ADSA 2020. Virtual Conference. June 21 – 24, 2020. *J. Dairy Sci 103 (Suppl1).*
Individual paper listed by abstract number in summary statements. **101 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 was always offered (didn't repeat it to save space) ad lib. 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 (1 Abstract)

1. 8L/d 24:18 CMR fed over 60 d: ADG, MR intake, S. intake, F.E. were same between all-milk or when 35% CP replaced w/ soy alone, wheat alone, or 50:50 blend. Uruguay. 140.

Additives in milk replacer, whole milk, or starter grain (27 abstracts):

1. Calves reared in winter on a typical CA strategy using whole milk w/ 5% bovine plasma (~22g/d) + CMR 22:20 to 14% solids note ↑body weight, ↑health. CSU Fresno. 50.
2. Calves reared in summer on typical CA strategy using whole milk w/either 5% bovine or porcine plasma + CMR 22:20 to 14% solids note ↓scours, ↑health. CSU Fresno. M66.
3. Calves fed on autofeeder noted ↑pellet intake around weaning when fed 0.8% butyric acid from protein encapsulated tributyrin. Na butyrate ↓grain intake. Grober. M72.
4. Tributyrin supplemented at 2.8 and 5.6 g/kg of waste milk linearly increased post-wean ADG & DMI, ↓scours, ↓blood concentration of inflammation marker. China Ag U. 48.
5. Blend of organic Se, Co, Cu, Zn, Mn, Fe + Biomos outgained inorganic TM in grower (d 57 – 168). Starter intake ↓ d 1 – 56 when fed organic vs. inorganic TM's. Waseca. M104.
6. One of two Lucta sweeteners may have averted ↓in drinking speed due to addition of a mix of bitter compounds to 8 L of milk fed at 39 d age. No stat diff. IRTA. Lucta. M105.
7. Na Butyrate at 0.24%, 0.48% or 0.72% of 22:20 CMR had no effect on ADG, G:F, starter intake or health. ↑Na butyrate tended ↓hip height gain. Waseca. Alltech. M108.
8. Calpis bacillus subtilis DFM fed at 3 billion cfu/d with or w/o MOS had no effect on any performance measure, minimal effect on health. Same w/ 7.5 g/d MOS. Waseca. M110.
9. Prebiotic, Bacillus or combo: NSD mortality, culls, diarrhea, pneumonia. Combo ↑56 d ADG. Prebiotic & combo ↑post-wean ADG. Bacillus ↓ADG, ↓crypto. UC Davis. 146.
10. Feeding 1 g/d Smartcare in CMR and 5 g/d NutriTek yeast product on grain ↓clinical disease, ↓lung damage, ↓virus shedding during BRSV challenge. ISU. Diamond V. 188

11. Feeding 1 g/d Smartcare in CMR & 0.8% NutriTek in grain ↑temp, ↑respiratory rate, ↑proinflammatory cytokine, ↓grain intake during LPS challenge. Purdue. Diam. V. 266
12. Fdg 1 g/d Smartcare in CMR and 0.8% NutriTek in grain improved G:F d 57 - 112, NSD ADG, NSD scours, NSD lung scores, ↓respiratory treatments by 2/3's. Purdue. Dia. V. 49.
13. Aleta Beta Glucan (2g/d) fed in 6 L/d CMR ↑final BW gain, ↓fecal score and days with diarrhea, tended to ↑ADG and G:F, NSD in starter intake. Kemin. U of Sao Paulo. M111.
14. VetAgro AviPlus R combo organic acids and plant botanicals supplemented for 8 weeks at lo & hi dose: NSD in health, growth, blood measures. Healthy calves. Cornell. M112.
15. Post-wean d 62-88, AviPlus restored a portion of ADG and DMI lost due to heat stress. 95F resulted in 17% ↓grain DMI and 36.4% ↓ADG compared to 68 F. Cornell. M100.
16. Lactoferrin and Schizochytrium (kelp & algae) reduced fecal scores and improved immune parameters in newborn Holstein calves challenged with E coli K-99. China. 141
17. In ↑health status herd +fish oil/flax seed oil to colostrum with or w/o 200 mg vit E noted no improvement in calf health & minimal effect on inflammation. Mich St. U. T17
18. Blend of Se yeast, MOS, Yucca, Vitis Vinitera & essential oils (New-Start Probiotech) NSD in ADG or scours but ↓crypto oocyst shedding d 9 (peak). CVCQ, Probiotech, PQ. T29
19. Herbal extract CalfPerk administered at 3 h age (CR administered at 4 h) did not affect calf vigor score (measured 2.5, 3.75, 24, 48, 72 h), blood BRIX, or serum IgG. U KY. M56.
20. In vitro assays show Lactobacillus animalis LA51 counteract damage to gut cells and bacillus licheniformis ↓binding and bacillus subtilis ↓viability of E coli. C. Hansen. 265
21. Bacillus subtilis & Bacillus licheniformis strains were shown in vitro to ↓gas production & ↓cfu count of clostridium, ↑enzyme production, ↑biofilm. Chris Hansen. 233
22. Bacillus tested in hi and low health status herds. Hi health status it improved ADG. Low health status it reduced overall health problems, ↓scours, ↓meds. MDG. 187.
23. Apex essential oil fed in CMR did not affect blood metabolites or IGF-1 but may improve immune function as measured in basophils and platelets. Federal U. Brazil. M106
24. Apex had no effect on organ weight of spleen, bladder, liver, kidney, rumen, heart, but ↑pancreas, ↑s. int. & ↓respiratory tract. Apex ↑villus height ileum only. Brazil. M107
25. 3 different Nordic seaweeds were examined added to 8 L/d whole milk. NSD in ADG, organ weight, rumen, or s. int. pH, or in total VFA. ↓butyrate, ↑acetate. Aarhus. 46.
26. Same 3 different Nordic seaweeds added to whole milk noted NSD in ADG, serum total protein, albumin, IgG, IgM. Acute phase proteins tended better w/seaweed. 47.
27. Systemic review of prebiotics in dairy calves screening for proper study design and bias found 5 of 21 ↑ADG & 4 of 10 ↓scours. 48% had group size less than 15. UC-Davis. 144

Colostrum, colostrum replacers (CR), and feeding transition milk (11 abstracts):

1. Calves fed transition milk (milkings 2 – 4) for 4 d post colostrum noted ↑ADG d 6, ↑serum IgG, ↓cough, fecal, nasal & ear health scores & ↑innate immunity. MSU. M61.
2. Calves fed 4 L heat-treated colostrum by 2 h were then tubed at 12 – 16 h either 3 L colostrum or 3 L milk. NSD in ADG or hip height. 2^{nd} fdg colostrum ↑STP. Cornell. M69.

3. Calves provided 6 L of maternal colostrum were monitored for STP and IgG d 1, 4, 8, 12, & 16. Serum total protein and serum IgG decline over first 16 d of life. UC Davis. M93.
4. Feeding transition milk d 2 to 5 ↑intestinal development (villous length & width, mucosal & submucosal thickness), ↑cell proliferation, ↓pH, vs. CMR. Mich. State. 51.
5. Autofeeder calves experiencing ↓20% milk intake or ↓30% drink speed assigned to 1 L/d CMR or 1 L/d Colostrum replacer for 3d. Colostrum ↓BRD incidence. U of KY. 190.
6. Colostrum status had no correlation with days at conception after 1st calving, 1st lactation MY or survival to 1st and 2nd lactation. 193 heifers traced to 2nd Lact. CSU. T156.
7. Survey of 18 (1,409 cows) farms colostrum mngt, STP, colostrum Brix. 57.4% STP ≥6.2, 20.5% <5.7. 94% feed within 2 h. Colostrum brix avg 25.1%. 3.7 L/heifer. Cornell. T26.
8. 1,631 Holstein calves monitored for STP at calf ranch placement noted +56% odds death, ↑morbidity, ↓ vit. A, E, glucose if poor vs. excellent STP. NSD ADG. U of ID. 262
9. Prevalence of FPT was 24% as measured on both auction (n=386 male) and dairy farm (n=444, mixed) calves in Ontario. Heavier calves ↓respiratory score. U Guelph. 264.
10. Use of cephaprin benzathine at dry off did not affect colostrum microbiome (except a difference in type of diversity) or presence of antibiotic resistance genes. Cornell. T24.
11. STP is 8% heritable and genetic correlation exists between STP and cow longevity and improved calving traits. ↑STP resulted in earlier calving in 1st lactation. PSU. 196.

CMR and milk feeding rates and strategies (10 abstracts):

1. 2 x 2: 1.5 vs. 3.0 lbs./d CMR & lo (12%) vs. hi (35.6%) starch pellet. ADG ↑in hi MR fdg pre- & ↑ in low MR post-wean. Grain intake effects GIT more than starch. Guelph. M60.
2. M60 follow-up: Inflammatory response not linked to ↑fermentation or starch intake. Diet particle size may influence GIT pH more than starter starch & NDF. Provimi. 221.
3. In winter, feeding +20% CMR first 3 weeks of life ↑ADG more than ↑ CMR fat from 17% to 34% (equal energy intake to ↑CMR fdg. rate). ↑energy improved G:F. Provimi. M63.
4. 2 x 2: 1 vs. 1.5 lbs/d CMR & low 18% vs. hi 25% fat. Jerseys. Prewean high fdg rate ↑ ADG, not frame & ↓fiber dig. 4 months no advantage hi fdg rate or hi fat. Provimi. M74.
5. 20:20 1.25 lbs./d vs 28:18 2 lbs./d or hybrid 28:18 2 lbs./d d 1 – 21, then 20:20 to wean. 84 d ADG↑ with 2 lbs./d vs. other 2. Total DMI same. 2 lbs./d ↑scours. Waseca. M127.
6. Calves fed 24% fat 37% lactose CMR ad lib noted ↓(8.8 vs. 7.6 L/d) intake vs. 18% fat 44% lactose NSD prewean ADG. NSD wk 1 – 12 ADG, grain intake, G:F, BHB. Guelph. 143.
7. 1.5 or 1.75 lbs./d & 2x or 3x/d in GA summer or winter (heat stress model). ↑CMR, ↑ADG both seasons. ↑to 3x/d ↓pancreatic insulin secretion both seasons. U GA. 338.
8. Follow-up to 338: Acetaminophen measured abomasal emptying rate and 3x/d fdg accelerated emptying rate in both summer and in winter. U of GA. 339.
9. Calves fed 6 L/d of either saleable whole milk, waste milk (cows treated with AB's) or same waste milk pasteurized. Comparable (NSD) ADG & body dimensions. Brazil. M67.
10. Addendum to M67: Presence of antibiotics in milk ↑reticulo-rumen weight. Pasteurized waste milk ↑acetic and propionic acid vs. non-AB saleable milk. Brazil. M68

Dry cow strategies and their impact on the calf (5 abstracts):

1. Microbiome is most similar between vagina and cow oral cavity and meconium. Microbiome in calf feces becomes more like cows as it eats starter. VA Tech. 128.
2. Calves from cows fed either sulfates or Alltech organic TM's in dry period noted NSD in colostrum volume, BRIX, IgG but noted ↑total IgG mass (303 vs. 376 g IgG). Guelph. 145
3. Calves from cows fed Ajinomoto rumen protected lysine 28 d prepartum noted ↓medical events (males only); ↑plasma methionine and lysine. U of Ill. T112.
4. Additional poster to T112 on bypass lysine to dry cow: author summarizes that calves from dams fed bypass lysine had ↑overall growth & intake. Stats confusing. U of Ill T113
5. Calves from dams with high body condition score (≥3.75 on scale of 5) noted ↓birth weight, ↓post-natal BW, & ↑proinflammatory cytokine at birth. U of Ill. 77.

Fats and oils nutrition (2 abstracts):

1. No effect on health or growth of 15% or 25% of fat as coconut oil in low (46 lbs/calf) fdg rate CMR. No benefit to 25% over 15% coco oil in hi (81 lbs./calf) CMR. Waseca. M109.
2. 30 ml/d canola oil vs. 30 g/d fish oil added to CMR solution. Fecal and nasal scores and blood lactate tended ↑ for canola. NSD ADG, rectal temp, starter intake. U of GA. T16.

Health, respiratory Disease (BRD), enteric disease, and immune function (15 abstracts):

1. Mixed buffer (bicarb, Na acetate, citrate) powder & liquid acetate corrected acidemia from scours quicker than basic bicarb electrolyte. All 3 worked. Animix. Mapleview. 191.
2. 9,099 calves monitored Indiana dairy. Heifers w/↑ pre-wean ADG, ↑ genomic milk indexes note ↑1st lact milk & repro. Less BRD = ↑repro & ↑survival. Purdue. *M58, 76*.
3. Survey of 105 Canadian dairy farms: 98% use antibiotics to treat BRD, 33% have written protocol. Elevated breathing, cough, fever leading indicators to use AB's. Guelph. T19.
4. Same 105 Canadian farm survey: 60% use producers who treat diarrhea with antibiotics check for fever & other indicators, >50% have a written treatment protocol. Guelph. 231
5. Leukocyte counts by QScout BLD test measured at arrival associated w/future veal calf morbidity & ADG. Taken at 72 h were associated w/mortality & morbidity. Guelph. 189.
6. Diarrhea, drug use & mortality monitored on 10 farms for 1 Y pre and post use of a decision tree protocol to treat scours. 85% ↓drug use. No diff in mortality. Guelph. 230.
7. Infrared camera poorly correlated w/rectal temps, particularly when ↑ambient temps. Infrared had good sensitivity and specificity (60% & 71%) in detecting fever. Guelph. 290
8. Review of 9 published studies examining antibiotic or coccidiostat use in young calves found high outcome bias. 7 of 9 improved clinical signs or fecal score. UC Davis. T27.
9. Survey CA calf raisers notes 10% ↓in antibiotic use in milk & 5% ↓ in grain post VFD. Pre-VFD 50% did not use AB's in milk. Neo, OTC, CTC, Sulfa major drugs. UC Davis. 408.
10. Cost per occurrence of bovine respiratory disease d 0 – 120 based on DairyComp305 records on 104,100 heifers & BRD data vary from $240 to $269. M. Overton. Pfizer. 261

11. Bacterial lipopolysaccharide intramuscular injection in 5 – 11 mo. old calves noted ↑ serum cortisol, ↓WBC & lymphocytes, ↑proinflammatory cytokines. Guelph. T20.
12. E coli were sensitive to sulfonamides in 82.35% of fecal samples collected from 14 Holstein calves. Federal U of Pelotas. Brazil. M113.
13. Telomere is part of a chromosome. This study shows it shortens during illness. PCR analysis to measure telomere may be a health indicator in the future. Penn State. M70.
14. Calves with high fecal score d 0 – 21 noted ↑respiratory disease, ↓starter intake, ↑rectal temp, ↑lying time, ↑lying bouts/d, ↓body weight over time. SDSU. 232.

Management and housing (17 abstracts):

1. Calves offered 3 qts 100 F water via bottle noted ↑ water intake wk 0 – 5 in winter vs. ambient temp ad lib water via pail. Post-wean starter ↑ w/ bottle. Provimi. M73.
2. Calves fed 70 lbs. CMR noted ↑ADG d 1 – 56 if paired. When grouped d 57 – 112 calves reared individually d 56 made up difference. Same 1.89 lbs. ADG d 112. Waseca. T4.
3. Paired hutch calves sharing an exterior apron noted ↑starter DMI at weaning vs. individual hutch-housed calves. Slow-flow teat nipple pail ↓cross sucking. UW. 228.
4. A massive scoping review of auto-feeder studies fond milk consumption, drinking speed, & rewarded/unrewarded visits the most used measures to track disease. Guelph. T28.
5. Disbudded calves where pain mitigation was used spent more time in 1.2 x 1.2 m shelters preferring visual and physical barriers from pen mates (8/pen). U of Fla. 225.
6. Heat stress ↓IgG, IgM, & complement during final 60 d of pregnancy. Immune status colostrum-fed newborn same as dam. Heat stress NSD in calf immunity. U Fla. T21
7. Heat stress both pre- and post-natal drives calf behavioral thermoregulation like ↓feed intake, ↑standing time & maximizing lying surface area to lose heat. U of Fla. 257.
8. Heat stress resulted in ↑rectal temp, ↑respiratory rate, ↓frame growth and ↑respiratory disease but no effect on ADG. Fan ↑air velocity, ↓ temp. U of Fla. 263.
9. Grouping calves (5/pen) in either 60, 50, or 40 ft^2 pre-wean noted similar cleanliness & standing time but ↑standing bout number/d & ↓duration w/60 vs. 50 or 40. U Fla. T5.
10. Calves housed individually or paired (2 wks), then grouped, were behavior tested at 4 wks. Paired calves approached unfamiliar calves, human, object more readily. U Fla. T2
11. Calves housed individually or paired (2 wks), then grouped on autofeeder. Paired noted trend ↓duration scours and ↑efficiency of autofeeder use. NSD milk intake. U Fla. T1.
12. following cautery disbudding, xylanase sedation w/local anesthetic & NSAID ↓ behavior indicators of pain but also impact suckling behavior for up to 48 h. U of Guelph. 226.
13. Rubber ring castration causes longer lasting pain vs surgical castration as measured by wound licking behavior, causing ↓ADG, ↓grain intake, slower wound healing. U BC. 227
14. Wisconsin survey on disbudding practices: 73% disbud prior 8 wks. (caustic paste #1); 40% use pain control (Meloxicam, NSAID); 27% comply with F.A.R.M. rules. Guelph. 224
15. Inserting a forefoot weigh scale into an autofeeder to capture daily body weight and ADG showed high correlation to a digital scale (Pearson correlation 0.989). U MN. 337.

16. Cows reared as calves suckling a nurse-cow produced more first lactation 305 d milk, tended heavier 30 d into lactation, and got thru a maze more quickly. Slovakia. M101.
17. 3-D imaging calf dorsal surface w/point cloud deep learning techniques 95.5% accurate. Accuracy during growth requires more images. Replaces ear tags/RFID. UW-Mad. 135.

Physiology (particularly gut microbiome) (8 abstracts)

1. Dosing young calves w/rumen fluid from high performance dairy cows changes the calf's rumen microbial population, ↑grain intake, ↑rumen papillae length. UW-Madison. 406.
2. Fecal microbial composition 5 – 24 d old calves: 57% Actinobacteria & 38% firmicutes at phyla; 47.3% Bifodobacterium, 11.1% Blautia, 9.7% Lactobacillus genus level. Wash. T22.
3. Feeding fecal microbiota transplants from healthy calves changed the gut microbiome in 4 – 12 d old recipients but also ↓likelihood of recovery from diarrhea. Wash. State. 45.
4. Fecal microbiome examined in sick & healthy Holst & Jersey calves. Microbiome ↓ diverse in sick calves. ↑Bifidobacterium in healthy; ↑lactobacillus in sick. Wash. St. 229
5. Fecal Gene expression is futuristic tool to evaluate calf health. "Internal Control Genes" (ICG's) measure fecal gene expression. This study ID'd the top ICG's. SDSU. T23.
6. RNA diversity measured in feces & jejunum tissue. 5-week Jerseys. 90%+ of genetic RNA found in feces was found in GIT tissue. Genes expressed 3:1 tissue vs. feces. SDSU. T25.
7. Rectal extracted feces microbiome monitored wk 2 – 3 thru wk 10 – 12 notes considerable variation pre-wean becoming more stable & like adult. U of PA. 75.
8. Fecal phyla: Fusobacteria ↑ diarrheic calves, Proteobacteria & Actinobacteria ↑ healthy calves. Fecal genera varied between healthy and diarrheic calves. U of PA. M71.

Starter grain & forage feeding (5 abstracts)

1. Fdg hay ↑frame growth. Hay can be too long. Pelleted hay may encourage gut fill and poorer F/G. 5% hay (1" particle length) should be included 2 – 4 m of age. Provimi. M59.
2. Whole corn & cracked corn performed comparably week 12 to 16 in a texturized grower composed of 5% hay. Starch dig ↑from 89.7 to 92.8% w/cracked corn. Provimi. M62.
3. In winter feed +20% CMR or high fat CMR during wks. 1 - 3? Both strategies ↑G:F. Both ↑wk 2 ADG. In colder climate hi fdg rate ↑ADG d 1 – 56, NSD grain. Provimi. M63.
4. ↑fat in starter to 7% via extruded hydrogenated palm pellet ↑112 d BW gain (+18.8 lb), ↑grain intake post-wean, ↑ME intake, no effect rumen function. Wageningen. 142.
5. 10-month slaughter weight similar on Holstein x Zebu cross calves fed corn, corn + 31.7% millet, or corn + 37.1% sorghum. Corn + 10% babassu mesocarp ↓'er. Brazil. M64

More complete analysis of each ADSA 2019 research paper:

Alternative proteins in CMR (1 Abstract):

1. *35% of CP as micronized soybean meal, 35% of CP as hydrolyzed wheat protein, or 35% as a 50:50 blend of each, performance?* Male Holstein calves averaging 88 lbs. were fed 20% of bodyweight 2x/d of 12.5% solids (8 L/d) milk replacer solution composed of 24% C.P. and 18% fat with protein composed of either a.) milk protein 100%, b.) 35% of protein from micronized soybean meal and 65% milk protein, c.) 35% of protein from wheat gluten and 65% milk protein, or d.) 35% of protein from a 50:50 blend of the same soy and wheat protein sources and 65% milk protein. Calves were offered 21% CP starter grain starting d 21 onward and calves were gradually weaned commencing week 8 to complete wean d 60. No mention of analysis of colostrum status at placement. Total feces were collected d 14 to 18 to determine digestibility and blood samples were taken d 23 and 51 to measure glucose and insulin. Over the 60 d study daily gain averaged 1.62 lbs./d, final body weight averaged 189.4 lbs., milk replacer intake averaged 2.07 lbs./d and calf starter intake averaged 0.86 lbs./d with NSD in any parameter between treatment groups. DM digestibility was greater (P=0.01) for the 100% milk protein diet (94.8%) as compared to the soy (91.1%) or wheat (91.3%) with the 50:50 blend intermediary (92.6%). CP digestibility was 91%, 82.8%, 82.7%, and 88.3% in control, soy alone, wheat alone and 50:50 blend, respectively, with milk protein greater (P<0.01) than soy or wheat alone and the 50:50 blend intermediary. CP intake was greater (P=0.02) for calves fed the 50:50 blend as compared to soy alone or the 100% all milk with the wheat alone diet intermediary. Blood insulin was lower (P=0.03) for the all milk compared to wheat alone or to the 50:50 blend with soy intermediary. Bottom line: digestibility and performance was the same as an all-milk protein when feeding a 50:50 mix of micronized soybean meal and wheat gluten at 35% of CP in a 24% CP CMR fed at 8 L/d and feeding either the same soy or wheat as the sole milk protein replacement resulted in the same ADG, MR intake, Starter intake and feed efficiency but noted lesser week 2 C.P. and total DM digestibility. n=48 IPAV, Veterinary faculty, Uruguay. UdelaR, Paysandu, Uruguay. Royal Agrifirm Uruguay Group. 140.

