ADSA 2022. Kansas City. June 20 – 24, 2022. *J. Dairy Sci Vol. 105. (Suppl1).*

Individual paper listed by abstract number in summary statements. 84 **dairy-calf pertinent abstracts.** Dave Wood, Animix, 920-342-9039. davewood@animix.net

Summary statements (each research paper in "two lines"), segregated by topic. More complete analysis, with statistics and details, later in this paper (also, a summation of several reviews that did not include original research):

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 (0 Abstracts)

1. .

Additives in milk replacer, whole milk, via capsule, or starter grain (16 abstracts):

1. Tributyrin in starter (0.6%) ↑plasma GLP-2 post-wean and added to both starter and CMR ↑total DMI and GIT development. NSD ADG at any measure. U Hiroshima. 2125M.
2. Phytogenic and functional mineral (bentonite) compounds ↑BW and ↑grain intake at 8 wk wean. Phytogenic ↓scours. Monoglyceride product ↑ADG wk 0-2. NutriQuest. 1166.
3. Mix of bentonite, phytogenic compound & yeast cell wall ↓ADG wk 0 – 2, +5 lbs. BW at wean, ↓scours. Combo mung bean & phytogenic ↑ADG wk 6 - 8. NutriQuest. 1168.
4. Lactoferrin (0, 1, 2, or 4g/d) had no impact on calf health, growth or G:F in relatively healthy heifer calves. ↑daily supplementation ↑G:F d 1 – 14. Waseca. Hubbard. 2256T.
5. Ghuanidinoacetic acid (direct precursor creatine) in CMR tended ↑grain intake. Similar response 1 or 2 g/d. Response continued post wean. Holstein x Angus. K-State. 2257T.
6. Bacillus-based DFM (Chr Hansen) fed for 180 d in milk pre and top-dress post-wean ↑intake d 1 – 74 and F:G d 1-91. NSD in ADG or health measures. UC Davis. 2313W.
7. Boreox BX50 antioxidant added to grower grain wk 12 – 16 ↑final body weight vs. low vitamin E diet. Dietary oxidative stress (1200 ppm Fe, 10 IU E) ↓ADG. Kalmbach. 2350W
8. *Megasphaera elsdenii* 5B CFU at 15 d ↑ADG 1.67 to 2.4 lbs/d, ↑grain intake 38.5%, ↑rumen dev., ↑liver size. NSD pH. 2nd dose d 39 no added bene. U KY Lex. 2352W.
9. Sodium butyrate ↓ADG. Phytogenic compound & Egg yolk antibody ↑ADG, G:F, & health in some stages of growth & on one of two farms. U of Ag, Krakow, Poland. 2510V.
10. Phytogenic compound (Digesterom) ↑ADG on 1 of 2 farms. Combined Digesterom + egg antibody (EW) ↓d 1-50 ADG on one farm but ↑ADG d 1 – 21 on another. Poland. 2511V

11. Na Butyrate fed in CMR d 4-60 ↑alpha diversity of microbiota in feces not rumen fluid d 60, ↑abundance of some beneficial bacteria & ↓*Escherichia-Shigella*. China. 1538V.
12. 1.25 B CFU combined lactic acid producing bacteria & bacillus/d in CMR ↓post-wean grain intake. NSD in ADG, G:F or health. K-State. Church&Dwight. Mich State U. 2354W.
13. Sodium butyrate in CMR increases alpha diversity in feces, regulates ratio *Firmicutes* and *Bacteroides*, promotes beneficial bacteria, ↓E coli. Chinese Academy Ag Sci. 1538v.
14. Prophylactic neomycin fdg for 14 or 28 d ↑week 2 gut permeability, caused changes in bile acid metabolism & altered gene expression for immunity & lipolysis. Guelph. 1340.
15. *Boulardii* live yeast in CMR d 5 – 89 ↑starter & growth in calves stressed with 2 h delay in AM fdg 3 d/wk. Yeast ↑WBC production in stressed calves. Stellenbosch S. Af. 1345.
16. Duodenal development ↑with Na butyrate fed in 1st 30 d of life regardless of incidence of diarrhea. Butyrate ameliorated negative gene expression from scours. Brazil. 2349W

