55.
2. Antimicrobial (AM) use tracked on 6,281 preweaned calves for 12 mo's on 40 WI dairies. AB doses 10.4/calf & ↑w/bottle fdg colostrum & preventative AM use. UW-Mad. M58.
3. Systematic lit review of calf BRD & antimicrobials – 37 trials. 22 clinical, 15 challenge, 15 negative control, 29 randomized, 14 blinded, 14 macrolides. UC-Davis. W22.
4. Subcutaneous 1ml of mycobacterium cell wall fraction prior 18 h transport of 5 d old calves noted ↓hazard of treatment for pneumonia. U of MN, TX Tech, NovaVivie. 453.
5. Scouring & healthy calves tested for bacteremia. Diarrheic calves: 15.3%. Healthy calves: 18.5%. No link between clinical signs & presence of blood bacteria. U of MO. OSU. 441.
6. The mycotoxins deoxynivalenol (DON) and fumonisin B_1 effected mitochondrial metabolism of calf intestinal epithelial cell line. They are toxic. Ghent, Belgium. W13.
7. Fecal samples 277 clinically ill Ohio calves: Rotavirus 75.5%, K99+*E Coli* 42.8%, *C. parvum* 28%, coronavirus 10.1%, *Salmonella* 3.7%. Most deadly? *Salm* & *E coli*. OSU. W11.

Management and Housing (22 abstracts)

1. Water via nipple pail, plain pail, or no water? NSD in ADG. ↑water intake from nipple pail. NSD at wean. Post wean ↑abnormal sucking behavior nipple-pail. Czech. M138.
2. Calves offered ad lib drinking water d 0 of life vs. starting d 17 note improved gut microbiome (species and richness) and results in ↑ ADG & fiber dig. ISU. M149
3. Calves implanted w/microchips monitoring temp noted consistent measures between ear, scapula & neck placements but poor correlation w/rectal measures. U of KY. 47.
4. Hot-iron disbudding at 4 – 10 d age using nerve block and meloxicam ↓ time ruminating from 18% to 10% of time and ↑ time with head down from 26% to 31%. UC-Davis. 54.
5. An automated computer vision system (Amcrest Outdoor Wi-Fi Cam) can accurately monitor individual dairy calf behavior weeks 4 – 8 when group housed. UW Mad. 57.
6. Cooling calves with a fan in addition to shade ↑milk & grain intake. Providing dam w/fan and soaker in addition to shade during preg ↑birth and wean wt. U of Fla. 144.
7. HOBO Pendant G accelerometer accurately measures lying and standing behavior of 53 d old Holstein calves in tropical environment (Puerto Rico). U of Puerto Rico. T1.
8. Hot-iron disbudding 5 to 6 wk old group-housed auto-fed Holstein calves did not affect milk intake, feeder visits, lying bouts but ↑ frequency seeking shelter. U of Fla. T7.
9. Calves continuously exposed to pulsed alternating wavelength (PAWS, Xiant Technologies) in hutch noted ↓melatonin, NSD serotonin or cortisol. CSU, TX A & M. T9.
10. Data from 90,926 beef x dairy crossbred calves in Denmark determined heritability of calf survival is linked to sire selected. Belgium Blue best. Jersey dam worst. Aarhus. 278.
11. Genomic evaluation of calf wellness traits in US Jersey Cattle notes heritability of respiratory disease 0.055, diarrhea 0.084, mortality 0.103. Zoetis. 280.
12. A survey of dairy veterinarians for timelines to euthanize calves for various maladies found “Treat and monitor” for multiple days was the primary response. OSU, ISU. 268.
13. An automated leukocyte cell counter (QScout BLD test) was compared to microscopy and found hi accuracy classifying neutrophils & lymphocytes. U of Guelph. 357.
14. QScout BLD test: at 72 h post-arrival, it was found that for every 10^9 cells/L increase in neutrophils risk of mortality ↑. QScout helps find sick calves. U of Guelph. 452
15. Holstein & Angus x calves monitored for milk intake: ≥4 pneumonia treatments ↓milk intake 13.4%; 3 treatments ↓BW 15.4 lbs. Males +9.9 & Holsteins +3 lbs. Purdue. W44.
16. Holstein & Angus x calves monitored on autofeeder: Lung consolidation score is better predictor of milk consumption & ADG than pneumonia incidence. Purdue. 508.
17. Pens of 4 Holstein calves (16 d age) on autofeeders noted no improvement in feed intake or performance when enriched with 20 L tub of hardened molasses. U of Fla. W6.
18. Calves reared individually note no learning ability improvement whether water offered via nipple or pail, but if reared in pairs, nipple calves learn faster than pail. Cal Poly. W8.
19. Calves transported 683 miles at a light body weight and with a depressed attitude are at increased risk of early morbidity and mortality. U of BC. 451.

20. In-depth assessment of 31 Italian farms found colostrum quality and dam vaccination correlated with calf ADG, not cleanliness, grain or animal density. U of Padova. W90.
21. Survey of 106 Australian farms & assessment of biological samples notes pre-wean morbidity 23.9% & mortality 5.8%. Crypto, salmonella. FPT 41.9%. C. Sturt U. NSW. W89.
22. Heart girth tape measure accurate BW measure. BW (kg)=119.04-3.3089 x HG (cm) + 0.02959 x HG^2 [r(0.99) accuracy]. Wither/hip height & hip width too. Laval. McGill. W50.

Physiology (5 abstracts)

1. 18 d old Holstein calves injected w/ serotonin or tryptophan serotonin precursor for 10 consecutive days noted increased blood insulin. No effect glucose or NEFA. U FLA. M17.
2. 5-month-old Holstein bull calves were fed either 15% or 21% CP complete grain and slaughtered. Aquaporins are important transporter of blood N metabolism. China. 218.
3. A new method to determine fecal RNA in calves including inflammatory-related genes. Fecal RNA may be tool to evaluate GI tract molecular adaptations in calves. SDSU. W18.
4. Same researchers evaluated GI-tract tissues from Jersey calves & determined RNA between calf gut tissues correlates with RNA found in the same calf's feces. SDSU. W19.
5. GIT microbiome changes 2 h to 5 d life: colon notes ↑fermentation activity; ↑acetate (90% of SCFA), ↑bifido, lactics, prausnitzi, ↓E coli. U of A Edm, U of Guelph. 443.

Starter Grain & forage feeding (13 abstracts)

1. Post-wean texturized grain w/ pelleted cottonseed hulls outgained whole oat/chopped hay mix, pelleted oat hulls or chopped hay, but poorer G:F from gut fill. Provimi. M121.
2. Addition of NeoTec5 to starter ↑ADG, ↑G:F & ↑hip width wks 0 – 8 & 8 – 16. NeoTec5 increased digestibility. No diff between texturized and pelleted starter. Provimi. M123.
3. Starch digestibility pelleted vs. texturized starter. Digestibility of starch was greater for texturized wk 6, but was greater for pelleted wk 8, 10, 13, and 16. Provimi. M183.
4. Post-wean DMI, ADG, & heart girth gain ↑ if grass hay is offered separately from grain as compared to mixed w/ grain 90:10. NSD pre-wean. ZEN-RAKU-REN. U of AB. M124.
5. ↑chopped grass hay 0% to 5% in grain d 56 – 112, ↑digestion of DM, NDF, ADF. Minimal effect ADG, DMI. 5% to 10% hay ↓ diet digestibility and ADG. Provimi. M144.
6. Fdg hi NDF (31%) soy hulls (27% of diet) ↑early rumen development vs. fdg free choice hay, however, grass hay ↑rumination & ↓abnormal oral behavior. U Sao Paulo. M143.
7. 24%CP, 14% NDF grain alone, + ad lib chopped hay, or + ad lib whole shelled corn. +hay ↑ADG +34% vs. control or +corn. +corn no effect on rumen health. U Sao Paulo M142.
8. Superconditioning pellets for 4 m (but not 2 m) at 185F ↑ ADG & dig of starch and DM post-wean (d 56 – 70) but not pre-wean. Tended ↑rumen prop. Iran & Korea. M153.
9. Free-choice chopped wheat straw d 15 – 90 ↑rumen pH, starter intake and 90 d ADG regardless of a chop length of 1 mm, 4 mm, or 7 mm (0.28 inch). Iran. W186.
10. 56 d ADG same in texturized starters composed of soybean meal or soy + 25% sunflower or soy + 25% linseed meal. Post wean DMI greater with 25% linseed. Waseca. M172.

11. Pelleted starter ↑ starch digestibility week 10 – 16 compared to texturized starter. Feeding NeoTec5g fatty acid improved starch digestibility week 4 – 8 only. Cargill. M183.
12. Post-wean TMR fed wks 7 – 16 composed of either 10%, 17.5%, or 25% (DM-basis) chopped grass hay. Linear ↓ body weight gain, digestibility, & DMI as hay ↑. PSU. 296.
13. Top-dressing liquid condensed whey solubles on pelleted grain tended ↑post-wean DMI, BW gain, withers height & heart girth. No effect on rumen VFA or BHB. SDSU. 544.

Veal. (2 abstracts)

1. 5,010 incoming veal calves were monitored. Incoming bodyweight (100 lbs.+ best), no dehydration & normal umbilical cord were key attributes to monitor. Guelph. 103.
2. Blood concentrations of cholesterol, haptoglobin & iron at calf arrival were associated with mortality. Creatine kinase, Mn, STP, Co, Zn, Se & Mo were not. Guelph. U KY. W17.

Weaning (1 Abstract)

1. 2 x 2. Calves fed 21:19 at either 77 or 55 lbs./calf gained same. Grain ↑ for 55 lbs. Wean started d 30 and no diff in ADG between 2-step and 4-step wean to d 45. Guelph. M141.

Vitamin and Mineral Supplementation (4 abstracts)

1. Fdg. D3 at 5,000 IU/d or feeding 25-hydroxyvitamin D3 at equiv. to 2,500 IU/d improved tolerance to a d 91 endotoxin challenge. NRC 600 IU/d inadequate. Bulls. U FLA. M33.
2. Concurrent to M33. Fdg 25-hydroxy D3 ↑ serum D levels more than fdg D3, also ↑ADG vs. fdg D3 but NSD vs. control, also ↑ P vs. D3. No diff Ca. BHB ↑ fdg D3 or 25-D. M154.
3. Concurrent to M33 & M154. Fdg 25-hydroxy or vitamin D3 had no effect on d 116 ADG, BW, organ weight, Ca or Mg retention. 25-hydroxy tended ↑bone density. M158.
4. Heifers fed 25-hydroxyvitamin D3 noted ↑ serum D concentrations, ↑56 d BW gain (+4 kg), ↑CMR intake +1 L/d on autofeeder vs. calves fed added vitamin D3. U FLA. M152.

More complete analysis of each ADSA 2019 research paper:

Alternative proteins in CMR (3 abstracts):

1. *12.5% of CP profile in CMR from hydrolyzed wheat protein. Any effect on growth?* Auction (188 calves) or direct from farm (51) sourced bull calves were individually housed and fed 25% CP, 19% fat CMR composed of either all-milk protein or 22% CP from milk protein and 3% from wheat (12.5% of CP profile). Lysine, methionine and threonine were balanced. Calves consumed 66.6 and 66.8 lbs. of CMR powder over the 49-d milk feeding period in the all-milk protein and 3% wheat protein CMR's, respectively. Peak CMR intake was 1.98 lbs./calf/d and all calves experienced a 14 d wean period. Texturized calf starter (18% CP) was offered ad lib and a second phase

starter composed of 50% whole corn and 50% pellets (18% CP) was transitioned to on d 21 – 27. Mortality was 8% (10 calves) and 10% (12 calves) for calves fed wheat protein and all-milk protein, respectively. No differences noted in the incidence or severity of enteric or respiratory disease and expenditures on injectable meds (averaged $17.32/calf) and water-soluble meds ($4.24/calf, the same between groups) were nearly identical. No differences were noted in ADG or feed conversion during the 49-d milk feeding period and calves gained 68.7 and 70.8 lbs. when fed the wheat protein containing and all-milk formulas, respectively. However, calves fed the all-milk outgained those fed wheat protein during the post-wean d 49 – 78 growth period (wheat-fed calves noted reduced 0.44 lbs. ADG post-wean, P<0.003) and for the entire 78 d study period (wheat-fed calves noted reduced 0.18 lbs. ADG, P<0.004; 1.82 and 2.0 lbs. ADG). Combined milk and grain feed conversion were nearly identical pre-wean (2.83 and 2.87), however, post-wean was 4.16 and 3.73 lbs. of feed per lb. of bodyweight gain for wheat-fed and all-milk-fed calves, respectively. A detailed economic analysis noted cost per **kg** of gain to 78 d nearly identical at $2.43 and $2.42 ($1.10 and $1.097 per pound, US$), however, with 7 extra days yardage to reach the same BW the all-milk CMR provides greater ROI. n=240. Mapleview Agri. U of Guelph. W48.

2. *How is CMR digestibility effected by replacing 50% of CP with Hamlet enzyme-treated soybean meal (HP 100 brand)?* Holstein calves cannulated at the ilium at 15 d of age were fed an all-milk protein 15% solids CMR solution, containing 28.5% CP, 15% fat CMR and fed at 2% of BW (~2.8 lbs. CMR daily). Research diets were introduced two weeks later, fed at the same rate and were composed of either a.) the same WPC-based protein, b.) 50% of the CP from soy (Hamlet HP100, 24.1% of formula), or, c.) nitrogen-free (2.6% CP). Synthetic amino acids were not used to standardize amino acid concentrations between WPC- and soy-based formulas, lysine concentration was 2.99% and 2.39% for WPC and soy, respectively. No grain was offered at any time. The nitrogen free diet was higher in osmolarity (476 mmol/L) compared to all-milk (329 mmol/L) and soy (311 mmol/L) and resulted in increased incidence of scours and an increase in flow of digesta (2.5x) and a lower fecal dry matter content (2x lower) as compared to either other treatment. No difference in BW gain between WPC and soy, however, N-free diet reduced the calf's body weight during the 5 d duration of data collection. Soy increased wither height vs. WPC in the same period of time. Apparent ileal digestibility was 74% and 69.8% (P=0.12) for WPC and soy, respectively, while standard ileal digestibility tended (P=0.08) greater for WPC (82.3%) vs. soy (77.7%), and true ileal digestibility was not different (P=0.43) reported as 84.2% for WPC and 83.1% for soy. Ala, His, Ile, Leu, Thr, Trp, and Val digestibilities were decreased (at least P<0.05, sometimes more significant) in soy when measuring apparent ileal digestibility. Ala, Gly, His, Ile, Leu, Phe, and Val were decreased (at least P<0.05) when feeding soy and measuring standard ileal digestibility. Ala and Ile were lowered (P<0.05 or more) when feeding soy when measuring true ileal digestibility. Mucin secretion was increased (P<0.001) in soy diets vs. WPC and the authors speculate that 2.0 ppm beta-conglycinin and the presence of

trypsin resulted in its increased secretion, feeding soy also resulted in more endogenous host protein being released. Bacteria made of 39% of the total flow of CP in the calves fed soy and none of the CP in the calves fed WPC. The authors assert that digesta outflows are corrected by the estimated endogenous-protein losses captured in the true ileal digestibility calculations. The authors summarize by stating "Substitution of 50% of the protein from whey with an enzymatically treated soybean meal did not affect major nutrient digestibility or calf growth and improved fecal consistency during the length of the study." 9 Holstein calves, 8 males, 1 freemartin heifer. U of Illinois. Nouriche, St. Louis. Hamlet Protein. Abstract LB4, published JDS January, 2020, https://doi.org/10.3168/jds.2019-17699.

3. *Will addition of coconut oil in the fat blend increase calf performance in an alternative protein blend? Will a 25:20 composed of plasma, wheat, and soy isolate outperform an all-milk 20:20 CMR when both are compared at 680 g/calf/d feeding rate?* Holstein heifer calves were fed 65 lbs. of non-med CMR composed of either a.) all-milk protein 20:20, all animal fat, b.) all-milk protein 25:20, all animal fat, c.) mix of bovine plasma, hydrolyzed wheat gluten, and soy isolate replacing 35.6% of total CP, also with animal fat and as a 25:20, or, d.) mix of bovine plasma, hydrolyzed wheat gluten, and soy isolate replacing 35.6% of total CP, with animal fat and coconut oil and as a 25:20. All diets fed over 42 d pre-wean period. Neo-oxytet was supplemented to all calves for d 0 - 14. Calf starter (18% CP, with Deccox) offered ad lib. Pre-wean (d 1 – 49), the 25:20 all-milk with animal fat outperformed (1.41 lbs. ADG, $P<0.05$) the 20:20 all-milk with animal fat (1.23 lbs. ADG) and the 25:20 blended-protein mix that used all animal fat (1.23 lbs. ADG). Pre-wean, the 25:20 blended-protein mix that used mix fat (animal and coconut) noted performance on-par (1.37 lbs. ADG) with the 25:20 all-milk with blended fat sources. Day 1 – 56 these same differences held, but changed to statistical trends ($P=0.10$). No differences in CMR intake. No differences in calf starter intake over 56 d ranging from between 59.5 (25:20 blended-proteins, animal fat) and 74.1 lbs (25:20 all-milk proteins, animal fat plus coconut oil). Frame growth increased over 56 d averaged +4.4 inches, NSD between groups. Scour days tended ($P=0.07$) to be higher for calves fed 25:20 using blended proteins and only animal fat as compared to the other treatments, otherwise, no differences in any health parameter. n=103. U of MN, Waseca. Milk Specialties Global. M163.

Additives in colostrum, milk replacer or starter grain (16 abstracts):

1. *Does sodium butyrate supplementation at weaning help?* In a 2 x 2 factorial design, Holstein bull calves (10.7 d age ±4.1 d) were fed 1.2 kg CMR/d (CP:Fat not reported) either with or without continual ad lib access to starter grain (CP not reported) and hay and either supplemented or not supplemented sodium butyrate (Nutriad) at 1% of DMI during weaning transition. Weaning commenced wk 7 by decreasing CMR to 900 g/d, and then to 600 g/d wk 8 and 0 g/d wk 9. Calves were harvested at 6 wks and 9 wks to measure rumen fluid for volatile fatty acid (VFA) and pH and rumen tissue for VFA

transporters. Supplementing sodium butyrate during weaning transition increased starter grain intake from 1.489 kg to 2.071 kg/d (P=0.01), reduced rumen pH from 6.4 to 5.83 (P=0.05) and tended to reduce total mM of VFA (154.4 vs. 131; P=0.09) and duration pH <5.8 (209 vs. 730 m/d; P=0.07). Offering starter grain pre-wean tended (11.9 vs. 36.5; P=0.08) to increase mM VFA. NHE3 VFA transporter increased (P=0.04) when feeding starter grain pre-wean, however, no other VFA transporter (MCT1 and NBC1 measured) was affected at any juncture in the trial. 36 calves. U of ID. Nutriad. M16. JDS 2019: https://doi.org/10.3168/jds.2019-16652

2. *Sodium butyrate fed at 0, 15, 30, or 45 g/d.* Holstein calves housed in individual hutches and fed 2x/d whole milk d 0 – 21 and reconstituted whole milk powder d 22 – 60 (quantities fed not disclosed) and offered ad lib starter (no details provided) were supplemented one of the aforementioned sodium butyrate strategies by blending the sodium butyrate with a small amount of milk and feeding it first at each meal. Body dimensions and incidence of scours were not affected, however, ADG increased +11.4% (P<0.01; 1.94 lbs.), +10.1% (P=0.01; 1.92 lbs.), and +11.4% (P=0.02 1.94 lbs.) for 15, 30, and 45 g/d, respectively. F/G improved (P<0.01) for calves fed 15 or 45 g/d with 30 g/d intermediary (NSD). At d 14 rumen pH decreased linearly (P<0.05) with addition of sodium butyrate, however, no pH changes occurred d 28 or 60. 40 calves. Chinese Academy of Ag Sci, Beijing, China. The Ohio State U. M147
3. *Schizochytrium (marine algae) in CMR.* Heifer calves were supplemented via whole milk either 0 g, 5 g, 10 g, 20 g, or 40 g/d of powdered *Schizochytrium* split between 2x/d feedings from d 4 to 60 when calves were weaned. Schizochytrium had no effect on BW, body dimensions or DMI, however, ADG increased linearly (P<0.05) with increased supplementation. ADG improvement for 20 g/d supplementation was +16.76% over control, increasing from 1.87 lbs. to 2.16 lbs. ADG (F/G improved 15.9%). ADG on calves fed 40 g/d was not different from d 0 and was less (P<0.05) than those fed 20 g/d. No mention of grain being fed. 50 Holstein calves. Chinese Academy of Ag Sciences. Ohio State U. CASS-ICRAF Beijing. M148.
4. *Does feeding Yucca effect calf health or growth?* Holstein calves were fed whole milk d 1 – 21 and CMR d 22 to 60 d wean and were fed either 0, 3, 6, or 9 g/d of Yucca added to a small quantity of milk or milk replacer fed first in each meal (2x/d fdg). Starter was offered (no details provided). No differences noted in ADG or body dimensions. F/G was improved (P<0.01) 15.2%, 18.4%, and 13.3% for calves fed 3, 6, and 9 g/d of yucca, respectively. A linear reduction (P<0.05) in fecal score was noted as yucca fdg increased. 40 calves. Chinese Academy of Ag Sci. The Ohio State U. CAAS-ICRAF, Beijing. M159.
5. *What is the effect of orally doses lipopolysaccharide (LPS) and sodium butyrate, either alone or in combination, on rumen development in dairy calves?* The authors noted in their oral presentation that gram-negative LPS is naturally found in the rumen cell walls and that toll like receptor 4 binds to LPS. Calves were administered twice daily either a.) control (0.9% saline), b.) 11 mM sodium butyrate dissolved in water fed orally, c.) LPS, I assume also dissolved in water, ranging from 2.5 to 40 microgram/kg bodyweight, or, d.)

a combination of the same doses of sodium butyrate + LPS. Authors do not denote in abstract whether the compounds are fed in water or milk and I failed to take notes either way. LPS concentration increased across weeks of age from 10 to 40 mL/dose. Calves were fed 22:20 CMR until weaned at 6 weeks of age and ad lib grain (20% CP). Calves were euthanized at 8 weeks age. "Feed intake, health measures, and blood metabolites did not differ by treatment." However, in the oral presentation the author noted LPS had increased glucose (P=0.008) greater than butyrate. Gain:feed did not differ. "Irrespective of week, LPS weighed more and had higher ADG" (P=0.02) than butyrate-fed calves. Withers height was also higher in LPS (P=0.006). No difference in rumen pH or rumen VFA concentration. Total empty stomach (P=0.014) and reticulorumen weights (P=0.012) were greater in the combination of LPS + butyrate as compared to feeding butyrate alone. The authors noted that dairy calves can tolerate a high dose of LPS. VA Tech. Abstract 33, orals.