Additives in milk replacer, whole milk, or starter grain (27 abstracts):

1. *Effect of adding plasma to whole milk in winter season in a traditional CA calf ranch scenario.* Holstein bull calves sourced from 8 different dairies and placed in early January were fed 4 quarts daily to d 49 and then half rate to wean d 56 of either a.) whole milk fortified with 22:20 CMR to 14% solids, or b.) calves fed APC Lifeline Protect at arrival meal (1 lb. in 2 quarts solution) and then whole milk with Nutrapro B spray dried plasma added at 5% of total solids fed (app. 27.2 g/d) combined with 22:20 CMR to reach 14% solids. Commercial pelleted starter, 18% CP, was offered. Calves were housed individually in wooden, 3-hole calf hutches. Calves fed plasma had heavier

(P=0.04) 14 d bodyweight (95.9 lbs. vs. 98.4 lbs.), however, NSD at d 56 (163 vs. 164.3 lbs. for control and plasma, respectively). Gain:feed tended (P=0.08) better for plasma group (0.47 vs. 0.53). Avg attitude score was improved (P=0.02, 0.366 vs. 0.0915) as was avg. fecal score (P=0.04), 0.9634 vs. 0.6976) for calves fed plasma. Also, author reported significantly fewer days with fecal score +3 (no stat or details provided) if fed plasma. Number of treatments was reduced from 11.96 to 7.32 (P=0.02) per calf and treatment expenditures per calf were also reduced from $16.48 to $6.19 (P=0.05) if fed plasma. NSD in mortality, however, after 3 culls reported to be due to clinically sick with therapeutic treatments deemed enough to alter results, mortality was 2 in the plasma group and 5 in the control. Income over expenses was calculated to improve +$3.77 per calf if fed plasma. Take home: adding plasma in the milk feeding program increased body weight, improved health outcomes and reduced treatments in a winter, CA calf-rearing system. n=54. CA State U Fresno. APC. 50.

2. *Effect of adding plasma to whole milk in summer season in a traditional CA calf ranch scenario.* Holstein bull calves sourced from 12 local dairies and placed June, 2019, and reared in wooden, California style calf hutches were fed either a.) whole milk with added 22:20 CMR to 14% solids, or, b.) APC Lifeline Protect as an arrival meal (1 lb. in 2 quarts solution) and then whole milk with Nutrapro P spray dried porcine plasma (app. 27.2 g/calf/d) combined with the same 22:20 CMR to 14% solids, or c.) APC Lifeline Protect as an arrival meal and then whole milk with Nutrapro B spray dried bovine plasma (app. 27.2 g/calf/d) combined with the same 22:20 CMR to 14% solids, to d 49, and then half-feeding d 50 – 56 d wean. Commercial pelleted starter was offered. Calves were provided a midday bottle of electrolytes d 3 to 17 if ambient temp exceeded 100F and if experiencing a diarrhea event thereafter. Body weight was taken d 1, 14, 21, 28, and 56. Results: NSD in bodyweight at any measure, d 56 weights were 164.7, 165.9, and 167.3 lbs. for control, pork plasma and bovine plasma, respectively. Average fecal scores were reduced (P<0.05; 0.93, 0.81, 0.79, control, P and B, respectively) and attitude improved (P<0.05; 0.053, 0.0329, 0.0351 for control, P and B, respectively) if either plasma source was fed. NSD in number of treatments per calf (14.57, 10.21, 11.31, control, P, and B, respectively) or in individual calf treatment costs ($45.05, 11.88, 25.73, for control, P and B, respectively). No difference in mortality (mortality 16, 13, and 13%, for control, bovine, and porcine plasma, respectively) or respiratory scores. Take home: calves had improved health if fed either bovine or porcine plasma. n=90. CA State U, Fresno. APC. M66.
3. *What is the effect on feed intake, health, and growth from supplementing protein encapsulated tributyrin in CMR? How does it compare to sodium butyrate?* Holstein calves of mixed sex were fed 26:18 CMR with either a.) no butyrate, b.) 0.8% dry matter butyric acid from a proprietary protein encapsulated tributyrin, or c.) the same 0.8% butyrate from sodium butyrate. Calves were housed in pens in groups of 7 and on an autofeeder. Calves could consume up to 9 L/d (150 g powder/L) providing 3 lbs. of milk replacer solids daily. Gradual weaning occurred between d 54 and 63. Pelleted starter

(details not disclosed) was offered ad lib. Calves consumed an avg of 165.3 lbs. of CMR, NSD between groups. Pre-wean (0- 53) pellet intake NSD, 21.2, 18.6, and 26.5 lbs./calf for control, sodium butyrate, and tributyrin, respectively, however, pellet intake tended (P<0.10) greater for calves fed tributyrin weeks 4 and 5. Week 7 pellet intake was greater (P<0.05) for tributyrin fed calves (6.15, 5.1, and 7.78 lbs./d for control, sodium butyrate, and tributyrin, respectively). ADG was reduced (P=0.02) post-wean when sodium butyrate was fed compared to control and tributyrin-fed calves. Calves fed sodium butyrate noted increased (P=0.0593) incidence of medical treatments. Take-home: calves fed encapsulated tributyrin noted increased intake of pelleted starter around weaning; sodium butyrate resulted in poorer post-wean ADG and poorer grain intake. n=41. Grober. M72.

4. *Effect of tributyrin supplemented at different levels in waste milk.* Holstein heifer calves fed waste milk (abstract reports CMR, oral presentation reports pasteurized waste milk) and either a.) not supplemented, or b.) supplemented with 2.8 g of tributyrin per kg of whole milk, or c.) supplemented with 5.6 g/kg of whole milk. Whole milk was fed at 4 L/d and incrementally increased to 8 L/d days 11 to 42, and then gradually declined to 4 L/d days 50 – 56 until weaned. Pelleted starter was offered continuously, and oat hay offered d 56 to 77. Calves were housed individually in straw-bedded hutches. Individual body weights taken d 1, 7, 14, 28, 42, 56, 63, 70, and 77, and blood samples taken d 1, 28, 56, 63, and 77. Neither ADG nor DMI was effected pre-wean, however, post-wean, DMI increased linearly (P<0.001); ADG post wean was 1.74, 2.3, and 2.06 lbs./d for control, 0.28% and 0.56% tributyrin, respectively and NSD. D 1 – 77 ADG increased linearly (P=0.01: 1.48, 1.63, and 1.76 lbs/d for control, 2.8g/kg and 5.6 g/kg, respectively) as did DMI (P=0.005). D 77 wither height tended (P=0.06) to increase linearly with addition of tributyrin. Tributyrin decreased (p value not clear) incidence of diarrhea and linearly decreased (P=0.02) blood concentrations of endothelin, a peptide involved with inflammation. n=48. China Ag U, Beijing. 48.
5. *Calf starter with or without Alltech organic TM and with or w/o Biomos.* Holstein heifer calves were fed starter (d 1 – 56) and grower (d 57 – 168) with either a.) inorganic trace minerals, b.) organic trace minerals (Se, Co, Cu, Zn, Mn, Fe), or c.) a mix of organic trace minerals + Sel-Plex selenium yeast + Biomos known as “Blueprint” (Alltech). In the nursery phase calves were housed in individual pens and fed a 22:20 all milk non-med CMR at 1.25 lbs./d to d 36 and then half rate to d 42, and an 18% CP texturized starter with approximately 30% starch and containing Deccox ad lib. In the grower phase calves were fed 6 lbs. of 16% C.P. grain containing Rumensin, offered free-choice alfalfa hay and housed in group pens of 7 calves. Individual weights recorded d 1, 14, 28, 42, 56, 84, 112, 140, and 168. ADG d 1 – 56 tended (P<0.10) to improve for calves fed Blueprint mix of supplements vs. organic trace minerals alone (1.54 vs. 1.41 lbs./d), and those fed inorganic TM’s were intermediary (1.45 lbs./d). Hip height gain d 1 – 56 was greater (P<0.05) for calves fed inorganic TM vs. organic TM (+4.4 vs. +4.1 inches hip height gain) with Blueprint-fed calves intermediary. Days scouring decreased (P<0.05) when fed

Blueprint as compared to inorganic TM in starter (2.02 vs. 0.94 d) with those fed organic TM intermediary (1.21 d). Medical costs per calf were also less (P<0.05) for calves fed grain with Blueprint as compared to inorganic trace minerals ($0.45 vs. $0.19/calf). Day 57 – 168 calves fed Blueprint tended (P=0.07) to outgain those fed inorganic TM (2.25 vs. 2.15 lbs./d) with organic TM intermediary (2.18 lbs./d). Starter grain intake d 1 – 56 was greater (P<0.05) for calves fed either Blueprint or inorganic TM's vs. those fed organic TM (113.8 and 110.2 vs. 98.5 lbs. for Blueprint, inorganic TM, and organic TM, respectively). Bottom line: calves fed Blueprint d 1 – 56 tended (P=0.06) improved ADG vs. those fed organic TM's with those fed inorganic TM's intermediary. Calf starter intake decreased (P<0.05) for calves fed organic vs. inorganic TM's d 1 – 57, with Blueprint intermediary. Calves fed Blueprint in the grower tended (P=0.07) to outgain calves fed inorganic TM's, with those fed organic TM's intermediary. n=102. U of MN Waseca. Hubbard. Alltech. M104.

6. *Can Lucta sweeteners overcome a bitter additive proven to reduce milk replacer intake when added at d 39 when calves are consuming 8 L/d of milk replacer?* Dairy calves (breed & sex not disclosed) consuming 8 L/d of 12.5% solids 25:21 CMR were fed commencing d 39 either a.) no additive, b.) a bitter mix of additives at 30 g/kg of CMR, c.) the same bitter mix additive strategy + Lucta sweetener additive #1, or d.) the same bitter mix strategy + Lucta sweetener additive #2. Milk replacer intake and speed of intake (L/minute) were monitored for 14 meals (2 meals per day, fed at 7 am and 5 pm, over 7 days). Comparison measures were made to average milk replacer intake the prior week. The authors did not report a statistical difference in intake or drinking speed between any group, however, they did show sweetener number 2 noted similar L/minute of milk replacer intake as the control by the 6th meal in the 14 meal (7 day) period, whole sweetener number 1 tracked more with the group fed the bitter mix alone and only became intermediary between the bitter mix and sweetener number 2 from meal 11 onward. N=47. IRTA. Lucta. M105.
7. *Effect of various feeding rates of sodium butyrate.* Holstein heifer calves were fed 22:20 CMR at 1.23 lbs./d d 1 – 35 and then half rate to 42 d wean with either a.) no sodium butyrate, b.) 0.24% sodium butyrate, c.) 0.48% sodium butyrate, or d.) 0.72% sodium butyrate. Neo-Terra was fed d 1 – 14. An Alltech blend of these various concentrations of sodium butyrate in conjunction with palm fat, hydrolyzed yeast, zinc proteinate, sodium hydroxide and flavors were used to supply the sodium butyrate. An 18% C.P., 30% starch, 20% NDF starter with Deccox was offered ad lib. No difference in pre-wean, post-wean or total gains d 1 – 56 averaging 1.23, 2.46, and 1.54 lbs./d, respectively. No differences in G:F. "There was a trend (P=0.08) of a linear decrease in overall (d 1 – 56) hip height and hip height gain with increasing levels of sodium butyrate fed in the milk replacer. Pre- and post-weaning calf starter intake was similar across treatments averaging" 39.9 and 68.8 lbs., respectively. Also, no differences in overall health costs (averaging 90 cents) or fecal score (averaging 1.27 on a 1 – 4 scale). Bottom line:

"Supplementing sodium butyrate in CMR did not affect performance or health of calves pre- or immediately post-weaning." n=108. U of MN Waseca. Hubbard. Alltech. M108.

8. *Calpis bacillus subtilis blend? MOS? Combo?* Holstein heifer calves fed 1.25 lbs. 22:20 d 1 – 35 and then half rate d 36 – 42 d wean were fed in their CMR either a.) no supplement, b.) brewery yeast cell wall (MOS) 7.5 g/d, c.) Calpis bacillus subtilis DFM 3 billion cfu/d in 5 grams of product, or d.) both 7.5 g MOS + 3 billion cfu Calpis DFM. Grain (18% CP, 30% starch, containing Deccox) was offered. Calves were weighed d 1, 14, 28, 42, and 56. No effect on ADG (56 d averaged 1.5 lbs.), G:F, calf starter intake, med costs, or general fecal score, the only difference (P<0.05) noted was number of days fecal score 4 (scale 1 to 4): "calves fed control averaging 0.58 d compared with 0.18 and 0.22 d, respectively, for brewery yeast cell wall and DFM/MOS with DFM being intermediate at 0.35 d." n=107. U of MN Waseca. Calpis America Inc. M110.
9. *Prebiotic and Bacillus subtilis, alone or together.* Holstein bull calves reared on one dairy from January to July were fed pasteurized whole milk with a balancer and either a.) negative control, b.) enzymatically hydrolyzed yeast cell wall and yeast culture, a.k.a. prebiotic, c.) bacillus subtilis, a.k.a. probiotic, or d.) combination of prebiotic and probiotic. Respective treatments were added to the buckets at each meal prior to adding milk. Church and Dwight was acknowledged as funding the trial, however, neither brand nor feeding rate of additives were discussed. Weights were taken d 7, 42, and 56, and fecal samples were taken on 10% of the calves d 7, 14, and 21 to measure for fecal oocysts of crypto. There was no difference in the median age at 1st diarrhea (8 d), no difference in length of the first diarrhea event (4.5 d), no difference in pneumonia, no difference in calf mortality (5.4%, 6.6%, 7.8%, 5.9% for control, prebiotic alone, probiotic alone, and combination, respectively), no difference in culled calves (2.6%, 4.2%, 4.2%, 5.1%, for control, prebiotic alone, probiotic alone, and combination, respectively), no difference in oocyst shedding d 7 or d 21, however, there was a 100 fold reduction in crypto oocyst shedding d 14 in the probiotic group vs. the control (4 fold reduction in combined prebiotic and probiotic vs. control, but NSD). ADG d 7 – 56 was +20 g/d (+2 lbs. at 56 d; 2.00 vs. 2.04 lbs./d) for combined vs. control, and post-wean ADG d 42 – 56 was +80 g/d (P=0.007; 1.56, 1.75, 1.74 lbs./d for control, prebiotic and combination, respectively), and, finally, probiotic alone decreased ADG d 7 – 42 compared to control (1.47 vs. 1.53 lbs./d). n=1801. UC Davis. Scibus, NSW Australia. 146.
10. *Bacillus-based DFM in high- and low-health status herds.* Bacillus based DFM was examined in two large fields studies, one high- and one low-heath status. High health: Holstein calves fed a gallon of colostrum within 2 hours of birth and housed in individual pens 3 – 5 days and fed 1 gallon of whole milk daily, and then grouped (18 – 30 calves/group) and fed pasteurized waste milk via an autofeeder and were either fed DFM (1.84 billion cfu/d of bacillus subtilis strains) or no DFM. Milk intake ramped up to 12 L/d to d 35 and then cut 0.4 L/d to a 60 d wean with starter grain offered ad lib d 14 – 21 onward. There were 5 groups (n= 18 to 30, depending on the group) in control and 5 groups (n=18 to 24) in DFM. Daily milk intake and bodyweight were recorded. Each

feeding stall contained a scale measuring calf bodyweight at each feeding and data was recorded by Calfguide software. Sickness rate was 24 and 25.7%, treated 24% for both, died 2.63% and 1.91%, and scours 2.63% and 0.95% for control (n=115) and DFM (n=104), respectively. NSD in any health matter. However, DFM group noted +15 lbs. (=9%) improvement in body weight at weaning (P<0.001) despite milk intake being similar (NSD). ADG d 1 – wean was +38% (P<0.001; 1.37 vs. 0.99 lbs./d) and body weight gain was (81.3 vs. 59.7 lbs.) for DFM vs. control. For the low health-status herd Jersey calves were fed colostrum and then transferred to hutches and fed one gallon of 28:20 CMR daily and weaned at 60 – 90 d. Data was collected May to Oct and the herd was in the Southwestern U.S. Calves were fed either no DFM (control; n=212) or 1.84 billion cfu/d of the same bacillus subtilis strains as in the high-health herd. Calves were segregated by row of hutches and 3 rows with calves placed sometime between 05/19 and 07/21 were fed w/o DFM while 3 rows with calves placed sometime between 06/01 and 07/21 were fed the DFM daily in their milk replacer solution. Starter was offered ad lib. A "sick" calf had one or more health events including either scours, bloody scours, constipation, fever, born premature, or pneumonia, a calf diagnosed as "sick digestive" experienced scours, bloody scours and/or constipation, a "treated calf" was one treated for 3 days. Sick calves were 55.4% and 44.9% (P=0.0494), sick digestive were 42.9% and 33.5% (P=0.0639), fever were 5.2% and 5.9% (P=0.74) and treated were 51.9% and 44.5% (P=0.144), for control (n=212) and DFM (n=236), respectively (n=448 total). No ADG measures taken. Rectal swabs were taken on calves from the high health (n=60) status herd and found NSD in E coli concentration between DFM and control, rectal swabs were also taken on calves from the low health (n=46) status herd and DFM noted a reduction in E coli (P<0.001) concentrations. In summary: DFM resulted in increased ADG and final bodyweight in the high health status herd with no effect on health. DFM resulted in reduced overall health problems and reduced enteric disease in low health-status herd. n=209 in high health-status herd. n=448 in low health status herd. United Animal Health, Indiana. Microbial Discovery Group, Wisconsin. 187.

11. *Diamond V Smartcare fed in milk and Nutritek yeast top-dressed on grain in calves challenged with Bovine Respiratory Syncytial Virus (BRSV).* Holstein X Angus cross calves were fed milk replacer and grain either with or w/o a *S. cerevisiae* fermentation product supplement strategy composed of 1 g/d of Smartcare in the milk replacer combined with 5 g/d of NutriTek yeast fermentation top-dressed on the calf's grain. Calves were infected via aerosol inoculation d 20 – 22 (4 control and 4 yeast fermentation product calves each day for 3 days) and calves were necropsied 10 days post-infection. NSD noted in calf BW, starter intake (51 vs. 52 g/d), or ADG (1.07 vs. 1.11 lbs/d for control and yeast product, respectively), however, there was a treatment x time interaction (P<0.0001) at the end of the study for calves fed the yeast-fermentation product strategy for increased feed intake. A clinical disease score based on body temperature, respiratory effort, respiratory rate, cough, nasal/ocular discharge, and ear position noted calves fed yeast-fermentation product had less (P=0.03) clinical disease symptoms

following infection at d 6 to 8 d post infection. Calves were euthanized d 10 post infection and gross pathology scores were significantly less (P=0.031) for calves fed yeast-fermentation product vs. control. Differences were very noticeable in pictures of lungs from both groups. Virology data showed yeast-fermentation product-fed calves shed less virus d 7 post-infection, and virus isolation in nasal swabs noted no differences between groups d 0, 1, and 3 post infection with BRSV, however, d 7 post-infection noted 9 of 10 (90%) calves with nasal virus isolation in control group as compared to 6 of 12 (50%) in the yeast-fermentation product fed calves and on d 10, 5 of 9 (55.5%) in control and 1 of 12 (8.3%) in yeast fermentation-fed calves. Virus isolation in the lung was measured noting 4 of 10 (40%) in control and 2 of 12 (17%) in the yeast-fermentation fed calves (P=0.0511). Secondary infections occurred in 5 of 10 (50%) control calves and 2 of 12 (16.7%) of yeast-fermentation fed calves. Various cytokines and immune parameters were measured d 10 post BRSV infection and the researchers noted yeast fermentation product enhanced immune function in the periphery while positively modulating it in the actual respiratory tract, noting less proinflammatory cytokines (P=0.003; TNF alpha) from an LPS stimulation if the calf was fed the yeast fermentation product-fed strategy. Bottom line: yeast fermentation product decreased clinical disease, decreased lung damage, decreased neutrophil infiltration, decreased virus shedding and decreased incidence of secondary infection while improving immune response when calves were challenged with BRSV. n=24. Iowa State U. Veterinary services and Ministry of Ag, Egypt. Diamond V, Iowa. 188.

12. *Calves fed both Diamond V Smartcare in CMR and NutriTek in starter challenged with LPS at 8 weeks age (oral presentations 49 & 266 combined).* Holstein bull calves (n=60) were fed a 24:17 CMR d 0 – 56 at 6 quarts/d (12.5% solids) either with (1 g/d) or w/o Smartcare and correspondingly an 18% CP texturized starter offered ad lib either with or w/o NutriTek yeast culture (0.8%), an 18% CP grower with or w/o NutriTek (0.44%) for 4 weeks post weaning, and an 16% CP grower with or w/o NutriTek (0.274%) until the study ends at 112 d. Comparison was made between feeding calves this combined saccharomyces cerevisiae fermentation products (SCFP) strategy and the control diet void of SCFP. Daily fecal and respiratory score were recorded to d 56 and all medical treatments recorded. Lungs were scanned to measure consolidation 0, 14, 28, 56, and 112, and scored 0 – 4 with 4 being consolidation of 2 more lobes in the lung. Body condition score, hip height, and hip width were measured bi-weekly, as were daily feed intake. Calves were housed individually in hutches until weaning and then housed in groups. Calves were enrolled in the LPS portion of the study (n=20) if they met these criteria: a.) no respiratory treatment, b.) no lung consolidation, and c.) >900 g/d starter intake. On d 50 and 51 calves (n=20) were dosed with E coli (0111:B4) at 0.125 microgram/kg of BW and blood samples were drawn -1.5, -0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4, 5, 6, 7, 8, and 24 h in relation to LPS dosing. Serum was analyzed for NEFA, glucose, cortisol, IL-6, TNF-alpha, IFN-gamma, haptoglobin, serum amyloid-A, and fibrinogen. Temperature and respiration rate were also monitored. There was 1 mortality in the

SCFP group during the LPS challenge and no data was collected on this calf after 2 hours. Temperature at 0.5 h post challenge in the SCFP group was greater (P<0.05; 103.1 fever), otherwise, NSD to 24 hours and NSD overall. Respiration rate at 0.5 h and 1.5 h post LPS dosing was greater (P<0.05) in SCFP group vs. control and estimates based on visual examination of the graph were 102 vs. 89 breaths per minute at 0.5 h and 82 vs. 65 breaths/m at 1.5 h post LPS-challenge, otherwise, NSD by treatment (P=0.15). Starter intake was less (P=0.0022; 1,258 g vs. 325 g) d 0 (day of LPS challenge) for the SCFP-supplemented calves, however, days 1, 2, 3 and 4 post LPS-challenge, there was much narrower differences (just numeric reductions in fed intake) for SCFP-group (NSD). NEFA was less for SCFP-fed group at 1 h (P<0.05) but overall, only tended different in a treatment over time effect (P=0.08; 0.227 vs. 0.242 Meq/L for control and SCFP, respectively). SCFP-supplemented calves noted greater TNF-alpha (P<0.05) at 1 h (app. 5000 vs. 3000 pg/mL) and at 1.5 h (app. 3000 vs. 1500 pg/mL) post LPS challenge and noted greater (P=0.005) overall levels (701 vs. 441 pg/mL). NSD in IL-6, IFN-gamma or haptoglobin. In oral presentation no. 49, the same researcher reported calf performance and health measures on the full group of 60 calves: no effect on pre-wean ADG (3.83 vs. 3.9 lbs. ADG d 0 – 56; P=0.78) or on any performance measure, however, there was a trend (P=0.07) of improved post-wean ADG (d 57 – 112; 2.49 vs. 2.67 lbs./d) for the SCFP-group. No effect on starter grain intake (d 0 – 14 1.3 vs. 1.67 lbs./calf, d 15 – 28 9.7 vs. 10.9 lbs., d 29 – 42 25.8 vs. 26.7 lbs., d 43 – 56 40.4 vs. 39.6 lbs. for control and SCFP-fed group, respectively) but group intake (lbs./calf) post-weaning was numerically greater at 503.3 vs. 486.8 lbs. for SCFP-group and control, respectively. Yeast inclusion resulted in improved feed efficiency d 57 – 112 (0.29 vs. 0.3 G:F; P=0.02). No differences noted in any body dimension. There was no difference in incidence or severity of scours. Respiratory treatment incidence was reduced (P=0.001) from 0.95 to 0.31 treatments per calf in the SCFP-group vs. control, however, there was no difference in lung scores in either the right or left lung. There was a trend (P=0.08) toward reduced incidence of "other" treatments which the researcher noted included things like joint infections when calves were supplemented SCFP. Health probability improved in SCFP-fed calves: as calves got older likelihood of not being treated maintained at approximately 80% in SCFP-fed calves, however, it continually declined as the calf aged to just 40% at 112 d in control-calves. Take home: SCFP increased temperature and respiratory rate, decreased grain intake and increased proinflammatory cytokine production around LPS challenge. Inflammatory symptoms in SCFP-fed calves did not sustain. ADG did not improve at any measure but G:F improved post-wean. SCFP-fed calves noted fewer respiratory treatments (one-third as many). n=60 total in study, n=20 of the 60 in the LPS sub-study. Purdue. Diamond V. *49 and 266*.