Amino acid nutrition/supplementation (1 abstract)

1. Tight juncture proteins prevent gut permeability. In vitro exposure of epithelial cells to glutamine ↑cell energy status & presence of tight juncture proteins. ISU & SDSU. 1434

Colostrum, colostrum replacers (CR), and feeding transition milk (8 abstracts):

1. Feeding colostrum replacer (50% of CMR) & bovine-derived DFM (1 B cfu/d) d 1 – 7 ↓E coli concentration in feces week 1 – 4 & ↑G:F week 1. NSD ADG. Alberta, Guelph. 1170
2. Fdg colostrum or transition milk to 22 d old calves w/feed restriction & transport noted ↑intestinal function & ↑gut immune protection, NSD ADG, ↑fat oxidation. IRTA. 1171
3. Hi colostrum status calves fed colostrum replacer (50% of solids) 2 d or as 10% of CMR for 14 d tended ↓mortality, delayed onset scours, ↓severe BRD. SCC & Guelph. 1174.
4. Brix was highly correlated to solids content & with IgG content in poor or average quality colostrum, but underestimates hi IgG colostrum. Nouriche. La Belle. 2258T.
5. Topic: S. Mann summarized 2021 ADSA Calf Discovery Conf. colostrum: insulin levels impact; Dry cow heat stress impact; Pasteurization impact. IgF-1 post gut close. 1216
6. IgG decay (g/L): 26.3, 24.3, 20.4, 18.1, 16.6, 15.3, 14.2 d 1, 2, 3, 4, 5, 6, 7. Sample at 24h. IgG decay fast. Extended colostrum feeding minimal effect on IgG decay. Guelph. 2314W
7. Survey 250 calves on 33 farms in Shaanxi Province China. FPT 14.8%. No association FPT w/health. No severe BRD. Minimal scours. 1000 cow dairies. NW A & F Shaanxi. 1494v
8. 41st Discovery Conference: colostrum ↑intestinal gut microbiota, ↑Bifidobacterium, ↓E Coli presence in tissues. Heat treating colostrum ↓disease. Renaud. 1218.

CMR and milk feeding rates and strategies (2 abstracts):

1. Topic: M. Steele summarized 2021 ADSA Calf Discovery Conf. CMR: Phase Fdg delivers specific nutrients and bioactives. Fdg impacts gene expression & herd survival. 1217.
2. NASEM: Validation model examined reported ADG in 111 published studies (689 g/d) to NASEM est. (697 g/d). NASEM ↑accuracy vs. NRC with milk+grain diets. Drackley 1381.

Dry cow strategies and their impact on the calf (8 abstracts):

1. Offspring from cows with higher body condition -21 d prior calving noted +1” wither height at birth and wean. Otherwise NSD in birth wt, ADG, etc. Parana, Brazil. 2085M.
2. Supplementing rumen protected choline 24 d prior calving ↓oxidative stress markers and altered metabolic parameters in the calf. NSD in ADG. Mich State U. 2126M.
3. Dry cows fed -25 d prepartum clostridium beijerinckii or bacillus did not impact cow health or performance. Bacillus tended to ↑colostrum yield, IgG and Brix. U of Ill. 1183
4. Rumen protected choline fed prepartum ↑growth in male Holstein x Angus cross calves and ↑G:F in male & female Holstein x Angus calves. ↑DNA methylation. UW Mad. 1175
5. Rumen protected choline (RPC) fed prepartum tended ↑Holstein heifer growth & G:F wks 1 – 2 only. ↑dose = ↑ growth. RPC ↑blood glucose in calves. UW Mad. 2259T.
6. Records from 7,815 Holstein & 1,693 beef sired calvings show NSD between beef & dairy in calving ease or stillbirths. Beef-sired calves carried +2 d longer. PSU. 1125.
7. Topic: S. Mann summarized 2021 ADSA Calf Discovery Conf. dry cow: Genome & environ ↑impact on calf. Gestation heat stress ↓calf lifespan in herd. Turn genes on/off. 2016
8. Global lit review on dry cow nutrition impact on calf. Optimize body condition score & optimize energy/protein/fat/VTM/Se: ↓ perinatal DL, ↑calf health. J Mee. Ireland 1341