6. *Strategic use of microbial-based solutions in calf production.* Some key statements made in this oral presentation by M.A. Steele of U of Guelph: "in the past 5 years it has been shown that gut microbial colonization during early life plays a role in immune and metabolic development of calves. Thus, calf production could benefit from the ability to control gut microbiota through supplementation of microbial-based solutions at strategic points." Some interesting papers discussed: https://doi.org/10.1016/j.rvsc.2011.05.001, a meta-analysis of DFM's in young calves. https://doi.org/10.3390/medsci6030056, human work documenting early life impact on gut microbiota, of particular interest is the impact of feeding breast milk. http://dx.doi.org/10.1016/j.anifeedsci.2017.02.010, boulardii yeast supplementation in young calves shows no effect. https://doi.org/10.1093/jas/sky404.052 boulardii yeast supplementation in young calves shows a positive effect on health not on growth. http://dx.doi.org/10.3389/fmicb.2016.00582, development of ruminal and fecal microbiomes in calves and effect of weaning strategy. Other areas of interest – maternal supplementation of microbials can encourage early maturation of the adaptive and innate immune systems of offspring; *Yarrowia lipolytica* has shown promise; antibiotics are confounding factors in newborn calf studies as they effect intestinal microbiome; ruminal acidosis in a young calf, is it a good thing or a bad thing? Soberon 2012 noted increased antibiotic use pre-wean had an impact on future milk production. U of Guelph. U of Alberta, Edmonton. Lallemand, France.
7. *Probiotics supplementation for dairy calves: a systematic review*. An exhaustive lit review of 5 electronic databases (CAB abstracts, PubMed, Science Direct, Scopus and Web of Science) found 97 trials that met the study's inclusion criteria. Studies were conducted in 22 countries, mostly in Asia. 93 compared to an untreated group, 4 to antibiotics. *Lactobacillus* (n=37)*, Bacillus* (n=10)*, and Saccharomyces* (n=11) were the most evaluated genera. Average study size 58.3 calves but 52 had less than 30 calves. Holsteins and crossbreds were the breeds most assessed (only 1 Jersey) and age was 10.6 ±24.9 day and avg. duration probiotic was fed was 64.2 d (±75.8, range 1 to 364 d)

(in both cases, I assume this meant avg. age/duration days). 80 studies were pre-wean. UC-Davis. T122.

8. *"Probisan" (Pentabiol, Spain) ("from metabolites of lactobacillus and yeast" according to Pentabiol website), effect on calf health and the impact of dehorning on calf*. No data reported in abstract on dosage, feeding strategies implemented, colostrum status, housing, no calf details, no report of ADG. Supplemented Probisan birth to 18 weeks age. Dehorned d 43 ±2 d and scored (1 – 3, low to high infection) 10 and 20 d later. Avg score greater (1.77 vs. 1.38; P<0.05) d 10 and (more scored 2 and 3) d 20 for control vs. Probisan-supplemented. No differences in diarrhea incidence. n=70. SDSU. U of Autonoma de Barcelona, Spain. T123.
9. *Effect of "Surmount,""Victant," and "Calf EXP Pak" additives on health and growth of Holstein calves fed in both milk replacer and starter to 13 weeks of age*. According to PMI Additives' website, "Surmount" is water-dispersible and is composed of the prebiotics glucans, mannans, quitines, and galactans and is these compounds are combined with essential oils, and "Victant" is a blend of palatants, prebiotics, probiotics, and essential oils for use in starter. "Calf EXP Pak" is identified as an experimental blend of direct-fed microbials and phytogens, according to the abstract. Male calves were blocked into either a.) control with no additive in milk replacer or starter, b.) "Surmount" in milk replacer and "Victant" in starter grain, or c.) "Calf EXP Pak" in the same milk replacer and starter. Calves were weaned on d 49 and moved from hutches to group housing and monitored to d 91. NSD in total DMI to d 56, however, group starter intake was greater (P<0.02) as was pre-wean body weight gain (P<0.04) which continued to d 56 "and after" (P<0.04) (to d 91? abstract not clear) for calves fed the combination of "Surmount" in CMR and "Victant" in starter as compared to the other two groups. Mean body weight at 91 d were 222.4, 248.2, and 236.3 lbs., for control, "Surmount"+ "Victant," and "Calf EXP Pak," respectively, and the abstract reports body dimensions (body length, hip width, and hip height) followed suit. Calves fed "Surmount" + "Victant" also noted fewer times (P<0.01) medicated (63 times) compared to control (144) and "Calf EXP Pak" (145). Instances of fecal scores >2 (4-point scale) was also fewer (P=0.04, 366 instances, as compared to 463 and 441 instances) and the abstract reports nasal discharge scores showing "similar patterns." n=90. University of Illinois. Land O'Lakes. T165.
10. *Supplementing colostrum with omega-3 fatty acids (Fish oil/flax oil)?* Holstein calves receiving 3 L colostrum within 6 h of birth also had either 0, 30, 60, or 120 mL of a 1:1 mix of fish and flax oils supplemented in their colostrum. Blood was sampled prior colostrum feeding and at 1, 2, 4, 7, and 14 d to monitor plasma fatty acids, phospholipid fatty acids, oxidant status, and oxylipid concentrations. Supplementing the fish/flax oil blend increased omega-3 free fatty acid concentrations by 23 to 90% in the first week of life (P<0.01). The same with omega-3 fatty acids of plasma phospholipids (P<0.01) and some omega-3 fatty acids derived oxylipids such as 14,15-dihydroxy-eicosa-tetraenoic acid (P<0.01) and 19,20-dihydroxy-docosapentaenoic acid (P=0.01). No change in

oxidant status (P=0.35). "Treatments did not alter calf health or growth (P<0.22). All variables returned to control values by d 14." Michigan State U. 358.

11. *Omega-3 fatty acids and vitamin E supplementation of colostrum. Reduce inflammation and oxidative stress in calves?* Calves were administered 3 L of colostrum within 6 h of birth (22% on brix) with either a control with no supplementation or with 60 ml of a 1:1 blend of fish and flax oils and 20% polysorbate 80 emulsifier that also included 200 mg alpha-tocopherol (vit E). Blood samples were taken d 1, 2, 4, 7, 14, and 21 after birth, with weekly weight and hip height measures. Addition of omega-3 FA supplement did not affect serum IgG (IgG 36 g/L for colostrum alone, 31 g/L for supplemented colostrum group), growth, or presence of diarrhea (P>0.10), however it did improve nasal scores from 0.4 to 0.1 in the UW-Health Score system (P=0.07). No differences noted in eye, ear, or fecal scores. Supplementation increased plasma omega-3 FA concentrations by as much as 90% by 1 d of age, nothing a 6-fold increase in EPA and a 3-fold increase in DHA (P<0.01). Supplementation also noted oxidant status index (OSi) decreased by 55% by 2 d of age (P<0.01) and maintained a reduction the entire first week of life (P<0.01), with OSi returning to normal state by d 14. Michigan State U. n = 16.
12. *2nd study supplementing colostrum with omega-3 fatty acids (Fish oil/flax oil). Also, added vitamin E to colostrum?* Holstein calves were either supplemented with 60 mL 50:50 blend of fish oil and flax oil including 200 mg alpha tocopherol in 3 L of colostrum or not supplemented with either. Blood samples taken on d 1, 2, 4, 7, 14, and 21 found supplementing oils and E did not alter serum total protein, increased plasma concentrations of omega-3 fatty acids as much as 90% by 1 d of age (P<0.01, decreased oxidant status index by 55% by d 2 and remained lower the first week of life. Supplementing the oils and E did not affect prevalence of diarrhea or rate of growth, but tended to improve nasal scores (P=0.07), Michigan State U. W24. Published JDS, 2020: **https://doi.org/10.3168/jds.2019-17380**
13. *Tributyrin supplementation in milk replacer?* Holstein heifer calves were supplemented with either 0.3% palm oil or tributyrin on a dry matter basis in their 28:15 CMR offered at 1.27 lbs./d d 7 – 13, 1.7 lbs. d 14 – 20, 2.54 lbs. d 21 – 41, 1.7 lbs. d 42 – 48 and 1.27 lbs. d 49 to wean d 56. Starter grain offered ad lib and 200 g/d (as-fed) chopped hay. ADG "did not differ" (1.72 vs. 1.59 lbs., both had a 30 g/d standard dev.) no p value reported. DMI of CMR and hay did not differ, however, DMI of calf starter, total DMI, intake of metabolizable energy were lower (P<0.05) for calves fed tributyrin on d 46, 47, and from d 50 – 55. Blood samples were collected weekly and plasma GLP-2 concentrations were higher for calves supplemented tributyrin (56 vs. 41 ng/mL; P<0.05). Blood glucose and serum BHA concentrations did not differ. It was noted that GLP-2 has been shown to increase nutrient uptake, enhance gut integrity after injury by protecting intestinal mucosa from inflammation. n=20. ZEN-RAKU-REN, Dairy Tech Research Inst., Hiroshima U. Japan. W49.

14. *Combined sodium butyrate and bacillus subtilis as CMR additives or spray dried pork plasma alone, which is better?* Holstein bull calves were fed 84.6 lbs. over a 7 week period of a 26:17 CMR with either a.) no feed additives and all-milk protein, or b.) same all-milk CMR with addition of sodium butyrate (2 kg/MT) + bacillus subtilis (1.3 million cfu/g CMR; Bioplus 2b), or c.) spray dried porcine plasma at 5% of the absolute formula. Calves were individually housed until weaning and then comingled into groups of 5 until d 78. Calf starter (21% CP) was offered ad lib. No differences in arrival serum total protein or calf body weight at d 0, 49, or 78, or in ADG or med treatments. Calves in the group fed the combination of sodium butyrate and bacillus subtilis noted increased risk of mortality (P=0.02) when compared to the control group. Mortality was 7.5%, 11.5%, and 24.5%, for the control, plasma, and sodium butyrate + bacillus subtilis groups, respectively. Calves fed plasma had a reduction in the number of days with a fecal score of 3 (0 to 3 scale; P=0.03). n=158. Animix. U of Guelph. Mapleview Agri. APC. W45.
15. *NeoTec5g in different CMR feeding regiments.* Male Jersey calves were fed 24:21 CMR at 14% solids at either a.) 1 lb./d to d 42 then half-rate to wean d 49, or b.) over the first week increase to 1.5 lbs./d fed to d 42 and then half-rate to wean d 49, and either strategy with or w/o NeoTec5 added to both the respective milk replacer and corresponding grain in a 2 x 2 factorial design. Texturized starter contained 20% CP and 39% starch and was offered ad lib. Calves housed individually to d 56 and then in groups of 4 d 57 – 112 when the same calf starter was mixed with 5% chopped grass hay. "Total tract digestibility was measured on 5 calves/treatment at wk 3 and 7 and from pens at 9, 11, and 15 weeks using acid insoluble ash as a digestion marker. No differences were detected in calf starter intake or performance. No total tract digestibility differences were detected at wk 3." Post-wean (wk 7) total tract digestibility of dry matter, starch and ADF and NDF were greater (P<0.05) for calves fed the lower CMR feeding rate and digestibility of dry matter, NDF and ADF, and fat were greater (P<0.05) for calves fed NeoTec5g. Measures week 9, 11, and 15 noted similar results with total tract digestibility of DM, NDF, and NDF greater (P<0.05) for calves fed low and DM, sugar, NDF, ADF, CP, and fat greater (P<0.05) for calves fed NeoTec5g. "Average total tract digestibility for wk 9, 11 and 15 of DM, OM, sugar, NDF, ADF, CP and fat were 78, 80, 95, 47, 39, 78, 67%, respectively." n=48. Provimi. W46.
16. *YANG (multi-strain yeast) effect on health and growth of veal calves.* Commercial-reared male veal calves (17 d of age) were fed milk replacer either a.) with YANG (Saccharomyces cerevisiae & Cyberlindnera jadinii fraction product) at 5 g/d 1st 30 d, then 3 g/d until d 90, then 0 g/d to 190 d slaughter, or b.) no YANG. Body weights and blood parameters were analyzed and monitored on 23 randomly selected calves (12 control, 11 treatment) of the 158 calves in the room. "No differences were observed on carcass weights at slaughter and carcass classification between the 2 groups. However, sampled animals' ADG was affected. ADG from d 0 to 47 and 47 to 82 was 236 g/d and 321 g/d higher in TRT than in CTR (0.47kg/d, P=0.01; 1.01 kg/d, P<0.01 respectively). No difference was observed in mortality; however, health of calves was improved.

Morbidity was reduced from 56% in CTR to 38% in TRT (P=0.02), with a reduction of number of chronic animals (≥2 treatments per animal) by 50% (P=0.03).” Yeast-treated (TRT) calves noted increased serum total proteins (P<0.01), higher IgG (P<0.01) and higher alpha-globulins (P<0.01) from blood measures taken d 47 and d 118. “These analyses are in favor of a better activated immune system of veal calves in TRT.” No diff in hemoglobin but more consistent hemoglobin in TRT. U of Bologna. Lallemand, France. 298.

Amino Acid Nutrition (3 abstracts)

1. *Glutamine at wean. Does it affect calf health and growth?* Holstein heifer calves, 28 d of age, were assigned to either a.) a late weaning age of 49 d, b.) an early wean age of 35 d, or c.) the same early 35 d wean with diet supplemented with L-glutamine at 2% of DMI via milk 1 week prior and 1 week after weaning began. Weaning process entailed lowering milk allowance from 9.0 to 3.0 L/d and fully weaning when starter intake reached 1 kg/d. Weight and body measures were taken weekly and serum haptoglobin was measured during the first week of weaning. Early wean calves supplemented L-glutamine noted improved (P=0.011; 0.44 lbs./d) ADG during the first week of weaning as compared to early wean calves not supplemented L-glutamine. Calves supplemented L-glutamine also noting fewer days (P<0.01; 15 d vs. 17 d) to achiever 1.0 kg of starter intake. Post wean, calves supplemented L-glutamine noted improved (P=0.014) hip width and a trend (P=0.054) toward improved body length. Late wean (commencing d 49) were completely weaned at 59 d and noted similar ADG, BW and starter intake as compared to early wean calves. Haptoglobin concentrations in blood were not statistically different, however, calves fed L-glutamine noted numerically lower levels. Authors note: “Supplementation of L-glutamine could help calves withstand weaning stress successfully as reflected by improved ADG and starter intake during weaning.” n=36. Iowa State University. Dicle University, Turkey. Oral 242.
2. *Effect of supplementing rumen-protected methionine or methionine analogs in calf starter.* Older data points determined methionine is the first limiting a.a. for the transition calf. Holstein calves 14 d old and individually housed were fed starter grain with either a.) no added methionine, b.) supplemented with rumen protected methionine (Smartamine), c.) supplemented with HMTBa (2-hydroxy-4-(methylothio)=butanoic acid, a.k.a. methionine hydroxy analog), or d.) supplemented with HMBi (isopropyl ester of methionine hydroxy analog). Starters were offered ad lib and contained 23% CP, 2.5 Mcal ME/kg, and supplement inclusions were set to provide 0.16% DM of methionine equivalents. Calves were fed CMR offered up to a max of 3.5 lbs./d of 28:15 powder and weaning occurred d 49 – 63. BW measured weekly. Prewean starter intake increased from 90 g/d to 130 and 120 g/d for calves fed grain with Smartamine rumen protected methionine and isopropyl ester of MHA (HMBi), respectively. Calves fed grain with standard MHA (HMTBa) noted just 90 g/d prewean starter intake, the same starter intake as control. HMBi tended (P<0.10) to increase

starter intake post-wean (8.4 vs. 7.2 lbs.) when compared to control calves. HMTBa (methionine hydroxy analog) noted reduced ($P<0.05$) post-wean (d 63 – 91) BW gain (2.9 vs. 2.6 lbs./d) in comparison to control. Separation in ADG occurred during weeks 10 – 13. Authors hypothesized metabolizable methionine supply resulted in a rumen fermentation effect. Authors report in oral presentation that HMBi increased ($P<0.01$) post-wean DMI while HMTBa decreased ($P<0.10$) DMI. n=74. Cornell. Zen-Raku-Ren. Adisseo. 143.

3. *Tryptophan is a precursor of serotonin. Does it help calves cope with weaning stress?* Holstein bull calves (48.2 d old, 181 lbs. BW) were used to evaluate supplementing 4.5 g/d tryptophan via milk replacer. Calves were fed 6 L/d at 15% solids for 7 d, then 4 L/d from d 8 – 14 and 2 L/d in one fdg until 21 d of study. Calves were weaned at around 63 d of life. Starter (18% CP and 16.1% NDF) and chopped straw were offered ad lib. Calves were weighed weekly and motion was monitored using accelerometers throughout the study. Activity was monitored via a scan sampling 2x/week conducted 1 h post morning feeding where behaviors like suckling neighboring calves, lying, rumination, vocalizations, eating and drinking were recorded. "Tryptophan supplementation did not affect calf performance nor concentrate and milk replacer intake, but straw intake tended ($P=0.07$) to be greater in non-supplemented compared with tryptophan-supplemented calves (153 vs. 129 ±9.0 g/d, respectively)." When milk replacer feeding rates changed lying duration decreased and lying bouts increased independent of treatment and the main change in behavior was an increase in vocalizations and standing time 1 h post the AM feeding at weaning, but, again these were independent of treatment. "Supplementing 4.5 g/d of tryptophan via milk replacer between 48 and 62 d of life had no effect on performance and behavior in calves around weaning." n=27. Institut de Recerca I Tecnologia Agroalimentaries, Barcelona. U Autonoma de Barcelona, Institucio Catalana de Recerca I Estudis Avancats, Spain. W1.