13. *Aleta Beta Glucan (Kemin)?* Holstein calves individually housed in tropical shelters were fed 6 L/d of 24:18.5 CMR with or w/o Aleta Kemin Beta Glucan fed at 2 g/d. Addition of beta-glucan resulted in NSD in ADG (P=0.10; 276 vs. 328 g/d for control and beta-glucan, respectively), an increase in final 8 week body weight (P<0.05; 113.6 vs. 124.2 lbs., with

body weight increases noted weeks 5, 7 and 8), trend toward improved G:F (P=0.08; 0.238 vs. 0.290; differences noted weeks 3 & 5), NSD in grain intake (P=0.17; 252 vs. 311 g/d), improved fecal score (P=0.01; 1.46 vs. 1.06), and decreased days with diarrhea (P=0.01; 25.7 vs. 14.7). n=32. U of Sao Paulo, Brazil. Kemin. M111.

14. *Vetagro dietary organic acid and plant botanical supplementation (AviPlus R), any effect on health or growth or in diminishing weaning stress in calves?* Holstein bull and heifer calves were fed either a.) no supplement, b.) 75 mg/kg of BW AviPlus R, or c.) 150 mg/kg of BW AviPlus R. AviPlus R daily dose was administered in two equal boluses via the esophagus week 1 – 8. AviPlus R is composed of 25% citric acid (hypothesized to lower intracellular pH), 16.7% sorbic acid (hypothesized to inhibit microbial enzymatic apparatus and nutrient transport system), 1.7% thymol (hypothesized to permeabilize and depolarize cytoplasmic membranes of bacterial cells like E coli), 1.0% vanillin (hypothesized to provide anti-inflammatory agents and stimulate IL-4), and the balance (55.6%) triglyceride. All calves received the same bolus concentration of triglycerides. Starting BW not reported. Calves were fed a 26:20 CMR at 1.75% of BW and a 27% CP starter ad lib. Weekly body weight and body dimensions were recorded, and blood samples were taken d 2, 42, 47, 49, 50, 51, and 52 to measure white blood cells (WBC's), hematocrit, and metabolites. NSD was reported in any BW measure (final BW 131.6, 130.7, and 129.2 lbs.). NSD in hip height, DMI, or G:F at any measure. NSD in WBC populations or any metabolite at any measure. Calves were reported as healthy and expressing no weaning stress. n=36. Cornell U. U of Bologna, Italy. China Ag U, Beijing. Henan Ag U, Zhengzhou. VegAgro, Italy. M112.
15. *Vetagro AviPlus R post wean during heat stress.* Heat exposure disrupts intestinal barrier and may promote enterotoxemia, and perhaps nutritional support helps alleviate heat stress. From weeks 1 to 13 of life Holstein bull and heifer calves (n=62; 200.6 lbs. body weight) were fed either a.) bolus 2x/d of triglyceride flakes to mimic triglycerides from AviPlus, or b.) bolus 2x/d providing 75 mg/kg of calf body weight of AviPlus R, or c.) bolus 2x/d providing 150 mg/kg of BW AviPlus R. AviPlus R is composed of 25% citric acid, 16.7% ascorbic acid, 1.7% thymol, 1% vanillin, and 55.6% triglyceride. All calves were kept in thermoneutral conditions post-wean (62 ±2 d age) for 7 days, and then introduced to one of five treatment groups, either a.) thermoneutral (68 ±3 F) ad libitum intake (n=12), b.) thermoneutral pair-fed to consume same feed intake as heat stressed control calves (n=11), c.) heat-stressed (95.5 ±2.3 F), ad lib intake (n=12), d.) heat-stressed, ad lib intake, low dose 75 AviPlusR mg/kg body weight (n=14), or e.) heat-stressed, ad lib intake, high dose (150 mg/kg calf body weight (n=13). Calves fed either no AviPlus R or one of the two options of AviPlus R had been fed the same dose prior this study commencing. Calves reared in thermoneutral environment were maintained in pre-study environment and those exposed to heat stress were moved to high heat environment. Calves were monitored for 19 days, blood collected d 1, 2, 3, 7, 14, and 19; weekly bodyweight measures taken, and a subset of each group was slaughtered at the end of the study. Heat stressed calves noted increased rectal temps (P<0.001),

increased skin temperatures (P<0.0001), and increased respiratory rate (P<0.0001) throughout the 19 days of the study. Heat stress reduced grain intake by 17%; avg DMI was 8.4 (a), 6.9 (b), 6.72 (b), 7.43 (ab), and 6.92 (b) lbs./d (subscripts different P<0.01) for thermoneutral control, heat-stress control, pair-fed control, heat stress low AviPlus R, and heat stress high AviPlus R, respectively. AvilPlus R fed at low rate restored about half of the feed intake decline from heat stress. Average ADG was 2.91 (a), 1.85 (b), 2.29 (ab), 2.05 (b), and 2.11 (ab) (subscripts different P<0.01) for thermoneutral control, heat-stress control, pair-fed control, heat stress low AviPlus R, and heat stress high AviPlus R, respectively. Heat stress reduced ADG 36.4% and feeding the high rate of AviPlus R restored some of that lost ADG (27.5% loss). "Plasma fatty acids were elevated in thermoneutral pair-fed verses all other groups (P=0.04; not observed for heat stress control)." Organs (small intestine, pancreas, liver, rumen, heart, lungs, kidneys, spleen) were weighed from the subset slaughtered (n not disclosed) and heat stress tended (P=0.15) to decrease s. intestine, decrease (P=0.03) liver, and tended to increase (P=0.09) kidney weight. The author noted s. intestine and liver have higher energy demands thus the smaller organ in heat stressed calves, and that kidneys likely got larger due to overcompensating drinking behavior associated with heat stress. Bottom line: heat stress method worked in the study as measured by increased rectal temp, skin temp, and respiratory rate, AviPlus R restored a portion of DMI and ADG losses associated with heat stress. Cornell. U of Bologna. China Ag U, Beijing. Henan Ag U, China. VetAgro, Italy. M100.

16. *Lactoferrin? Schizochytrium (kelp and algae)? Combination?* Newborn Holstein calves were fed whole milk (12.4% solids, 3.64% CP, 4.2% fat) with either a.) no additive, b.) + lactoferrin (1 g/d), c.) + Schizochytrium (SZ; kelp and algae; 20 g/d), or d.) combination + SZ (20 g/d) + lactoferrin (1 g/d). Additives were administered d 2 – 14 of life. Calves were challenged with E coli K-99 (10^{10} cfu/mL, 10 mL dose) in their milk on d 7 at 7 am and fecal samples were collected from the rectum at hour 3, h 12, and h 24 post-challenge. Blood samples were taken d 7 and d 14. Lactoferrin reduced (2.05 vs. 2.30, P<0.049) fecal score. SZ alone and in combination with lactoferrin tended (P=0.064 and 0.052) to reduce fecal score. Differences in fecal score occurred d 3, 8, 9, and 14 post-challenge. The combination reduced nitric oxide (P=0.031), SZ reduced D-lactic acid (P=0.02), the combination tended to reduce LPS (P=0.097), SZ tended to increase IL-10 (P=0.096) and SZ tended (P=0.082) to decrease TNF-alpha. Institute of An Sci Chinese Academy of Ag Sciences, Beijing, China. The Ohio State U. 141.
17. *Will addition of omega-*3 *fatty acids (fish and flax seed oil) or vitamin E to maternal colostrum improve calf health?* Maternal colostrum fed to heifer calves received either a.) no supplement, b.) 60 mL of a 1:1 blend of fish oil and flax seed oil, or c.) the same 60 mL of the fish oil and flax seed oil blend inclusive of 200 mg of vitamin E. Serum total protein measures indicated successful passive transfer in all calves (no discussion about differences in STP). Calves were health scored using the U-W Madison health score chart 3x/week for the 8-week duration of the study. "All scores were very low (for all calves)

throughout the preweaning period . . . all calves had relatively good health.” Calves fed the fish oil and flax seed oil blend void of vitamin E noted lower (P=0.04) overall eye score days >0 vs. either of the other two treatments (6.5, 6.6, and 6.4 days for control, flax and fish with E, and flax and fish w/o vitamin E, respectively) differences were reported as not likely biologically different due to low differences observed by day. A subgroup of app. 18 calves in each treatment group were evaluated for oxidant status, inflammatory gene, and cytokine protein expression in blood after an in vitro LPS challenge. 10 ml of blood was drawn day 2 of life and split, 5 mL mixed with control media and 5 mL LPS stimulated. IL-10 anti-inflammatory and IL-8, TNF-alpha, and COX-2 pro-inflammatory cytokines were measured using gene expression tools. The only difference noted was in IL-8 in the group fed colostrum with fish/flax mix tending (P=0.07) lower than control and (P=0.09) lower than fish and flax with vitamin E. Performance details were not reported but authors said “Health scores and growth were similar regardless of treatment.” BW and dimension measures were taken d 0, 3 weeks and 8 weeks age. Bottom line: in a high health status herd addition of a fish oil / flax seed oil blend, either with or w/o 200 mg of vitamin E, noted no improvement in calf health and minimal effect on inflammation. Michigan State U. T17.

18. *New-Start blend of Selenium yeast (1.335 ppm Se), MOS, Yucca Schidigera, Vitis Vinifera (grape flavonoids?), and essential oils fed in a crypto-challenged herd.* Calves on a Quebec dairy with persistent record of crypto infections were fed either a.) no additive, or b.) 10 g/d (5 g, 2 feedings) of New-Start (Probiotech International). Calves were initially housed in individual pens and first fed colostrum ad lib and then paired and fed 6 – 8 L/d of milk replacer. A measuring tape was used to estimate body weight d 2 and d 30. Scour scores were taken. Fecal samples were taken from the rectum of calves d 6, 9, 12, 15, 18, and 30 (n=15 in each group; crypto oocysts measured at BioVET) and blood samples were taken d 2 and 15 to measure Haptoglobin (n=6 in each group; U of Guelph lab) concentrations. NSD reported in ADG (approximately 500 g/d). NSD in scour frequency or scour score (intensity). New-Start reduced crypto oocyst shedding on d 9 (P<0.05) which was peak oocyst concentration in both groups, otherwise, no differences at any other measure. The increase in oocysts from d 6 to 9 was in the top quartile for 6 of 15 control calves and only 1 of 15 calves fed New-Start. Blood haptoglobin measures were reported as indicators of intestinal epithelium inflammation and the control calves fluctuated much higher and approached an upper limit of 0.5 g/L, however, calves supplemented New-Start stayed stable within a reference range of 0.23 to 0.247 g/L haptoglobin. n=31. Probiotec Int., Quebec. Clinique Veterinaire Centre du Quebec. T29.
19. *Does supplementing Calf Perk (TechMix) improve calf vigor or the rate of colostrum IgG absorption?* Calves were monitored at birth to dystocia score and to ensure no maternal colostrum was suckled. Calves were vigor-scored at 1.5 h, 2.5 h, 3.75 h, 24 h, 48 h, and 72 h post-birth. Vigor score included measuring heart and respiratory rates, rectal temperature, nasal stimuli, and suckling reflex. Blood samples were taken at 6 h, 12 h, 24 h, 48 h, and 72 h. Either Calf Perk or distilled water was administered (treatment or

control) at 3 h and colostrum replacer (Premolac Plus IgG, Zinpro, 4 L) was tube fed at 4 h post-birth. Baseline blood BRIX and vigor were not different at 1.5 h baseline measure and extract was not associated with a change in blood BRIX (placebo 7.77, 0.1% extract, a.k.a. Calf Perk, 7.72). There was no effect of Calf Perk extract on improving vigor likelihood and no effect of extract on serum IgG. n=22. U of KY, Lexington; U of Sao Paulo, Brazil. M56.

20. *In vitro assays measure effects of Lactobacillus animalis LA51 on protecting the gut and Bacillus strains on binding E coli.* Transepithelial Electrical Resistance (TEER) in vitro assay method was used to measure passage of ions through a monolayer of cells. Using this method, Lactobacillus animalis LA51 was shown to reduce (P<0.01) damage to cells and the authors infer this may demonstrate LA51 reduces damage associated with "leaky gut" syndrome. In another in vitro assay wells of E coli 0157 and bacillus were used to determine Bacillus licheniformis (DSM 5749) and Bacillus subtilis (DSM5750) reduce binding of E coli by 78% and 51%, respectively, while reducing E coli viability by 5% and 15%, respectively. Chris Hansen. 265.
21. *In vitro analysis of the ability for bacillus strains to produce enzymes, produce biofilm, and inhibit pathogens.* Two bacillus subtilis strains (DSM 756 and DSM 5750) combined with one bacillus licheniformis strain (DSM 5749) were tested in the Chris Hansen lab. Qualitative lab measures combined with monitoring zones of inhibition via a streak plate assay, determined these bacillus strains create protease, xylanase, and galactomannanase enzyme activity. The bacillus *licheniformis* strain was shown to reduce gas production from clostridium perfringens type A by 20% and reduce cfu count of clostridium perfringens type A & B by 63%. The effect on gas production and cfu count shedding of clostridium perfringens type A was 20% and 63%, respectively, if these bacillus *subtilis* strains were used in the same test. A crystal violet assay was used to determine that bacillus licheniformis formed a strong biofilm, while the bacillus subtilis strains produced a weak biofilm. Chris Hansen. 233.
22. *APEX essential oil (Adisseo) in CMR . . . effect on blood metabolites.* Newborn Holstein x Gyr cross calves (n=29) were fed 5 L/d of 15% solids CMR and ad lib starter with either a.) 1 g/d Apex split evenly between two feeding fed daily in CMR, or b.) no additive. Blood samples were collected 3 h after AM feeding every 7 d and examined for BHB, urea, and glucose, and every 14 d for IGF-1, and on d 0, 30, and 60 for erythrogram and leukogram analysis. NSD in BHB, urea, glucose, IGF-1, pre- or post-wean. NSD in RBC's. Basophils decreased (P<0.001) and platelets decreased (P<0.001) with APEX feeding but, otherwise, NSD in any white blood cell. NSD in leukocytes, Eosinophils, Band Eosinophils, lymphocytes, monocytes. "The lower counts of basophil and platelets on blend of essential oil treatment may influence and modulate inflammatory response by secretion of immune modulators, growth factors or chemotaxis on variety of white blood cells." n=29Federal U of Minas Gerais, Brazil. M106.
23. *APEX effect pre-wean fed in CMR on gut weight and histology*. Newborn Holstein x Gyr cross calves fed 5 L/d CMR with starter grain ad lib with either a. 1 g/d Apex essential oil

daily in CMR, or b.) no additive. Calves were euthanized d 60. Individual organs were weighed, and gut surface area measured. NSD in any organ (spleen, bladder, liver, kidney, rumen-reticulum, omasum, abomasum, large intestines, tongue, heart) except feeding APEX increased pancreas (P=0.05), small intestine (P=0.03) and decreased respiratory tract (P=0.03). APEX also increased villi height in ileum (P=0.02), otherwise, NSD in any gut morphological measure. N=16. Federal U., Minas Gerais, Brazil. EMBRAPA, Brazil. Nation Center for Research on Dairy Cattle, Brazil. M107.

24. *Ground Nordic seaweed*. Prebiotics in seaweed were hypothesized to improve hind gut fermentation, produce short chain fatty acids and result in improved gut health. Three types of ground (0.8 mm) powdered seaweed were supplemented to Holstein (n=40) calves from d 2 to 49. Calves were fed 8 L/d whole milk with either a.) no supplement, b.) *Ultra lactuva* green seaweed from Denmark 50 g/d (aka sea lettuce), c.) *Ascophyllum nodosum* brown seaweed from Denmark (aka knotted wrack) 50 g/d, or d.) *Laminaria saccharina* brown seaweed from Iceland 50 g/d (aka sugar kelp) . Calves were slaughtered at either 35 d (n=20) or at 50 d (n=20) and intestinal samples, digesta, and organs examined. There was NSD in ADG, varying from 2 to 2.2 lbs./d. Final bodyweight was NSD between 185.6, 187.2, 182.1, and 173.1 for control, green seaweed, Danish brown seaweed, and Icelandic brown seaweed supplemented calves, respectively. NSD in rumen and reticulum, abomasum, or s. intestine weight. NSD in rumen or mid s. intestine pH. Total VFA concentration was not different mid small intestine or mid-colon. Week 5 & 7 acetic acid was at a higher % of total VFA, and week 7 butyric acid was lower for 2 of 3 seaweeds (P=0.007) vs. control (% of total VFA basis; P=0.007). n=40. Aarhus U. Denmark. 46.
25. *Ground seaweed #2*. Same feed protocol as oral presentation 46 (prior abstract listed). Authors hypothesized chelated minerals (Zn, Fe, Cu) and antioxidants (tocopherols and carotenoids) in seaweed would improve immune function. Blood samples collected d 2, 4, 7, 14, 21, and 28 after birth. NSD in ADG (1.98 lbs.). NSD in total protein, albumin, IgG or IgM. Fibrinogen increased d 14 in *Ascophyllum nodosum* and *Ultra lactuva* (P=0.06) vs. control, and increased d 21 and d 28 for *Ascophyllum nodorum* supplemented calves vs. control with the other two seaweeds intermediary. Plasma serum amyloid A concentrations were higher (P=0.025) d 14 for calves fed *Laminaria saccharina* and *Ascophyllum nodosoum* vs control with *Ulva Lactuca* intermediary. Plasma haptoglobin concentration was higher for *Ulva lactuca* and *Ascophyllium nodosum* vs. control (P=0.09) with *Laminaria saccharina* intermediary. n=40. Aarhus U. 47.
26. *Systemic review of prebiotics in dairy calves*. A web-search of 5 electronic databases (CAB abstracts, PubMed, Science Direct, Scopus and Web of Science) was conducted Dec 2019 searching for probiotic and prebiotic studies. Prebiotics were classified as substrates selectively used by host microbiota conferring health benefits to the host. 2,177 studies were screened for being controlled and conducted on dairy calves and measuring performance or health outcomes and presence of bias including randomization, blindness for personnel or staticians, how they handled missing data and

the reporting of selective data. Just 27 studies were left after these screenings. Most of the 27 studies enrolled calves less than 15 d of age, most administered the prebiotic via CMR, whole milk, or waste milk, and 48% used less than 15 calves per group. ADG was evaluated in 21 of the studies and only 5 reported an increase. Fecal scores were measured in 10 and four reported improved fecal score. Twenty of 27 investigated oligosaccharides with 5 each for MOS and FOS. UC-Davis. 144.

Colostrum, Colostrum Replacers (CR), and feeding Transition Milk (11 abstracts):

1. *Does feeding transition milk help the calf?* Holstein bull calves were fed either a 27:21 CMR (0 g IgG) or transition milk (milkings 2, 3 or 4, containing 218, 94, and 47 g IgG/kg DM, respectively) 3x/d at 1.9 L/feeding for 4 days after receiving 2.8 L of colostrum within 20 m of birth on day one of life. Blood samples were taken d 1, 2, 3, and 5. Both groups noted refusals of 10%. Feeding transition milk on d 2 – 5 doubled weight gain (TM provided +0.7 Mcal ME/d vs. CMR; ADG was 1.4 lbs./d for transition milk and 0.55 for CMR, P=0.005) and improved indicators of health compared to feeding milk replacer. 5 d BW gain was 2.2 lbs. for calves fed MR and 5.78 lbs. (P=0.05) for calves fed transition milk. Also, calves receiving transition milk noted tendency toward increased change in hearth girth (P=0.07) and in hip height (P=0.09) if fed transition milk as compared to CMR. Days 2 and 3 of life calves that received transition milk noted greater (P<0.05) serum IgG concentration as compared to those receiving CMR, also, day 3 but not day 5, calves that received transition milk noted lesser (P<0.05) serum haptoglobin. Calves receiving transition milk also noted lower levels (P<0.05) of lipopolysaccharide-binding protein, which plays an important part in innate immune function. Regarding health scores, calves that received transition milk noted reduced incidence of coughing (P=0.05), reduced fecal score (P=0.006), reduced nasal discharge (P=0.05) and reduced ear infection (P=0.002). B-cells noted NSD between groups but T-cells tended (P=0.06) to increase from feeding transition milk and both “blood neutrophil oxidative burst and phagocytic capacity was elevated in MR compared with transition milk (35.62% of cells vs. 12.91% of cells P=0.04; 57.64% of cells vs. 48.39%, P=0.05 of cells respectively).” Take home message is that feeding transition milk for 4 days after feeding colostrum doubled weight gain and improved indicators of health compared to feeding milk replacer. n=23. Michigan State U. M61.
2. *Is a second feeding of maternal colostrum worth it?* Holstein heifer calves born unassisted and fed 4 L of heat-treated maternal colostrum within 2 hours of birth were fed at their second meal at 12 to 16 h age via esophageal feeder either a.) 3 L of acidified pasteurized whole milk, or b.) 3 L of pooled heat-treated maternal colostrum. Thereafter, all were offered pasteurized acidified milk ad libitum to d 43 and then gradually weaned d 63. Calves were weighed and hip height monitored weekly to week 8. NSD in ADG to 8 weeks (1.5 lbs./d for both group). Wither height was NSD to 8 weeks. No difference in hematocrit. Calves fed the second feeding of colostrum noted increased (P=0.0004) serum brix (9.5 vs. 9.1) the first week of life. Incidence of mortality

was 3.05% and 4.27% (P=0.54) for treatment and control, respectively. No morbidity information reported. n=164. Cornell. M69.