Fats and oils nutrition (2 abstracts):

1. Calves (6/ group) supplemented to 24:16 CMR fed at 6 L/d added powdered fat to 21% total fat noted ↓body dimensions but NSD in ADG or metabolites. U of Reading. 1079.
2. Continuation of abstract 1079: no effect of added saturated or unsaturated fats on calf microbiome (phyla, family, or genera). Some diff in individual bacteria. U Reading. 1172

Genetics (1 Abstracts)

1. 675 calves (‘15 – ’21) BW taken 0, 30, 60 d to see correlation of BW gain and genetics. Mean birth, 30 d, & 60 d weights 89.9, 145.3 & 205.9 lbs. 1st abstract. Guelph. 2043M.

Health, respiratory Disease (BRD), enteric disease, and immune function (9 abstracts):

1. *Clostridia,* virulent *E coli, & salmonella* detected in 69.6, 73, & 8.5% of 3,221 calf fecal samples, respectively. Highest levels were in calves <2wks age. Church&Dwight. 2040M
2. Long transport calves that got BRD noted ↓blood Mg & creatinine. BRD*Time difference in TP, albumin, Ca, P, BUN, GLDH, Na, K, Cl, Zn, haptoglobin. TX Tech. 2035M
3. *Health Management of calves – from intrauterine life to successful weaning. Renaud DVM*. Details too numerous to report here. Synopsis p. 38. View video. 1218.
4. Serum lactulose to mannitol ratio more accurately measured gut permeability in 5-month-old heat stressed Holstein heifers vs. Cr-EDTA or haptoglobin. ISU. 2353W.
5. Survey 6 yrs 882 dairies 33 states 34k fecal samples from cows ID clostridia in 98.6% fecal & 84.7% feed. C. perfringens in 78.5% of fecal and 33.6% of fd. C & D. 2283W

6. Survey 6 yrs 217 dairies 21 states 3.3k calf fecal samples, 7.6% Salmonella+, 20 serovars. S. Montevideo 25.9%, S. Meleagridis 13.1%, S. Cerro 11.2%, Dublin 5.2%. C & D. 2292W
7. Paromomycin sulfate d 7 -14 in milk noted ↑90 d BW gain (+29 lbs.), ↓clinical & severity of scours, and ↓crypto vs. sulfa trimethoprim. Tec. de Monterrey, MX. 2493V
8. Diarrhea incidence monitored on large Chinese dairy: ADG ↓0.25 lbs./d w/scours; STP correlated w/ADG & risk of scours. ↓STP = ↑mortality. NW A&F, China. Guelph. 1539V
9. Scoping review of calf diarrhea measures in all studies since 1977. High variation in diarrhea scoring methods. Larson (1977) & McGuirk (2008) most common. Guelph. 1346

Management and housing (25 abstracts) (key topics: housing, heat stress, behavior, transport, surveys of calf raisers, genetics, disbudding, and pain management):