Colostrum, Colostrum Replacers, and feeding Transition Milk (9 abstracts)

1. *Is serum total protein a heritable trait?* Researchers attempted to quantify the relationship between serum total protein and genetic predicted transmitting abilities for production, health, and fertility in organic Holstein calves. Serum total protein was monitored on calves born between 2015 and 2018 on two organic dairies and were genotyped using Neogen Geenseek Genomic Profiler HD150K. Also, official genomic predicted transmitting abilities were accessed from the Council on Dairy Cattle Breeding. Genomic predicted transmitting abilities regarding milk production (milk, fat, protein yield) and confirmation (type, udder, stature, etc.) traits were not associated with serum total protein. Fitness genomic predicted transmitting abilities regarding lower somatic cell count and higher mastitis resistance tended ($P<0.10$) increased while milk fever resistance decreased ($P=0.02$) serum total protein. Factors around birthing difficulties such as lower daughter stillbirths ($P<0.05$) and higher gestation length decreased ($P=0.03$) serum total protein. 159 calves. PSU and U of MN Morris. M59.

2. *Premolac PLUS Bovine IgG colostrum replacer (Zinpro) or maternal colostrum*? Calves were fed either a.) high quality maternal colostrum (106 g/L IgG; 404 g IgG total fed), b.) low quality maternal colostrum (30 g/L) supplemented with Premolac (41 g/L; 154 g IgG total fed), c.) solely Premolac supplying 150 g of IgG, or d.) solely Premolac supplying 110 g of IgG. Colostrum and/or Premolac was administered via a single fdg within 1.5 hrs of birth. Calf serum IgG (mg/mL) at 24 h was 27.04, 22.33, 16.9, and 12.79 for high quality maternal colostrum (a), low quality maternal colostrum plus Premolac used as a colostrum supplement (b), solely Premolac supplying 150 g IgG (c), and solely Premolac supplying 110 g IgG. AEA (apparent efficiency of absorption) was 24.38, 54.28, 40.09, and 41.44% for a, b, c, and d, respectively. Maternal colostrum noted higher (P<0.01) calf serum IgG values than Premolac supplemented maternal colostrum while calves fed maternal colostrum supplemented with Premolac noted increased (P<0.01) AEA. Serum total protein and BRIX readings noted high correlation (r=0.98, P=0.01). 80 calves. PSU & Zinpro. M18. JDS 2019: https://doi.org/10.3168/jds.2019-17949
3. *Effect of feeding pasteurized transition milk d 2 – 4 of life.* Pasteurized (161 F, 15 s) pooled transition milk (milking 2 – 4, 42% CP, 26% fat on a solids basis) harvested from on-farm Holstein cows was fed at 2 quarts 3x daily for 3 days and was compared to fdg the same quantity of either a CMR (28:10) or CMR + colostrum replacer blended in a 1:1 ratio (39:15). All respective treatments commenced after two feedings of colostrum replacer (1st fdg was Alta Gold Colostrum Powder replacer SCCL, 3 qts., and 2nd was Alta HiCal colostrum powder, 2 qts.). Calves were then fed the same CMR at 14% solids in a step-up strategy with a 2-week wean consuming 114 lbs. of solids over 55 d. Starter offered ad lib (no grain details provided). Calves fed either transition milk or the combination of CMR + colostrum replacer outgained calves fed solely CMR (P<0.02; d 55 BW gain 69, 75.6, and 75.4 lbs. for CMR, CMR + colostrum replacer, and transition milk, respectively). No differences noted in health scores (UW Madison calf health score sheet for eye, feces, and ear), however, poster reported minimal disease challenge. Blood measures for haptoglobin and LPB (Lipopolysaccharide binding protein) were taken d 14 and d 21, and calves fed CMR plus colostrum replacer and those fed transition milk noted decreased (P<0.05) blood haptoglobin. NSD noted in LBP. 105 calves. Michigan State University. Saskatoon Colostrum Company. T91.
4. *Does Saskatoon Colostrum Company 100 g IgG colostrum replacer used either to replace colostrum or enhance maternal colostrum effect serum IgG or calf growth*? Calves were fed at birth either a.) 2 L of maternal colostrum, b.) 4 L of maternal colostrum, c.) 2 L of maternal colostrum + one dose colostrum replacer (100 g IgG), d.) 2 doses colostrum replacer (200 g IgG total), or, e.) 2 doses colostrum replacer at birth and another dose between 6 and 8 hours after birth (300 g IgG total). Starter (24.6% C.P.) fed free-choice, and 6 L/d CMR (22:16, 14% solids) until 56 d. NSD in serum IgG or total serum protein at 48 h, however, increasing IgG intake with higher volumes of maternal colostrum or colostrum replacer reduced apparent efficiency of absorption (AEA). NSD in health or growth. Poor quality CMR and crypto infection was reported as reasons why ADG results

ranged from just 210 to 290 g/d (NSD). n=50. U of Sao Paulo, Brazil. Saskatoon Colostrum Co. T89.

5. *Does supplementing powdered colostrum replacer the first 5 days of life help the calf*? Holstein heifer calves from one herd received 4 L of colostrum within 4 hours of birth and were then transitioned to a whole milk diet with supplemental 22% CP, 19% fat CMR that increased solids to 18% (basal diet), and were assigned to either a.) basal diet + 60 g/d of supplemental colostrum replacer powder for 5 days, or b.) basal diet alone. Blood samples collected at 24 h after colostrum intake ensured adequate immunity (serum IgG/>10.0 g/L). All calves received "6 L of milk three times daily" (yes, that is precisely what the abstract reports, that's 3.24 kg solids fed daily to a newborn) and colostrum replacer powder was fed 20 g/6 liters three times daily (60 g/d). Calf starter was offered ad lib. 30 d onward calves received 4 liters twice daily (8L/d) until weaned at 60 d. Calves supplemented colostrum replacer were 11.2 lbs. heavier (P<0.01) and gained +80 g/d more than control (1.89 vs. 1.72 lbs./d) calves at weaning. Incidences of diarrhea nearly doubled (13 vs. 7) in non-supplemented calves but was not significant (P=0.11). Incidence of diarrhea was negatively correlated with body weight at 30 and 60 d (P<0.05), and ADG at 30 and 60 d (P<0.03). n=66. Universidade Federal de Goias, Jatai, Goias, Brazil. T90.
6. *Does feeding transition milk d 2 – 4 of life impact calf health and growth?* All calves received colostrum replacer for the first 2 feedings after birth, and then were transitioned to one of three diets fed at 1.9 L, three times daily for 3 days, either a.) CMR fed at 14% solids, approximately 798 g/d solids, b.) transition milk (3.79% fat, 6.1% protein, 14% solids) pasteurized at 161°F for 15 seconds, or c.) a 50:50 blend of CMR and colostrum replacer fed at 15% solids. Transition milk is defined as milk from the 2nd through 4th milkings post-calving. After 4-d all calves were fed and managed similarly. All but one calf achieved successful passive transfer of immunity (over 10 mg/ml). 21-d ADG was 410, 490, and 450 g/d for milk replacer, transition milk, and 50:50 blend of milk replacer and colostrum replacer, respectively. Calves fed transition milk and CMR + colostrum replacer noted +60 g/d ADG (P=0.06) to d 21 with no difference noted between transition milk and CMR + colostrum replacer. Calves fed transition milk and CMR + colostrum replacer powder noted +5.5 lbs. body weight gain by weaning (P=0.06) and total body weight gain at 56 d wean was 75.6, 74.7, and 69.7 lbs. for calves fed transition milk, milk replacer + colostrum replacer powder, and milk replacer alone, respectively. No effect on health scores for ears (0.11, 0.14, and 0.12 for milk replacer, transition milk, and milk replacer + colostrum replacer, respectively; P=0.55), health scores for eyes (0.03, 0.007, 0.019; P=0.15), or for feces (0.3, 0.37, 0.35; P=0.34). n=105. Michigan State U. T91.
7. *A study of the effect on passive transfer status on morbidity and mortality in Holstein calves*. Researchers gathered individual calf heath data and serum total protein (STP) data from Feedlot Health Management Services proprietary software system, iFHMS. STP was determined from blood samples captured within 48 hours of placement from

dairy farms by using a digital refractometer. Calves were categorized by STP as **poor**: total protein <5.1 g/dL, n=159, mean 4.68, SD ±0.31 g/dL; **fair**: total protein range 5.1< to 5.7 g/dL, n=399 calves, mean 5.45, SD ±0.19 g/dL; **good**: total protein range 5.8 – 6.1 g/dL, n=322, mean 5.96 g/dL, SD ±0.11 g/dL; and **excellent**: total protein >6.1 g/dL, n=751, 6.9 ±0.59 g/dL. There was a significant difference (P<0.001 for both) in both total respiratory disease treatments and total gastrointestinal disease treatments between poor (<5.1 g/dL) and excellent (>6.1 g/dL). Enteric and respiratory disease "were defined and diagnosed subjectively on an individual animal basis." There were also differences (P<0.01) in the incidence of ear disease treatments between poor (<5.1 g/dL) vs. excellent (>6.1 g/dL) and between fair (5.1< to 5.7 g/dL) vs. excellent. n=1,631. University of Idaho, Moscow. 356.

8. *How heritable are colostral IgG and IgM (natural antibodies)?* 1,719 colostrum samples from 1,313 Swedish Red (70%) or Swedish Holstein (30%) cows between 1 to 6 parities were collected and analyzed for antibodies using indirect ELISAs. ASReml 4 statistical software was used to estimate heritability. "Heritabilities for colostrum NAbs (natural antibodies, (a.k.a. IgG, IgM) ranged from 0.15 to 0.27 with a permanent environment effect for IgG isotypes accounting for 30% of the variance and for IgM ranging from 15 to 19%. Genetic correlation between IgG and IgM ranged from 0.1 to 0.4." "Our results suggest that natural antibodies can potentially provide an effective tool to improve colostrum quality using genetic selection." Swedish U of Ag Sci, Uppsala. Wageningen U, The Netherlands. 361.
9. *Effect of feeding Zinpro Premolac colostrum replacer (43.5% IgG) the first 14 days of life.* Holstein calves upon arrival to the facility were fed either a.) no colostrum replacer, b.) 10 g IgG (23 g Premolac), or c.) 20 g IgG (46 g Premolac) added to their milk replacer and fed 2x/d to individually housed calves. FPT incidence was 80%. BW measures taken d 0, 15, pre-wean d 53, and hutch exit d 69. Supplementing Premolac reduced % of calves that had at least one milk refusal during the first 3 weeks on trial (38.8, 23.3, and 20% for 0, 10g, and 20g/fdg IgG from Premolac; P<0.01). "Among refusals, 20 g IgG calves refused less feedings (1.5 vs. 2.1; P=0.03) and less total milk (1.51 vs. 1.99 L; P=0.04) compared with 0g IgG calves." NSD in grain intake (P=0.29). "Total gain and ADG from d 0 to 14 were greatest for 20 g IgG fed calves, intermediate for 10 g IgG and lowest for 0 g IgG calves (7.93, 6.61, and 4.85 lbs., and 0.53, 0.44, and 0.33 lbs./d respectively; P<0.01)." Mortality was 6.6, 5.4, and 2.0% for 0 g, 10 g, and 20 g IgG and 20 g was less (P=0.01) vs. 0 g. Overall antibiotic use rate was 92.4, 88.7, and 86.2% of the calves for 0 g, 10 g, and 20 g IgG, respectively, and P=0.03 diff for 20 g vs. 0 g IgG. 20 g IgG decreased antibiotic treatment rate for diarrhea percentage, 44.4, 39.3, and 35.3%, for 0 g, 10g, and 20 g IgG, respectively, P<0.05 between 0 g and 20 g. n=1,037. Zinpro, MN. Dairy Experts, Tulare, CA. W16.

CMR and Milk Feeding Rates and Strategies (10 abstracts)

1. *Meta-analysis of 10 trials comparing moderate (app. 1.45 lbs./d) to high (app. 2.2 lbs/d) CMR fdg rates.* Ten studies conducted at Provimi Nurture Research Center in OH between 2016 and 2019 encompassing *26 dietary treatments* and 491 calves (all males) were examined using PROC MIXED model in SAS. Starter was offered ad lib throughout the nursery period in all trials (19.4 – 22.3% CP). Pre-wean period ranged from 35 to 44 d with additional weaning period ranging from 3 to 7 d across the 10 studies. Total CMR intake varied from 55.8 lbs. to 58.6 lbs./calf and from 85.5 to 106.5 lbs./calf for moderate and high CMR fdg rate treatment groups, respectively, and CMR's varied from 24.8 to 28.6% CP and 17.6 to 20.2% fat. In all studies fecal digestibility measures were taken over a 5 d period during wk 8 from fecal samples from 5 calves/treatment. **Results to d 56**: calves fed *high fdg rate* noted increased average daily CMR intake (1.77 lbs. vs. 1.02 lbs.), improved ADG (1.4 vs. 1.2 lbs., P<0.001, resulting in +11 lbs. BW gain in 56 d period), reduced avg daily starter intake (1.04 vs. 1.53 lbs., P<0.001), improved Gain/DMI (0.488 vs. 0.466, P<0.002), improved hip width change (0.069 vs. 0.064 cm/d, P=0.002), increased abnormal fecal days (score of 3 or more) per week (0.09 vs. 0.05, P=0.003), and increased medical d/wk (d treated with AB, 0.23 vs. 0.17, P=0.001). Again, **to 56-d, average intake per kg of BW gain** was greater for calves fed higher quantity of CMR in regards to DM (58.8 vs. 55.9 g/d, P<0.001), CP (14.5 vs. 12.9 g/d, P<0.001), apparently digestible protein (12.7 vs. 10.9 g/d, P<0.001), fat (8.2 vs. 5.8 g/d, P<0.001), and Metabolizable energy (0.251 vs. 0.219 Mcal/d, P<0.001), while calves fed moderate CMR fdg rate noted increased starter (30.8 vs. 19.2 g/d, P<0.001) and increased NDF intake (6.2 vs. 4.0 g/d, P<0.001) during the same 56 d period. Calves fed moderate fdg rate of CMR noted increased digestibility of DM (78.4 vs. 73.3%, P<0.001), CP (78.9 vs. 74.8%, P<0.001), ADF (39.3 vs. 25.2%, P<0.001) and NDF (53.9 vs. 40.8%, P<0.001) during the wk 8 post-wean measure. Starch and fat digestibility did not differ. High CMR fdg rate resulted in improved growth (+11 lbs.) and improved gain:DMI to 56d, however, feed digestibility wk 8 was relatively poorer (particularly ADF and NDF digestibility) in calves fed high vs. moderate CMR fdg rates, and the researchers hypothesize that moderate CMR strategy "may better prepare calves for weaning." Provimi. M155. JDS 2020: https://doi.org/10.3168/jds.2019-17206.
2. ***Concurrent poster to M155****. Meta-analysis of 10 trials comparing moderate (app. 1.45 lbs./d) to high (app. 2.2 lbs/d) CMR fdg rates – the same calves carried on in post wean period from 2 – 4 months age.* On d 56 calves were housed by group in pens mostly of 4 calves each until 112 d age. Calves continued offered ad lib access to the same starter grain as was fed in the nursery phase, however, with addition of 5% chopped grass hay. ADG (P<0.001), DMI (P=0.008), and hip width change (P<0.001) was greater d 56 – 112 for calves that were fed moderate fdg rates (avg. 57.6 lbs. CMR/calf) as compared to high feeding rate (avg. 98 lbs. CMR/calf) pre-wean, in fact, calves that received moderate fdg. rate CMR strategy during nursery period outgained those fed high fdg

rate CMR strategy by +4.8 lbs. in the grower phase. For the entire 1 – 112 d period (nursery and grower) calves fed hi-fdg rate CMR strategy noted improved ADG (P=0.004, 1.73 vs. 1.77 lbs.) and increased total DM intake (P<0.001) resulting in +5.2 lbs. BW gain as compared to calves fed moderate CMR fdg strategy, whereas calves fed moderate CMR fdg strategy noted improved gain:DMI (P=0.007, 0.403 vs. 0.39). Calves in the high-fdg rate group consumed +40 lbs. more CMR powder per calf, however, calves in the moderate fdg rate group consumed +11.2 lbs. more dry feed intake per calf (433.2 vs. 422 lbs.). Hip width change in the 112 d period tended (P=0.081) greater for calves fed the moderate CMR fdg strategy. Digestibility measures were taken over 5 d periods during weeks 11 – 13 and week 16, and calves fed moderate CMR noted improved DM (P<0.001), C.P. (P=0.017), ADF (P<0.001; 52 vs. 40.8% digestibility), NDF (P<0.001, 54.8 vs. 45.8%), and fat (P=0.002) digestibility during the wk 11 – 13 period, however, no differences were noted wk 16. The researchers summarize that fdg high rates of CMR in nursery "decreased ADG and structural growth in grower period" and that digestibility of most nutrients, but particularly ADF and NDF were greater for calves fed moderate CMR and that "when fed more MR in the nursery period, a calf would gain 2.4 kg (5.3 lbs.) more body weight with no more hip width change, but consume 18.3 kg (40.3 lbs.) more MR from 0 to 4 months of age." 10 studies, 13 trials, *22 dietary treatments*, 485 calf meta-analysis. Provimi. M157. JDS 2020: https://doi.org/10.3168/jds.2019-17206

3. *Organic Jersey calves, whole milk, or milk replacer?* Individually housed Jersey calves were fed either whole milk (3.7% C.P. and 4.64% fat, estimated to be 29.6% C.P. and 37.1% fat on a solids basis) or organic milk replacer (21.3% C.P. and 22.1% fat, Organi-Calf, Milk Specialties Global, mixed at 283 g/2L warm water) at 4 L/d from birth until weaning at 8 wks age. Study was conducted in the winter in NH in a 3-sided calf barn and calves were supplied with blankets and heat lamps. Starter (24.9% CP, 5% fat) was offered ad lib. ADG was greater weeks 1 (P=0.04), 2 (P<0.001), and 3 (P=0.03) for calves fed whole milk, however, starter grain intake was greater wks 4 (P<0.01), 5 (P<0.001), 6 (P<0.001), 7 (P<0.001), and 8 (P<0.001), for calves fed organic CMR. 8 wk ADG was greater (P=0.02) for calves fed whole milk and 8-wk BW gain was 59.7 lbs. and 50.7 lbs. for whole milk and CMR, respectively (+17.8% advantage for whole milk). Calves fed whole milk also noted increased body length (P=0.01), wither height (P<0.01), hip height (P<0.01) and heart girth (P<0.01). Avg. daily starter intake during the study was 0.42 lb. vs. 0.82 lb. for whole milk and CMR, respectively (P<0.01, +96.3% for calves fed CMR). The authors advise these data suggest whole milk should be fed until wk 3 of life due to greater ADG followed by CMR wk 3 to wean due to increased starter intake and associated improved rumen development, they also challenge research needs to measure performance post weaning and an economic analysis needs to be considered. U of NH & U Estadual do Oeste do Prana, Brazil. M156.
4. *On-farm, component-based CMR vs. commercial agglomerated CMR.* Holstein bull calves were fed either a 24:24 commercially available agglomerated CMR or a 24:24 "component-based milk replacer formula, mixed on farm, using high quality,

individually-sourced ingredients." No further details of components provided. Both were devoid of medications or feed additives. Calves consumed 1.61 lbs. CMR daily and were step-down weaned d 35 – 42. Total CMR consumption was 65.7 lbs. per calf for both groups. Calves fed the component based CMR outgained ($P<0.05$) those fed the agglomerated CMR d 0 – 28 (0.99 vs. 1.16 lbs. per d ADG). Calves had ad lib access to an 18% CP starter. Average daily starter intake was greater (0.46 vs. 0.66 lbs. $P<0.05$) d 1 - 42 for calves fed the component made CMR, and this difference continued for the d 1 - 49 (0.88 vs. 1.13 lbs., $P<0.05$) period, resulting in improved ADG ($P<0.05$) for the calves fed component made CMR at both junctures (d 1 - 42, 1.15 vs. 1.37 lbs. ADG, +9.24 lbs. BW gain; d 1 - 49, 1.25 vs. 1.43 lbs. ADG, +8.8 lbs. BW gain). Gain:feed was greater ($P<0.05$) for calves fed component based CMR at all measurement junctures (d 0 – 28, 0.554 vs. 0.639; d 0 – 42, 0.56 vs. 0.62; d 0 – 49, 0.557 vs. 0.581). The authors reported total feed costs (combined CMR and starter) to d 49 was and $88.93 ($1.44 per lb. of BW gain) and $72.54 ($1.03 per lb. of BW gain) for commercial agglomerated- and on-farm component based-CMR, respectively. 64 calves. United Animal Health. Progressive Dairy Solutions. W98.