3. *What is the degradation rate of serum IgG over the first 16 days?* Holstein (n=64) and Jersey (n=24) heifer calves were administered 6 L of maternal colostrum over 3 individual meals on day 1: 2 L at 38 m (±26 m), 2 L at 7 h, 19 m (±1 h, 5 m), and 2 L at 7 h and 45 m (±1 h) and then serum IgG and serum total protein (STP) were measured d 1, 4, 8, 12, and 16. Single radial immune-diffusion was used to measure serum IgG and a Misco digital brix refractometer was used to measure serum total protein. Calves were housed individually in hutches during the study. Serum IgG ranged from 252 and 10,619 mg/dL (mean: 2,124 mg/dL), and serum total protein from 3.6 to 9.3 g/dL (mean 6.0 g/dL) and hematocrit from 18 to 44% (mean: 30%). "Relative to 1 d, serum IgG tended to decrease at 4 d (205 mg/dL) and it was significantly lower at 8 d (343 mg/dL), 12 d (583 mg/dL) and 16 d (747 mg/dL). Relative to 1 d, serum total protein concentration significantly decreased with time at 4 d (0.344 g/dL), 8 d (0.470 g/dL), 12 d (0.704 g/dL) and 16 d (1.107 g/dL). There was a moderate correlation between serum IgG at 1 d with serum total protein at 1 d (r=0.66), 4 d (r=0.61), 8 d (r=0.63), 12 d (r=0.54), and 16 d (r=0.66). The model fit for serum IgG prediction did not improve when serum total protein was adjusted by hematocrit. In summary, our results indicate that serum IgG and serum total protein declined during the first 2 weeks of life." In the oral presentation the researcher reported that serum IgG decreased over the first 12 days but then started increasing d 16 (P<0.001 between day 1 IgG measures and all others). She also broke out the data on calves and reported those with ≥15 g/L IgG day 1 (n=50 calves) noted decreased serum IgG d 8 and d 12 (P<0.05) relative to day 1, but if serum IgG was <15 g/L IgG (n=14) then IgG was stable d 4, 8, 12, and 16 compared to d 1. Regarding serum total protein, if ≥5.5 g/L at 1 h (n=54) then serum total protein decreased (P<0.001) d 4, 8, 12, and 16, but if <5.5 g/L serum total protein was higher d 4 (P<0.001) but not different d 1, 8, 12, and 16. n=64. UC Davis. M93.
4. *How does feeding transition milk d 2 – 5 effect calf intestinal development?* Holstein bull calves fed 2.8 L of colostrum within 20 m of birth were then fed 2 quarts 3x/d of either transition or 27:21 CMR. Transition milk was collected, pooled by milking number and fed at 2 quarts per feeding as follows: from milking 2 was fed feedings 2 to 5, from milking 3 was fed feedings 6 to 8, and from milking 4 at feedings 9 to 12 in the study. "Transition milk was not pasteurized and averaged 30% fat and 39% protein on a DM basis and 20 g IgG/L." Refusals were similar at 10%. Calves were euthanized d 5 and GIT harvested. Morphology measures note: transition milk resulted in +63% (P<0.05) villus height, +43% (P<0.05) villus width, +37% (P<0.05) mucosal thickness, +35% (P<0.05) submucosal thickness in the duodenum with a similar magnitude of change in jejunum and ileum; transition milk resulted in +40 to 78% increase in cell proliferation depending on the section measured whereas milk replacer did not; transition milk tended lower pH in gut and also resulted in curd formation; glucose was measured prior meals and feeding transition milk resulted in stable glucose measures, however, feeding CMR

resulted in lower glucose levels d 2 to 5 (P<0.05); feeding transition milk resulted in stable blood insulin concentrations, whereas, insulin decreased when feeding CMR; blood NEFA concentrations tended higher in calves fed transition milk d 2 but differences to CMR narrowed by d 5. Bottom line: feeding transition milk increased intestinal development and altered gut pH. Michigan State U. 51.

5. *Spray dried colostrum as an intervention strategy to prevent BRD when feed intake declines and/or when a slow drinker?* Calves with successful passive transfer were offered 10 L/d of 28:14 CMR via an autofeeder and weaned gradually over 3 weeks with complete wean d 70 and were monitored for feed intake. Starter and alfalfa hay were offered. Respiratory and diarrhea health scores were taken daily, and lungs were ultrasound and calves weighed 2x/week. A baseline of milk replacer intake and drinking speed was established for each calf using an algorithm on the autofeeder over the first 14 days. An alarm triggered if milk intake decreased 20% or more and/or drinking speed decreased 30% or more from this 2-week baseline and once triggered, the same calf could not re-trigger the same process for two weeks. Calves were eligible to enroll themselves via this feed intake trigger d 15 – 49 and calves were required to have a UW BRD score >5 and one lung had to be fully consolidated (>3 cm of consolidation) to be enrolled. Diarrhea had to be watery and sift through the bedding. The researchers wanted true disease not subclinical symptoms. Calves were treated with antibiotics (Enrofloxacin) the 1st d of diagnosis. Once enrolled, a calf received either a.) a placebo of 1 L milk replacer by bottle for 3 days, or b.) 1 liter of water containing 125 g of Premolac Zinpro colostrum replacer for 3 days (achieving one dose over the regiment). 84 calves (70.6%) triggered the alarm (i.e. noting reduced milk intake or drinking speed; 42 calves were put on placebo, 42 on colostrum powder) and there were 110 alarms (57 placebo, 53 colostrum replacer). There was NSD between groups in age (32 d, +/- 12.5 d), body weight (122.7 lbs.), quantity of milk consumed (8.2 L/d), drinking speed (0.9 L/m), rewarded visits/d (3.9), unrewarded visits/d (2.5), clinical signs of BRD (4 placebo, 3 colostrum) or clinical signs of diarrhea (14 placebo, 13 colostrum) the day prior to the alarm. Results 7 days after respective treatment/enrollment: 126.1 and 123.5 lbs. body weight and 1.61 lbs. and 1.54 lbs. ADG for placebo and colostrum (NSD). Intervening with colostrum replacer reduced (P<0.001) the odds of BRD as placebo-fed calves were 1.6x more likely to have a positive BRD bout vs. colostrum-fed calves in the 7 days post-enrollment (confidence interval 1.1 to 2.43), however, the placebo did not increase likelihood of scours incidence. Using Breslow Survival Estimates colostrum increased the likelihood of staying healthy from BRD (60% vs. 33% odds of still being healthy) at 15 days post alarm trigger. Placebo did not increase likelihood of having diarrhea within 15 days post alarm trigger (exact statistics not presented but is in 40 – 50% probability range for both). A Cox Proportional Hazard model showed that placebo-fed calves were 2.38x more likely (P=0.001) of incurring BRD than if fed colostrum. NSD for Cox Proportional Hazard of diarrhea disease 15 d after enrollment. Bottom line: colostrum helped ameliorate BRD in young calves. n=119. U of Kentucky. U of Guelph. 190.

6. *Does colostrum status effect future cow productivity?* A retrospective analysis of 193 Holstein heifer calves on 4 dairy farms in Colorado categorized as either excellent (≥25 g/L; n=79 (40.9%)), good (18 – 24.9 g/L; n=57 (29.5%)), fair (10 – 17.9 g/L; n=36 (18.6%)) or poor (<10 g/L; n=21 (10.8%)) in serum IgG were followed through beginning of 2nd lactation and monitored for a.) age at first calving, b.) days at conception after 1st calving, c.) adjusted 305 d first lactation milk yield, and d.) survival to 1st and 2nd lactation. Year of birth, season of birth, and source farm were considered in the statistical analysis. No correlation between colostrum status and any measured attribute except age at first calving were noted. Calves with excellent colostrum status noted poorer (P=0.005) age at first calving as compared to those with poor colostrum status (715 vs. 695 d) and the author attributes this unexpected outcome due to small sample size and high variability of calves within the poor colostrum status group. n=193. Colorado State U. USDA APHIS Vet Services Fort Collins. T156.
7. *What are colostrum practices in New York?* Colostrum management practices were assessed via a questionnaire of 18 farms averaging 1,409 cows (range 540 – 4,150) conducted between 10/2019 and 02/2020. Colostrum harvest, storage, and feeding practices were recorded, serum total protein (STP) and packed cell volume (indicator of blood concentration) was read on 195 Holstein heifer calves 1 to 7 d old, and STP was adjusted to the average of all calves packed cell volumes. Colostrum brix % was collected on colostrum collections over a 30-d period on 17 farms. Colostrum harvest in the parlor was most popular (66.7%), followed by hospital parlor (11.1%) and maternity pen (22.22%). Colostrum was harvested three times in 64% of instances where a milking parlor was used. Colostrum was discarded in 55% of farms due to visual abnormality, oversupply or not meeting brix guidelines for the farm. "Colostrum was pooled (38.9%), heat treated (16.7%), refrigerated (66.7%), filled into bags or containers (77.8%), frozen (44.4%), or fed directly to the dam's calf (11.1%)." Colostrum Brix and calf STP was read by a refractometer on 77.7% and 27.8% of farms, respectively. Colostrum harvest time after birthing was variable, however, 1st feeding of colostrum occurred within 0 – 2 hours 94% of the time. First feeding of colostrum was administered solely via esophageal feeder in 67% of farms and average first feeding of colostrum was 3.73 and 3.5 liters for heifers and bulls, respectively. Calves were solely bottle-fed colostrum on 11.1% of farms (22.2% of farms used a mix of tubing and bottle-feeding colostrum). A second colostrum feeding was administered on 77.7% of farms when feeding heifers and on 38.9% of farms when feeding bulls with an average colostrum meal of 2 L. Serum total protein (n=195) was ≥6.2 in 53.6%, 5.8 to 6.1 in 14.4%, 5.1 – 5.7 in 19.1%, and <5.1 in 12.9% of calves if packed cell volume was adjusted, and was ≥6.2 in 57.4%, 5.8 to 6.1 in 22.1%, 5.1 to 5.7 in 16.4%, and <5.1 in 4.1% of calves if not adjusted for blood concentration. Colostrum brix averaged 25.1% with a range of 22 – 27.5%. n=18 farms. Cornell U. T26.
8. *How does STP effect morbidity, mortality, ADG, and blood metabolites in calves raised on a calf ranch?* Male Holstein calves (n=1,631) purchased from dairy farms were

measured for serum total protein (STP) upon arrival at a Western USA calf ranch at 1 day of age. A blood sample was taken at 48 h (±6 h) post arrival and STP analyzed using a digital refractometer, lipid soluble vitamins measured from serum by HPLC and glucose measured via an assay. Calves were classified by STP status as either poor if <5.1 g/dL (n=159, mean 4.68 g/dL), fair if 5.1 to ≥5.7 g/dL (n=399, mean 5.45 g/dL), good if 5.8 to ≥6.1 g/dL (n=322, mean 5.96 g/dL) or excellent if >6.1 g/dL (n=751, mean 6.9 g/dL). Treatments were monitored. Calves treated at least 1x for respiratory disease by STP were 84.3%, 84.7%, 83.9%, and 81.1%, for poor, fair, good, and excellent STP status (NSD, P=0.69). Calves treated at least 1x for gastrointestinal disorder by STP status were 25.8%, 21.3%, 17.4%, and 20.6% for poor, fair, good, and excellent status (no P value reported). Ear disease treatment was 1.9%, 4.6%, 3.7%, and 6.1% for poor, fair, good, and excellent STP status, with poor vs. excellent and fair vs. good noting increased incidence (P=0.03). ADG d 0 – 90 was not different (P=0.35) with estimates ranging from 1.1 to 1.15 lbs./d when examining the graph, and ADG arrival to shipping, culling, or death approximately 1.34 lbs./d (NSD), again, based on rough estimates when examining the graph. Total mortality was less (P=0.03) for calves of excellent vs. poor colostrum status (mortality % not reported) and odds of death were +56% for poor vs. excellent STP "with the true population effect between 62% and 16% (P=0.0337)." Glucose concentrations were lesser (P=0.02) for poor and fair vs. excellent with good STP status intermediary. Retinol (vitamin A) concentration was less (P=0.0006; app 190 mcg/mL) for poor vs. good and excellent (app. 300 mcg/mL for both) with fair intermediary. Beta-carotene concentration for poor, fair, and good were all similar at app. 300 mcg/mL vs. excellent was much greater (P=0.0412) at about 1000 mcg/mL. Alpha-tocopherol (vitamin E) concentration ranged from 1300 to about 1900 mcg/mL for poor, fair, and good, with excellent STP greater (P=0.0006) at about 2,600 mcg/mL. Incidence of FPT was 25%. Take home: FPT significantly effects morbidity, mortality, and serum metabolites. n=1631. U of Idaho. 262.

9. *What is prevalence of FPT in Ontario, Canada, calves?* Certified vet techs monitored serum total protein (STP) of male Holstein calves (n=386) at 4 auction sites and students monitored FPT and health scores on Holstein calves (n=444; 203 male and 241 female) on 105 dairy farms. Calves at auction sites had mean STP of 5.8 g/dL with range of 4.1 to 7.9 and incidence of FPT (<5.2 g/dL) 24%. No other measures were taken on auction calves. Calves monitored on farms noted mean STP 5.7 g/dL with range 3.6 – 8.9 and incidence of FPT the same 24%. On the dairy farms students also monitored age (mean 4 d, range 1 – 9 d) and weight (mean 101.4 lbs., range 75 – 145.5 lbs.) and there was no correlation between weight and age. Median time to provide first colostrum provision was 2.5 h (range 0 – 12 h) and 83% fed colostrum from the dam of the calf as the predominant source. Most colostrum was fed via a nipple bottle (82% of farms) and 25% of farms reported managing colostrum differently for male calves, feeding lesser or poorer quality colostrum. Health scores of dairy farm calves (n=301) were measured with a median score of 4, range 0 – 14. Respiratory score noted 95% <4 as measured by

the UW-Madison app, noting just 3 calves having respiratory disease. Fecal scores noted 24% normal and 54% semi-formed and 22% diarrheic (16% loose, 6% watery). Neither sex, age, nor weight were associated with FPT incidence. Increased respiratory score tended (P=0.10) with older calves. Heavier calves noted lower (P=0.02) respiratory scores and calves with FPT noted higher respiratory scores. Older calves were more likely to have diarrhea, otherwise, no correlation with weight, sex, or FPT incidence on incidence of diarrhea. U of Guelph. ACER Consulting. 264.

10. *Is the microbiome and drug resistance genes of colostrum from low somatic cell count cows effected by intermammary treatment at dry off with cephaprin benzathine mastitis treatment?* Composite colostrum samples taken within 4 hours of birth and quarter level milk samples taken d 1 – 7 days in milk were analyzed on one NY farm from June 2016 to March 2017. Cows were eligible for study entry if a.) last DHIA test was ≤200,000 cells per mL, b.) average of ≤200,000 cells per mL over the last 3 tests, and c.) no more than one case of mastitis in the current lactation. There were two treatments, a.) intermammary cephapirin antibiotic treatment and external teat sealant on all quarters both applied at dry off, b.) teat sealant only, at dry off. Colostrum and milk samples were tested using amplified bacterial DNA, target enrichment, sequenced, analysis for counts and similarities, comparison of microbiome and resistance genes between treatment and control, and analysis of diversity of microbiome and resistance genes. Results: raw microbiome counts were similar (within 1%) and most abundant phyla were Firmicutes (70%), Proteobacteria (24%), and Bacteroidetes (3%). There was no difference in the bacterial phylum, class, or order levels. Resistance genes were found in 14 of 26 pools (9 in control and 5 in antibiotic-treatment; interestingly, more incidence in the control). The most abundant resistance genes were to aminoglycoside (35% abundance in both groups; drugs like dihydrostreptomycin, gentamicin, neomycin, streptomycin, apramycin), tetracyclines (22% in control, 54% in antibiotic group), and Beta-lactam classes (control 15%, antibiotic group 12%; drugs like penicillin, ceftiofur, cloxacillin, cephapirin, amoxicillin). The only drug with use history on the farm was beta-lactams on a portion of cows at dry off (author hypothesized natural resistance in the environment and co-resistant genes). Distribution of resistance genes were not different. There were differences in diversity (P=0.03) of microbiome and there were trends (P=0.06) in richness of diversity between groups. Bottom line: no differences in microbiome or antibiotic resistance compositions between colostrum harvested from cows with and w/o use of mastitis treatment at dry off. n=1800 cow farm pool to select candidates from. Cornell. Texas A & M. Colorado State U. T24.
11. *Is serum total protein (STP) a heritable trait?* The performance records of Holstein calves (n=7,518) with STP records and with assured minimum 2 generations of Holstein sires and with no known non-Holstein genetic background were analyzed. The genetics of cattle analyzed represented 256 sires with at least 10 daughters in the pool of cattle. Mean STP was 6.39 and incidence of FPT was 10%. Heritability of STP was estimated to be 8% and heritability of failure of passive transfer (FPT) was estimated to be 6%,

however, the FPT analysis was reported as containing wide variation and the authors report they cannot say heritability of FPT was above zero. The genetic correlation of STP and net merit, productive life, cow livability and somatic cell count were +0.28 ($P<0.05$), +0.40 ($P<0.05$), +0.42 ($P<0.05$), and +0.01, respectively, demonstrating moderately positive correlation between STP and cow productive life in the herd. There was no genetic correlation (-0.04) between STP and daughter stillbirth rate, however, there was moderate genetic correlation between STP and sire stillbirth rate (-0.24; $P<0.05$; meaning reduced still birth rate if STP was greater), daughter calving ease (-0.24; $P<0.05$), and sire calving ease (-0.31; $P<0.05$). There was also positive correlation (+0.25; $P<0.05$) between early first calving and increased STP, meaning calves with improved STP calved in earlier as heifers in their first lactations. STP did not correlate with yield traits, +0.17 ($P<0.05$), +0.16 ($P<0.05$), and +0.09, positive for milk yield, fat yield, and protein yield with improved calf STP. n=7,518. Penn State U. U of MN, Morris. 196.

CMR and Milk Feeding Rates and Strategies (10 abstracts):

1. *1.5 lbs. per d or 3 lbs. per d CMR? Low starch or high starch starter? Which combination performs best and how does each effect GIT (gastrointestinal tract) development and weaning transition? How does MR intake correspond with differing levels of starch in grain?* Holstein bull calves were fed a 24:20 at 4.74 L/d (15% solids) week one and then week 2 – 6 were fed either 1.5 lbs./d (4.74 L/d) or 3 lbs./d (9.5 L/d) of the same milk replacer and offered either a low 12% starch (44.6% NDF, 2.87 Mcal/kg) or a high 35.6% starch (19.6% NDF, 2.87 Mcal/kg) pelleted starter in a 2 x 2 factorial study design. Calves were bedded on straw to wk 5 (then bedding was covered) and housed individually. Calves were weaned wk 7 in step-down fashion and the study lasted through wk 8. ADG was greater ($P<0.01$) weeks 2 and 3 in calves fed the high feeding rate of MR and was greater weeks 7 and 8 ($P<0.01$) for calves fed the low feeding rate of MR due to increased starter grain intake. Calf body weight was not different week 1 or week 8 but otherwise was greater ($P<0.01$) for the calves fed high rate of MR weeks 2, 3, 4, 5, 6, and 7 as compared to low feeding rate of MR. Calves were dissected week 8 and reticulorumen measures (full weight and empty weight) were greater ($P<0.01$) and digesta was greater ($P=0.01$) for calves fed low as compared to high MR feeding rates, also, calves fed low starch starter noted the same differences noted in low vs. high MR in reticulorumen measures when compared to calves fed high starch starter ($P<0.01$). Two-dimensional papillae measures for calves fed low MR noted longer ($P<0.01$), wider ($P=0.01$) and greater surface area ($P<0.01$) when fed low MR vs. high MR feeding rates, again, due to increased starter intake. Also, the duodenum was heavier ($P=0.02$; full, empty, & digesta) in calves fed low MR feeding rate vs. high MR and the cecum was also heavier ($P=0.03$ as full weight, $P<0.01$ as digesta) in low MR feeding rate vs. high MR. Prewean energy and protein intake was not linked to GIT growth post wean. Take home messages: a.) increased starter intake prewean improves ADG around weaning and promotes GIT growth and the shift from a non-ruminant to a ruminant, b.) growth

advantages early on from high MR feeding rates diminish post-wean, c.) starter intake had more effect on GIT growth than did starch content of the grain. n=48. Provimi/Cargill; U of Guelph. M60.

2. *Corresponding oral to M60: Take home: "form of diet (pelleted or textured) may influence GIT pH more than starter starch. Starter intake more significant for rumen fermentation than starch level." NDF content and inflammatory response not linked to increased fermentation or starch intake.* Further analysis of the study reported in M60. Weekly blood measures taken. Rumen dwelling pH bolus (Dascar T9) continuously measured rumen pH every 2 minutes and was in the rumen d 35 – 60. Rumen fluid was sampled d 28, 35, 42, 49, and 56. Starter DMI: calves fed low CMR feeding rate noted increased starter intake (P<0.01) weeks 6, 7, and 8. Starch intake: increased in low CMR feeding rate (P<0.01) but was also greater (P<0.01) in calves fed high starch. VFA was measured weeks 4 – 8 and low CMR feeding rate-fed calves noted increased (P<0.01) total VFA's week 5 only. Propionate and butyrate accounted for more of this increase than acetate and this increase occurred the week prior the starter intake increasing. All treatments noted a rumen pH decrease to below SARA pH 5.6 threshold at week 7 (weaning), and all rebounded from danger-zone pH week 8. In the reticulum a lower pH was noted in low CMR-fed calves (P=0.02). In the abomasum lower pH was noted in low starch-fed calves (P=0.01). In the cecum lower pH was noted in high starch-fed calves (P=0.01). In the colon there was a tendency (P=0.07) for lower pH in high starch-fed calves. The researcher speculates this may be due to more hind gut fermentation occurring with high starch diets. Inflammatory response was assessed via haptoglobin in blood and NSD (P=0.25) due to starch levels fed, but inflammatory response was higher (P=0.03) in higher CMR-feeding rate fed calves and high CMR/high starch had numerically highest levels of haptoglobin. ADG was similar across treatments, "minor fermentation and pH changes did not alter overall utilization of nutrients for growth." U of Guelph. Provimi. U of KY. 221.
3. *When attempting to meet caloric needs for the first 3 weeks of life and in the winter, which is better, feeding more CMR or feeding higher fat CMR?* Males Holstein calves were fed one of three milk replacer strategies, either a.) 1.5 lbs. per d of 24:17 CMR, b.) 1.8 lbs. per d of the same 24:17 for d 1 – 21 and then 1.5 lbs. per d thereafter, or c.) 1.5 lbs. per d of higher fat 24:34 CMR for d 1 – 21 and then 1.5 lbs. 24:17 thereafter. All calves weaned by cutting feeding in half d 43 – 49. The high fat CMR contained +18% more ME and lactose was reduced from 49.5% to 38.6% of the formula. Texturized calf starter composed of 21% C.P. and 40% starch and whole corn was fed. Day 0 – 56 ADG was NSD at 1.42, 1.49, and 1.44 lbs./d for control, high MR and high fat strategies, respectively, however, G:F improved with higher feeding rate CMR strategy (P<0.01) vs. control and tended greater for high fat (P=0.06) vs. control. There was NSD in grain intake d 0 – 56 with average daily starter intake 1.56, 1.59, and 1.47 lbs./d respectively for control, high CMR and high Fat CMR, respectively. Week 1 ADG was significantly higher for higher feeding rate of CMR over the other two treatments, and week 2 ADG

was higher for both high fdg rate CMR and high fat CMR vs. control (no stats provided). There were two blocks of calves in the study, the first block placed in November that experienced an average temperature of 37.4 F and a second block placed in February that experienced an average 41.3 F temperature. All calves were housed in a non-heated naturally ventilated barn with deep-straw-bedded pens. The block of calves placed in November noted not only a lower average temperature but also a colder range of low and high temps during grow out and when the data from these November-placed calves was broken out they noted increased (P=0.02) ADG and improved G:F (P<0.01) for high feeding rate-fed calves vs. control calves while the high fat-fed calves only noted improved G:F (not ADG) when compared to control. Interestingly, in the November-placed calves there was no effect on starter grain intake (1.57, 1.59, and 1.47 lbs./d for control, high CMR and high-fat, respectively). Take home: a.) providing more energy the first 3 weeks of life improved G:F in 2 winter trials, and it didn't matter if it came from feeding more CMR or a higher fat CMR, b.) "feeding 20% more CMR in the first 3 weeks of life appears to be a more efficient way to improve growth rate vs. feeding a higher fat milk replacer at an equivalent energy intake," and c.) it doesn't matter energy source as long as energy needs are met, d.) easier to manage one CMR on-farm than two, e.) starter intake might not be impacted by increased CMR feeding rate or fat content in more extreme cold weather. n=96. Provimi. M63.