1. 1 – 3 d old calves fed 6 – 9 L/d CMR via nipple bottle noted no ↑in suckling of sham nipple (possible pain amelioration) after disbudding using caustic paste. UW-RF. 2017M.
2. 2 different lidocaine injection sites for disbudding compared. Dyes showed coverage of cornual nerve evaluated. Both worked. Details in bigger write up below UW-RF. 2018M
3. Review of disbudding & pain mngt: pain is poorly understood but can be managed: NSAID's, lidocaine, topical anesthetics, transdermal pain relief. UW-RF. 1014.
4. *Health Management of calves – from intrauterine life to successful weaning*. Renaud DVM. Review of pain management, welfare, & surplus calves. Page 43 & 44. 1218.
5. Survey 1,119 calves at livestock dealers in OH found 78% male. 20% had FPT w/heavier calves noting ↓odds. 25% naval inf. 13% scours. 21% fever. OSU. Guelph. PEI. 2023m
6. Dexamethasone prevented ADG loss & ↓gut permeability from daytime 104 F heat stress in 41 d old calves. Inflammation is likely root of heat stress losses. U TN. 2031M.
7. Lallemand biofilm applied to disinfected hutch created expected biofilm, and when incubated at 82F noted ↓E coli & crypto but NSD salmonella. Miner I. U of VT. 2023M.
8. Transporting older calves ↑50 d BW gain (7 – 11 d +5.6 lbs.; 12 – 14 d +11.6 lbs.; 15 – 19 d +13.4 lbs.) vs. 2 – 6 d old calves. ↑duration of transport ↓BW gain. Guelph. 2034M.
9. Survey antimicrobial use on 74 Canadian farms found little AB use classified as very hi human importance. Fdg transition milk cut AB use by more than ½. U Guelph. 2037M.
10. 56% of calves note dried navel cord remnants post 14 d. Pen hygiene, navel care & bedding impact navel healing more than birthing, cow, or calf factors. Cornell. 2038M.
11. Retrospective assessment of 10,019 calves on autofeeders over 6 years note drinking speed and milk intake ↓1 d & 3 d, respectively prior BRD treatment. Purdue. 1167.
12. Analysis perinatal mortality on 1832 Quebec/NB farms. Avg perinatal mortality 7.9%. Key factors: ↑males born, ↑dystocia, delayed colostrum. ↑straw helped. Guelph. 1034
13. Calf behavior review, Costa. Early socialization - ↑growth, ↑competition at bunk, ↑learning (key for automation), ↓fear. ↑ Fdg rates, ↑future performance. KY. 1025
14. Calves paired in hutch in WI winter noted ↑hutch ambient temp, NSD in rectal temp, NSD DMI, tended ↑ wk ADG & BW vs. individually housed calves. UW Madison. 21567.
15. Vet survey (n=129) on calf welfare issues: 57% prefer individual housing. 98% step-down weaning. 51% prefer nipple-feeding, 23% no nipple, 26% accept both. UW Mad. 2189T.

16. Holstein heifers housed paired or individually were compared at 17-18 mo's age. NSD in G:F, ADG, Hip width, heart girth, DMI, methane or CO_2 emissions. UW-Mad. 2260T.
17. Topic: M. Steele summarized 2021 ADSA Calf Discovery Conf. behavior: nutritional & mngt strategies need to consider group housing and cow/calf separation in future. 1217
18. Computer vision systems accurately monitor 24h indoor/outdoor behavior in hutches. THI Index of 70+ ↓time inside, ↓time lying &↑time standing outside. UW Mad. 2331W
19. Birth & wean lbs. ↑in cool seasons but ↓ ADG as age & seasons warm. Summer born & wean ↓ but as age & cooler ↑ADG. NSD ADG from birth season 175 d. U of Ill. 2355W.
20. Pair housed calves in hutches in TX noted mean of 57 steps/d & mean lying time of 18.5 hours in 22 lying bouts/d. The mean lying bout duration was 57 m. TX A&M. 2414V.
21. Autofeeder data analyzed behavior in large commercial dairy noted calves introduced to pen 1st were more connected to each other. Stable groups perform better. Purdue. 1319
22. Lidocaine w/ either willow bark (salicin) or "Dull It" tincture (willow bark +) offered no +analgesic effect vs. Lidocaine alone in hot iron disbudded calves. U of MN. 1324.
23. Calves reared in pairs noted ↑grain intake but NSD in ADG. Paired calves also exhibited more close proximity and direct contact with other calves. U of Fla. 1323.
24. NSD ADG between individually, paired, group (5 calves) housed calves. Group calves modest ↑in immune response to novel antigen. Minimal immune dev. diff. U Fla. 1322.
25. 9 week old weaned dairy heifer calves are equally reward motivated to learn of an escape as they are of food or presence of another heifer in a T-maze. U of Fla. 1492v.