5. *Are equations to determine maintenance and allowable energy gain and protein gain optimal?* Harvest data from 206 calves (68 to 231.5 lbs.) fed 31 different liquid diets ranging from 14.3 – 31.2% protein, 14.8 – 33.4% fat, and 148 – 353 kcal of M.E./d/$kg^{(0.75)}$ full body weight were used to estimate maintenance energy requirements and develop equations to predict energy and protein requirements for growth to 231.5 lbs. full body weight. "Data included individual nutrient intake, weight gain and retention of fat, protein and energy in an empty body weight basis." Individual calf data from 4 Holstein calf and 1 Jersey calf study was utilized in the analysis. New equations to predict energy and protein allowable gain were generated. "Fasting heat production was 76 and 85 kcal/$kg^{(0.75)}$ whereas ME_m was 105 and 129 kcal/$kg^{(0.75)}$ empty body weight for Holsteins and Jerseys, respectively." Blood and organs composed 17% and 18% of Jersey and Holstein calves, respectively, while head, hide, feet, and tail composed 53% and 22% of Jersey and Holstein calves, respectively, leaving 30% and 60% of Jersey and Holstein calves, respectively, as carcass. "The equations to predict empty body protein gain (0.183 x empty body weight gain (kg/d) + 4.52 x $MP_{(gain)}$ – 0.344 x $ME_{(gain)}$) and empty body protein gain (0.099 x empty body weight gain (kg/d) + 0.228 x fat intake (kg/d) +0.152 x $ME_{(gain)}$ – 8.59 x $MP_{(gain)}$ + 27.22 x $ME_{(gain)}$ x $MP_{(gain)}$) accounted for 89 and 88% of the variation." "Estimates of metabolizable energy requirements for maintenance were 23% higher for Jersey compared to Holstein calves as a result of a higher fasting heat production and lower efficiency of use of metabolizable energy for maintenance. Part of this difference could be attributed the greater proportion of head, hide, feet and tail in the body, and surface area to body weight relationship in the Jersey animals." 206 calf analysis amongst 5 published studies. Cornell. M161.

6. *Organic milk replacer vs. organic whole milk.* Holstein and crossbred calves sequentially assigned over two calving seasons (March to July and September to December) were fed

via an autofeeder up to 8 liters/d day 5 – 56 of either whole milk or organic milk replacer. NSD between milk and CMR for ADG, wean weight, hip height and heart girth. Calves fed whole milk noted shorter (P<0.05) feeding station visit duration (2.44 vs. 3.01 m), slower (P<0.05) consumption rates (1.85 vs. 2.48 L/m)and higher (P<0.05) consumption amounts (1.52 vs. 1.32 L/m). Calves fed whole milk noted more unrewarded visits to the fdg station (16.07 vs. 12.07), fewer unfulfilled visits (3.092 vs. 10.34) and fewer fulfilled visits (3.73 vs. 5.05). Drinking speed was greater (P<0.05) in calves fed whole milk (1,301 vs. 581 mL/m). Cost per kg of gain for CMR was $8.82/kg and for whole milk $6.35/kg. n=81. U of MN Morris. 224.

7. *Supplementing condensed whey solubles to milk replacer.* Jersey (n=124), Holstein (n=42), and cross (n=35) calves housed in individual hutches were supplemented either a.) no condensed whey solubles, b.) 42 g/d condensed whey solubles, or c.) 84 g/d of condensed whey solubles. During the first 2 weeks condensed whey solubles were added via milk replacer and during weeks 3 to 12 via a 22% C.P. starter offered ad lib. Week 1 calves were fed 4 quarts CMR and week 2 were fed 6 quarts daily and weaned by 1x/d feeding week 8.5 to 11. Starter DMI tended (P=0.09) greater in the lower feeding rate of condensed whey solubles (1.26, 1.39, and 1.2 lbs./d for 0, 42 g, and 84 g/d condensed whey solubles, respectively). Total DMI tended to be greatest (P=0.08) in control (2.73, 2.73, 2.52 lbs./d for 0, 42 g, and 84 g/d, respectively). Starch intake was greater in the low feeding rate of condensed whey solubles (0.47, 0.51, 0.41 lbs./d, respectively). Sugar intake greater in the two groups fed condensed whey solubles (0.55, 0.64, 0.65 lbs./d, respectively). Calf body weight (553.4, 639.3, 654.8 lbs.) and ADG (2.18, 2.34, 2.14 lbs./d) were greater (P<0.05) in the group fed 42 g/d, as was blood glucose and BHB. Also, calves fed the lower 42 g/d feeding rate noted lesser incidences of diarrhea (0.17, 0.11, and 0.18%). NSD in gain:feed, body dimensions, plasma urea nitrogen and fecal scores. n=201.SDSU. Idaho Milk Products. 418.
8. *26:17 CMR fed at either 1.5 or 1.74 lbs./d and either 2x or 3x/d feeding during a Georgia summer.* Calves were fed a 26:17 CMR either 2x (0700 and 1600 hours) or 3x (0700, 1600, and 2200 h) and either 1.6 lbs. or 1.74 lbs. of CMR per day (12.5% solids) in a 2 x 2 factorial. Calves were weaned by cutting to half daily feeding 1x/d (0700) commencing d 42 for a 7 d wean and calves were followed until d 63. Starter grain offered ad lib. Ambiant temp and relative humidity inside and outside induvial hutches measured hourly and the temperature-humidity index averaged 77 in and outside the hutches during the trial. Respiration rate and rectal temps were recorded 3x per week. Fdg 3x reduced (P<0.05) respiration rate from week 3 to 6 by 10 – 18% and tended (P=0.06) to decrease rectal temps compared to 2x/d calves but only in the 1.5 lbs. CMR/d group. CMR feeding rate and 2x or 3x strategy did not affect ADG or any body dimension. Scours incidence week 2 resulted in similar daily CMR intake that week regardless of CMR feeding rate. "Feeding 3x tended to increase MR intake compared with 2x fed LOW" CMR feeding rate, P=0.07. Feeding 3x increased starter intake weeks 8 and 9 as compared to 2x (P=0.05). Starter intake was greater (P=0.05) week 7 for 1.5 vs. 1.74

lbs./d CMR feeding rate. Feeding 3x increased total DMI weeks 4, 5, 8, and 9 (P<0.05) as compared to 2x/d CMR feeding. "In conclusion, feeding milk replacer 3x during summer may reduce heat strain on calves and increased intake, but did not alter growth." n=48. U of GA. 520.

9. *A calf stress test under various milk replacer feeding rates; same hot GA summer.* Holstein calves were fed one of three CMR strategies: 1.) 1.25 lbs./d of 20:20, or, 2.) 1.5 lbs/d of 26:17, or 1.74 lbs./d of 26:17. All strategies fed d 2 to 42, weaning by feeding half rate (1x/d feeding) to full wean d 49. Calves housed individually in hutches and monitored to d 56. Blood measures for cortisol d 2, 5, 10, 14, 28, 42, 43, 45, 47, 49, 51, and 56. 8 calves in each group were subjected to adrenocorticotropic hormone (ACTH) at d 40 (ACTH causes a spike in cortisol) and plasma was collected -30, -15, -5, 5, 10, 15, 30, 45, 60, 90, and 120 m relative to ACTH infusion (0.125 IU/kg of BW) for measure of cortisol, insulin, and metabolites. Calves were also under heat stress (temp/humidity index 75 in and outside of hutch) and avg. rectal temp of the calves was 103.3 F, indicative of heat stress. "Feeding rate of MR did not influence (P>0.13) plasma cortisol concentrations during the experiment or the ACTH challenge. The ACTH infusion decreased insulin concentration and increased nonesterified fatty acid concentration (P<0.01)." Plasma glucose(P<0.05) and insulin (P=0.03) were higher in calves fed high feeding rate vs. low and calves fed high feeding rate tended (P=0.08) greater glucose and noted greater insulin (P=0.03) vs. moderate CMR feeding rate. Plasma NEFA were greater for low feeding rate as compared to high at 15 m post ACTH challenge or medium feeding rate at later (45 m) time measures. U of GA, Tifton. W87.
10. *Let calf suckle dam? Nurse cow?* Holstein calves, half male and half female, were assigned to one of three rearing treatments: a.) pen with mother d 2 to 21 and allowed to suckle 3x/d then group pen and fed 6 kg milk/d for 63 d via nipple bucket (n=36; 84 d total milk feeding period), b.) pen with mother 3 days and then allowed ad libitum access to nursing cow, and number of calves assigned per nursing cow was based on milk yield, affixing 6 kg milk per calf per day (n=34; total 84 d to suckle), or, c.) allowed to nurse their dam for 24 h and then placed in individual hutch d 2 – 56 and fed 6 kg milk replacer solution daily via bucket with nipple (no details on CMR provided), and then loose-housed and fed 6 kg milk replacer solution via bucket with nipple (n=35, 84 d on milk or milk replacer). All calves weaned d 84. All calves offered starter grain and alfalfa hay ad lib. Starting live BW not statistically different, however, weaning body weight was: calves nursing dam for 21 d then fed whole milk in nipple pail, 242.2 lbs. BW, next, calves placed on nursing cow, 209.6 lbs. BW, and, finally, calves fed CMR 178.2 kg, P<0.001, and ADG, birth to wean, was 1.78, 1.48, and 1.06 lbs., respectively (P<0.001). "After weaning from milk feeding, all calves were kept sex separately in age-balanced groups in bedded pens with the same ration," and "a significant difference (P<0.001) was found also for the period from birth to 180th day of life" (1.81, 1.65, and 1.48 lbs./d, ADG, respectively). n=105. S. Bohemia U., Czech Republic. W96.

Dry Cow Strategies and Calving and Impact on the Calf (12 abstracts)

1. *Starch level in close-up dry cow diet impacts insulin sensitivity in newborn calves.* Dry cows commencing 28-days from calving date were fed either a 26% starch diet composed of 22% barley grain or a 14% starch diet composed of 23.6% straw. 12 d prior calving dam glucose did not differ; however, insulin was greater (P=0.04) in dams fed hi-starch diet. No differences noted in birth weight. Heifer calf offspring were fed colostrum (6 L, 24 h) and then offered 10 L/d of 13% solids 26:18 CMR fed via Calf Rail feeding system spread over 5 fdgs daily. On d 2, 10, and 20, a min 6 hrs post colostrum or milk meal, a glucose tolerance test was performed. This test entailed IV infusion at 180 mg/kg BW of glucose and sequential blood sampling (11 samples) for 90 m. Glucose concentrations did not differ, however, heifers from dam's fed high-starch close-up diets noted higher maximum insulin concentration (P=0.01) and greater insulin area under the curve (P<0.01) indicative that more insulin was necessary to clear the same quantity of infused glucose. Calves consumed all colostrum offered. Over the 20-day period there was no effect of dry cow diet on the ADG or milk intake of offspring. 38 calves. U of Alberta. Hiroshima U, Japan. **M26**.
2. *Concurrent poster to **M26**: Glucagon-like peptide 1 (GLP-1) is involved in insulin secretion and glucose management, is GLP-1 in the newborn calf effected by starch level of it's dam's diet?* Sub trial of M26, calves were injected with either saline or 1.0 microgram per kg BW of GLP-1 within 5 seconds of CMR fdg on d 2, 10, and 20 after birth, and at d 20 plasma glucose concentration was lower (P=0.02) for calves from dam's fed high starch (26%) close-up diet than from dam's fed moderate starch (14%) diet when GLP-1 was administered. Fdg a hi-starch close-up diet resulted in the dam's calf having enhanced glucose lowering action by GLP-1. The researchers also noted plasma glucose (P=0.05) and insulin (P=0.04) were higher for calves from cows fed moderate starch diets as compared to high starch diets and that ADG was greater (no p value) during the d 2 to 10 period in calves from cows fed hi-starch as compared to lo-starch diets, indicative of suppressed digestive organ development in calves from dams fed lo-starch diet. U of Alberta. Hiroshima U. M29. JDS, 2019: https://doi.org/10.3168/jds.2018-16226
3. *Does supplementing bypass lysine and bypass methionine for 21 d prior calving effect calf metabolism & immune status?* 21 d prior expected calving multiparous cows were supplemented a diet with 1,314 g/d (+22 g/d vs. control) metabolizable protein, 102.5 g/d metabolizable lysine (+15.2 g/d source AjiPro-L, Ajinomoto vs. control) and 33.8 g/d metabolizable methionine (+5 g/d source Met Plus, Nisso Shoji vs. control). The comparison was made between two commercial farms. After birth calves received the same amount of colostrum and the same diet. Total protein d 7 and 14, albumin d 2 or 3, 7, and 14, total cholesterol d 7 & 28, total amino acids d 2 or 3, and glucose d 2 or 3 all increased with fdg of additional bypass a.a. IgG d 7 and gamma glutamyltransferase

d 7 and 14 increased (P<0.05) with a.a. supplementation. 15 Holstein cow/calf pairs. Ajinomoto. Total Herd Mngt. Service, Japan. M145.

4. *Does feeding a DFM to the dam impact immunoglobulin concentration in the calf?* Close-up TMR fed to dam was either supplemented or not supplemented with a commercial DFM. Calves were weighed weekly until weaning and no differences noted in ADG at any juncture. All calves were fed 4 L of maternal colostrum within 4 hrs. At 24 h, 72 h no differences noted in serum IgG. Serum IgG increased in both groups at 4 weeks (1681 vs. 2813 mg/dL for control and DFM; P=0.43), and 7 weeks (2636 vs. 2653 mg/dL for control and DFM; P=0.43). Authors note calf endogenous IgG production appears to exceed maternal IgG denaturation between 4 and 7 weeks of age. U of Idaho. Lallemand, Milwaukee. Oral 45.
5. *Does supplementing methionine in the dry cow period impact the calf?* Calves from cows either supplemented with rumen-protected methionine (Mepron) at 0.09% of diet dry matter during the dry period or fed same basal diet without added methionine were monitored via liver biopsies harvested d 4, 14, 28, and 50 of age and measured for "metabolomics via GS-MS," and via calf performance measures. Daily starter intake, ADG, and feed efficiency of calves were not affected by methionine supplementation of their respective dam. Calves from dams supplemented with added methionine "noted greater (P<0.05) overall activity of cystathionine-beta-synthase, while betaine-homocysteine S-methyltransferase (BHMT) and cystathionine-beta-synthase (CBS) increased (interaction P<0.05) in MET calves (calves from methionine-supplemented dams) between d 4 and 14 with a peak at 28 d. Despite a liner increase from d 4 to 28, activity of methionine synthase (MTR) in MET calves was lower on d 4 and 50 d." Bottom line: the precursors of methionine metabolism (betaine, choline and the like) were increased (P<0.05) in MET calves. n = 28. U of Illinois. Kafrelsheikh U, Egypt. Evonik, Germany. Front. Microbial, 2019, https://doi.org/10.3389/fmicb.2019.02159
6. *Do calves benefit from being fed feces from a healthy high performing adult cow?* Holstein calves were dosed daily via CMR 25 g of fecal donor material that tested negative for infectious pathogens and was from healthy, high performing cows. Feces was dosed d 8 – 12 of age. Blood samples were taken weekly to measure health parameters and weekly growth recorded. Calves were fed 6 quarts per d of non-med CMR weeks 1 – 5 and 3 quarts per d week 6, weaned at 42 d. Non-med starter offered ad lib. Body weight tended (P=0.09) greater (112 bs. 116.2 lbs.) for calves fed feces. ADG was not mentioned in the abstract, I assume NSD. Haptoglobin "was reflected in a positive quadratic effect (P=0.04)" in calves fed feces but not in the control, as did a treatment by week "positive quadratic effect" (P=0.07) for IL1B over time in the feces-fed calves and a linear increase (P=0.07) in control. The liver function biomarker paraoxonase tended (P=0.06) greater at week 3 in calves fed cow's feces. n=16. SDSU. U Cattolica del Sacro Cuore, Italy. 145 & T16.
7. *Does late gestation body condition score of dam effect the calf?* Holstein calves from cows with prepartum body condition score of either ≤3.25 or ≥3.75 were monitored.

Blood samples were taken from dam 10 d prior parturition, and calf body weight and body dimension measures were monitored weekly until wean at 42 d. Blood measures were taken on calves at birth, pre- and post-colostrum, and at 7, 21, 42, and 50 d age. DMI tended (P=0.06) less (26.5 vs. 28.5 lbs./d) prepartum for low body condition score cows. Blood fatty acids (P=0.01), ceruloplasmin (P=0.05), and nitric oxide (P0.05) were greater for high body condition score cows at the ten days prior calving juncture. Dams with high body condition score noted lower (P=0.03) calf birth weights (93.7 vs. 98.5 lbs.). No differences noted in 42-d calf body dimensions, ADG or daily starter intake, however, calves born from dams with lower body condition score maintained greater (P=0.04) postnatal body weight (139.6 vs. 131.6 lbs.) at weaning. n=49. U of Illinois. Beni-Suef U, Egypt. Nanjing Ag U, China. Magna Graecia U, Italy. U Cattolica del Sacro Cuore, Italy. 216.

8. *Does close-up cow urine pH correlate with incidence of stillborn calves?* A sole Argentinian herd fed prepartum diet with DCAD of -90 mEq/kg DM. Urine pH was categorized as <6.09 (n=22), between 6.0 and 6.9 (n=46) or ≥7.0 (n=135). Data was adjusted for days from pH evaluation to calving, parity, sex of the calf, type of parturition, season of urine pH evaluation, and body condition score of cows at calving. No correlation (NSD) between urine pH measures and incidence of dystocia, metritis, ketosis, RFM (?), LDA (?) and mastitis, however, cows with urine pH <6.0 were 2.39x more likely (P=0.035) to have a stillborn calf than cows with urine pH ≥6.0. Incidence of stillborn was 13.6% in cows with urine pH <6.0, 8.7% in cows with urine pH 6.0-6.9 and 4.4% in cows with pH ≥7.0, the incidence of milk fever was 0 (<6.0 pH), 4.2% (6.0 – 6.9 pH) and 2.3% (≥7.0 pH), NSD. 200 prepartum cows. U of Georgia, Tifton. National U of La Pampa, Argentina. Gral Pico, Argentina. Bovine Practitioner, Argentina. 217.
9. *Does supplementing to the dam Balchem's ReaShure rumen-protected choline during late-pregnancy effect the calf's metabolome (bodily metabolites)?* Dry cows were fed basal diet of 15.8% CP, 2.9% methionine and Lysine:methionine ratio of 2.6:1 without or with 60 g/d of ReaShure during the final 21 d of pregnancy. Blood samples were taken immediately after birth and calves from cows that received ReaShure noted: glycodeoxycholic acid, lactate, 5'deoxyadenosine, and l-arginine were reduced (P<0.05), while cytidine, alpha linolenic acid, cytosine, 1-aminocyclopropane-1-carboxylate, glutathione disulfide, pipecolate, threonine/homoserine, and 1-proline increased (P<0.05) by rumen protected choline supplementation to the dam. 305 unique metabolites were analyzed including amino acids, benzoic acids, lipid molecules, carbohydrates, purines, pyrimidines, vitamins, and other intermediate and secondary metabolites. n=24 Holstein heifers. Balchem. Instituto de Reproduccion Animal Cordoba, Cordoba, Argentina. T92.
10. *Does supplementing b-vitamins in late gestation affect colostral and calf serum b-vitamin concentrations?* Dietary biotin (0 or 20 mg/d) and dietary folates (0 or 2.6 g/d) combined with weekly injections of B12 (0 or 10 mg) for the final 26 days of gestation were compared in a 2 x 2 factorial. Blood samples from dam were drawn once the week

prior calving. Colostrum was harvested first milking and calves were fed 2.4 kg of their dam's colostrum via nipple bottle within 3 h of birth. Calves were blood sampled and weighed at 25 h after birth. Supplementing b-vitamins increased (P≤0.01) the dam's respective b-vitamin in plasma concentration. Colostral and calf plasma IgG did not differ between treatments (P≥0.14). Biotin supplementation increased colostral biotin concentrations from 35 to 298 ng/mL and calf plasma biotin from 1 to 8.1 ng/mL (P<0.01). Supplementing folates in combination with B12 increased colostrum folates from 673 to 1,094 ng/mL and colostrum B12 from 29 to 58 ng/mL (no stats, so NSD?), and calf plasma folates from 16 to 30 ng/mL (P<0.01) and tended to increase (P=0.09) calf plasma B12 from 0.8 to 1.2 ng/mL (P<0.01). Calves born from dams supplemented the folate/B12 combination were heavier (110.2 vs. 97 lbs.; P<0.01). Folate did not affect birth weight (P≥0.6). n=23 calves). Ag and Agri-Food Canada, Sherbrooke, Quebec, Canada. T93.