4. *What is the best milk replacer strategy for a Jersey calf?* Jersey heifer calves were fed either a.) 1 lbs. per day to d 42 then 0.5 lb./d to 49 d wean, or b.) 1 lb. per d to d 7, then 1.5 lbs./d to d 35, then 0.75 lb./d to 42 d wean, and either a.) 18% fat, or b.) 25% fat, in a 2 x 2 factorial study design. Calf starter (21% C.P., 40% starch) was offered and 5% chopped grass hay was included in this same grain post-wean. Calves were weighed weekly to d 56 and then at d 84 and 112 (4 months age). Calves were placed in 2 blocks, the first noted average temp 58 F with range of 25 to 104 F, and the second noted average temp 64 F with range 39 to 91 F with 72% relatively humidity, on average. Fecal digestibility was determined week 3. Prewean noted increased (P<0.05) starter intake for low vs. high CMR intake (1.67 vs. 1.41 lbs./d) and low 18% fat vs. high 25% fat (1.67 vs. 1.41 lbs./d), and ADG was greater for high vs. low CMR intake (1.23 vs. 1.15 lbs./d); and hip width change was greater (1.9 vs. 1.73 inches) for lower 18% fat vs. higher 25% fat. Total tract digestibility week three was higher for the increased CMR feeding rate-fed calves on dry matter (P=0.002), ADF (P=0.032), NDF (P=0.046), starch (P=0.047), fat (P=0.064), and CP (P=0.022). NDF digestibility week 3 was improved (P=0.005) when fed low fat CMR and the authors postulate this corresponds with the 14% reduction (NSD) in total 3 week starter intake in the high-fat CMR groups. Post-wean weeks 8 – 16 noted decreased ADG (P=0.076), decreased G:F (P=0.079), and decreased hip width (P=0.033) for high 25% fat CMR group vs. lower 18% fat group. High feeding rate group noted reduced hip height change. Take home: feeding more than one pound of CMR daily to Jersey calves increased dry matter and decreased fiber digestibility at 3 weeks age, and increased ADG but not frame at 8 weeks age. At 4 months age, high fat CMR (25%)

decreased ADG and decreased G:F to 4 months age. This research shows no advantage to high amounts of milk replacer and no advantage to higher 25% fat CMR vs. lower 18% fat to 4 months age. n=100. Provimi. M74.

5. *28:18 fed for 3 weeks at 2 lbs./d, then convert to 20:20 at 1.25 lbs./d; maximize early growth but push the calf onto grain, is it the best of both worlds?* Holstein heifer calves averaging 86.4 lbs. body weight were fed either a.) 20:20 CMR at 1.25 lbs./d to d 35 and then ½ rate to 42 d wean, b.) 28:18 at 2 lbs./d to d 21 then converted to 20:20 at 1.25 lbs./d to d 35 then ½ rate to 42 d wean, or c.) 28:18 at 2 lbs./d to d 42, then ½ rate to d 49 wean. Both CMR's were all-milk fed at 13.5% solids in a 2x/d strategy. Total CMR consumption per calf average was 45.8, 59.7, and 84.9 lbs. for control, moderate, and high milk replacer intake groups. Texturized starter composed of 18% CP, 25% starch and 18% NDF with Deccox was offered ad lib. Calves were weighed d 1, 7, 14, 21, 28, 35, 42, 49, 56, and 84. ADG d 1 – 56 was 1.65, 1.70, and 1.87 lbs./d for control, moderate, and high feeding rates, with high significantly (P<0.05) greater. ADG d 1 – 84 was 1.74, 1.76, and 1.87 for control, moderate, and high, with high greater (P<0.05). G:F was 0.52, 0.58, 0.65, for control, moderate and high with P<0.05 difference between all three treatments. Calf starter intake d 1 – 84 was 173, 107.6, and 84.7 lbs./calf for control, moderate and high with P<0.05 differences between all three groups. Total DMI was 173.1, 167.8, and 170.2, for control, moderate, and high with a trend (P<0.10) for moderate to be less than control and high group intermediary. Change in hip height was 4.5, 5, and 5.5 inches for control, moderate, and high, with P<0.05 differences between all three. Average fecal scores were less (P<0.05) for control (1.33) vs. either moderate (1.4) or high (1.44) and treatment costs tended (P<0.10) higher for calves fed the high quantity of milk ($1.42) vs. control ($0.75/calf) or moderate ($0.80). Control calves noted fewer (P<0.05) scouring days as compared to calves fed high quantity of milk replacer. n=111. U of MN Waseca. U of MN, Morris. M127.
6. *High lactose or high fat CMR fed on autofeeder.* Holstein bull calves were fed either a.) high lactose CMR composed of 18% fat, 4.4 Mcal/kg M.E., 44.3% lactose, with an osmolarity of 429 mOsm/kg, or b.) high fat CMR composed of 24% fat, 4.7 Mcal/KG M.E., 37.3% lactose and an osmolarity of 429 mOsm/kg. Prewean calves were fed CMR at 15% solids ad libitum in teat-buckets the first 14 days individually housed and then transferred to an autofeeder pen (4 blocks of 8 calves) where they stayed the balance of the study. Calves had ad lib access to milk on the autofeeder until d 36 when limit fed to 6 L/d and then slowly weaned decreasing 0.2 L/d until fully weaned over 21 d (d 63). Starter containing 20% CP and 24% starch and chopped wheat straw were offered ad lib when transferred to the auto-feeder. Pre-wean calves fed high-fat CMR noted decreased (P=0.014) CMR intake (8.8 vs. 7.6 L/d) but NSD in grain intake (4 vs. 3.74 lbs./d) and NSD in ADG (1.85 vs. 1.61 lbs./d for 18% and 24% fat, respectively). Weeks 1 – 12 noted no difference in protein intake, metabolizable energy intake, ADG, or feed efficiency. Calves fed high lactose CMR noted increased (P=0.001) CP:Mcal intake. Calves fed high lactose CMR noted taller (P<0.05) in hip height measure. Calves fed lactose

noted 41% more unrewarded visits (P=0.045) to the autofeeder during 21 d wean as compared to those fed high fat CMR. Blood samples were taken weeks 2, 4, 6, 8, 10, and 12, and calves fed high fat noted higher cholesterol levels prewean (P=0.0029). No differences noted in blood glucose or in BHB, indicating similar rumen development between groups. Take home message: calves can control their feed intake based on caloric density and increased fat at the expense of lactose in the formula decreases voluntary feed intake w/o influencing solid feed intake or calf performance, also, rumen development is not affected by CMR composition of fat and lactose. n=32. U of Guelph. Trouw Nutrition, The Netherlands. 143.

7. *Does increasing CMR feeding frequency (from 2x to 3x/d) alleviate insulin resistance on peripheral tissues when larger feeding rates of CMR are fed during a Georgia summer? Does glucose metabolism limit energy utilization for growth in summer? Is abomasal emptying rate effected?* (combined 338 & 339). Holstein calves were enrolled in the summer (June to August) or the winter (Nov to Jan) and fed either 1.5 or 1.75 lbs./d of 26:17 CMR and either 2x/d (7 am and 4 pm) or 3x/d (7 am, 4 pm, and 10 pm) in a 2 x 2 factorial study design. Ambient temperature and humidity was continuously recorded using a logger and in the summer averaged 74.1°F with temperatures typically exceeding 86°F in the afternoons and relatively humidity routinely ranging from between 60 – 100% and thus achieving the goal of causing heat stress and in the winter averaging 50.9°F with minimal or no heat stress. Dietary treatment started d 8 and was continued to d 42 when all calves received half fdg rate 1x/d (7 am) to a complete wean d 49. Both a glucose tolerance test and an insulin challenge were conducted d 28 and d 49 (n=8/treatment) by pulling blood samples -15, -5, 0, 5, 10, 15, 20, 30, 40, 50, 60, 75, 90, and 120 minutes relative to the glucose or insulin infusion. Performance results: there was NSD in body weight change for 2x vs. 3x fdg in summer (P=0.62), however, in winter there was a trend (P=0.07) for 3x over 2x. Feeding more milk resulted in more body weight gain (P=0.02) in both summer and in winter. Plasma glucose tolerance test and insulin challenge results: during the *summer*, no treatment effect on plasma glucose clearance (NSD due to feeding rate or feeding frequency); feeding 3x/d lowered plasma insulin release (P=0.02)relative to glucose infusion (meaning increased feeding frequency may improve insulin action on glucose clearance); when the insulin test was performed there was no treatment effect on insulin clearance; and feeding 3x/d lowered glucose (P<0.01) and lowered NEFA (P<0.01) area under the curve after insulin infusion; take home for summer feeding from this blood work: increasing from 2x to 3x/d feeding rate decreased pancreatic insulin secretion in summer during the glucose tolerance test, and increasing from 2x to 3x/d increased glucose uptake and efficiently inhibited lipolysis during insulin challenge; during the *winter*, when glucose was infused, there was no treatment effect on plasma glucose clearance, and increasing feeding frequency lowered (P=0.02) insulin release to glucose infusion; when insulin was infused there was no treatment effects on insulin clearance; increasing feeding frequency lowered (P=0.03) plasma glucose to a greater extent after insulin infusion; feeding 3x/d

may increase insulin action and glucose clearance in winter. Plasma NEFA was lower for high feeding rate 2x than high feeding rate 3x. Blood levels of the pain and fever medication Acetaminophen (ACE) correlate with abomasal emptying so the time of maximum ACE concentration is an indicator of abomasal emptying. ACE was administered in the milk replacer solution to a subset of 10 calves in each group on d 21 (ACE, 50 mg/kg of BW) and plasma was collected at -15, 15, 30, 60, 90, 120, 150, 180, 210, 240, 270, 300, 330, 360, 420, and 480 min relative to feeding to analyze for ACE. Increasing feeding frequency from 2x to 3x accelerated (P=0.01) abomasal emptying (233 vs. 172 mg/L plasma acetaminophen) in summer and in winter (P=0.01; 252 vs. 188 mg/L). The lower CMR feeding rate tended (P=0.10) to accelerate abomasal emptying rate in summer but not in winter. Take home: "increasing feeding frequency from 2x to 3x/d reduced pancreatic insulin secretion in both seasons; increasing feeding frequency from 2x to 3x/d improved dependent glucose uptake in both seasons; increasing feeding frequency in the summer enhanced the inhibitory effect of insulin on lipolysis; the inhibitory effect of feeding frequency on lipolysis was inconsistent in the winter. Also, feeding 3x/d in summer or winter accelerated abomasal emptying rate." n=48/season. U of GA. 338 & 339.

8. *Saleable whole milk, waste milk, or pasteurized waste milk.* Holstein x Gyr cross calves (83.8 lbs. birth weight) were fed app. 3.7 L of colostrum standardized using powdered colostrum to minimum 25 BRIX within 6 h of birth, and then transition milk to d 4 when placed on one of three treatments, either a.) saleable whole milk, b.) waste milk from cows treated with antibiotics for either mastitis, retained placentas, or hoof injuries, or, c.) the same antibiotic waste milk pasteurized at between 161.6 to 167 F for 15 seconds. All calves were fed 6 L/d. No mention of plate counts taken on milk, nor any report of protein, fat, or solids content. Water and starter offered ad lib. Heart girth, wither height, hip height, hip width, and body weight measures taken. Rumen fluid collected d 14, 28, 42, and 56 and acetate, butyrate, and propionate measured. Calves were euthanized d 60 and organs were evaluated in proportion to empty body weight. D 57 (end of study) calves weighed 167.6, 170.6, and 163.1 lbs. body weight with an ADG of 1.48, 1.57, and 1.37 lbs./d for whole milk, waste milk, and pasteurized waste milk, respectively. NSD in final weight, ADG, or in any measured body dimension. Rumen acetic acid was 20.49, 33.08, and 39.75 mmol/L for calves fed saleable whole milk, waste milk, and pasteurized waste milk, respectively with P=0.008 increase for pasteurized waste milk over the other two treatments. Rumen propionic acid concentration was 20.84, 22.21, and 28.12 mmol/L for saleable milk, waste milk, and pasteurized waste milk, respectively, with saleable milk and pasteurized waste milk different (P=0.012) and non-pasteurized waste milk intermediary. Rumen butyric acid was 4.98, 5.51, and 6.25 mmol/L for saleable, waste, and pasteurized waste milk, respectively (NSD). Both waste milk- and pasteurized waste milk-fed calves noted increased (P=0.01) reticulo-rumen weight as compared to calves fed saleable milk. NSD in weight of omasum, abomasum, small- or large-intestine. Author hypothesized that

presence of antibiotics in the calf's rumen changes microbiota and nutrient metabolism resulting in increased rumen weight. n=45. Nat. Center for Research on Dairy Cattle, Brazil. Fed U of Minas Gerais. Brazilian Ag Res. Corp. Brazil. M67 & M68.

Dry cow strategies and their impact on the calf (5 abstracts):

1. *What is the relationship between the microbiome of the dam and its calf?* Microbiome is transferred between the dam's feces and vagina at birth, from the oral cavity as she cleans the calf, from colostrum, and, most recently determined to come from the dam's uterus and placenta and amniotic fluid and possibly calf meconium and feces from the calf at birth. Multiparous Holstein cows (n=6) were isolated in wood shave bedded box stalls 10 d prior calving. Posterior vagina swabs were taken daily for 10 d prior birthing. At birth samples of colostrum (pooled from quartiles), swabs of placenta cotyledon just prior birth crowning, swabs of the cow oral cavity and cow feces samples were all snap frozen. The calf was isolated in a hutch and assigned the same bottle for the entire feeding period. The calf was fed 4 L of its dam's colostrum and fecal samples were collected from the calf d 0, 24 h, 7 d, 42 d, and 60 d. Starter was introduced d 28 and a step-down wean occurred starting d 42 w/complete wean d 60. It was not reported which the calf received CMR or whole milk. A DNA extraction and sequencing method was implemented to analyze samples (16S rDNA library system used) and categorized in clustering analysis using Spearman correlation calculated. The diversity within a sample (alpha diversity) was greatest in the oral cavity and least in the placenta and colostrum. The diversity between samples (beta diversity) found placenta and colostrum clusters more independent in microbiome diversity as measured between all samples. Fecal samples of meconium (24 h calf fecal) clustered together (similar in microbiome) and gradually became more like cow and d 60 calf fecal samples as taken from an older calf. Proteobacteria (major phylum of gram-negative bacteria that also include E coli and salmonella) are dominant phyla on all but cow fecal and calf fecal samples. Colostrum and calf 24 h fecal sample are somewhat similar in microbiome. Bacteroidetes (composed of 3 large classes of gram-negative non-spore-forming, anaerobic or aerobic and rod-shaped bacteria) are prevalent in cow fecal, meconium, calf fecal 7d, 42 d, and 60 d, but are not present in calf fecal 24 h samples. There was low to medium genera microbiome correlation between colostrum, placenta, vagina, oral cavity of the cow, and fecal samples with the highest correlation noted between meconium and vagina (0.451), meconium and cow oral cavity (0.527), and between cow fecal and meconium (0.337). Genera correlation was 0.337 for cow fecal and meconium and correlation ascends to 0.42 between 42-d calf fecal sample and cow fecal sample and 0.477 between cow fecal sample at birth and the 60 d calf fecal sample showing that when the calf consumes a grain diet the cow and calf fecal microbiomes become more similar. Authors note calves used in the study were healthy. n=6. Virginia Tech. 128.
2. *Alltech organic trace minerals replacing sulfates in dry cow ration – improve colostrum quality? Reduce FPT?* Cows (n=182) were fed elemental cobalt, copper, manganese, and

zinc at recommended concentrations of 0.25, 13.7, 40.0, and 22.8 ppm, respectively, from either sulfate or Alltech Bioplex proteinate sources, and selenium at 0.3 ppm, from either sodium selenite or Alltech Sel-Plex. Respective diets were fed via automatic feeding gates for 45 d prior expected calving date. Groups were blocked by parity. At calving, colostrum volume was measured and analyzed for BRIX and IgG. Calves were fed 3 L of colostrum with BRIX % > 22 within 6 hours and 3 L again 6 hours later. Colostrum was standardized with frozen colostrum if necessary. Blood was collected from calves at 24 h. Results: NSD in total harvested colostrum volume (4.41 and 4.84 L for inorganic and organic, respectively; P=0.21). NSD in colostrum BRIX (24.6% for both groups). NSD in colostrum IgG concentration (73.96 and 81 mg/mL for inorganic and organic, respectively), however, total secretion of IgG was greater (P=0.03) in cows fed organic TM's (302.8 and 376.4 grams for inorganic and organic, respectively). In calves there was NSD in calf birth weight (92.8 lbs. for both), NSD in serum total protein (6.3 g/dL in both) and NSD in calf serum IgG (30.2 and 31.4 mg/mL for inorganic and organic, respectively). n=182. U of Guelph. 145.

3. *Supplementing rumen protected lysine prepartum: the effect on calf.* Holstein cows were blocked by parity, previous 305 d milk, expected calving date and body condition score 30 d prior calving date and assigned to one of two groups, either a.) control, TMR only, or b.) top-dress rumen protected lysine at 0.54% of TMR daily 28 d before calving. Calves (n=72; 37 male, 35 female) were monitored weekly for temp/fecal/respiratory scores and health assessments and meds as needed and blood samples drawn for metabolite panel d 0 (prior colostrum, 3.8 L colostrum replacer), and 2, 7, 14, 28, 42, and 56 d at 16:00 h. Calves were fed 28.5:15 CMR to d 42, 20% CP grain ad lib. CMR. Results: male calves in the control group noted higher medical events (P=0.05) than those from dams fed rumen protected lysine; males in the control group also showed higher (P=0.03) antibiotic utilization compared to males from dams fed bypass lysine. Calves from dams fed bypass lysine had greater total plasma amino acids (P<0.05). "Additionally, calves from cows supplemented with rumen protected lysine had increased plasma methionine and lysine concentrations than calves from cows not treated with rumen protected lysine." Author also reports "In conclusion, calves from dams fed rumen protected lysine prepartum, had improved overall growth and intake than calves from dams not receiving rumen protected lysine." However, ADG week 1 – 8 was reported as 1.5, 1.54, 1.52, and 1.52 lbs./d for control (no bypass lysine fed to dam), bypass lysine fed to dam, female calves, and male calves, respectively, with a treatment P-value reported as P=0.47, and a treatment by sex P value reported as P=0.08. n=72. U of Illinois. Ajinomoto. T112 & T113.
4. *Does maternal body condition effect future calf growth and gene expression?* Calves born from cows that were either a.) normal body condition, ≤3.25 body condition score on scale of 5; n=30, or b.) high body condition ≥3.75; n=19, as measured 4 weeks prior calving were monitored. Bodyweight and dimensions were recorded d 0, 21, 42 (wean) and 63, and blood samples were taken d 0 (prior colostrum feeding), 21, and 42. Blood

samples were exposed to an LPS E coli 0111:B4 challenge and then evaluated for cytokine, cytokine receptors, Toll-like receptor pathways, adhesion and migration, antimicrobial function, antioxidant, and l-carbon metabolism gene concentrations. Calves were fed colostrum from their respective dam and then a 28:15 CMR to d 35 and then 1x/d until complete wean d 42. Starter grain (20% CP) was offered ad lib. Calves from high body condition score cows had lower birthweight (93.7 vs. 98.5 lbs.; P=0.03). Calves from normal body condition score dams had greater postnatal body weight (139.6 vs. 131.6 lbs.; P=0.04), however, body dimensions, starter intake, and ADG did not differ. Blood taken at birth prior colostrum feeding noted increased proinflammatory cytokine IL1B (P<0.01), lower GPX1 (P=0.02) and greater GSR (P=0.03) antioxidant genes if born from a high body condition score dam, otherwise, NSD in any gene measured. Over time (d 0, 21, and 42) almost all genes decreased in concentration as measured in the blood LPS challenge model, but only one gene, GPX1 differed, being lower for high body condition score calves (P=0.02). Take home: body condition score in late gestation not only influences calf development in utero "but also the abundance of key genes related to cytokine production and antioxidant function in whole blood." U of Illinois. Universidade Federal de Pelotas, Brazil. King Saud U, Saudi Arabia. Nanjing Ag U, China. U Cattolica del Sacro Cuore, Italy. 77.

Fats and oils nutrition (2 abstracts):

1. *Coconut oil replacing either 15% or 25% of animal fat?* Holstein heifer calves were fed either a.) 24:20 (tested 26% C.P.) fed at 1.25 lbs./calf d 1 – 35 then half rate to 42 d wean composed of 100% animal fat, or b.) 24:24 fed at the same 1.25 lbs./calf d 1 – 35 then half rate to 42 d wean composed of 85% animal fat and 15% coconut oil, or c.) 24:24 fed at the same 1.25 lbs./calf d 1 – 35 then half rate to 42 d wean composed of 75% animal fat and 25% coconut oil, or d.) 24:24 fed at 1.89 lbs./calf d 1 – 35 then half rate to 42 d wean composed of 85% animal fat and 15% coconut oil, or e.) 24:24 fed at 1.89 lbs./calf d 1 – 35 then half rate to 42 d wean composed of 75% animal fat and 25% coconut oil. All CMRs contained Biomos. Lower feeding rate provided approximately 46 lbs. of CMR and higher feeding rate provided approximately 81.1 lbs. CMR per calf. Starter was composed of 21% C.P., 32% starch and 17% NDF and was provided d 1 – 56. Grower contained 16% C.P. and was fed at 6 lbs./d with free choice alfalfa hay. Weight measures taken d 1, 14, 28, 42, 49, 56, 84. "There was no difference in ADG (P<0.05) d 1 to 56, d 57 to 84 or d 1 to 84 averaging" 1.74, 1.98, 1.83 lbs./d, respectively. Hip height gain d 1 – 56 was greater in high vs. low milk replacer feeding rates (+5.2 vs. +4.6 inches). Calf starter intake (125.2 vs. 76.7 lbs.) and total dry matter intake (171.7 vs. 158.3 lbs.) was greater (P<0.05) d 1 – 56 for calves fed lower feeding rates as compared to higher feeding rates. G:F was improved for calves fed higher (P<0.05) feeding rates as compared to lower feeding rates d 1 – 56 (0.65 vs. 0.58). No differences noted in scour scores or med costs (averaged 1.82 and $0.50/calf, respectively). Take home: "There

was no benefit to offering calves CMR where more than 15% of the total fat comes from coconut oil." n=131. U of MN, Waseca. Hubbard Feeds. M109.

2. *Fish oil or canola oil?* Holstein calves housed at the U of GA were fed a 26:20 at 12.5% solids at 4 L/d week 1 and 6 L/d weeks 2 – 7 then half rate week 8 to wean that contained either a.) 30 ml/d of canola oil or b.) 30 g/d of fish oil. Respective oil was added to milk replacer solution in the AM feeding each day. Rectal temperature was taken, blood samples drawn, and body weight measured d 7, 14, 21, 28, 35, 49, and 56. Starter intake, fecal score, and nasal score determined daily. Lactate was measured in blood via a hand-held device. NSD in body weight, rectal temperature, or starter intake. There was a tendency for overall fecal score (P=0.1) and nasal score (P=0.053) to be higher in the canola oil- than the fish oil-fed calves throughout the trial. Blood lactate d7 tended higher d 7 (P=0.09) and d 28 (P=0.06) for canola-oil vs. fish-oil fed calves, possibly indicative of less metabolic stress if fed fish oil, otherwise NSD. Author speculates omega 3 fatty acids are more beneficial to the calf than supplemental omega 6 and omega 9 fatty acids. U of GA, Tifton. U of Chile, Santiago. Abraham Baldwin Ag College, Tifton. CSU, Fort Collins. Nat. U La Pampa, Argentina. T16.