11. *Can we effect the newborn calf's glucose management capabilities and liver oxidative stress by manipulating fatty acid nutrition in its dam?* Liver cells from 4 Holstein bull calves (<7 d old) that were cultured for 24 h were then exposed for another 24 h to either a.) no fatty acids (1% BSA), b.) 0.75 mM of a fatty acid blend that mimics that of typical cow's blood at parturition (3% myristic acid, 27% palmitic acid, 23% stearic acid, 31% oleic acid, 8% linoleic acid, and 8% linolenic acid), c.) the same fatty acid blend at 0.9 mM, d.) the same fatty acid blend at 0.75 mM plus 0.15 mM additional palmitic acid, e.) the same fatty acid blend at 0.75 mM plus 0.15 mM stearic acid, f.) the same fatty acid blend at 0.75 mM plus 0.15 mM oleic acid. The expression of genes that are associated with glucose management and oxidative stress were monitored. Adding the fatty acid blend increased expression of these genes, however, spiking additional individual fatty acids had no effect when compared to the 0.9 mM concentration fatty acid blend alone. "These results suggest additional shifts in circulating fatty acid profile within a biological range have minimal additional effects on hepatic gluconeogenic and oxidative gene expression." UW-Madison. T94. Published JDS: https://doi.org/10.3168/jds.2018-16150.
12. *Effect of supplementing bypass methionine (Evonik) during late gestation on future calf performance.* Holstein cows were either supplemented (supplementation rate not disclosed) or not supplemented with bypass methionine in their diets the final 28 d of gestation. Plasma samples from newborn heifer calves were drawn d 0 prior colostrum feeding, 2, and 42 of age. No differences noted in starter intake (P=0.77) during pre-wean period, however, heifers born from dams supplemented with bypass methionine noted greater body weight, hip height, wither height, body length, and ADG (P<0.05). Plasma metabolome profiles were measured in all calves and several amino acid metabolism pathways were upregulated (tryptophan, valine, tyrosine) as was thiamin metabolism and peroxidsomal oxidation in calves from dams that were supplemented. The calf's B-oxidation of fatty acids, TCA cycle flux, and CoA synthesis were all downregulated in metabolism when the calf was born from bypass methionine

supplemented cows. Stats on metabolism up- and down-regulation not shared in abstract. n=20. U of Illinois. Beni-Suef U, Egypt. Evonik, Germany. 315.

Fats and Oils (5 abstracts)

1. *Coconut oil in fat source?* Holstein heifer calves were fed d 1 – 42 CMR composed of either 100% animal fat (whether lard, tallow, or mix not disclosed) or 85% animal fat and 15% coconut oil, and either 1.23 lbs. per calf per day or 1.9 lbs. per calf per day of a 24% C.P., 24% fat CMR in a 2 x 2 factorial study design. Texturized starter (18% C.P.) was offered ad lib. All calves were gradually weaned by cutting to 1x/d fdg. (half daily CMR fdg rate) d 43 – 49. Study occurred December to April. 84 d ADG increased (P<0.05) from 1.74 to 1.85 lbs. in calves fed no coconut oil and from 1.76 to 1.92 in calves fed the formulas with coconut oil by feeding the higher CMR feeding rate (1.9 lbs. per d) as compared to the lesser one (1.23 lbs. per d). 84 d hip height also increased (P<0.01) approximately ½ inch from feeding high rate of CMR vs. low. Fat source had no effect on ADG however, addition of coconut oil tended (P=0.07) to increase 56 d gain in hip height. High CMR fdg rate improved 56 d gain:feed (P<0.01) approximately 8.5% and the addition of coconut oil also improved gain:feed (P<0.05) d 1 – 42. Low CMR fdg rate increased (P<0.01) starter intake to d 42 (+55% to 65%, depending on group comparison) and to d 56 (+33% to 38%) when compared to calves fed high CMR fdg. rate. High CMR fdg. rate increased (P<0.01) fecal score compared to lower CMR feeding rate. Addition of coconut oil reduced (P<0.01) calf treatment costs by 50% in calves fed both high and low CMR fdg rates. 100 calves. U of MN Waseca. Hubbard. M162.
2. *Coconut oil in fat source when feeding alternative protein blend.* Holstein heifer calves were fed 1.5 lbs. per d CMR composed of either a.) 20% C.P., 20% fat, all milk protein, all animal fat, or b.) 25:20 all milk protein, all animal fat, or c.) 25:20 with a combination of plasma, soy isolate and hydrolyzed wheat protein replacing 35.6% of C.P., all animal fat, or d.) 25:20 with the same alternative protein blend, however, with 15% of fat as coconut oil. Weaning occurred d 42 – 49 by cutting to 1x/d fdg (0.75 lbs./d). Neomycin OTC was fed for initial 14 d. Texturized 18% C.P. starter containing Deccox was offered ad lib. Study occurred May – August. Calves fed the 25:20 all milk, animal fat (1.5 lbs. ADG), and those fed the 25:20 alternative protein blend with 15% of fat as coconut oil (1.43 lbs. ADG) tended (P<0.1) to outgain d 1 - 56 the 20:20 all milk with animal fat (1.34 lbs. ADG) and the 25:20 protein blend with 100% animal fat (1.32 lbs. ADG). No differences in d 56 calf starter intake (avg. 67.7 lbs./calf), G:F ratio, health costs or daily fecal scores across treatments. Scouring days tended higher (P<0.1) for calves fed 25:20 alternative protein blend with 100% animal fat as compared to the other 3 treatments. 103 calves. U of MN Waseca. Milk Specialties Global. M163.
3. *Does supplementing lysolecithin in CMR effect performance?* Performance attributes of Kemin's lysolecithin (enzymatically hydrolyzed lecithin) when added at 4 g/calf/d were evaluated when feeding a 24:19 CMR at 6 L/d of 14% solids (1.85 lbs./d). Calves were individually housed, and bucket fed CMR 3 L/fdg 2x/d. Calves had ad lib access to a

24.6% CP, 13.9% NDF starter. 56 d ADG was greater (P=0.01; 0.89 vs. 0.62 lbs./d) in calves fed lysolecithin. Grain intake did not differ (P=0.59; 0.58 vs. 0.63 lbs./d). Feed efficiency improved (P=0.01; 0.68 vs. 0.48 G:F) as did fecal score (P<0.01; 1.53 vs. 0.78) when calves were fed lysolecithin. 32 colostrum-fed calves. U of Sao Paulo. Kemin. M151.

4. *Supplementation of flax oil or soy oil to whole milk and starter?* Holstein heifer calves housed in individual hutches were fed either a.) no added oil (control), or b.) 80 g/d flax oil, or c.) 80 g/d soy oil in pasteurized whole milk (3.8% fat, 3.2% protein, 12.8% solids) fed at 6 quarts/d during the first 5 wks, or in 3 qts week 6 and then weaned, or top-dressed on pelleted starter post wean. During transition oil was added half to milk and half over pellet. Starter was offered ad lib throughout the 12-week trial. Twelve wk avg DMI was 3.95, 3.28, and 3.64 lbs./d for control, flaxseed and soy oil groups, respectively, with control group DMI greater (P<0.05) than flax and soy intermediary (NSD between the two). Calves on flax oil consumed less (P<0.01) DMI in the last two weeks of the study. NSD in ADG. Blood was drawn 3 – 4 h post-fdg for metabolic analyses. Blood hydroxybutyrate and plasma urea nitrogen were not different between treatments, cholesterol was greater (P<0.01) in the two oil treatments and triglycerides greater (P<0.01) in soy. Glucose tended (P=0.05) lesser in calves fed soy. n = 36. SDSU. Total VFA production increased and pH was lesser in calves fed no added oil. Authors note: "supplementation of plant-based oils to young calves affects their metabolic profile." SDSU. Abstract 35.
5. *Concentration of omega-3 and omega-6 fatty acids in colostrum, transition milk and whole milk.* Fatty acids were measured in colostrum milked from primiparous (harvested 5.3 h post-calving) and multiparous (harvested 3.1 h) Holstein cows that consumed the same pre- and post-partum rations, and also in respective subsequent transition milk (harvested d 2 to 5) and whole milk (harvested d 12). Overall, omega-6 linoleic was 0.39%-units greater (P<0.05) and omega-6 gamma linolenic acid tended (P=0.06) 0.008%-units greater in lacteal secretions from primiparous cows vs. multiparous cows, while omega-6 arachidonic acid, omega-3 DPA, and C22n-3 increased (P<0.01) in lacteal secretions measured in multiparous cows as compared to in primiparous cows. The proportions of these aforementioned omega-3 and omega-6 fatty acids declined by a range of between 22.4 to 36.3%, depending on the fatty acid, in comparing levels in the first transition milk verses in colostrum and by milking 12 (whole milk) they were 76.8% for omega-6 linoleic acid, 53.8% for gamma linolenic omega-6 acid, 28.4% for arachidonic omega-6 acid, 27.4% for DPA omega-3 acid, and 35.7% DHA omega-3 acid as concentrated as compared to levels in colostrum. DHA omega-3 acid was several folds more concentrated in colostrum from multiparous cows as compared to colostrum from primiparous cows, and several fold less concentrated in transition milk and whole milk as compared to in colostrum. Arachidonic omega-6, DPA omega-3, and DHA omega-3 acids were lesser in yield (P<0.0.01) in whole milk as compared to colostrum but were stable in concentration in transition milk. "Greater proportions and yields of n-3

(omega-3) and n-6 (omega 6) FA (fatty acids) in colostrum indicate a neonatal requirement for n-FA (omega fatty acids)." University of Guelph, Wageningen University, Ag and Agri-Food Canada, Lacombe R & D Center, Alberta. 209.

Health. Respiratory Disease (Bovine Respiratory Disease, BRD). Toxins. (7 abstract)

1. *Survey of Clostridium populations from dairies across the USA.* 14,265 fecal samples were collected between late 2015 to early 2019 from 368 farms in 26 states in all major dairy regions in the USA. Fecal samples were analyzed for clostridium presence and PCR gene amplification and RAPD fingerprinting was used to map out the genetic diversity of clostridium in the nation's dairy herd. Toxin producing *Clostridium perfringens* was found in over half of the clostridium positive isolates (n=52,322) identified in feces taken from dairy cows while in calf feces a lesser 38.9% (n=6,219) noted the same classification. In both calf and cow 99% of the *Clostridium perfringens* isolates were identified as type A. Other prevalent strains of *clostridium* detected include *Clostridium bifermentans* group (14.4%) and *Clostridium beijerinckii* group (8.6%). "Twenty-eight species of *Clostridium* were detected including other toxin-producing species such as *C sordellii* and *C. difficile*." Populations of clostridium varied (P<0.05) between Idaho, Great Lakes, Mid Atlantic, Florida, I-29 corridor and the Northeast USA as compared to from CA, TX, the Upper Midwest, and Wisconsin. Arm and Hammer. M55.
2. *Antimicrobial use on large Wisconsin dairy farms.* 40 farms with over 250 cows encompassing 6,281 preweaned calves and that maintained computerized animal health records were tracked for antimicrobial use over 12 months. Antimicrobial usage was 10.4 defined daily doses (standardized veterinary defined daily dose) per preweaned calf per year. Antimicrobial use tended (P=0.08) to be associated with colostrum feeding method and mean defined daily doses were 13.7, 8.62, and 12.77 for calves fed via bottle, esophageal feeder, and bottle plus esophageal feeder, respectively. Antimicrobial use also tended (P=0.10) to be associated with preventative use of antimicrobials in milk or milk replacer prewean and mean defined daily doses were 16.11 and 9.49 when antimicrobials were used preventatively and not preventatively preweaning, respectively. UW-Madison. M58.
3. *A systematic review of literature on antimicrobials for use on respiratory diseases in calves.* Search of CabDirect, PubMed, Web of Science and Scopus was conducted 12/2018 and 2,058 publications retrieved that were clinical trials and experimental challenges using antimicrobials in calves <6 mo. 37 trials retained including clinical trials (n=22) and challenge trials (n=15) dating back from 1979. Number of calves in the studies ranged from 11 to 696, the median was 49. 17 were funded by pharma companies. 29 were randomized but only 14 were blinded. Macrolides (erythromycin, tylosin) were the most common tested (n=14). Fever was the most frequent clinical sign (n=26). Only 8 used a respiratory scoring system. 13 examined euthanized calves. "Although considerable numbers of studies have been conducted on antimicrobial use for BRD in calves, very few studies were controlled and randomized." UC-Davis. W22.

4. *Immune stimulant administered subcutaneously prior long-haul?* Jersey and Jersey-cross heifer calves 5 (±2) days old received either a.) 1 ml saline (n=458), b.) 1 mL immune stimulant (Amplimune, NovaVive Inc., Canada; authors reported it as a "mycobacterium cell wall fraction") administered subcutaneously on the source dairy farm in Minnesota (n=449), or c.) 1 mL of the same immune stimulant administered subcutaneously upon arrival at the calf raiser in New Mexico after an 18 h transport (n=453). Calves were health scored and monitored weekly. The number of disease treatment events was lower than the national average. 155 calves were treated at least 1x and 14 died within the first month of life. "The proportion of calves treated for any disease was 9.8, 11.2, and 13.1%; whereas mortality was 1.1, 1.6 and 2.4%" for the group administered immune stimulant prior trip, the group administered immune stimulant upon arrival, and the group administered saline, respectively. NSD in weekly health score measures, however, "calves that received the immune stimulant before transport had reduced hazard of treatment for pneumonia when compared with CON (saline; HR: 0.54; 95% CI: 0.31-0.94; p=0.03)." n=1,360. U of MN, Texas Tech, U CEU Cardenal Herrera, Spain. Novovive, Canada. 453.
5. *What is the prevalence of bacteremia in diarrheic calves and what clinical signs are associated with bacteremia?* "Calves (≤21 d of age) were enrolled across 2 dairy farms into a diarrheic or clinically health group (control to assess aseptic technique)." Calves were classified as diarrheic if presenting with loose to watery stools and based on skin tenting measures, presence of suckling reflex, and ability to stand and were then enrolled if they had not yet received antibiotic therapy. Upon enrollment health assessments were made (respiratory, joint inflammation, naval score, temp, heart, and respiratory rate measured). Blood sample were taken on all calves and cultured to determine bacterial species present using mass spectrometry. Bacteremia was detected in 15.3% (17/111) diarrheic calves and 18.5% (5/27) clinically healthy calves. "There was no association between clinical signs and bacteremia." n=138. U of Missouri College of Veterinary, Columbia. The Ohio Statue U, College of Vet Med, Columbus. 441.
6. *Does temperature and humidity index (THI) effect serum total protein (STP)? What impact does THI have on onset of scours?* STP and days to first scour were assessed retrospectively from farm records from between June 2017 and June 2018 on 420 heifer calves reared on an organic dairy in N. Colorado. Temp and humidity was continuously measured using automated loggers. "STP concentrations were categorized in 3 levels (1 [<5.5; n=11]; 2 [5.5-7.5; n=323]; and 3 [>7.5; n=86])." Calves were also grouped based on maximum temperature-humidity index on the date of their birth into THI1 (<55; n=122); THI2 (56 – 72; n=168); THI3 (>72; n=130). THI correlated (P<0.0001) with the first diarrhea episode with medium time in THI3 (>72) of 12 d, compared to THI1 (<55) 37 d and the mid-range (THI2) 33 d. The hazard ratio for scours presentation for the highest THI range (>72) was 1.76 times (P=0.0008) the hazard ratio of calves born with THI1 (<55). Serum total protein was not associated (P=0.44) with temperature/humidity index (THI). N=420. CSU, Fort Collins. 442.

7. *How do mycotoxins (DON and fumonisin B1) effect calf intestinal epithelial cells?* Calf intestinal epithelial cell line were incubated with 0 to 25 micromol of DON and FB_1 (fumonisin B1). The incubations went through a toxicity laboratory assay method. DON had "the greatest effect on mitochondrial metabolism" in calf intestinal epithelial cells at 0.39 micromole (P<0.05). FB1 had "the greatest effect on lysosomal activity" in calf intestinal epithelial cells at a concentration of 6.25 micromoles (P<0.05). The researchers also found similar toxicity from these two mycotoxins to primary bovine rumen epithelial cells. "Taken together, DON and FB1 had a toxic effect on bovine rumen as well as calf intestinal epithelial cells." BIOMIN Research Center, Tulln, Austria. Ghent U, Belgium. W13.
8. *Prevalence of 5 enteric pathogens on Ohio dairy farms.* "Fecal samples were collected from 277 clinically ill calves across 5 different farms on the first day of diarrheal diagnosis. Genomic techniques, including RT-PCR and ddPCR were used to test for the presence of the 5 enteric pathogens." Statistical methods were used to ascertain risk of mortality by pathogen and time to return to healthy clinical status by pathogen. Prevalence of diseases: rotavirus 75.5% (209/277), K99+*E. coli* 42.8% (115/269), *C. parvum* 28.0% (65/232), coronavirus 10.1% (28/277) and *Salmonella* 3.7% (10/269). "Risk of mortality was significantly higher for calves infected with *E coli* and *Salmonella* with relative risks of 4.32 (95%CI: 1.08, 17.27) and 10.98 (95%CI: 2.39, 50.53) respectively (P=0.038, P=0.002). The pathogens did not, however, have any statistically significant effect on time to return to a healthy clinical status. Only farm was a significant predictor of time to return to health (P=0.0139)." The Ohio State U, Columbus. W11.

Management and Housing (22 abstracts)

1. *Water provision via bucket, nipple-bucket, or no water offered?* Holstein calves suckled the dam's milk from a nipple-bucket ad lib for the first 4 d of life, and then were offered 6 liters daily of milk replacer divided into two portions. Neither poster nor abstract explains fdg method used for milk replacer. Calves were housed individually pre-wean in hutches. Calves were weaned at 8 weeks and no discussion on weaning method except to say all calves were moved to loose housed pens at wean time. From d 5 calves were divided into one of three groups, a.) offered free choice water via nipple-bucket, b.) offered free choice water via normal bucket, or c.) no water provision. Calves were offered free choice starter (no details on starter provided). The study was conducted in the Czech Republic from April to November. No differences noted in 8 weeks ADG (1.01, 0.95, 0.95 lbs./d for calves offered water via nipple-bucket, plain bucket, or no water provision, respectively). Calves fed water via nipple-bucket noted increased (no statistics provided) water intake as compared to calves offered water from plain bucket (70 vs. 51 liters, again, no stats). Starter intake was 31.8, 24.9, and 29.3 lbs. and alfalfa hay intake was 47, 49, and 52 lbs. for nipple bucket, plain bucket, and no water offered, respectively (again, no stats provided). No mortality or culls. Cross-sucking behavior was

individually monitored at weaning and to 6 months age. During the first day weaned no differences were noted in behaviors such as cross-sucking, self-licking, self-sucking, or licking/sucking barn equipment. Calves offered water in a nipple-bucket pre-wean noted increased (P<0.001) willingness to be cross-sucked post-wean when in loose housing (10.5, 5.1, 5.25 - I assume incidences per calf post-wean to 6 months age, not clearly stated in the poster - for nipple-bucket, plain bucket, no water, respectively). Also, the highest incidence of sucking barn equipment was in calves that had consumed water via nipple-bucket pre-wean (no stats). The number of cross-sucking activities tended (no stat) higher in calves offered water pre-wean via nipple-bucket. 63 calves, sex not reported. S. Bohemia U. Nat. Ag. & Food Centre, Slovakia. M138.

2. *Introducing water at d 0 or d 17, any effect on fecal microbiome?* Rectal drawn feces were analyzed for microbiome diversity wks 2, 6, and 10 from calves offered either ad lib water commencing d 0 or d 17 of life. Calves offered water d 0 consumed 0.75 l/d during the 1st 2 wks and once offered water, calves started d 17 consumed +60% more water than those started d 0 during the rest of the pre-wean period (42 d wean). DNA analysis of feces samples were conducted. Calves offered water d 0 onward noted increased observed species (P=0.033) and species richness (P=0.042) at the two wk sampling period vs. those introduced to water d 17 and the number of species and species richness increased over time (P<0.01) becoming similar at 10 wks age. Abundance of *Bacteroides* (gram negative anerobic bacteria generally viewed as beneficial bacteria when in the GI tract) at two wks age was 2.5x greater (P<0.04) in feces from calves starting on water d 0 as compared to d 17, whereas *Lachnospiraceae* (involved in creating butyric acid) and *Streptococcus* in feces from calves started on water d 17 were 2x and 8x higher than those started on water d 0 (P<0.05). At 6 wks age *Streptococcus*, *Fecalibacterium* and *Bifidobacterium* in feces from calves started on water d 0 were 3x, 7x, and 5x greater than those starting on water d 17 (P<0.04), whereas *Bacteroides* were 2x greater for calves started d 17. Calves started on water d 0 noted "species richness and the abundance of some beneficial bacterial taxa (*Bifidobacterium*, *Faecalibacterium*, *Succinivibrio*) in the gut increased compared to those first offered drinking water" d 17. 30 Holstein heifer calves. ISU. M149. JDS 2020 - https://doi.org/10.3168/jds.2019-17258
3. *Are implantable microchips a reliable way to continuously measure body temperature in dairy calves?* Three microchips were implanted subQ in each calf: behind the ear, by the upper scapula, and intramuscularly in the neck. Rectal temps, microchip measures, and tympanic temp were measured hourly in a 24 h study (n=12). Although readings were highly correlated between ear and neck microchip (r=0.78) and between scapula and neck (r=0.75), "rectal temperature had negligible correlations with the 3 microchips sites and tympanic temperature." The highest correlation of rectal temp was with tympanic (r=0.19) temperature. Calves were also monitored for rectal temp and microchip measures daily for 30 d. Correlation was equally poor, reported as negligible between rectal temp and ear or neck microchips and low (r=0.33) for rectal temp and

scapula. Measures between ear and neck microchips were similar (r=0.79). "Our results suggest that microchip temperature readings are consistent among microchips but readings vary by implant site and has a weak linear relationship with rectal temperature." n=10. University of KY. Abstract 47.

4. *Does hot-iron disbudding effect rest and rumination?* Holstein heifer calves 4 to 10 d of age that were disbudded with a heated iron and using lidocaine cornual nerve block and oral meloxicam at the time of the procedure were compared to calves not disbudded from 3 to 21 d post the procedure. All calves were provided starter from 5d of age and half (balanced between treatment groups) had access to hay. Behavior was monitored using ear tag accelerometers (eSense by Allflex). Ruminating behavior was tracked using 5 second scans taken every 5 minutes over a 24 h period monitored on a weekly basis over the test period. During the first two weeks disbudded calves ruminated less (P=0.003) at 10% (+/- 1%) vs. control at 18% (+/- 2%) of total time. Disbudded calves were also more likely (P=0.012) to lie with their head down and still across all weeks expressing this behavior 31% (+/-1%) vs. 26% (+/-1%) of total lying time. The authors summarize by stating, "We conclude that disbudding, in addition to resulting in prolonged sensitivity of the wounds, is severe enough to alter daily behavior patterns for at least 3 weeks, raising additional welfare concerns about the procedure." n=22. UC-Davis. Abstract 54.
5. *Can an automated computer vision system monitor individual dairy calf behavior?* Five group housed calves were individually monitored from 4 to 8 wks age. A wi-fi camera (Amcrest outdoor Wi-Fi camera, model IP2M-956EW) with night vision capabilities installed at 4 meters above the pen acquired images every 5 seconds that were stored in the cloud platform. Individual calves were labeled and classified as either lying, drinking, eating or standing. "A deep neural network approach called MASK RCDNN was implemented to generate the predictions." Python open source framework was used. "The accuracy to recognize a specific calf were 77%, 70%, 80%, 92%, and 80% for calves 1, 2, 3, 4, and 5, respectively," and the "accuracy to predict behavior activity of lying, drinking, eating, and standing were 91, 86, 85, and 100%, respectively." U-W Madison. 57.
6. *Hypothesis: keeping calves cool should improve calf thermoregulation and growth, particularly if the dam was kept cool during pregnancy.* Holstein calves born from dams either heat-stressed during pregnancy (provided shade only) or not heat-stressed during pregnancy (provided shade, fans, and soakers) were postnatally exposed to heat stress with minimal support (shade only) or heat stress with shade plus fans operating at 4 meters/second. Dam's were exposed to heat stress during final ~46 d of pregnancy and heat stress pre- and post-natal was defined as a temperature-humidity index ≥ 68. Skin (shaved rump) and rectal temps and respiration rates were recorded at 7 am, 1 pm, and 7 pm daily, weights were recorded weekly. Milk replacer offered ad lib up to 10 L/d and grain up to 6.6 lbs./d. Weaning commenced d 42. Calves offered maximum post-natal heat abatement born from dams housed with maximum heat abatement strategy

during pregnancy noted the lowest skin temp (P<0.01) at AM (85.9 F) and PM (91.7 F) vs. calves from minimal heat abatement post-natal, as expected, but, surprisingly, also from dams that received the maximum heat abatement during pregnancy noted the highest skin temps (AM 91.7 F and PM 95.5 F). As expected, if calves came from dam's cooled during pregnancy and also cooled post-natal, rectal temps were lower (P<0.01) at the AM and the midday 1 pm measures when compared to calves not cooled post-natal that came from dams also not cooled during pregnancy, however, only calves cooled post-natal noted improved rectal temps at the 7 pm measure. Calves from dams exposed to heat stress but provided maximum cooling post-natal noted lowest respiratory rates at all three daily measures, while calves from heat-stressed dams and exposed to maximum heat post-natal had highest (P<0.01) respiratory rate measures (42.6 vs. 52.5 breaths per minute). If kept cooler during pregnancy birth weight tended (P=0.09) higher (93.4 vs. 89.3 lbs.) as did weaning weight (177.5 vs. 167.2 lbs., P=0.07) as compared to calves exposed to maximum heat pre-and post-natal. Milk intake tended (P=0.07) higher (7.15 vs. 6.7 liters/d) and grain intake increased (P=0.03) during weaning (3.06 vs. 2.45 lbs./d) if calves were cooled post-natal. The presenter reported "heat stress abatement showed higher milk consumption during late morning and the 1 – 7 pm time periods." n=48. U of Florida, Gainesville. U of Puerto Rico. U of GA, Tifton. 144. Published JDS: https://doi.org/10.3168/jds.2019-17926

7. *Does a HOBO Pendant G accelerometer accurately measure lying and standing behavior of dairy calves in tropical environments?* Holstein calves (53, ±20 d old) in Puerto Rico were monitored from 0700 to 0900 on 2/7/2019 by both visual inspection and the accelerometer tied to the right rear leg (perpendicular to the floor). 99% of the recorded lying and standing events were captured by the accelerometer. "The evaluated accelerometers may be useful tools for remote monitoring of lying and standing behavior in dairy calves in the tropics." n=5. U of Puerto Rico. T1.
8. *Does disbudding 5 to 6-week-old calves effect calf behavior, lying time or use of shelter?* Holstein bull and heifer calves (16 d age, 4/pen, 7.4 m^2/calf) fed CMR ad lib via autofeeder for 6 wks and gradually weaned over 9 days were disbudded half in each pen week 5 and the other half week 6 using a hot-iron. Local anesthetic and analgesic was administered prior disbudding and behavior was continuously monitored via video for a 12 h observation period. Disbudded calves were compared to control calves that were handled only. All calves in the pen were handled in both weeks. Milk intake (8.85 L), visit duration (27.13 m), and visit frequency (4.49 visits/12 h) were not affected by disbudding. Frequency (12.4 bouts/12 h) and duration of lying time (483.4 min/12 h) did not differ. A 3-sided open top shelter made of plastic was offered and following disbudding calves entered more frequently (9.1 vs. 6.4 visits/12 h) but total duration in the shelter was similar (162.9 vs. 87.5 min/12 h; disbudded vs. control, P=0.44). U of Florida, Gainesville. T7.
9. *Does exposing calves to pulsed alternating wavelength system (PAWS; Xiant Technologies, CO) effect the hormones melatonin and cortisol and the neurotransmitter*

serotonin levels in young calves? PAWS delivers "specific light wavelengths and patterns" that may effect endogenous hormone production in calves. Holstein heifer calves (3 d old) were housed in sand-bedded polyethylene hutches with continued free access to individual-hutch front aprons of 2.25 m^2 and either with or w/o an interior lamp affixed to the roof of the hutch that was on at all times. Calves were fed and managed to the farm's protocol. Blood samples were collected to determine hormones at 0600 h, 1200 h, 1800 h, and 2400 h, and on d 0, d 2, d 4, and d 14. Hair samples were taken to determine cortisol d 0, d 14, d 40, and d 60. No differences noted in cortisol. No differences noted in serotonin at any time except trend (P=0.1) d 14 when levels were higher (1,870 vs. 1,458 ng/ml) in PAWS-treated calves. Melatonin decreased in PAWS-treated calves overall (P=0.02), d 0 (P=0.02) and tended lower d 2 (0.08) and continued numerically lower d 4 and d 14. n=8. CSU. Texas A & M. Aurora Organic Dairy. T9.

10. *Are genetics parameters associated with calf mortality in Danish beef x dairy cross calves? "*Data from 90,926 crossbred calves was extracted from the Danish Cattle Database and was provided by the Danish research center, SEGES." Young stock survival from d 1 – 30 and from d 31 – 200 was evaluated. "Results showed low but significant heritabilities (0.045-0.075) for both survival traits (periods). "Breed combinations with Belgium Blue cattle sires outperformed all other sire breeds. The lowest survival rates were found with breed combinations with Jersey dams or Blonde d'Aquitaine sires. The breeding values of the sires had an effect on young stock survival that ranged from -2.5 to 3.5% and -5.4 to 4.7% for survival from 1 to 30 d and 31 – 200 respectively." SEGES, Aarhus U, Denmark, Norwegian U of Life Sciences, Norway. 278. *Animal*, https://doi.org/10.1017/S1751731119002386
11. *What is the heritability of respiratory disease, diarrhea, and mortality in Jersey cattle?* A genomic evaluation of wellness traits was conducted by Zoetis in Jersey cattle using producer-recorded data. Calf pertinent findings include: trait – respiratory disease, 276,134 records analyzed notes incidence rate of 13.55% occurring between days 0 – 365 age and heritability 0.055; trait – diarrhea, 186,505 records analyzed notes incidence rate 36.85% between d 0 – 50 age and heritability rate 0.084; trait – mortality occurrence between d 2 – 365 was 5.9% in 380,429 records, and heritability rate 0.103. Zoetis, Kalamazoo, MI. 280. JDS Dec 2019: https://doi.org/10.3168/jds.2019-16903.
12. *When to euthanize calves?* An online survey of AABP veterinarians asked whether to "euthanize immediately," "treat and monitor for signs of improvement," "cull/sell for beef," "or "n/a," and if the veterinarian selected "treat and monitor" then a follow-up question was asked of "how many days . . . to improve . . . (before) euthanasia is the best option?" The only condition where "euthanize immediately" was selected a majority of times (53%) was when a calf was non-ambulatory. "Treat and monitor" was the majority decision for bloat (97%, and 3 d median selection, range 1 – 14 d), diarrhea (100%, mean 7 days, range 2 – 14 d), joint infection (95%, mean 5), severe lameness (79%, mean 5, range 1 – 10), naval infection (100%), nervous system disorder (82%, mean 3 d, range 1 – 7), pneumonia (97%, mean 5, range 1 – 14 d), and traumatic injury

(71%, mean 3 d, range 1 – 7 d). "The wide range of responses for euthanasia timelines make it difficult to establish recommendations for the industry. n=49 dairy veterinarians surveyed. The Ohio State U, Columbus. ISU. 268. Animal: https://doi.org/10.3390/ani10050770.

13. *Validation of an automated cell counter to determine leukocyte counts in calves.* Accurately measuring leukocytes calf-side may be an effective diagnostic tool for discerning antibiotic use and selection. The accuracy of an automated leukocyte cell counter, the QScout BLD test (Advanced Animal Diagnostic, Morrisville, NC) was evaluated by comparison to manual leukocyte differential counts done by microscopy on blood collected from 235 veal calves. Results showed minimal discrepancy between these two analytic systems for classification of neutrophils and lymphocytes, with just 4.2% and 5.8% disagreement in classification, respectively, and moderate agreement for monocytes with 23.3% classified differently, and poor agreement for eosinophils with 70.3% classified differently. U of Guelph. 357. JDS 2019: https://doi.org/10.3168/jds.2019-16370
14. *Follow-to abstract 357 (prior one): is the QScout machine leukocyte cell count test effective in a practical setting?* Leukocyte differential cell counts (DCC) were taken on blood samples from 233 calves upon arrival and on and a subset of 158 calves 72 h post arrival at a veal research farm in Ontario, Canada. The QScout tool was used to measure cells. All calves received a risk assessment upon arrival and a blood sample was taken to measure serum total protein. "At 72 h post-arrival, it was found that for every 10^9 cells/L increase in neutrophils the risk of mortality increased (HR=1.12; P=0.007)." Within the 72-h post arrival subset, 30 of 158 calves died and only 15 received antibiotic treatment in the first 3 d of life. "Machine DCC taken 72 h after the stress of transport has potential for use in selective antimicrobial therapy protocols with the purpose of reducing antimicrobial use without sacrifice to animal health and welfare in veal and dairy beef facilities." Authors also note that on the day of arrival every 1 g/dL increase in serum total protein lowers the risk of mortality (hazard ration =0.38; P<0.001; the magnitude of reduction was not reported). U of Guelph. 452. A related article: JDS 2019 https://doi.org/10.3168/jds.2019-16370
15. *Which factors effect milk intake?* Holstein (n=2,912) and Angus x Holstein F1 cross (n=1,273) calves were monitored for daily milk intake, serum total protein, pneumonia and scours incidence, birth weights and weaning weights from October, 2017 through January, 2019 (n=4,185 total number of calves). Calves were fed pasteurized waste milk that included 20 g/L of a 30% C.P., 5% fat powder and were fed via a Forster-Technik automated calf feeding system (16 pens, 2 feeders per pen) for an average of 68 days. STP was taken between d 1 and 7, and mean STP was 6.8 ±0.69 g/dL. Four variables highly predicted (all P<0.001; R2=0.56) milk intake including feeder, pneumonia incidence, STP, and days on feeder. For each additional day on the feeder calves consumed 5.7 L more milk. "Calves diagnosed with pneumonia had reduced total milk intake (0 cases=484, 1 case=468, 2 cases=458, 3 cases=440, ≥4 cases=420 L)." "Six

variables contributed to predicted body weight at 60 d: feeder, sex, total consumption of milk, and pneumonia incidences (all P<0.0001), breed (P<0.04), and STP (P=0.10; entire model R2=0.38). Calves were 7.0 kg (15.4 lbs.) less at 60 d if they were treated for pneumonia 3 times compared with calves with no treatment for pneumonia during the preweaning period. Holstein calves were 1.2 kg (2.64 lbs.) larger at 60 d than Angus x Holstein F1 calves and males were 4.5 kg larger than females." "No breed differences in milk consumption between Holstein and Angus x Holstein F1 calves and Holsteins had a slight advantage in predicted BW at 60 d." n=4,185. Purdue U. W44.

16. *Further monitoring (follow-up from W44, the preceding abstract reported on) of Holstein and Angus x Holstein F1 cross calves prewean on autofeeders.* Data from calves (n=212) including daily milk consumption (birth-weaning), serum total protein, pneumonia incidence, and lung scores were collected on a commercial farm during the winter 2018-2019. Calves were fed the same regiment as abstract W44: pasteurized waste milk with 20 g/L of a 30% CP, 5% fat powder through a Forster-Technik auto feeder in 4 pens for 55 – 72 days (mean 63.4 d). Thoracic ultrasounds were performed on each individual calf at 57 d using 1 – 3 scale for lung consolidation score (LCS, 1 = no lung consolidation, 2 = consolidation in 1 lung, and 3 = consolidation in 2 lungs). "Birth weight, lung consolidation score (both P<0.0001) and lung consolidation score by breed (P=0.02) affected milk consumption at 60 d (R2=0.33)." Angus cross calves with lung consolidation score of 1 consumed more (P<0.01) milk (452 L) as compared to Holstein with lung consolidation score of 1 (432 L). However, Angus cross calves with lung consolidation score of 3 consumed less (353 L) than Holstein calves who also had lung consolidation score of 3 (390 L, P<0.01). Days on feeder, birth weight (both P<0.01) and milk consumption up to 60 d (P<0.0001) all impacted ADG. "Lung consolidation score proved to be a better predictor of milk consumption and ADG than incidence rates of pneumonia. Overall, F1 and Holstein consumed different amounts of milk in an automated feeding system dependent on lung consolidation." n=212. Purdue U. 508.
17. *Inserting a tub of hardened molasses in group pens with calves on autofeeders, does it help?* A 20 L plastic tub filled with hardened molasses was inserted in each pen of 4 calves at 16 d of age. Calves were provided ad lib milk and starter intake from an autofeeder. Comparison was made with pens in the same housing/management w/o a molasses tub and all calves were monitored via a camera for behavior. The tub was weighed weekly and nutritive visits (calf's mouth in contact with tub's contents) and behavioral visits (calf licking plastic tub or calf's head, i.e. not tongue, touching tub) were monitored for one 24 h period over 5 weeks. Milk and starter intake were monitored pre- and post-wean. Calves were weaned over 9 d beginning at d 42. Holstein heifer and bull calves were in the study. Calves noted 25.3 nutritive visits per day and spent 11.3 m/d during these visits (means reported, min 1.2 and max 26.7 m), and calves also noted 68.7 seconds per d in non-nutritive behavior at the tub and pushed it with their heads 106.3 seconds/d. Dry molasses intake averaged 15.6 g/calf/d week one in the pen and increased to 115.1 g/calf/d at weaning. Milk intake (8 L/d) did not differ

(P=0.88) between calves that had access to the molasses tub vs. those that did not. Also, feeder frequency was similar between groups (11.5 visits/d; P=0.26). Nor was starter intake different (P>0.22). Bottom line: no effect on feed intake or performance from inserting a dry molasses tub in pens of 4 group housed calves on an autofeeder. n=32. U of Florida, Gainesville. W6.

18. *How does calf housing enrichments affect calf performance? Cognitive skills?* Holstein and Jersey calves were housed in either isolated individual hutches or paired and were offered a nipple or a pail to access water in a 2 x 2 factorial study. "At 8 weeks age calves began a visual discrimination task where they had to distinguish between an "X" and "O" cue to receive a milk reward." The reward/test was conducted for 14 consecutive days and calves achieved the learning goal if making the correct choice 80% of the time for 3 consecutive days. Calves housed individually and offered water out of a nipple reached the learning goal faster (P<0.05) than calves fed from buckets and housed either individually or in pairs. Calves offered water in nipples and paired learned faster than calves also paired but offered water in pails (P<0.05). Days to achieve learning goal were 11.5, 16.7, 14.8, and 17.0 for individually housed/nipple-fed water, individually housed/bucket, paired/nipple, and paired/bucket, respectively. "When housed individually there was no advantage to learning when calves had a nipple vs. a bucket (P=0.03); however among the paired calves, those that had the nipple made more correct choices over time than the paired bucket calves (P=0.05." Over the 14 d testing period calves housed individually and offered water via nipple tended (P=0.07) to have improved calf performance (no details provided). n=24. Cal Poly State U. W8.
19. *Which physical attributes correlate with morbidity and mortality after stress of long-transport?* Calves from 11 dairy farms in British Columbia, Canada, (n=373) were assessed by a veterinarian within 24 h prior a 683-mile transport and were monitored for 2 weeks on the destination farm. "Before transport, some calves were experiencing pneumonia (2%), diarrhea (19%), fever (5%), navel disease (11%), or a depressed attitude (4%). FPT was identified in 13% of the calves and chest girth averaged 32 inches and mean age was 4.6 (±2.6) days. In the first 2 weeks after arrival at the calf grower, 23% and 44% of calves were treated for diarrhea and pneumonia, respectively, and 4% died. Diarrhea treatment was negatively associated with chest girth (OR 0.90; 95% CI: 0.83-0.97; P=0.004), and higher mortality was associated with calves that had a depressed attitude (OR: 13.2; 95% CI: 2.9-59.7; P<0.001)." n=373. U of BC. 451.
20. *Survey of Italian calf rearing practices.* Producers in Northeastern Italy were surveyed, facilities assessed for cleanliness and management protocols, and all female calves 1 to 70 d of age measured for weight and wither height (n=271 calves) on 31 Italian dairy farms milking from 35 to 600 cows and producing an average of 17 to 40 kg/head/d of milk. Assessments made July to Dec 2018. Statistical analysis of all factors made. Among weighed calves, BW at weaning was 197.8 lbs. and ADG 1.7 lbs. Stepwise regression analysis selected the following factors to explain ADG: amount of colostrum given within 6 h of birth (26% fed more than 3 L of colostrum within 6 h of birth), dam vaccination

against enteric disease (55% performed this practice), frequency at which colostrum quality is measured (16% measured colostrum quality) and type of colostrum given (48% fed only maternal colostrum) (R^2=0.98). No cleanliness, animal density or grain program were selected by this statistical model. Neither farm size nor milk yield were selected factors for affecting ADG except colostrum quality which was correlated (P=0.027) with high milk yield farms. U of Padova, Legnaro, Italy. W90.