Health, respiratory Disease (BRD), enteric disease, and immune function (15 abstracts):

1. *Which blood buffer used in an electrolyte is more effective at preventing or correcting acidemia in calves?* Grain-fed veal calves with either 2 days scour score 2 (runny, spreads easily) or 1 day scour score 3 (liquid void of solid material) were administered via esophageal tube either a.) a basic electrolyte powder composed of sodium bicarbonate (50.7 mmol/L), b.) a mixed buffer powder including sodium bicarbonate (33.8 mmol/L), sodium citrate (8.4 mmol/L), sodium acetate (6.3 mmol/L), and potassium citrate (1.9 mmol/L), or c.) a liquid electrolyte composed of sodium acetate (50.1 mmol/L). All three electrolyte options were standardized to have similar strong ion difference ranging from a low of 74.4 to a high of 82.6 meq/L. 2 quarts of the respective electrolyte was administered twice daily 1 h following milk feeding until the abnormal fecal score was resolved (fecal score 0 or 1). 45 of 80 calves placed in the room met fecal score requirements and were enrolled in the study. Calves were fecal scored for at least 14 d post enrollment and scaled d 1, 2, 7, 14, and 28. Blood gas measures were taken at 1, 8, and 24 h post enrollment using an i-STAT 1 Handheld Analyzer to measure Na, hemoglobin, K, pCO_2, pH, tCO_2, hematocrit, HCO_3, base excess, BUN, Anion Gap, glucose and Cl. Meds, NSAIDS, and IV fluids were monitored. Hydration status was monitored midday by a clinician who examined % dehydration, calf attitude, extent of eyeball recession, and incidence of skin tenting. Randomized fecal testing of enrolled calves showed high incidence of crypto (75% of the 12 fecal samples, 4 from each group), rotavirus A (67%) and coronavirus (50%), with no salmonella or E coli detected. Duration of diarrhea took a mean of 3.9 d to return to fecal score <2. No differences were noted in incidence of scour or respiratory medical treatments administered. Also, no difference in hydration measures except for basic bicarbonate powder-treated calves

noting more severe (P=0.02) eye recession as compared to calves provided mixed buffer powder. No mortality, minimal milk replacer refusals and no IV fluids were administered to any enrolled calf, all indicative of a relatively low diarrhea disease challenge. No differences noted in ADG at any measure. Blood glucose measures improved in all 3 groups. TCO_2, a measure of blood bicarbonate levels, was lower at 8 h (P=0.03) and 24 h (P=0.01) in the basic bicarbonate group vs. the other two groups. Sodium status was improved in all three treatment groups, but concentrations were higher (P=0.04 at 1 h, P<0.001 at 8 h and 24 h) in the mixed buffer electrolyte group. Actual blood bicarbonate (HCO_3, P=0.08), base excess (amount of excess blood bicarb; P=0.01), and anion gap (higher indicates acidemia; P=0.02), were all lower in the basic bicarbonate group at 24 h, and base excess was also lower at 8 h (P=0.05) compared to either of the other two electrolyte strategies. Blood pH tended higher (P=0.06) at 8 h and 24 h for mixed buffer powder and high acetate liquid as compared to the basic bicarb powder group. n=45. Animix. Mapleview Agri. ACER Consulting. 191.

2. *What is the effect of pre- and post-wean incidence of bovine respiratory disease (BRD) and the effect of prewean ADG on a calf's future conception rates and 280 d milk yield? What about genomics?* Calves (n=9,099) reared on a commercial dairy in Indiana from 2015 to 2019 were monitored regarding milk consumption (avg 508 L/calf, SD 67.3 L, whole milk supplemented with 20 g of 30:5 balancer/L, fed on 8 Forester-Technik autofeeders), ADG, mortality and incidence of BRD pre-wean 0 - 60 d) and BRD and mortality post wean 60 – 120 d, also, heifer conception age (n=5,187) and 280 d 1st lactation milk production (n=1,324) were tracked and analyzed. Regression analysis was used to predict pre-wean ADG & d 0 to 400 ADG. Diagnosis with respiratory disease 2x during d 60 – 120 decreased likelihood to survive to 800 d age (1st lactation age) by 11.55% (P=0.04) and decreased by 28.7% if diagnosed with BRD 3+ times (P=0.002). If BRD incidence d 60 – 120 was 2x heifers were 19% less likely to be bred (P=0.02) by 550 d and if BRD incidence was 3x+ then heifers were 34% less likely (P=0.05) to be bred by 550 d. Heifers were 9.3 lbs. lighter at 400 d if treated for respiratory diseases 3+ times during the 1st 60 d of life, compared with heifers no treated for respiratory disease. Avg age at conception was 437.5 d (SD 45.0 d) and avg 280 d milk production was 20,513.8 lbs. (SD 3,024 lbs.). Calves with higher 400 d ADG conceived earlier (r = -0.10; P<0.0001) than calves with lower ADG. Pre-wean ADG (0 – 60 d) was weakly positively correlated with 280 d milk production (r=0.08; P<0.0001); the bottom 25% (1.98 lbs. ADG) produced an average of 515.9 lbs. less milk than calves in the top 25% (2.65 lbs. ADG). Genomic milk index had an even greater spread between top and bottom quartiles (4.086 lbs.; r^2=0.24, P<0.0001). "Birthweight had a significant effect on predicted weights up to 400 d (P<0.001), and for every 2.2 lbs., there was a 5.5 lbs. increase in predicted body weight d 400." n=9,099. Purdue U. Massey U, Palmerston North, NZ. M58 & 76.
3. *Survey of Canadian dairies regarding management of respiratory disease in calves.* 105 dairies located in either Ontario, Alberta, British Columbia, or Nova Scotia (162 cow

average size) were personally visited and surveyed regarding respiratory disease management of dairy calves. 98% reported using antimicrobials to treat calf respiratory disease. 33% had a written protocol to treat the disease and 97% discussed treatment with their veterinarian. The case-specific symptoms most frequently cited for deciding to treat respiratory disease with an antimicrobial were elevated breathing/respiratory rate (80%), spontaneous/induced coughing (67%), fever (61%), presence of nasal/eye discharge (48%) and other characteristics (33%; lethargy and lack of appetite were most frequently offered in the "other" category). U of Guelph. Public Health Agency of Canada. U of Montreal, St-Hyacinthe. U of Calgary. U of PEI, Charlottetown. T19.

4. *Survey of Canadian dairies regarding management of diarrhea using antibiotics in calves.* Same 105 dairy survey as T19. Producers were asked "what case-specific information do you use to select a diarrhea case for antimicrobial treatment?" The were offered 5 choices: 78% chose "fecal consistency," 61% used "fever," 55% used "attitude," 53% used "level of dehydration," and 28% used 11 other indicators of which "milk intake" was the lead choice. 20% chose all 4 options and was the most popular choice. "Among 91 farmers who were asked whether they had a written treatment protocol for calf diarrhea, 35% reported they have the protocol and 94% of them discussed it with their veterinarians." U of Guelph. Public Health Agency of Canada. U of Montreal, St-Hyacinthe. U of Calgary. U of PEI, Charlottetown. 231.
5. *Use of QScout leukocyte differential cell counts at arrival and at 72 h in veal barn to predict morbidity, mortality, and ADG.* QScout calf side leukocyte counts are used as a diagnostic tool in beef feedlots to minimize metaphylactic use of antibiotics. Is the QScout useful in veal? Could calves be tagged at placement as zero risks, low risk, and high risk via a score? Data were collected at placement on 240 veal calves placed in 3 rooms, 80 calves/room, and on a 160 head subset of these calves at 72 h. At placement calves were screened as follows: a.) flank, whether visibly sunk (50% noted this), b.) naval palpation to determine pain, heat, or discharge (29% incidence), c.) trachea palpated to illicit a potential cough (occurred 3% incidence), d.) rectal temperature >103.3 F (27% incidence), e.) body weight (mean 104.7 lbs.), f.) blood sample for serum total protein, g.) blood sample for QScout measure of leukocytes. Blood samples to measure leukocyte cell counts and body weight measurements were taken again at 72 h with the thought that calves were by then on-feed and acclimated to the barn. Morbidity and mortality were tracked and ADG measured. Calf care providers used veterinarian established scour and respiratory scoring systems to decide to medically treat calves. A Cox proportional hazard statistical model was used to determine the hazard of morbidity and mortality from each arrival measure and a mixed linear regression model was used to estimate the effect of each arrival measure on ADG. The Cox proportional hazard for mortality decreased by 71% ($P<0.001$) if serum total protein upon arrival was ≥5.2 g/dL. There was inadequate 21 d mortality to assess any arrival measure at this juncture. The Cox proportional hazard for mortality at 77 d based on 72 h post-arrival measure on a subset of 160 calves noted if lymphocytes were between 4.6 and 5.8 10^9 cell/liter, the hazard of mortality decreased by 78% ($P=0.03$), and if neutrophil counts were >6.0 10^9 cells/L hazard of mortality increased 5.21x ($P=0.02$). The Cox proportional hazard for morbidity in the first 21 days in the barn based on arrival data decreased 41% if lymphocytes

>5.8 10^9 cells/L and increased 1.54x if rectal temps >103.3 F (p=0.04). The cox proportional hazard for morbidity in the first 77 days in the barn based on arrival data increased 1.5x if rectal temperatures >103.3 F (P=0.02). The Cox proportional hazard for morbidity in the first 21 d in the barn based on 72 h data noted a 53% decrease in the hazard of morbidity (P<0.01) if lymphocytes >7.09 10^9/L. The Cox proportional hazard for morbidity in the first 77 d in the barn based on 72 h data noted a 44% decrease in morbidity (P=0.02) if lymphocytes >7.0 10^9/L. A mixed linear regression model for ADG determined that lymphocyte 10^9 cell/L increases ADG (P=0.02) 0.066 lbs./d and dehydration at placement decreases ADG by 0.2 lbs./d (P=0.03). Leukocyte counts were near the normal range for young calves. These researchers hypothesize elevated lymphocyte counts indicated calf age and resilience to stress and that elevated neutrophil count is indicative of calf age or a developing pathology and that hydration status can indicate an existing pathology or prolonged transportation. Salmonella Dublin occurred in this study resulting in elevated mortality and morbidity. Take home message: leukocyte counts measured at arrival were associated with future morbidity and ADG and leukocyte counts measured at 72 h post-arrival were associated with morbidity and mortality. n=240. U of Guelph. 189.

6. *Implementation of a decision-tree algorithm for treating diarrhea on 10 dairies in Ontario, Canada noted an 85% reduction in antimicrobial use.* 10 commercial dairy farms in Ontario rearing from a minimum of 31 to a maximum of 842 calves annually recorded incidence of fever, diarrhea, and off-feed events and subsequent use of antimicrobials, electrolytes, and IV fluids for treatment of diarrhea in the first 30 days of a calf's life. Dairies recorded findings for one year and then were instructed on a decision tree for treatment of diarrhea, including a.) if stools were bloody treat with antimicrobials (ABs), nonsteroidal anti-inflammatory drugs (NSAIDs) and oral electrolyte solution (OES), b.) if the calf is drinking well, monitor, c.) if dull and drinking at 70% or greater of normal speed, monitor for fever and if fever is present, treat with ABs, NSAIDs, and OES, and if fever is not present, treat with NSAIDs and OES, d.) if off feed or drinking at 50% or lesser of normal speed examine for fever, and if fever is present, treat with ABs, NSAIDs, and OES, and if not present treat with OES, IV Fluids and monitor. Bi-weekly visits by university personnel occurred for one year to monitor and ensure the decision tree was properly implemented. Health: incidence of diarrhea, mortality, case mortality rate, and Antimicrobial use: total use and individual use on diarrheic calves were monitored pre- and post-implementation of the decision tree. Diarrhea incidence occurred in 77% and 75% of all calves in pre-and post-implementation of decision tree for treating diarrhea periods, respectively (NSD). Age at first incidence of diarrhea also did not change, occurring typically between 8 and 10 d of age. Treatment rates with antimicrobials in cases of diarrhea decreased from 85% to 18% in the pre- and post-decision tree annual periods while mortality was unaffected at 4% (75/2049 calves) and 3% (72/2,251) with NSD between pre- and post-periods, respectively, and NSD was found on any of the 10 farms. Mortality attributed to diarrhea also noted no difference between pre- and post-decision tree periods reporting 1.4% (22/1,573) and 0.75% (12/1,592), respectively. Trimethoprim-sulfamethazine (TMS) was the most prevalent treatment for diarrhea, used on 8 of 10 farms and use decreased in all 8, and at substantial rates of 4 to 5 fold in post- as compared to pre-implementation of decision tree for treating diarrhea periods. The mass of ceftiofur per diarrheic calf decreased in 3 farms and decreased, on average,

10-fold in post-as compared to pre-implementation periods. n=10 farms. Ontario Vet College, U of Guelph. 230.

7. *Is infrared thermography (infrared camera) a viable means to accurately measure core body temperature in veal calves?* Ocular infrared temperature was measured daily for 14 d on all calves placed from May to July 2019 in a SW Ontario veal farm. An infrared camera attached to an iPod captured images of the calf's eye while being held 12 inches away and estimated temperature, while at the same time, another vet tech took the calf's rectal temperature. The difference between rectal temp and infrared measures/estimates was 0.3°C ±1.5°C (0.54°F, ±2.7°F). Sensitivity was 60% (95% confidence interval: 53, 67) and specificity was 71% (95% confidence interval: 70, 73) with R^2=0.0122. The spread between rectal and infrared temps widened during hot ambient weather and a 0.6°C (1.08°F) spread occurred during particularly hot weather. As ambient temperature increased above 19.5°C (67.1°F) correlation weakened. Bottom line: infrared temperature alone was poorly correlated with rectal temp, possibly due to high ambient temperatures, but also possibly from poorly captured rectal temperatures. "Infrared resulted in good sensitivity and specificity to detect fever compared to a rectal thermometer." n=320. U of Guelph. U of KY, Lexington. 290.
8. *Literature review of coccidiostats and antimicrobials efficacy in diarrheic calves.* A review of 4000 manuscripts was screened to 53 full texts and just 9 reported to have reached the following inclusion criteria: a.) peer reviewed in English, b.) controlled studies, c.) calves under 6 months age, d.) oral or injectable antibiotics or coccidiostats tested, e.) outcomes reported. Most studies included in the review were from N. America or Europe. Six used dairy breeds. E coli and crypto were most studied (4 and 3 of 9, respectively), one studied giardia and one salmonella. 5 inoculated the calves with the pathogen and 4 used natural infection. Ten different antibiotics or coccidiostats were studied. 6 of 9 had high rates of bias assessment in measuring outcomes. Results: improved clinical signs or fecal score in 7 of 9 studies, reduced diarrhea duration in 2 of 9, mortality improved in 1 of 9, and weight gain improved in 1 of 9 and declined in 1 of 9. UC Davis. T27.
9. *Survey of antimicrobial use in preweaned calves in California.* Dairies and calf ranches were surveyed (mail and online survey sent to 1,361 farms) across CA in July 2017. Growers were asked about their antimicrobial use in calf rearing. The survey noted a 12% response rate with a mean of 245 calves of which 79% were Holsteins. Surveys asked about AB use pre and post the federal VFD (Veterinary Feed Directive). Antibiotic use in milk decreased 10% and in grain 5% post-VFD. Neomycin sulfate, CTC, OTC, and sulfamethazine were the most used antibiotics. Only 32% of respondents kept a drug inventory. Respondents (n=70) reported prior VFD 50% added no antibiotics, 24% added limited antibiotics, and 19% routinely added antibiotics to milk. UC Davis. 408.
10. *Bovine respiratory disease (BRD) incidence occurring in the 1st 120 d of life in a Holstein replacement heifer is estimated to cost between $240 and $269.* Published data shows incidence or BRD to range from 5 – 90% with most below 20%. Published estimates range from $21 - $51 cost per BRD incidence. Data from 23 DairyComp 305 herd files that appeared to consistently record respiratory disease were analyzed. Data encompassed 104,100 dairy heifers born in 2016 or 2017 in herd sizes ranging from 448 to 6,856 cows. 90% were Holsteins. BRD incidence rate 1 – 30, 31 – 60, 61 – 90, 91 –

120, 121 – 365, 366 – 730 d averaged 12.9%, 9.8%, 7.4%, 6.5%, 4.3%, and 0.3%, respectively. 41.1% of calves were treated for BRD with a 72.9% risk of treatment (55% in the first 60 d). Costs were modeled off the first 120 d (when most BRD occurred). Immediate consequences of BRD include decreased feed intake and ADG and increased med costs and mortality. Consequences of BRD that are more delayed include retreatment, increased culling risk, delayed 1st service, increased culling, and decreased milk yield. Calculations were made for two pools of incidences: a.) respiratory disease occurring 0 – 120 d, and b.) no BRD occurrence from birth to calving. Modeling costs incurred included indoor housing, feeding a 75:25 ratio of CMR (28:15) and whole milk fed at 8 L/d, 14% solids. Starter, grain, and hay in grower, and a TMR for older heifers. Newborn heifer cost was accrued at $85, labor $15/h, 6% interest, 884 lbs. breeding weight, $18 per AI service. Models assumed no fertility differences, and an overall ADG of 1.92 and 1.85 lbs./d for no BRD and BRD incidence, respectively. ADG differences were based on published data examining calf growth depression associated with BRD. Medical treatment with extended therapy macrolide was 1.7 treatments on average per BRD incidence. BRD incidence resulted in 2.6 higher mortality risk. 40% of deaths were attributed to BRD. The model assumed 10% of BRD incident cases were culled to the beef market and another 10% were culled after 10 months age. Total mortality with no BRD was 4.7% and with BRD 12.3% (2.6x higher). Culls due to BRD or repro were 6.7% with no BRD and 17% with BRD (2.5x higher). Losses per heifer culled were calculated for six stages of heifer development and were -$309, -$404, -$486, -$633, and -$616 depending on the stage in which culling occurred. 1st lactation differences based on pre-wean depressions in ADG attributable to BRD incidence (Soberon & Van Amburgh) estimate a loss of $29 in milk revenue in 1st lactation due to BRD occurrence. Bottom line: Cost of BRD incidence occurring in the first 120 days of life without considering 1st lactation milk yield were estimated at $240 and inclusive of 1st lactation milk yield were $269. M. Overton Elanco. 261.

11. *Effect of bacterial LPS injections on innate immune function in 5 to 11-month-old Holstein calves.* Calves were intramuscularly challenged with either 0 (saline) 100, 200, or 400 ng/kg of bacterial lipopolysaccharide (LPS). Serum was collected just prior the injection and again hourly for 8 hours and again at 24 hours post the challenge. Rectal temps were measured hourly for 8 hours post challenge. Cortisol concentrations were significantly increased for all LPS-treatments at 2, 3 (P<0.01) and 4 (P<0.05) hours post challenge with the low LPS-dose noted a quicker reduction in serum cortisol as compared to the two higher doses. Rectal temps were higher for all three LPS treatments through h5 post-challenge, however, NSD noted at any measure. White blood cell and lymphocyte counts showed declines (P<0.05). TNF-alpha (P<0.0001) and IL-10 (P<0.05) were both higher at 2 h post-challenge, as was IL-8 (P<0.05) at 4 h in the highest LPS-challenge group. U of Guelph. T20.
12. *Efficacy of sulfonamides administered via different routes.* Holstein calves (n=14) diagnosed with diarrhea were administered sulfonamides via either a.) oral (n=5), b.)

injectable (n=4), or c.) both (n=5). Fecal samples were taken d 0, 3, 5, and 7 post diagnoses and administration of sulfonamides. E coli was identified in 100% of collected samples (reported to be n=17) and 14 (82.35%) were sensitive to the sulfonamides and 3 (17.65%) were resistant through an in vitro sensitivity test. Calves injected with sulfonamides were reported as heavier at 60 d (P=0.05). n=14. Federal U of Pelotas, Brazil. M113.

13. *Use of telomere length to mark health.* Telomere is a compound structure at the end of a chromosome. Telomere length was measured from blood samples using multi-plex quantitative PCR on 521 observations from 434 Holsteins in 2 herds. When blood was collected it was marked as from an animal experiencing either a.) no health event (n=467), b.) some health event that week (n=32), or c.) two weeks after a health event (n=22). Telomere length was 5.18, 4.7, and 5.26 as measured in blood drawn from an animal experiencing no health event, a health event, and an animal recovered from a health event two weeks prior, respectively (P=0.02 for health event vs. the other two; P=0.71 for between no health event and recovered from health event). The variability of telomere length is different as cattle age with more variability after approximately 30 months of age in this data set. The author challenges that measure of telomere length may be useful as part of a health index. Penn State U. The Hebrew U, Jerusalem, Israel. M70.
14. *Effect of scours on calf performance and behavior.* A retrospective analysis of 42 calves housed in individual hutches and fed 6 quarts per day of CMR was conducted to measure differences due to scours in calf performance and movement over the first 21 days of life. Calves at SDSU dairy farm were fitted on their left rear leg with a three-dimensional accelerometer (Onset HOBO Pendant G) that recorded individual calf movement every 60 seconds. Daily calf fecal score (1 = well formed, 2 = soft, pudding-like, 3 = runny, pancake batter-like, 4 = liquid and splatters), respiratory score (1 – 5), rectal temp, and starter intake were recorded. Weekly body weight and withers height measures were taken. Data from calves were placed in two groups (P<0.001 different), a.) low d 0 – 21 fecal score, average fecal score 1.47, ±0.1, n=21, and b.) high d 0 – 21 fecal score, average fecal score 2.14, ±0.1, n=21. Fecal score peaked d 10 in the entire group. Low fecal score group noted not only a lower fecal score (P<0.001), but also lower respiratory score (1.01 vs. 1.11, P=0.02), lower rectal temp (100.8 vs. 101.7 F, P<0.0001), and increased starter intake (0.5 vs. 0.22 lbs./d, P<0.01). Lower fecal score group also noted an improved body weight (P=0.07), reduced rectal temp (P=0.06) and improved starter intake (P<0.01) as measured in group by time. Calves in the high fecal score group noted both a higher peak fecal score and a longer duration of elevated fecal score. Calves in the low fecal score group tended to spend more time standing (P=0.07) than those in the high fecal score group, and the differences was more pronounced the first two weeks of life. Standing bouts were unaffected by fecal score (P=0.60). Calves in the high fecal score group tended to spend more time lying down (P=0.07) and the author reported them as more lethargic. Calves in the high fecal score group also had

more (P=0.04) lying bouts per day than those in the low fecal score group. Accelerations four days prior a calf reaching fecal score 3 or 4 were analyzed and there were no differences (P>0.15) in behaviors 4 days prior severe scours occurrence. n=42. SDSU. U Federal de Lavras, Brazil. Escuela Agricola Panamericana El Zamorano, Honduras. 232.