21. *Survey of Australian calf rearing practices.* Surveys from 106 farms and biological samples from 23 farms (202 fecal, 253 calf serum, and 221 colostrum samples) were assessed to determine Aussie calf management practices and how they correlate with calf mortality and morbidity and to assess pathogens that cause diarrhea, measure serum total protein and assess colostrum quality. Farmers reported morbidity and mortality rates on pre-weaned heifers of 23.9% and 5.8%, respectively. *Cryptosporidium spp.* and *salmonella spp.* were the most prevalent enteropathogens with true prevalence of 40.9% and 25.2%, respectively. "Salmonella O-group D was the most prevalent at 67.9% of Salmonella-positive samples, followed by O-group B (17.9%) and C (10.7%). Failure of passive transfer of immunity was observed in 41.9% of samples (mean herd prevalence of 36.2%) and only 19.5% of colostrum samples met the standards of immunoglobulin content and microbiological quality." Michigan State U; Charles Sturt U, NSW, Australia. W89.
22. *Is a heart girth tape measurement of a calf accurate for determining body weight? How about other measures?* Heart girth circumference, withers height, hip height, hip width and scale body weights were analyzed of 329 Holstein dairy heifers at 2 farms in Quebec, Canada. All measures were taken 3x/week during the first 3 weeks of life and every 2 weeks until week following weaning at 76 d of age. "The prediction equation with the highest r(0.99) and the lowest RMSPE (6.87) was using heart girth. The prediction equation with heart girth was BW (kg) = 119.04 – 3.3089 x HG (cm) + 0.02959 x HG^2. Further analyses showed no mean bias (0.11 kg; P=0.51) or linear bias (-0.002 kg, P=0.47) for the proposed equation." The authors point out that these findings report less mean bias and linear bias as compared to the most commonly used equation (Heinrichs et al. 1992; J. Dairy Sci. 75:3576). "Predictions were also possible with the other parameters measured (hip width: r=0.97, RMSPE=9.92; withers height: r=0.97, RMSPE=10.82; hip height: r=0.96, RMSPE=11.38). (RMSPE means root mean square % error, and zero means perfect correlation, if I understand this stat measure correctly). n=329. U Laval, Quebec. McGill U, Quebec, Canada. W50.

Physiology (particularly rumen development) (5 abstracts)

1. *Does cell serotonin concentration effect calf energy metabolism?* Holstein bull calves (18 +/- 2d age) fed 8 L/d CMR and ad-lib grain were injected with either saline (8 mL/d), 5-Hydroxytryptophan (5-HTP; 90 mg/d; tryptophan is a natural precursor to serotonin), or fluoxetine (40 mg/d; commercial serotonin) for 10 consecutive days. No differences noted in circulating glucose concentrations and sporadic effect on liver 5-HT Receptors.

No effect on liver hepatocyte numbers. Injecting 5-Hydroxytryptophan increased ($P<0.05$) circulating insulin compared to the other two treatments, but only nominal effect on pancreas 5-HT receptors and no effect onn pancreas Islet of Langerhans numbers. No effect on circulating non-esterified fatty acid (NEFA) concentrations in plasma, and minimal effect on adipose 5-HT receptors, however, adipocyte numbers increased when injected with 5-HTP. 24 calves. U of Florida, Gainesville. M17. Domest Anim Endocrinol, 2019: https://doi.org/10.1016/j.domaniend.2019.04.007

2. *Effect of dietary protein (nitrogen) on expression of urea transporter mRNA in liver and rumen epithelium of 5 months old Holstein calves.* Calves (381 lbs.) were fed complete pelletized feed composed of either 21.02% CP or 15.05% C.P. for 35 d and then slaughtered. Rumen contents were harvested, and calves fed higher protein noted increased ($P=0.001$) rumen ammonia nitrogen and increased ($P=0.001$) urea nitrogen. Blood samples were drawn 0, 1, 3, and 5 h after feeding the day prior slaughter and concentrations of blood urea nitrogen were higher in calves fed the higher protein vs. the lower protein feed at 1 h ($P=0.005$), 3 h ($P=0.012$) and 5 h ($P=0.016$). Messenger RNA expression of AQP-3 (aquaporins, which facilitate water transfer between cells) was greater ($P=0.011$) in liver of calves fed higher protein as compared to lower protein grain, however, there was NSD in Urea Transporter B and AQP-10 concentrations. Also, NSD in mRNA expression of UT-B or AQ-3 concentrations in rumen epithelium between the two groups. Conclusions: AQP-3 may be an important transporter of hepatic nitrogen metabolism. Yangzhou U. China. 238.
3. *A new system to measure calf fecal RNA*. 200 mg of feces from 6 neonatal Holstein calves were analyzed for RNA measures. Much of this abstract is way beyond my understanding, but the bottom line is this abstract reports analysis of new methods to use fecal RNA measures to determine expression of inflammatory-related genes, and other RNA isolation. SDSU. W18.
4. *Do calf gastrointestinal tract tissue RNA match RNA in calf feces*? Researchers harvested tissue from ruminal epithelial, cecum, large intestine, duodenum, jejunum, ileum, and feces from 6 healthy male 5-week old Jersey calves and determined that RNA was similar in calf GI tract tissues as is in feces from the same calf. This proves RNA analysis of calf feces is strongly correlated with RNA of the calf's GI tract and this method can be used in future research to study molecular adaptations in the calf's GI tract. SDSU. W19.
5. *How does the calf's gut microbiome change from birth to 5 d age*? Holstein bull calves naturally-delivered were removed from the dam, housed in individual straw-bedded pens, administered standardized colostrum at 2-h age (fed at 7% of BW, 180 g IgG fed) and again at 12 h (3% of BW, 120 g of IgG fed) and then bottle-fed milk replacer (one pound/d 26:16, 15% solids). "Colonic endoscopic biopsies were performed within 2 h and at 5 d postnatal. Calves were euthanized at 7 d of age to obtain jejunal, ileal and colonic digesta. Data from colon biopsies were compared between d 0 and d 5 and data collected at d 7 were compared among digesta (jejunum, ileum, and colon)." Real-time quantitative PCR (qPCR) was used to determine bacterial density. Total bacterial density

in the colon-mucosa decreased from birth to 5 d age (respectively, 9.18 vs. 8.57 $\log_{10}$ rRNA genes copy number/g, P<0.01). *Bifidobacterium* spp., *Lactobacillus* spp, and *F. prausnitzii* increased from birth to d 5 (P<0.01), whereas *E coli* decreased (P<0.01) at d 5 (0.37% of total bacteria) compared to at birth (10.6% of total bacteria). "Total bacterial density was higher (P<0.01) in colon compared with the ileum and jejunum." Total short chain fat acid concentration was higher (P=0.03) in the colon compared to the ileum and jejunum. "Acetate was the predominant SCFA throughout the GIT (>90% of total SCFA)." Authors noted that SCFA in young calf are 30% of what is in an adult cow and most is in the colon (speculating caused by undigested milk?). n=20. U of Alberta, Edmonton. U of Guelph. Lallemand, France. 443.

Starter Grain & forage feeding (13 abstracts)

1. *Chopped grass hay, cottonseed hull pellets, or oat hull pellets in post weaning texturized grain?* Holstein calves (59 d of age, 167 lbs. BW) housed in groups of 4 per pen received grain composed of 25% whole corn, protein supplement, liquid molasses and either a.) 25% whole oats with 5% chopped grass hay, b.) 9.5% pelleted cottonseed hulls, c.) 9.5% pelleted oat hulls, or d.) 5% chopped hay. All diets formulated to be 21% CP. Starch ranged from 35 – 39% and NDF ranged from 12 – 17%. Calf DM intake (P<0.01), ADG (P<0.05), and body condition score change (P<0.05) were greater for calves fed grain composed of 9.5% pelleted cottonseed hulls as compared to the blend of 25% whole oats with 5% chopped grass hay, or the 5% chopped grass hay alone, but gain to feed ratio tended less for calves fed grain with 9.5% pelleted cottonseed hulls vs. 5% chopped hay (P=0.09). Dry matter intake as a % of BW was least for calves fed the grain with 25% whole oats and chopped hay combo (2.95%) and hay alone (3.05%) and greatest for calves fed pelleted cottonseed hulls (3.35%; P≤ 0.05). Hip width change was less (P<0.05) for the 25% whole oats and chopped hay combo vs. all other treatments (P<0.05). Digestibility was determined via fecal samples d 19 – 23 of the trial (d 78 – 82 of age) and no differences were noted except in NDF digestibility which was greater (P<0.05) for calves fed grain composed of 9.5% pelleted oat hulls vs. 9.5% pelleted cottonseed hulls or 5% chopped hay, but did not differ from the grain composed of 25% whole oats and 5% chopped hay. Calves fed pelleted cottonseed hulls as a roughage source noted improved ADG, however, the researchers hypothesize this was due to gut fill because feed conversion was also relatively poorer. 96 steers. Provimi. M121.
2. *Pelleted or texturized grain 0 – 4 months age, with or w/o Neotec5 functional fatty acid (2 x 2 factorial).* Holstein calves were fed whole milk powder (25% CP, 29% fat) at 1.45 lbs./d to 39 d and then 0.73 lbs./d until weaned d 42 and were also provided ad lib access to 20% CP grain in either texturized or pelleted form. Neotec5 was added to reconstituted milk at 25 g/d from d 0 – 39 and 12.5 g/d until weaned, and then continued forward via starter grain fed to the same calves. A control supplement composed of the vitamins and trace minerals and other additives, but no fatty acids fed via NeoTec5, was supplemented to the milk but not the grain of the same calves post-

wean. The texturized starter included whole corn (37%), whole oats (25%) molasses (3%), soybean meal (24.9%), wheat midds (4.5%) and additives, while the pelleted feed was composed of rolled corn (44.3%), soybean meal (25.4%), wheat midds (20%), 2.5% dry molasses and additives. Both grains were comparable in ADF (7.5%), NDF (about 15%), and starch (about 39%). The respective grain was mixed with 5% chopped hay in the post-wean grower phase. Wk 0 – 8 starter form had no effect on calf performance, however, addition of fatty acids of Neotec5 increased ADG (P=0.02), G:F (P=0.02) and hip width change (P=0.03). The addition of Neotec5 added to respective grain form fed week 0 – 8 resulted in an increase in ADG from 1.37 lbs. to 1.61lbs. in calves fed texturized starter and from 1.52 lbs. to 1.61 lbs. in calves fed pelleted grain. Wks. 8 – 16, again, no effect in performance from starter form, however, addition of Neotec5 increased ADG (P=0.001) and hip width change (P=0.02) and tended (P=0.09) to improve G:F. The addition of Neotec5 in grain fed to calves wks. 8 – 16 increased ADG from 2.35 lbs. to 2.53 lbs. when added to texturized starter and from 2.27 lbs. to 2.57 lbs. when added to pelleted starter. Digestibility measures were estimated using acid insoluble ash as a marker on 5 calves per treatment during weeks 4, 6, and 8, and on 3 calves per treatment weeks 10, 13, and 16. During wks 4, 6, and 8 the addition of Neotec5 resulted in increased digestibility of DM (P=0.01), starch (P=0.04), NDF (P=0.01), ADF (P=0.01), and CP (P=0.01) and all digestibility improvements from addition of Neotec5 nursery phase carried on in the grower phase during weeks 10, 13, and 16 measures. The texturized form of starter increased DM (P=0.001) digestibility in nursery phase but decreased DM (P=0.001) digestibility in the grower phase, and increased NDF (P=0.02), ADF (P=0.04), and CP (P=0.001) digestibility during pre-wean measures but not post-wean. The pelleted form of starter also increased starch (P=0.001) and fat (P=0.03) digestibility during post wean measures but not pre-wean. 48 male calves. Provimi. M123.

3. *Concurrent poster to M123, same calves and same study. Pelleted or texturized grain 0 – 4 months age effect on starch digestion.* Starch digestibility measures were taken wk. 4, 6, 8, 10, 13, and 16 during the trial presented in poster M123. Calves fed texturized starter noted increased (P<0.05) apparent total tract digestibility of starch week 6 as compared to calves fed pelleted starter, however, fecal starch % increased (P<0.05) with week during week 10, 13, and 16, in calves fed texturized starter, and correspondingly, total tract digestibility of starch decreased. In calves fed pelleted starter grain, total tract digestibility of starch maintained at a stable and higher-level week 10 (P<0.05), week 13 (P<0.01) and week 16 (P<0.01) as compared to in calves fed texturized starter. Provimi. M183.
4. *Feed hay mixed in with grain or feed hay separately?* Holstein calves fed 28:15 CMR at max intake of 2.43 lbs./d with a two week wean transition to a 56 d wean were offered texturized calf starter with either a.) Klein grass hay, theoretical cut ¾ inch length, mixed in the grain at a 90:10 ratio on an as-fed basis, or b.) the same grass hay and starter fed separately from d 14 to 90. The texturized grain contained 23.4% CP, 3.9% fat, 20.9%

NDF and 32.2% starch and was composed of flaked grains and a pellet in a 34.2:65.8 ratio on a DM basis. Starter was offered daily and quantities left unconsumed each day were collected and mixed weekly and measured for particle distribution. Pre-wean (d 14 – 41) no differences noted in solid feed intake, ADG, body dimensions or feed efficiency. During the two weeks weaning transition (d 42 – 55) all performance parameters were the same except feed efficiency, which improved (P<0.05, 0.53 vs. 0.50) if grain and hay were fed separately. Post-wean (d 56 – 90) feed intake (P<0.05, 7.8 lbs. vs. 7.25 lbs./d), ADG (P<0.01, 2.86 vs. 2.64 lbs./d), and heart girth gain (P<0.05) all increased if grain and hay were fed separately as compared to fed mixed. NDF intake as a percent of solid feed DMI was greater (P<0.01) weeks 3, 4, 5, and 6 and lesser week 9, 10, 11, and 12, for calves fed hay separate from grain as compared to hay mixed into grain at 10% inclusion. Calves fed the 90:10 starter/hay mix consumed starter and hay at 77:23 and 96:4 ratio pre- and post-wean, respectively. The particle distribution of the mix was 1.2, 14.2, 82.3, and 2.3% on the upper (19mm), second (7 mm), third (4 mm) sieves, and bottom pan in the Penn State Particle separator, respectively. When grain and hay were mixed calves sorted for large particle (>19 mm) in the grain/hay mix pre-weaning (P<0.05) and against large particle in the same mix post-weaning (P<0.01). The researchers conclude that mixing hay at 10% in grain reduces calf performance as compared to offering both separately even if calves sort against hay to some extent. 40 heifer calves. Zen-Raku-Ren, Fukushima, Japan. U of Alberta, Edmonton. M124.

5. *0, 5%, or 10% chopped grass hay in grain?* Holstein calves 56 d age were fed starter grain composed of chopped (app. 1 inch) hay at 0, 5%, or 10% inclusion. The base texturized starter grain was composed of 37% whole corn, 25% whole oats, 35% supplement pellet (soybean meal, wheat midds, alfalfa meal, animal fat, micro's including Deccox) and 3% molasses, and its nutrient profile was 38.4% starch, 20.5% C.P., 14.1% NDF, 6.8% ADF, and 3.8% fat. Calves were monitored to d 112. ADG was 2.54, 2.46, and 2.1 lbs. per d for 0%, 5%, and 10% grass hay inclusion (linear P=0.01). Hip width change was 1.8", 1.85", and 1.61" for 0%, 5%, and 10% grass hay (linear P=0.02, quadratic P=0.07). DM intake, % BW was 2.81%, 2.92%, and 2.67% for 0%, 5%, and 10%, respectively (linear P=0.06; Quadratic P=0.01). G:F was 0.336, 0.319, and 0.309 for 0%, 5%, and 10% grass hay, respectively (linear P=0.02). Apparent total tract digestibility was estimated using fecal samples from floor pens collected d 64 – 68 in age, d 85 – 89 in age, and d 106 – 110 in age. DM digestibility was 77.6%, 77.8%, and 71.1% for 0%, 5%, and 10% grass hay, respectively (linear P=0.001; quadratic P=0.001). Starch digestibility was 92.8%, 92.5%, and 90.8% for 0%, 5%, and 10%, respectively (linear P=0.03, quadratic P=0.36). NDF digestibility 33.7%, 44.8%, 33.4% for 0%, 5% and 10%, respectively (linear P=0.89; quadratic P=0.001). ADF digestibility 26.7%, 41.4%, and 29.8% for 0%, 5%, and 10%, respectively (linear P=0.27; quadratic P=0.001). C.P. digestibility 79.6%, 79%, and 72.5%, for 0%, 5%, and 10%, respectively (linear P=0.001; quadratic P=0.003). Fat digestibility 77.1%, 73.8%, and 68.1% for 0%, 5%, and 10%, respectively (linear P=0.002; quadratic P=0.52). "Digestion of organic matter and crude

protein increased from d 64 – 68 to d 85 – 89 and then decreased from d 85 – 89 to d 106 – 110." 48 calves. Provimi. M144.

6. *High fiber grain (27% soybean hulls, 31% NDF) vs. low fiber grain (11% soybean hulls, 22% NDF) vs. the same low fiber grain + free choice grass hay*. Calves individually housed on raised slats w/o bedding were fed 4 L/d CMR (12.5% solids, 22% CP, 16% fat, 1.1 lbs./d) to d 56 and ad lib access to either a.) 22% NDF calf starter composed of ground corn, soybean meal and 11% soy hulls (18.5% C.P.), or b.) 31% NDF calf starter composed of the same ingredients but 27% soy hulls at expense of ground corn in the diet (18.9% C.P.), or c.) the low NDF (low soy hull) grain with free access to grass hay (11.8% C.P. 69.9% NDF). Ruminal characteristics were measured weeks 4, 6, and 8. Feeding grass hay decreased total short chain fatty acids (P=0.06) but the proportion of individual fatty acids (acetate, propionate, butyrate) did not differ. Rumen N-NH3 (a measure of conversion from dietary N to microbial N) was greater (17.6 mg/dL, P=0.01) for calves fed the lower (22% NDF) soy hull diet vs. the higher (31% NDF) soy hull diet (9.9 mg/dL) or the lower soy hull diet with free access to hay (10.7 mg/dL). Behavior was monitored by taking measures every 5 m over a 10 h period 1x per week. Calves fed grass hay spent more time (68.8 m, P<0.05) in a 10 h period consuming solid diet as compared to calves fed the high soy hull, 31% NDF diet (41.1 m). Eating time for calves fed the low soy hull 22% NDF diet were intermediary (45.8 m, NSD). Calves fed hay noted more time ruminating (48.9 m/10 h period; P=0.02) as compared to the calves fed high NDF, 27% soy hull grain (17.8 m). Calves fed low soy hull, 22% NDF grain were intermediary (41.8 m). Non-nutritive oral behaviors were numerically reduced (36.2 m per 10 h; P=0.11) if fed hay as compared to high soy hull (58.1m) or low soy hull grain alone diet (51.6 m). 35 dairy calves. U of Sao Paulo/ESALQ, Brazil. M143.
7. *Free choice whole shelled corn or free choice chopped grass hay?* Calves were fed 6 L/d whole milk to d21 and then 4 L/d whole milk until gradual wean d56, and either a.) ad-lib starter grain (24% C.P., 14% NDF, 46% NFC) alone or the same grain supplemented with ad lib access to either b.) chopped Tifton hay (long-stem, Bermudagrass-like, hot-climate grass), or c.) whole corn grain. Rumen fluid was collected 2 h post fdg wk 6 & 8. Fdg long-stem chopped hay increased DMI (0.81 lbs. control (b), 1.37 lbs. hay (a), 0.94 lbs. whole shelled corn (b); subscripts different P<0.05). Hay supplementation increased NDF intake after the 5th week (P<0.05). Fdg supplemental hay increased starter grain intake (P<0.05), NDF intake (P<0.05) and NFC intake (P<0.05) relative to fdg. supplemental whole shelled corn. Fdg. hay increased 56-d ADG (1.07 lbs. control (b), 1.43 lbs. hay (a), 1.07 lbs. corn (b) subscripts different P<0.05) and final BW (134.7 lbs. control (b), 151.9 lbs. (a), 138.7 lbs. (b), subscripts different P<0.05). Hay supplementation increased acetic acid concentration relative to fdg. corn (P<0.05), whereas, feeding whole shelled corn increased rumen propionic acid concentration relative to fdg. hay (P<0.05). Butyric acid, total short chain fatty acids and ruminal pH were not affected "suggesting whole corn grain did not cause acidosis." 39 dairy calves. U of Sao Paulo/ESALQ, Brazil. M151.

8. *Does conditioning pellet for 2m or for 4 m at 185 F (85 C) result in improved calf performance?* Calves were fed pelleted starter grain that was either a.) not super-conditioned, b.) super-conditioned at 185 F for 2 minutes, or c.) super-conditioned at 185 F for 4 minutes. Calves were weaned d 56 and continued to be monitored until d 70. Post-wean ADG increased (P<0.05) in calves fed pelleted grain super conditioned for 4 m (2.02, 2.16, and 2.56 lbs. ADG for calves fed control, super conditioned 2 m, and super conditioned 4 m, respectively). Starter intake, F/G, and fecal score not effected pre- or post-wean. Ammonia nitrogen was reduced and molar proportions of propionate of total VFA's tended (P=0.085) to increase post-wean in calves fed grain processed 4 m, otherwise no effect on rumen function. Blood glucose and insulin increased (P<0.05) in calves fed pellet processed 4 m. No differences in any digestibility measure pre-wean, however, starch and DM digestibility increased (P<0.05) during the post-wean period when calves were fed pellets super-conditioned for 4 m. Dry matter digestibility was 76.44, 78.83 and 79.59%, and starch digestibility was 94.71, 96,63, and 97.4% for control, super-conditioning pellet for 2 m, and for 4 m, respectively. 36 Holstein calves. Ferdowsi U of Iran, Kangwon Nat. U, Republic of Korea. M153.
9. *Does supplementing wheat straw effect calf performance? How about chopped length of the straw?* Calves aged 15 – 90 d age were offered either a.) starter grain as sol dry feed offered, b.) same starter with ad lib access to wheat straw chopped at 1 mm particle length, c.) same starter w/wheat straw chopped at 4 mm, or d.) same starter w/wheat straw chopped at 7 mm. All calves had ad lib access to water, starter grain, and respective straw treatment. Whole milk was fed at 7 L/d, d 15 – 25, 6 L/d, d 26 – 35, 5 L/d, d 36 – 45, and 3 L/d, d 46 – 56 d wean. Study ended d 90. Calves fed starter w/no forage (control) noted lesser 1.78 lbs. ADG (P<0.05). With ad lib access to 1mm, 4 mm, and 7 mm chopped length wheat straw calves gained 1.98, 1.99, and 2.05 lbs. ADG, respectively (NSD between straw treatment groups) d 15 - 90. NSD in F/G. During post-wean and overall periods forage and total DMI were not affected by wheat straw chop length, however, control calves noted lower (P=0.05) starter intake and DMI. Rumen pH was recorded d 35 and 90 at 4, 8, and 24 h post morning feeding via stomach tube and calves fed straw noted increased (P<0.05) rumen pH at 8 h after feeding on d 35 (5.5 pH control vs. range of 6.01 to 6.16 for straw-fed groups), at 4 h on d 90 (5.32 pH control vs. range of 5.63 to 5.91 for straw-fed groups), and at 8 h on d 90 (5.48 pH control vs. range of 5.77 to 5.97 for straw-fed groups). 40 Holstein calves, half male half female, 106.5 lbs. BW. U of Tehran & Arak U, Iran. W186.
10. *Texturized calf starter composed of various protein sources*. Calves were offered ad lib access to a texturized 18% CP calf starter with Deccox composed of either a.) multiple sources (control, predominantly soy with mix of either canola, distillers, linseed, sunflower, or alfalfa), b.) 25% sunflower, 75% soybean meal, c.) 25% linseed meal, 75% soybean meal, or d.) 100% soybean meal. Across treatments starch content varied from 28 to 30.6%, ADF 9.6 to 11.7%. All calves were fed 1.23 lbs. daily of a 20:20 containing to d 35 and half rates to wean d 42. Neoterra supplemented d 1 – 14. NSD noted prewean

(d 1 – 42, avg 1.43 lbs.), post-wean (d 43 – 56, avg. 2.53 lbs.), or overall (d 1 – 56, avg. 1.7 lbs.). Hip height gain similar at avg +4.6 inches d 1 – 56. No differences in health parameters. Post-wean d 43 – 56 starter intake was greater (P<0.05) for calves consuming starter composed of 25% linseed and 75% soy (82.2 lbs./calf) as compared to control-fed calves (soy + mixed sources, 74.7 lbs. consumed) with the other two treatments intermediary. 108 Holstein heifer calves. U of MN Waseca. Hubbard. M172.

11. *What's the effect of grain form (texturized vs. pellet) and addition of fatty acids on starch digestibility?* Calves were fed a 20% CP, 38 – 40% starch grain in either texturized or pelleted form and either with fatty acids (NeoTec5g) or w/o fatty acids in a 2 x 2 factorial. Texturized grain contained 37% whole corn and 25% whole oats. Pelleted grain was composed of 44.3% rolled corn and 20% wheat midds. All calves were fed 25:29 whole milk powder at 14% solids at 1.45 lbs. d 1 – 39 and then half-rate to 42 d wean. NeoTec5g inclusive was fed via milk replacer to the treatment group, same additive minus fatty acids but inclusive of added vitamins, trace minerals, and other additives to the control and at weaning, the respective additive was then supplemented via grain. The same respective starter was fed with inclusion of 5% chopped grass hay d 57 to end of study d 112. Fecal starch and total tract starch digestibility was determined week 4, 6, 8, 10, 13, and 16. In pelleted starters fecal starch content increased (P<0.01) from 1.2% week 4 to 4.7% week 8 and then was stable through week 16. In texturized starters fecal starch content increased (P<0.01) from 2.1% week 4 to 7.2% week 8 and continued increasing (P<0.05) to approximately 12% week 16. Total tract starch digestibility was similar week 4 and 6 (98.6%) but declined (P<0.05) week 16 (96.7%) in calves fed texturized grain. Total tract starch digestibility was greater week 13 and 16 (P<0.01) or tended to be greater (P<0.10) week 10 for calves fed pelleted grain vs. texturized grain. DMI did not differ between groups. Fatty acid supplementation improved (P<0.04) total tract starch digestibility week 4 – 8 but had no effect week 10 – 16. 48 Holstein bull calves. Provimi Research Center, Cargill. M183.
12. *Post-wean TMR inclusive of 10%, 17.5%, or 25% grass hay, which is better?* Holstein calves weaned at 6 weeks of age were housed individually and studied week 7 to 16. Texturized calf starter (20% CP) and free-choice grass hay were offered week 7 – 9, and then calves were converted to a TMR composed of one of three concentrations (DM-basis), a.) 10%, b.) 17.5%, or c.) 25% chopped grass-hay offered ad lib. Initial 9-week weight averaged 179.9 lbs. (±19.8 lbs.). Blood samples were drawn at 9, 10, 12, 14, and 16 weeks, and fecal samples collected (12 calves) for 4 d at 11 and 15 wks. Both feed and feces were analyzed for DM, NDF, ADF, and starch to determine total tract digestibility. Although frame did not differ between groups, bodyweight decreased linearly with increased grass hay (P<0.01). NSD between weeks 7 – 9, however, ADG, DMI, and met. Energy intake all decreased linearly with increased grass hay (P<0.01). Plasma BHA tended (P=0.07) to decrease with increased grass hay. NSD in DM or starch digestibility, but NDF and ADF digestibility increased linearly with increased grass hay (P<0.01 and P=0.06, respectively). n=45. Penn State U. 296.

13. *Liquid condensed whey solubles top-dressed on starter pellets?* Holstein (33) and Brown Swiss (15) 2 day old calves, mix of heifers (30) and bulls (18) were blocked by breed, sex and birth date between the following groups, either a.) no condensed whey solubles, b.) 40 ml/d condensed whey solubles, or c.) 80 ml/d condensed whey solubles. Whey solubles were top-dressed on starter grain pellets daily. Calves were fed 5.7 liters/d pasteurized whole milk week 1 – 5 and half rate week 6 to wean d 42. Average 12-week DMI was 3.37, 3.62, and 3.7 lbs/d, for control, 40 ml/d, and 80 ml/d condensed whey solubles, respectively, tending increase (P<0.10) post-wean for both whey solubles groups. ADG 1.5, 1.59, and 1.65 lbs/d, not different, but body weight gain, withers height, and heart girth tended greater for condensed whey solubles groups. NSD in other frame measures and in body condition score. Health scores not different but fecal scores less (P<0.01) post-wean for lower feeding rate of whey solubles. Rumen fluid was taken week 8 and 12 and blood samples taken weekly and rumen VFA profiles, PUN, glucose, cholesterol, triglycerides, and BHB were similar across treatments. n=48. SDSU. 544.

Veal (2 abstracts)

1. *Which arrival traits impact profitability the most when purchasing male calves for veal placement?* 5,010 calves were evaluated assessing demographic variables and health traits at arrival in the veal barn. "A deterministic model was constructed using the prevalence of health abnormalities, weight at arrival, source of the calf, number of days in the barn, base carcass price, days to mortality, feed costs, season at arrival, interest rate, housing location, carcass dressing percentage, and costs associated with housing, labor, utilities, trucking, and health to calculate the breakeven purchase price and an estimate of profit." During the oral presentation the author pointed out that of all variables, housing location (barn 1, 2, or 3 in the study) had the largest impact on breakeven price with arrival weight (100 lbs. seemed to be the best target arrival weight, weights below this resulted increased mortality) second, dehydration score third (risk of early and late mortality were most sensitive to the level of dehydration measured at arrival) and source of calf and naval score fourth and fifth, respectively. Dehydration score was reported as the biggest predictor of early mortality and naval score was second. The winter season noted lowest mortality and best ADG and the fall season noted the worst. Housing location noted the most variability, dehydration score second and season third. Predicted ADG was 2.47 lbs., predicted mortality 2.2% d 1 – 21 and 3.7% post d 21. Average predicted profit predicted as $5.36 per calf. Key points: when purchasing veal calves monitor incoming body weight (100 lbs. or greater), ensure no clinical dehydration, and examine for normal umbilical cord. U of Guelph & Elanco. 103. JDS 2019, https://doi.org/10.3168/jds.2019-17220
2. *What blood metabolites (biomarkers) are associated with mortality in grain-fed veal calves?* Blood samples were taken upon arrival on 909 calves of unknown age from January to December 2017 at a grain-fed veal facility in Ontario and analyzed for the

following metabolites: creatine kinase, cholesterol, haptoglobin, manganese, serum total protein, iron, cobalt, zinc, selenium, and molybdenum. 67 calves (7.5%) died over the 11-week period under observation. "The level of cholesterol, haptoglobin, and iron were associated with mortality. For every 1 mmol/L increase in cholesterol, the odds of mortality are reduced (odds ratio: 0.57; 95% CI: 0.37-0.91; P=0.02). Compared with the referent category (less than 0.15 g/L), if the calf had a haptoglobin concentration between 0.15 and 0.16 g/L (Odds ratio: 2.24; 95% CI: 1.02-4.89; P=0.04) or 0.19-3.3 g/L (odds ratio: 2.38; 95% CI: 1.03-4.37), calves had an increased odds of dying. Compared with the referent category (less than 2.1 mg/mL), calves with iron concentrations of 2.8-3.6 mg/mL (OR: 2.12; 95% CI: 1.03-4.37; P=0.04) had a greater risk of mortality. These results demonstrate that cholesterol, haptoglobin, and iron could serve as biomarkers to identify calves at high-risk of mortality when measured at arrival to a veal facility." n=909. U of Guelph. U of KY. W17.

Weaning (1 Abstract)

1. *2-step or 4-step weaning process?* Holstein calves were fed a 23%CP:20% fat at 1 lb./d (4 liters) eased up to 1.37 lbs./d (5 liters) to d 12, and then groups were split into a 2 x 2 factorial and fed a 21:19 either slowly increasing to a peak of 9 liters/d or feeding the same milk maintaining 5 liters/d to weaning. These two groups were further split into two weaning strategies in a 2 x 2 factorial study designed either weaned via a 2-step, or 4-step process commencing d 30 to a complete wean d 46. Calves were then monitored to d 59. Calves fed the high quantity of CMR consumed 77 lbs./calf and those fed the low quantity of CMR consumed 55 lbs. over 45 d. Calves fed lower quantity of CMR consumed more starter intake pre wean (P<0.01, 1.1 vs. 0.66 lbs./d) and during weaning (P=0.02, 3.52 vs. 2.64 lbs./d) than calves fed high quantity CMR. Post wean, calves fed either CMR strategy consumed similar quantities of grain (P=0.13, 4.84 and 5.28 lbs. lbs./d for low and high fdg rate CMR strategy, respectively). ADG was similar prewean (P=0.4, 1.32 vs. 1.1 lbs./d for high and low CMR, respectively), and post weaning (P=0.6, both 1.76 lbs./d), however, during weaning calves fed the low quantity CMR fdg rate tended (P=0.09) increased ADG (1.98 vs. 1.76 lbs./d). Feed intake did not differ between the two weaning strategies both during weaning (2-step and 4-step both averaged 3.1 lbs./d) or post-weaning (both averaged 5.1 lbs./d), nor did ADG vary based on weaning strategy during weaning (both averaged 1.76 lbs./d) or post-weaning (P=0.2, 1.54 lbs./d for 2-step and 2.0 for 4-step wean). 84 calves. U of Guelph. M141. JDS 2020: https://doi.org/10.3168/jds.2019-18023.

Vitamin and Mineral Supplementation (4 abstracts)

1. *Supplementing 25-hydroxyvitamin D3 vs. Vitamin D3 during an endotoxin challenge d 91 of life*. Fiver groups of Holstein bull calves were fed CMR supplemented daily with either approximately 600 IU vitamin D3 (NRC), 2,500 IU vitamin D3, 5,000 IU vitamin D3, 63 mcg 25-hydroxyvitamin D3 (approximately equivalent to 2,500 IU vitamin D3), or 126 mcg 25-hydroxyvitamin D3 (app.

equivalent to 5,000 IU vitamin D3). The respective D source or dose was added first to milk replacer and then to grain post-weaning and was fed daily from d3 to d 131 of age. Amounts of D supplemented were adjusted weekly based on BW with vitamin D3 supplemented at 0.25, 1.75, 3.25, 0.15 and 0.25 microgram/kg BW for treatments 1, 2, 3, 4, and 5, respectively, and with 25-hydroxyvitamin D3 supplemented at 1.5 and 3.0 microgram/kg BW for treatments 4 and 5 only. Calves were weaned d 56 and had access to grain throughout the trial (5% hay d 116 onward). Calves were challenged with lipopolysaccharide (LPS, 0.1 microgram/kg BW) day 91 via IV injection. Avg rectal temps from 1 to 72 h post-challenge were 102.4, 102.4, 101.8, 102, and 102.4 F for 600 IU D3, 2,500 IU D3, 5,000 IU D3, equivalent to 2,500 IU 25-hydroxy, and equivalent to 5,000 IU 25-hydroxy, respectively, with calves supplemented 5,000 IU D3 and 2,500 IU 25-hydroxy resulting in significantly (P=0.01) lower rectal temps post LPS challenge. Reactive oxygen metabolites were also measured post-LPS challenge as a measure of tolerance to endotoxin challenge and researchers found the same (P=0.01) differences between groups. Serum 25(OH)D concentration were 13.3 ng/mL when calves were fed 600 IU D3, increasing to 22.9 for 2,500 IU D3, to 30.2 for 5,000 IU D3, to 40.8 for 2,500 IU 25-hydroxyvitamin D3, and to 74.2 for 5,000 IU 25-hydroxyvitamin D3. Serum 25-hydroxy-vitamin D3 concentrations reported are averages for each group d 35 to d 91 and across groups peaked about d 35. The increment of increase was greater (P<0.01) for 25 hydroxy-supplemented calves as compared to those supplemented vitamin D3. Serum phosphorous was greater (P=0.03) for all treatments compared to control. NSD was found between treatment groups in serum haptoglobin, calcium, Mg, NEFA, glucose. 45 calves. U of FL Gainesville. M33.

2. *Concurrent poster to M33. 25hydroxyvitamin D3 and vitamin D3: effect on growth and metabolites and minerals*. Same bull calves as in M33 were monitored for growth, metabolites and minerals. Vitamin D3 (what's commonly supplemented) is converted to 25-hydroxyvitamin D3 (25(OH)D3) in the liver. 25-hydroxy is the precursor to the active hormone. ADG to 56 d wean was greater (P<0.05) for calves fed control diet (570 g/d) and those fed either 25-hydroxy supplemented diet (500 and 510 g/d, low and high fortification, respectively) as compared to those fed vitamin D3 (430 and 390 g/d, low and high fortification, respectively). There were 9 calves per treatment group. Height and feed intake did not differ. Calves fed either added vitamin D3 or 25-hydroxy noted increased (P=0.01) serum betahydroxybutyrate (BHB) concentrations. No effect on IgG1 or IgG2. M154.
3. *Concurrent poster to M33 and M154. Vitamin D3 and 25-hydroxyvitamin D3 – effects on mineral metabolism in calves.* Same bull calves as in M33 and M154 slaughtered d 131 and tissues collected. Series of blood samples taken commencing 15 d prior slaughter. Series of fecal and urine samples taken commencing 4 d prior slaughter. DMI monitored final 14 d of life. No effect from any D source on DMI, final d 131 ADG or BW, F/G, digestibility or retention of Ca or Mg, or the weight or dimensions of kidneys, spleen, liver or the pancreas. Supplementing 25-hydroxy increased (P=0.04) serum Ca concentrations relative to supplementing vitamin D3 whereas supplementing vitamin D in general tended (P=0.08) to reduce blood Ca. Calves fed 25-hydroxy tended (P=0.06) to have increased bone density. M158.
4. *Does adding 25-hydroxyvitamin D3 result in increased growth?* Holstein heifer calves were fed daily either 2,500 IU vitamin D3 or the same 2,500 IU vitamin D3 + 1.7 microgram 25-hydroxyvitamin D3 (25D), which is equivalent to an additional 2,500+ IU D3 equivalency. Calves were enrolled d 7 – 14 of life and were offered CMR and grain ad lib. CMR access was via an

automated fdg system and treatments applied daily to individual calves. Avg milk intake d 35 to 49 was 8 and 9 L/d for calves fed 2,500 IU vitamin D3 and the 25D-fed calves, respectively. NSD in starter intake. Calves fed the added 25D were +4.4 kg (P<0.01) at 56 d and +3.7 kg (P=0.01) at 112 d. ADG d 1 – 112 was 1.72 and 1.81 lbs. (P=0.04) for 2,500 IU D3 and 2,500 IU D3 + 25D, respectively. Calves fed 25D were +1 cm taller (P=0.06) at 112 d. Neutrophil, oxidative burst and phagocytosis were measured d 0, 3 and 7, post weaning and no differences were noted. 143 calves. U of FL. DSM.