Management and housing (17 abstracts):

1. *Offer water in a bottle or bucket in the winter?* Holstein bull calves fed 1.5 lbs./d 24:18 CMR d 1 – 38 and then 0.75 lbs./d to wean d 42 via a bottle at 12% solids were offered daily week 0 – 5 either a.) ambient temperature water (cold tap water) from a bucket ad libitum, or b.) a 3 quart bottle of 100.4 F water midday for one hour, and then week 6 onward all calves were offered ambient temperature water ad libitum in a bucket. Water refusals were measured daily 0 to 5 weeks. Calves were housed in an unheated barn individually on straw bedding and weighed weekly. The study was conducted in the winter and average temperature was 37.8 F and ranged from 5 F to 88 F. Texturized starter (21% CP, 41% starch) was offered free choice. Free water intake was increased (P<0.01) dramatically if fed as warm water in a bottle as compared to ambient tap water offered ad libitum in a pail week 0 – 5; example: on week 3 calves offered warm water via a bottle consumed nearly 2 L/d, vs. almost 0 L/d if offered ambient temp water ad lib via a pail. NSD in starter intake, ADG, G:F, or hip width prewean, however, post-wean d 43 – 56 starter intake increased in calves fed bottled warm water (4.5 vs. 4.9 lbs./d; P=0.03). Post-wean ADG, G:F, and hip width NSD. Author points out that at 5 weeks age the calf needs more water than is available in one 3-quart bottle and the calf also needs to learn to drink from a pail, thus the conversion to bucket fed water at 5 weeks. n=48. Provimi. M73.
2. *Pair housed or individually housed d 1 – 56?* Holstein heifer calves were housed either a.) individually in a 7.5 x 3.8-foot (n=34; 28.5 ft^2) stall or b.) paired in a 7.5 x 7.7-foot (n=33 pairs; 58 ft^2) pen within a naturally ventilated curtain-side wall calf barn at U of MN Waseca from d 1 – 56 and then all calves were housed in groups of 6 in a naturally ventilated barn in pens 14.4 x 29.5 ft (424 ft^2) from d 57 – 112. All calves received a 24:20 fed at 1.23 lbs./d d 1 – 7, then 1.9 lbs./d d 8 – 35, and then half rate d 36 to wean d 49. CMR was fed in milk-bar teat buckets with two nipples in one reservoir for the paired calves. Minimal cross sucking was reported. Calves were offered 18% CP, 33% starch, 15% NDS texturized starter grain d 1 – 56 and an extended 10 – 12 d in the grower phase, and then limit fed 6 lbs./d of 16% CP grower feed and free choice alfalfa hay to d 112. CMR DMI was greater (P<0.05; 69.7 vs. 70.3 lbs./calf d 1 – 56) for paired calves vs. individually housed calves, as was calf starter intake d 1 – 56 (64.6 vs. 78 lbs.; P<0.05). NSD in G:F d 1 – 56. Bodyweight was measured weekly pre-wean and bi-weekly d 57 – 112. ADG d 1 – 56 was 1.48 and 1.63 lbs./d for calves reared individually vs. paired (P<0.05). ADG d 57 – 112 was 2.29 and 2.14 lbs./d for calves reared individually vs. paired d 1 – 56 (P<0.05). ADG d 1 – 112 was the same (1.89 lbs./d) for both groups. Hip height d 56 NSD. Take home: paired-housed calves noted increased ADG and starter

intake d 1 – 56 while calves reared individually d 1 – 56 noted increased ADG d 57 – 112, thus identical ADG d 1 – 112. n=100. Either option, same net result d 112. U of MN Waseca. Hubbard Feeds. T4.

3. *Hutches for paired calves? Pail vs. slow-flow nipple on teat bucket? What about use of Braden bottle (2-liter grain bottle with nipple-like feeding structure)?* Holstein heifer calves were housed either in a.) individual hutches with milk and water provided in the same bucket (n=16), b.) paired calves with their own individual pail providing both milk and water in the same bucket (n=8 pairs), c.) paired calves with their own individual pail providing both milk and water from the same bucket but with the addition of a Braden bottle for feeding grain placed on the exterior fence (n=8 pairs), d.) paired calves with milk provided through a slow-flow nipple on a teat bucket and an open bucket of water (n=8 pairs), and e.) paired calves fed milk through slow-flow nipple on a teat bucket and open bucket of water but with the addition of a Braden bottle on the fence. All calves had continual access to starter grain located in a pail located inside their hutch. Individual hutches offered 27 ft^2 in the hutch and 23 ft^2 in the outside apron and paired calves were provided 30 ft^2 in their own hutch and shared an exterior 52 ft^2 apron. All were fed pasteurized whole milk at 4 qts./d week 1, increasing to 6 quarts and then 8 qts./d weeks 3, 4, 5, and 6, and then slowly weaned feeding 4 quarts week 7, and then 2 qts./d until fully weaned d 52. Weekly body weight and weekly starter grain DMI were determined. Calf behavior was observed week 3 – 8. Results: week 1 – 9 starter DMI tended (P=0.07) to increase from 1.3 to 1.56 lbs./d if paired, primarily due to increases during weaning (2.89 vs. 2.23 lbs./d; P=0.03). NSD in body frame measures. NSD in ADG or final bodyweight. ADG 0 – 9 weeks averaged between 1.55 and 1.65 lbs./d. Cross-sucking incidence was reduced pre-wean if milk was fed in the slow-flow teat bucket compared to feeding milk in an open bucket (P=0.009) even with addition of the Braden bucket which resulted in less cross-sucking than when milk was fed in an open bucket (P=0.009) and no Braden bucket was offered. Cross-sucking incidence during weaning was least when slow-flow teat bucket was used pre-wean (vs. pail, P<0.001), or, when milk pail and Braden bucket was utilized (P=0.003), and both noted less cross-sucking incidence compared to when milk was offered in a pail and the sole source of grain was in a pail. Bottom line: slow-flow nipple on a teat bucket was most effective in limiting cross-sucking behavior and use of a Braden bottle assisted in reducing cross-sucking too, and an open pail for milk and another open pail as the sole source for grain resulted in the greatest incidence of cross sucking. Competition: NSD in stealing during the milk meal if paired, this research showed little theft between calves when paired. n=80. U-W Madison. 228.
4. *What parameters measured by an automated milk feeder have been most studied to predict calf health?* A scoping review of CAB direct, Scopus, Medline, Web of Science, and Proquest was conducted to characterize the body of literature investigating the use of automated milk feeders to predict morbidity and mortality in dairy calves during the preweaning period. From 8,603 results reviewers sorted these studies down to 352 and

then further reviewed full manuscripts to come up with 13 studies. Although 93 of the 352 reported use of automated milk feeders to provide some measure of morbidity or mortality, only 15 examined parameters of the feeder for associations with morbidity and mortality. Of the 13 chosen, n ranged from 30 to 1,052 with a median of 100 calves. Studies were conducted in the following locations: N. America (7), Europe (6) and New Zealand (2). One or more of the following was monitored to measure disease: milk consumption, drinking speed, or rewarded/unrewarded visits. 13 correlated milk consumption, 6 correlated drinking speed, and 7 correlated rewarded/unrewarded visits to the measure of enteric disease. 11 correlated milk consumption, 6 drinking speed, and 6 rewarded/unrewarded visits to the measure of respiratory disease. The UW Health Scoring App was used in 5 studies to track respiratory disease while 4 had their own scoring system and 1 used a system established by Groutides and Michell. Frequency of disease measures varied from 2x/d to just twice in the study and those taking measures ranged from vet techs, farm staff, veterinarians, and others. All were published in English. U of Guelph. U of Kentucky. T28.

5. *Do group-housed calves prefer using a shelter post disbudding?* Male and female Holstein calves were housed at birth either individually (n=8) or paired (n=4 pairs) and then moved to group pens (8/pens) at 15.7 d (±2.2 d) age. Each pen had two open-top 1.2 x 1.2-meter pens located in pen corners. Pens were constructed of corrugated plastic creating both visual and physical separation from pen mates. Monitored calves were either a.) disbudded (2/pen) using meloxicam 3 – 4 h prior and a sedative, or b.) handled only, and for the same length of time as disbudded calves (2/pen). All processing was done d 36.2 (±3.9 d) and behavior was monitored 72 h post-disbudding using pen cameras. Calves were also monitored for a 24 h period sometime the week prior disbudding to establish a baseline of activity. Loggers were used to track movement. Results: All calves used a shelter at least 1x/d, typically for several hours with range of 1.4 m/d to max of 13.6 h/d. Disbudded calves tended (P=0.08) more shelter use (d 1 about +50%; day 2 about 2x; 142.6 m/d for disbudded calves and 93.9 m/d for control calves). Both groups noted an average of about 3 visits/d but length of visit was greater for disbudded calves (32.5 m/visit) vs. control (19.2 m/visit). Disbudded calves spent less time lying per d (P=0.03; 16.8 vs. 17.2 h/d) and on all 3 days. The percent lying time in the shelter was more (P<0.001) for disbudded calves. Take home: “Disbudding results in changes undisturbed behavior, including lying time, even when accompanied by pain mitigation.” U of Florida, Gainesville. 225.
6. *Impact of heat stress on dam and newborn calf.* Pregnant heifers housed in Florida during heat stress were housed the final 60 d of pregnancy with either a.) shade only, or b.) shade, fans, and soakers (cooling). Serum samples were taken weekly through one week post calving and from their calves d 0 (after colostrum feeding), 14, 28, 42, and 56. A D2Dx rapid blood test was used to detect humoral immunity (IgM, IgG, and Complements) and provide a D2Dx immunity test score. Test results showed “humoral immunity of pregnant heifers decreased as they approach parturition, reaching the

lowest level around the day of calving." On day of calving heat stressed heifers recorded lower immunity scores (P=0.03) as compared to results from cooled heifers and newborn calves administered colostrum noted similar immunity scores as their dams. NSD noted at any blood measure between calves born of heat-stressed or cooled heifers. In all calves the nadir of immunity occurred between d 14 and d 21. n=31. U of Central Florida, Orlando. U of Florida, Gainesville. T21

7. *Impact of pre- and post-natal heat stress on dairy calf behavior.* Heat stress results in many behavioral changes including adjusting posture to increase surface area, seeking cooler areas, and seeking water. Amphibians are best known to do these things, what about calves? During the summer of 2018 at the U of Florida dairy dry pregnant dams were enrolled at about 46 d prior expected calving date to either a.) heat stressed with access only to shade of the barn, or b.) heat stressed with access to both barn shade and fans and soakers (n=60 cows). Body temp was monitored with ibuttons above the rectum and Hobo Pro loggers tracked hourly temperature and humidity. Calves from these dams were either a.) only offered shade of the barn, or b.) shade of the barn plus two fans, one at calf level and another from above. Calves were broken into a 2 x 2 factorial design of either a.) pre- and post-natal cooled, b.) prenatal cooled and post-natal heat stressed, c.) prenatal heat stressed and post-natal cooled, or d.) pre- and post-natal heat stressed (n=12/treatment). "Calves were group housed 8 pens, n=6 calves/pen where n=3 calves/prenatal treatment/pen." Autofeeders offered max of 10 L/d in 3 L milk replacer increments and calves were weaned d 42. Feeder visits and drinking speed were monitored. Calf activity was logged hourly using a hobo logger. A cognition study conducted d 35 using a T-maze with a liter of milk reward was conducted on a subset of calves to measure learning ability, and, finally, lying behavior was monitored examining posture, social lying, location in pen, and water seeking behavior via video monitoring d 22 ±3 d age for 3 days. Pre- and post-natal heat stress was achieved noting elevated temp humidity index (THI) and elevated vaginal temp in the dams. Ambient temperature post-natal was app. 100 F with THI ranging from 68 to 80. Post-natal rectal temps were greater (no stat provided) in calves not provided fans. CMR intake was monitored early AM (to 7 am), late AM (7 am to 1 pm), early PM (1 pm – 7 pm), or late PM (7 pm to midnight) noting increased heat stress late AM and early PM. Post-natal heat stressed calves (no fan) noted decreased (P=0.03) CMR intake in late AM vs. calves provided fans. Calves with both pre- and post-natal heat stress noted decreased CMR intake (P=0.03) vs. the other 3 groups. Rewarded feeder visits were decreased (P=0.01) weeks 5, 6, and 7 if calves were not provided fans to cool. Intake per visit was also reduced (P=0.02) from app. 1.5 to 1.0 L/visit if no fan was provided. Pre-natal heat stressed calves stood longer (P=0.01) each day. Post-natal heat stress caused calves to maximize exposure of skin surface area during cooler times of the day as measured by standing and type of lying behaviors. Pre-natal heat stressed calves distanced themselves more from other calves. NSD in learning behaviors were noted in the "T-maze" study with milk rewards, however, if calves were born from cows with pre-

natal cooling then the calves consumed 100% of milk offered while if pre-natal heat stressed they consumed just 70% of milk offered. n=48 Holstein calves. U of Florida, Gainesville. 257.

8. *What is the effect on health and growth of heat stress in calves reared in Florida?* Holstein bull calves were housed in one of three treatments, a.) hutch in a barn with no cooling fan, b.) hutch in a barn with cooling fans that forced air movement through the wire fence partitions, or c.) calves house outdoors in hutches with 50% of the hutch covered with plywood for shade. "Hutch" is defined as rectangular pens made of wire panels and "barn" is defined as a tall roofed structure with no side walls and concrete aprons on the exteriors to enable bottle wagons underroof in order to feed. Calves were monitored d 0 – 70 with BW measures taken d 0, 12, 18, 26, 33, 47, 54, 61, and 70, and rectal temps taken twice per week. Respiratory frequency was also measured twice weekly as were air velocity and air temperature at calf level. Calves were health scored using the UW-Madison Health Scoring system. Results: calves housed in shaded barn with access to fans had more ($P<0.01$) air velocity in their hutches at both the AM and PM measures and through weeks 1 – 10. Calves housed outdoors noted increased ($P<0.01$) air temperature in both AM and PM weeks 1 – 10, however, differences were noted about half of the weeks in the PM and all weeks in the AM measure. Respiratory frequency was greater ($P<0.01$) in calves housed outside both AM and PM weeks 1 to 10. Rectal temperature was higher ($P<0.01$) in heat stressed calves housed outside in AM and PM, but the magnitude of increase was much greater in the PM. NSD in BW or ADG at any measure, however, wither height ($P=0.03$; 0.78 inch shorter vs. in barn with fan) and hip height ($P=0.02$; 1.0 inch shorter vs in barn with fan) at weaning were shorter in heat stressed outdoors housed calves as compared to those housed in the shaded barn (fan or no fan). Upper respiratory treatment score was 0.43, 0.31, and 1.08 for calves housed in the shaded barn, shaded barn with fan, and outdoors heat-stressed 50% shade covering, respectively with $P<0.01$ increase for heat-stressed outdoors calves verses calves housed in the shaded barn (fan or no fan). NSD in fever (>102.9 F). Take-home: "use of large commercial ceiling fans at 80% of capacity was only able to increase air velocity at calf level in 1 meter/second but air temp at calf level was reduced 1 degree C," and NSD in ADG, however, heat stress reduced frame size. Heat stress was detrimental to animal welfare as measured by rectal temp and respiratory frequency, and improvements in upper respiratory tract score demonstrate importance of air exchange at the calf level. n=60. U of Florida, Gainesville. 263.
9. *If provided more space in group housing, will group-housed calves be cleaner and more comfortable?* Holstein calves were grouped at 14 d of age at 5 calves per pen. Each pen (n=5) was exposed to three different space allowances according to replicated Latin square design with three 7-day periods to either a.) 40 ft^2, b.) 50 ft^2, or c.) 60 ft^2, per calf. Calf cleanliness was recorded 2x per week based on a scoring chart of 1 = clean or only dirty feet, 2 = dirty on back and tail, 3 = dirty on tail, thighs, or legs, 4 = tail, thighs and legs dirty. Laying time was measured continuously using electronic leg-based

accelerometers. Daily standing time, frequency of standing bouts, and standing bout average duration were all recorded. Results: cleanliness score was not affected by space allowance (mean 2.2 score; P=0.82). Standing time (389 m/d) did not differ (P=0.31) between treatments. Space allowance did affect standing bout number per day (P<0.05) more for higher space allowance (60 ft^2 vs. 40 or 20 ft^2 groups). Space allowance also affected standing bout duration as measured by minutes/bout with less duration for 60 ft^2 vs. the other two groups (P<0.05). The coefficient of variation between groups showed that when space was more restricted there was more variability in standing time, standing bout frequency, and standing bout duration (P<0.05). n=30 Holsteins. U Nacional de Cordoba, Argentina. U of Florida, Gainesville. T5.

10. *Is social contact from birth important to calves?* Holstein bull and heifer calves were housed from birth either a.) individually (n=16), or b.) paired (n=8), and at approximately 2 weeks age (13 ±2 d) calves were dispersed between treatment groups (8 calves/pen) based on age (average = 14 d). At 4 weeks of age calves were tested for 10 m in each of the following, a.) open field test: start box was placed on one end of pen, calf behavior observed, b.) novel object: green ball placed 2.5 m from start box, behavior monitored, c.) unfamiliar calf: 2 unfamiliar calves placed in small pens 2.5 m from start box in the open pen, or, d.) an unfamiliar person (same person used across all calves) standing stationary 2.5 m from start box in open pen, extending arm w/o eye contact. In each case researchers analyzed the following: a.) latency to exit start box, b.) contact with stimulus, or c.) duration of contact directed towards the calf or human using video monitoring. Results: a.) open field test: NSD in latency to exit start box, b.) novel object test: paired calves tended more rapid (P=0.09) exit of start box and to having contact (P=0.036) with the green ball as compared to calves housed individually the first 2 weeks of life, c.) unfamiliar calf and unfamiliar human, no difference between paired or individually housed calves in how they exited the start box, however, calves that were paired the first 2 weeks of life spent more time (P=0.04) with the unfamiliar calf and, also, more time (P=0.06) the unfamiliar human vs. individually housed calves. U of Florida, Gainesville. T2.
11. *Follow-up to T2. Effect on calf health and feeding behavior of individual- and paired-housing the first 2 weeks of life prior grouping with an autofeeder.* Although not mentioned as so, it appears this data was collected in addition to the aforementioned calf behavior data (T2), calves housed either a.) individually (n=16) or, b.) paired (n=8), and at 13 d moved to group housing and mingled. Before group housing measures of number of required assistance instances when drinking, individual calf daily milk intake, and age at onset and duration of scouring were taken and after group housing measures of number of times requiring assistance to eat from the autofeeder, daily milk intake, and number of visits to autofeeder and milk meal durations, were measured. Results: All calves developed scours during the first 2 weeks of life. Age at first scouring event did not differ (6.2 d; P=0.35). Paired calves tended (P=0.06) to scour fewer days (5.8 vs. 4.2 d). Latency to learn to eat from the teat bucket was not affected (1.9 assists. P=0.26).

Social housing did not affect milk intake the first 2 weeks of life (6.1 L/d; P=0.7). Latency to learn to use the autofeeder was not affected by housing treatment (1.5 assists; P=0.7). Milk intake overall was not affected by housing after grouping (7.3 L/d; P=0.6). Individually housed calves spent more time each day in the feeding station (26.6 vs. 24.9 minutes/d for individual and paired calves, respectively; P=0.003). Bottom line: pair housing from birth had minimal effect on health and feeding behavior but tended to decrease duration of scouring and increase efficiency of auto-feeder use after grouping. N=32. U of Florida. T1.

12. *Survey of disbudding and dehorning practices on Wisconsin farms.* A survey of 217 dairy farmers and calf raisers was conducted in 2019 using either an online survey platform or conducted at extension events. Avg herd size was 486 cows (SD=785) and 110 heifer calves on milk (SD=415). 87% performed at least some disbudding themselves, the other 13% outsourced dehorning entirely to their veterinarian. Caustic paste was used by 67% of farms and it was implemented day one, day 1 – 7, and d 8 – 28 in 51%, 41%, and 8% of caustic paste users, respectively. A hot iron/burning was used on 60% of farms, and use d 1 – 7, d 8 – 28, d 29 – 56, d 57 or older was 4%, 27%, 34%, and 35%, respectively. Use of surgical procedures like a gouge scoop or wire saw was used on 21% of operations and was done age <4 weeks, 4 – 8 weeks, and 8 weeks plus 5%, 2.5%, and 92.5%, of surgical dehorning instances, respectively. NSAID was used 35% of the time and Meloxicam was the most popular source (72%) with Banamine/Flunixin second (37%). A local nerve block (Lidocaine) was used by 21% of NSAID users and a sedative/tranquilizer like Xylazine was used by 5% of farms that used pain management medications. Many survey takers used multiple methods. F.A.R.M. (Farmers Assuring Responsible Management) guidelines require a.) veterinarian be involved with herd health and disbudding protocol, b.) calves be disbudded prior 8 weeks age, and c.) pain control be used with all types of disbudding practices. Compliance based on this survey is as follows: disbudding by 8 weeks is 73% (100% of caustic paste users, 65% of hot iron users, and just 7.5% of those using surgical procedures); use of pain control is 40% (local nerve block 21%, NSAID 35% (anti-inflammatory), combination of meds 15%); veterinarian involved in protocol compliance is 55%. Compliance with all three F.A.R.M. requirements was done by 27% of farms. 62% of growers report changing their disbudding protocol over the last 10 years and 51% changed their disbud med protocol in the same period of time. When asked "what resource was used when evaluating new farming practices or technologies?" 86% report veterinarian, 81.5% report other producers or calf raisers, 76% report publications, 73% get info online, and 72% from their nutritionist. n=217 farms. UW Madison. OMAFRA, Ontario. U of Guelph. UW Madison. 224.
13. *Xylazine sedation for disbudding, is it worth it?* Healthy 2 – 6 week old Holstein bull and heifer calves (n=120) were either 1.) sedated using local anesthetic (lidocaine), NSAID (meloxicam) and sedation (IM of xylazine), or, 2.) no sedation, using only local anesthetic (lidocaine) and NSAID (meloxicam). Meloxicam and xylazine were

administered 30 m prior disbudding and Lidocaine nerve block was administered 15 m prior disbudding. Calves were on an autofeeder and there was NSD in daily milk consumption, however, sedated calves drank slower (P=0.03) for 48 h following disbudding, but by 72 h post disbudding there was NSD compared to non-sedated calves. An algometer was used to measure pressure sensitivity and at 1 h and 4h post disbud the sedated calves could tolerate more force (P<0.01), but later measures noted NSD. Play behavior was measured by monitoring bucking, running, and head-to-head contact behaviors via video monitoring. The day prior disbud there was NSD in play behavior between the groups, but non-sedated calves noted 79x more (P<0.01) play behavior at 3 h post disbud (sedation was expected to last app. 2 h) indicating a longer duration of sedation than thought. By 24 h sedated calves were 2x more likely (P=0.08) to play as compared to non-sedated calves. Non-sedated calves noted 4.5 x more struggling behavior during the actual disbud process as compared to sedated calves, and if sedated, less time was needed (P<0.01) to admin the nerve block, however, there was NSD in the amount of time necessary to disbud. Also, NSD in haptoglobin concentration in blood at any measure. Bottom line: following cautery disbudding, xylanase sedation with local anesthetic & NSAID can reduce behavior indicators of pain but also impact suckling behavior for up to 48 h. n=120. U of Guelph. 226.

14. *Rubber ring or surgical castration?* Holstein calves were castrated d 28 of age by either a.) a rubber ring used to interrupt blood flow to testicles resulting in tissues going necrotic and sluffing off, or b.) surgical castration via incision of scrotum and complete removal of testicles. Procedure was conducted by a veterinarian and pain sedation; local anesthesia and analgesia were used at the time of procedure in both groups. Surgical area was fully healed after 4 weeks using surgical castration. Tissue sluff-off occurred at 7 weeks with rubber ring castration and only one calf was fully healed by 8 weeks in the rubber ring castrated group. ADG did not vary between groups d 0 – 21 post castration, however, from day 22 to 56 post castration, the calves castrated via rubber ring noted significantly reduced (P=0.019) body weight gain resulting in a 29.8 lbs. reduction in BW gain at 56 days post castration (84 days of age) for rubber ring-castrated calves in comparison to surgically castrated calves. Milk intake was not different (P=0.057), however, starter grain intake decreased 0.88 lbs. per day in the rubber ring castrated calves (P<0.001). Wound directed behavior (calf licking the wound area) was monitored commencing 3 days prior the castration procedure (author reports calves routinely lick their groin area, perhaps due to an itch or some such minor discomfort) and this licking behavior was monitored post castration and the researchers found +25.8 more instances of licking behaviors to their groin on a daily basis when rubber ring castration was used (i.e. 5 licks/d prior castration, 30.8 licks/d (5 + 25.8), on average, post castration). Conversely, when surgical castration was implemented wound licking behavior increased, but by 7 – 14 days it decreased back to normal incidence. Clearly, bull calves castrated with rubber rings are in more discomfort for longer periods of time as measured by exhibition of pain mitigating behaviors than when surgically castrated,

resulting in depressed ADG due to depressed starter grain intake. n=24. U of British Columbia. 227.

15. *Accuracy of a forefoot weigh scale inserted in an autofeeder stall.* Individual calf weight measures were taken daily as calves consumed whole milk (13% solids) at approximately 8 L/d from an auto-feeder (Holm and Laue HL 100 calf feeder, Germany). The scale was inserted into the 4 autofeeder stalls and determined weight based on the calf's two front hooves having contact with the scale floor. Calves were also individually weighed weekly using an Avery Weightronix calf scale also used in research. The study was composed of 47 total calves including 11 Holsteins, and the balance Holstein cross or Limousine cross. A comparison of individual weights from both the autofeeder and the gold standard digital scale was made, and it included 587 individual scale observations taken across 8 weeks on 40 calves. Correlation (PROC CORR of SAS), Regression of body weight on auto-feeder weight (also using SAS) and a Bland-Altman Plot to analyze bias (also SAS) were used to analyze the comparison. Correlation was 0.989. Concordance correlation was 0.99. Correlation range of the calves was 0.971 – 0.999. Fit Plot for weight showed points fit along the regression line closely with a slope of 0.93. The Bland-Altman plot showed a mean bias of 0.279 kg and the range was approximately +12 to -12. Bottom line: correlation was high for the gold standard digital scale weight compared to the forefoot weigh scale inserted into the autofeeder stall. n=47. U of MN Morris. 337.
16. *Suckling dam vs CMR and hutch, effect future heifer's milk production?* Holstein heifers (n=35) were reared by either a.) nursing dam to d 21 and then bucket fed 6 L/d whole milk to d 83 wean, (n=13) or b.) suckling dam to d 3 then suckling nurse-cow with other calves to wean d 83, (n=9) or c.) 1 d with dam, then d 2 – 56 bucket fed CMR in a hutch (n=13). Author reports each calf got 6 kg (liters) per day of milk or milk replacer pre-wean. No further diet details provided. Post wean all kept in age-balanced groups in bedded pens with the same ration until calving. Post-calving monitored for body weight, daily milk yield and the ability to maneuver a maze at the 5th month. Body weight 30 d into lactation was 1,164, 1,261, and 1,175 lbs. for cows reared suckling dam, suckling nurse cow, and bucket fed CMR, respectively. 305-d milk yield was 15,750, 16,193, and 13,977 lbs. for cows reared suckling dam, suckling nurse cow, and bucket fed CMR, respectively. Cows reared suckling nurse-cow with other calves in the pen with them produced more milk (P<0.05). Cows reared suckling the nurse cow as calves crossed the maze more quickly (no stat provided). Vocalizations were 32, 21, and 10 for cows reared suckling dam, suckling nurse-cow and bucket-fed CMR, respectively, with more vocalizations if suckling dam (P<0.01). No further details about this vocalization stat provided. The same researcher examined 99 Holstein calves reared in the same three methods (suckling dam, suckling nurse cow, or CMR in a hutch) in how they traversed a series of six mazes at both 6 months and 10 months of age. NSD in time to traverse the six mazes, however, the first of the six mazes were completed most quickly (P<0.05) for

calves nursing dam or nurse cow as compared to CMR in a hutch. National Ag and Food Centre Luzianky, Slovakia. M101. T3

17. *Can 3-D imaging accurately identify a growing calf?* Ear tags and RFID technology are labor-intensive, prone to human error or fraud and can generate stress when implemented. 2D technology does not work well for similar pattern cattle like Jerseys. 3-D animal biometry shows promise as it is like human facial recognition technology. 3-D learning entails depth images and then computer assembly of a point cloud. The goal of this study was to measure the accuracy of 3-D dorsal images of 5 calves taken either a.) the same week (156 images), or b.) taken over a three week period as the calf grows (274 images taken weeks 1 & 2 and 172 images taken week 3). The accuracy of week 1 images was 95.5%, and the author speculates that if more images would have been taken of one of the 5 calves the accuracy would have been even higher. The accuracy of the algorithms over the three-week period was 55.3% and the author points out that most errors occurred in calves with fewer images analyzed, and that calves that scored high in accuracy in identification used 70 or more images (higher end of individual calf range of number of images), thus the author speculates that if more images were taken, overall accuracy of 3-D imaging to ID calves would surely improve. n=5. U-W Madison. Embrapa Dairy Cattle, Brazil. 135.

Physiology (particularly gut microbiome) (8 abstracts)

1. *Can inoculating rumen fluid from high performance dairy cows into the rumen of newborn calves enhance growth and future milk production?* Three cohorts of 6 bull calves were dosed with either a.) rumen inoculant from a high performing/high efficiency dairy cow, b.) rumen inoculant from a low performing/low efficiency dairy cow, or c.) an autoclaved 50:50 mix of the two rumen inoculants that was used as a microbe-free control. Rumen fluid from these cannulated cows was collected fresh, blended under CO_2, strained through 4 layers of cheesecloth, and administered in 50 mL doses via tube direct into the calf's rumen, promptly followed by 50 mL of sterile buffer. Rumen inoculum were administered to each calf at birth, 2, 4, 6, and 8 weeks. Fecal and oral swab samples were taken from the bull calves at 0, 2, 4, 6, and 8 weeks and calves were sacrificed at 8 weeks age to examine rumen tissue. ADG was not different at 6 weeks. DMI pre-wean increased ($P<0.05$) week 4, 5, 6, and 7 for bull calves inoculated with rumen fluid from high-performance cows as compared to the control calves fed autoclaved rumen fluid with calves dosed with rumen fluid from the low-efficiency cow intermediary. Density of rumen papillae was NSD, however, average length of papillae (mm) tended ($P=0.06$) greater for calves dosed with rumen fluid from the high efficiency dairy cow vs. both low-efficiency or control group. The diversity of microbe community was measured and rumen inoculum from calves sacrificed at 8 weeks age dosed with rumen fluid from high performance dairy cows noted a microbe population more similar ($P<0.001$) to that of the adult lactating dairy cows as compared to rumen fluid from calves dosed with rumen fluid from low-efficiency cows or autoclaved micro-free rumen

fluid. Take home: dosing adult rumen contents into the rumen of young calves changes its rumen structure and community and impacts length of rumen papillae and starter intake. A similar analysis is ongoing on 24 female calves monitoring rumen fluid for 18-months using non-invasive oral swabs to track the microbial community and for impact on 1st lactation. n=18 bull calves. UW-Madison. US Dairy Forage Research Center. 406.

2. *Microbial composition of fecal transplant inoculum from young dairy calves.* Can fecal inoculum from healthy donor calves "re-set" microbiome in sick calves? This was the goal of the research presented in the next two abstracts (T22 & 45). Feces from 73 healthy Holstein, Jersey, beef-cross, or Jersey-cross calves 5 – 24 d of age were combined in a blender, centrifuged, and turned into a slurry. The inoculum was put into a gel-capsule and frozen until used (abstract 45, next). Three, 1-gram samples of final fecal microbial transplant (FMT) were analyzed for gene sequence and an ASV Table was prepared to compare taxonomic profile. The FMT was salmonella negative but also PCR-tested positive for rotavirus, coronavirus, and crypto. The microbial composition at the phyla level was 57% Actinobacteria, 38% Firmicutes, 3.4% Bacteroidetes and 1.1% Proteobacteria. "At the genus level, the product consisted of 47.3% *Bifidobacterium*, 11.1% *Blautia*, 9.7% *Lactobacillus*, 8.5% *Collinsella*, and 2.1% *Faecalibacterium*. The predominant species were *Bifidobacterium longum* (21.5%), *Bifidobacteriuim pseudolongum* (15.2%), *Collinsella aerofaciens* (8.5%) and *Faecalibacterium prausnitzii* (2.2%)." Alpha diversity noted 200 observed species. Wash. State U. T22.
3. *Can feeding feces from healthy calves (a fecal microbiota transplant) be used like a probiotic on all calves?* Holstein and Jersey calves on a commercial calf ranch (n=151) were either fed (n=82) or not fed (n=69) concentrated fecal matter from healthy calves 5 – 24 d of age. Calves were individually housed in hutches and fed milk replacer at 4 L/d the first weeks and then 6 L/d. Grain was offered free choice. The inoculum was prepared by collecting from healthy calves, tested to be salmonella negative, mixed in a commercial blender, centrifuged, distilled, put into a capsule (35 g/dose) and then frozen. Capsules were used within several weeks. The capsules were administered 1x/d for 3 consecutive days to calves 4 to 12 days of age. Fecal samples (n=319 samples) were collected from recipients at enrollment and 10 days later and analyzed for genetic diversity. Results: "fecal microbiota transplants changed the gut microbiome making it more diverse," but "the proportion of healthy calves that progressed to bright sick (diarrhea but alert), depressed sick (diarrhea and not alert) or died did not differ by FMT (fecal microbiota transplant) administration (P=0.14). However, calves initially diagnosed as bright sick and depressed sick that did not receive FMT were **more likely** to recover to the healthy state (P=0.02)." Bottom line: FMT hurt disease recovery. n=151. Washington State U. 45.
4. *How does fecal microbiome change with diarrhea incidence and are there differences in fecal microbiome between Holsteins, Jerseys, and crosses?* Holstein, Jersey, Jersey cross, and beef cross calves reared on a calf ranch and fed 4 L/d of CMR and free choice grain were monitored 2x daily for health status, CMR intake, and clinical signs of disease.

Disease incidence was 34% (123 of 360 calves) and 63% of disease incidence was gastrointestinal (GI) tract (n=78), 14% respiratory (n=17), and 23% other (n=28). 17%, 32%, 17, and 30% of all Holstein, Jersey, beef cross, and Jersey cross calves, respectively, were treated for diarrhea, noting a near doubling of incidence in Jerseys relative to Holsteins. Diarrhea was classified as fecal score 3 (loose) or 4 (watery). Calves were also classified as either "bright" or "depressed" based on behavior and appetite. Fecal score of less than 3 was considered healthy. Fecal samples were taken from the calf's rectum d 4 – 15 in age from 61 healthy calves, 30 calves at the onset of diarrhea (n=12 bright; n=18 depressed), and six from sick calves that were salmonella+ (n=3 bright; n=3 depressed). 16S, rRNA, V3-V4 region gene sequencing was performed on the fecal sample. A beta diversity plot was established that determined no breed specificity for genetic make-up of feces, however, there was beta-diversity on calves of different health, noting clusters of health calves on one part of the chart. A Shannon Index of Diversity noted as the calf got sicker the genetic diversity decreases. A Cladogram plotted biomarkers and determined that healthy calves note enrichment of Bifidobacterium and bright sick and depressed sick calves note decreased Bifidobacterium and enrichment of Lactobacillus and E coli. n=360. Washington State U. 229.

5. *What are the internal control genes (ICG's) that accurately measure fecal gene expression in calves?* Gene expression detected in feces may be a future tool to evaluate calf health. "Internal control genes," a.k.a. ICG's are recognized to be the most reliable method to quantify input RNA. Using "geNorm" procedure this study evaluated the most suitable ICG's to accurately measure fecal gene expression in calves. Fresh fecal samples from six, 5-week-old calves was homogenized, and RNA was quantified and sequenced and mapped against *Bos Taurus* U of MN genome. Procedures screened the 20 top genes as potential ICG's and these were plotted for "average expression stability M" and "Pairwise variation." M values <0.2 (the cutoff) included *SMS*, *VPS37A*, *ACTB*, and *GAPDH* and the V-value (<0.15 cutoff) selected genes with "geometric average of the ICG's" included *SMS*, *VPS347A*, *ACTB*, and *GAPDH*. N=6. SDSU. T23.
6. *Genetic makeup of calf feces and jejunum tissues, same or different?* Fecal and jejunum RNA were measured in samples (100 mg fresh feces and 40 mg jejunum tissue) taken from 5-week-old (n=6) Jersey calves. Samples were frozen and then analyzed for RNA quantity and sequencing and were mapped against Bos Taurus genome. An RNA gene expression profile was established for the individual calf feces and jejunum tissues. Genes expressed were approximately 10,000 for feces and approximately 30,000 for jejunum tissue. 92% to 95% of the fecal RNA, depending on the individual calf, overlapped with jejunum RNA. Bottom line: fecal RNA approaches can detect physiological and gene regulatory patterns associated with the gastrointestinal tract of dairy calves. SDSU. Oregon State U. B25.
7. *How does the gut microbiome change as the calf transfers from neonate to ruminant?* Rectal extracted fecal samples from Holstein heifer calves (n=10) all located on one PA

farm were monitored for bacterial diversity first at 2 – 3 weeks age and then every other week until 12 – 13 weeks of age (6 sample periods). Author noted that fecal microbiome changes follow classic mammalian colonization patterns during immediate neonatal period: the first colonizers are facultative anaerobes such as E coli and lactobacillus, which create the environment for true anaerobes such as bifidobacteria (recognized as the core microbiome in neonatal calves) however, little is known about the gut microbiome during transition. In this study, calves were fed acidified colostrum and then acidified milk starting with 4 quarts daily but ramping up to 10 quarts daily and then easing back down to a 56 d wean. Starter grain was offered ad lib commencing week 2 (2 lbs./d offered) ramping up to offering 5 lbs./d. Hay was offered commencing 2 – 3 d post wean and, therefore, two of the six rectal samples were taken when hay was being fed. Alpha diversity, Beta diversity, and Shannon diversity measures were analyzed. DNA and RNA analytics on feces were conducted. Results: diversity increased with time; more species ($P<0.05$). Shannon diversity (measures abundance and evenness of the diversity) also increased with time ($P<0.05$). Beta diversity, a measure between communities, noted more clustering, i.e. bacteria became more similar, post wean, but beta diversity also differed with time ($P<0.05$). Leading bacteria phyla found were Firmicutes (60.7% at 1st measure, 61.5% at 6th time point). Interesting changes in relative abundance of significant bacterial genera (ANCOM test) were: no bifidobacterium were found in any feces and lactobacillus averaged <1% in the first measure and the author hypothesizes calves were too old at first measure to capture typical findings of these neonatal microbiome bacteria; Firmicutes Faecalibacteriaceae peaked at time point 2 (about 4 weeks; during peak acidified milk intake) and then dropped off, faecalibacterium (found at 16.5% concentration) are known to correlate with lower incidence of diarrhea and better growth in calves, faecalibacterium produce butyrate and are known to be part of the core microbiome in calves; Bacteroidetes Prevotella (14.5% concentration) and Bacteroidetes S24-7 increased sharply (to 6.3% of bacterial concentration) after timepoint 3 (approximately 6 weeks age), author noted likely indicative of starter grain with Monensin driving these changes (Monensin is shown to increase these two bacteria in adult cattle). Treponema (author noted Treponema is associated with forage intake; 4% concentration at approximately 6 weeks age) increased sharply at timepoint 4. The other 9 leading individual bacteria genera were relatively stable throughout the study. Take-home: there is considerable variation in microbiome pre-wean but microbiome becomes more stable and more similar to adult microbiome after weaning as large shifts occur due to transition from milk diet to energy coming from fermented solid feeds. n=10. U of Penn School of Vet Med, Kennett Square. Oceanside High School, NY. NW High School, MD. Drexel U, Philadelphia. 75.

8. *Fecal microbiota of both healthy and scouring calves the first weeks of life.* Fecal samples extracted rectally from 10 diarrheic calves from 7 dairy farms in SE PA were compared to samples from age-matched healthy control calves. Avg age was 8 days old. DNA and RNA analytics were conducted on the feces. No differences seen between groups of

farms in alpha diversity. “Firmicutes and Bacteroidetes were most abundant phyla in both groups; Fusobacteria was higher in diarrheic calves while Proteobacteria and Actinobacteria were higher in healthy calves. Genera that were more abundant in healthy calves included *Ruminococcaceae* (P<0.05) and *Faecalibacterium*. Genera that were more abundant in diarrheic calves included *Fusobacterium*, *Streptococcus*, and *Sutterella*.” “Although differences were noted between diarrheic calf and healthy calf groups, these differences were not significant due to the differences between farms. Penn State Vet Med, Kennett Square. Oceanside H.S., NY. Drexel U. M71.

Starter grain & forage feeding (5 abstracts)

1. *Is fiber beneficial in the diet of a 2 – 4-month-old calf? If so, in what form?* Male Holstein calves 2 – 4 months of age housed 4 – 5 steers per pen were fed a texturized calf starter composed of 37% whole corn, 25% soybean-based pellet, 25% whole oats, and 3% liquid molasses (21% C.P., 41.1% starch, 13% NDF) mixed with either a.) no forage, b.) pelleted hay (60% NDF) added at 5% of diet, c.) short particle (1.0 inch) timothy hay added at 5% of diet (61% NDF), or d.) long particle (5 inch) timothy hay added at 5% (61% NDF). Results: feeding hay increased hip height (P<0.01) and increased hip width change (P=0.04) as compared to not feeding hay. Feeding pelleted hay increased DMI (P<0.01) and tended (P=0.08) to increase ADG vs. feeding short hay. Feeding pelleted hay increased (P=0.02) body condition score, increased (P<0.01) DMI, and increased ADG (P=0.03; 2.68 vs. 2.38 lbs./d) as compared to feeding long hay. Also, feeding pelleted hay tended (P=0.09) to decrease G:F vs. feeding long hay. Feeding short hay resulted in increased (P=0.05) DMI as % of BW vs. feeding long hay. 28-d (app. 3 month old) fecal digestibility was measured and digestibility of ADF was lower (P=0.01; app. 34% vs. 43 – 44%), as was dig of NDF (P<0.01; app. 43% vs. 51%) in calves fed no hay vs. fed hay. Bottom line: a.) feeding hay increased frame growth, b.) hay length can be too long, c.) pelleted hay may encourage more gut fill and poorer feed conversion, d.) take-home message: post-wean diet should contain 5% hay that is app. 1 inch particle length and longer particle length may result in gut fill. n=98. Provimi. M59.
2. *Does whole shelled corn perform as well as cracked corn in a grower at 12 to 16 weeks age?* Holstein steers 170.6 lbs. and 58 – 60 d age were fed a 20% C.P., 43% starch texturized grower feed composed of whole corn (42% of diet), a soybean-meal based protein pellet, 25% whole oats, and 3% molasses blended at a 95:5 ratio with chopped hay and fed from 8 to 12 weeks and then either a.) fed the same grower feed through week 16, or, b.) replacing all of the whole shelled corn with cracked corn. Fecal digestibility measures were taken at 9, 13, and 15 weeks. There was no significant difference in DMI, ADG (performance was 2.204 vs. 2.293 lbs. ADG for whole and cracked corn, respectively), or G/F. Starch digestibility improved (89.7 vs. 92.8%; P=0.05) in calves fed cracked corn at the 16 week measure, and fat digestibility improved for whole corn in the 13 week measure, otherwise, NSD in digestibility. Take home: increased corn processing did not improve calf performance. Digestibility was similar

with exception of starch which increased for cracked corn vs. whole corn, however, increased starch digestibility did not increase ADG when fed texturized grain with 5% chopped hay to calves 12 – 16 weeks of age. Provimi. M62.

3. *Add fat to starter feed to help in weaning transition?* Holstein bull calves individually housed and fed 7 L/d 24:20 at 15% solids until d 42 and then weaned over 7 d were fed either a.) pelleted low fat starter grain composed of 19% C.P., 3% fat, and 2.48 Mcal/KG ME, or, b.) high fat starter composed of the same pelleted low fat starter (90%) with addition of an extruded fat pellet composed of 40% hydrogenated palm fat included at 10% of the formula ending up with an 18% C.P., 7% fat feed providing 2.74 Mcal/kg M.E diet. Straw was offered ad lib. Prewean 0 – 49 d there was NSD in calf starter intake and NSD in ADG. Post-wean d 50 – 84 the calves fed the high fat starter consumed more starter ($P<0.05$) and noted improved ADG ($P<0.05$). Post-wean period 85 to 112 noted a numeric improvement in starter intake reported as a trend (no p value shown) in the group fed the higher fat starter feed and NSD in ADG. Total bodyweight increased ($P<0.05$) +18.8 lbs. (290 vs. 308.6 lbs. body weight at 112 d) if fed high fat starter. Total starter intake increased ($P=0.02$) from 4.2 to 4.6 lbs./d as measured from d 0 – 112 if fed the higher-fat starter feed, and the high fat starter fed group noted increased metabolizable energy intake prewean (4.3 to 4.5 Mcal/d; $P<0.05$), post-wean d 50 – 84 (5.6 vs. 6.8; $P<0.05$) and post-wean d 85 – 112 (8.6 vs. 10.4, NSD). There was NSD in crude protein intake, and NSD in plasma BHB, plasma glucose or plasma IGF-1 as measured by blood samples taken week 4, 6, 7, 8, 10, and 11. NSD in body dimensions at any juncture. Body fat was not measured (and author reported earlier studies have shown increased body fat when high fat starters were fed). Interesting concepts were laid out in the intro: how to maximize energy intake at weaning to prevent weaning dip? Sustain growth? Optimize rumen development? Maximize solid feed intake? Fat is perceived to be detrimental for rumen function. Rumen bypass fats separate from the pellets and offer poor palatability and an opportunity for feed sorting. Pellet hardness and durability and palatability are issues when adding fat to starter feeds. The product tested was a blend of the conventional starter pellet offering rumen degradable fat and an extruded pellet with vegetable fat (palm) that is intestinally digestible and largely rumen bypass. n=40. Trouw Nutrition, The Netherlands. Wageningen U. 142.
4. *Brazilian grain strategies for post-wean calves slaughtered at 10 months age.* Holstein x Zebu cross calves 60 d old, 121 lbs., were fed either a.) corn-based diet, b.) corn-based diet incorporating 10% babassu mesocarp (palm kernel flour), c.) corn-based diet incorporating 31.7% millet, or c.) corn-based diet incorporating 31.7% sorghum. Diets were standardized for DM, CP, and NFC, except the babassu mesocarp-containing formula, which was lower in all three (DM, CP, and NFC) however, no details provided. Calves were housed individually. Total weight gain was 540.3 (a), 394.2 (b), 555.8 (a), and 570.3 (a) lbs. for corn, corn + babassu mesocarp, corn + millet, and corn + sorghum, respectively (subscripts different $P=0.02$). Cold carcass weight was 335.8 (a), 260.8 (b), 332.7 (ab), and 352.7 (a), for corn, corn + babassu mesocarp, corn + millet, and corn +

sorghum, respectively (subscript different P=0.04). n=15. U Federal de Goias, Brazil. U Federal do Tocantins, Brazil. Instituto Federal do Tocantins, Brazil. M64.