Physiology (particularly gut microbiome) 1 abstracts):

1. Dosing newborn calf with fresh rumen fluid from adult cow alters hindgut microbial colonies, down-regulates genes involved in health function. USDA. 1176.

Starter grain & forage feeding (5 abstracts):

1. Jerseys 80 d 178 lbs. fed ad lib TMR composed of either grass hay or 11% hydroponically sprouted wheat grains. Sprouts ↑height, BUN, glucose, starch dig. ↓costs. Brookings SD
2. 43% starch 15% NDF pelleted feed (rumen acidotic diet) ↓growth, ↓rumen pH, ↓grain intake, ↑concentrations of gram negative, ↓gram+ rumen & liver bacteria. USDA. 1169
3. Topic: M. Steele summarized 2021 ADSA Calf Discovery Conf. Grain: milk and grain fdg. strategies need to match; post-wean ideal time to cost effectively get growth. 1217.
4. Addition of 8% whole cottonseed to starter noted ↑rumen function & development, +14 lbs. BW at d 80, ↑grain intake during wean. NSD in ADG. Italy. 1081W.
5. NASEM: Validation model examined reported ADG in 111 published studies (689 g/d) to NASEM est. (697 g/d). NASEM ↑accuracy vs. NRC with milk+grain diets. Drackley 1381.

Weaning (1 abstracts)

1. Oxylipids promote or resolve inflammation and come from PUFA's. Effect of weaning (early/late; abrupt/gradual) sporadically impacted oxylipid concentrations. U of ID. 1040

Veal (2 Abstracts)

1. Compared traditional Swiss veal barn with outdoor paddock to hutch 3 wks then roofed no wall enclosure with max 10 calves. ↓antibiotics, ↓mortality, ↓BRD. U of Bern. 1038
2. Antibiotic resistance in Abstract 1038 production system comparison? ↓AB use noted ↓AB resistance. ↓AB resistance in new system (Direct-source, hutches 21 d) Bern. 1039

Vitamins and Trace Minerals (3 Abstracts)

1. 7 d old calves w/↓ADE status noted ↑acute phase proteins (inflammation), ↑RBC's & ↑% neutrophils. Plasma ADE concentrations ↑correlation w/each other. K-State. 2205T
2. Bypass (Jefo) b-vits supplemented 21 d pre & post-wean (weaned d 75) resulted in +18.7 lbs. BW gain, +0.4 lbs. ADG, +7% final body weight during 42 d period. Hungary. 2312W
3. CMR: Ca ↓20%, P ↓15%, Mg ↑2x+, K 2x, cobalt 0. Cu ↓50%, I ↑, Fe ↓ 100 to 85 ppm, Mn ↑40 to 60 ppm, Zn ↑40 to 65 ppm. A, D3, E, 110, 32 & 2 IU/kg resp. NASEM. 1381.

More complete analysis of each ADSA 2021 research paper:

Alternative proteins in CMR (0 Abstract):

Additives in milk replacer, whole milk, via capsule, or starter grain (16 abstracts):

1. *Tributyrin in CMR and starter?* Holstein heifer calves (n=38) 91.3 lbs. BW and bull calves (n=16) 101.9 lbs. both groups 8 d age were fed CMR (28:18) and/or starter (23% CP, 18% aNDFom, 33% starch) both either with (0.6%) or w/o tributyrin in a 2 x 2 factorial design. Calves were started on 1.32 lbs./d CMR d 1 – 14 and increased to as much as 2.9 lbs./d d 15 – 21, then 3.1 lbs./d d 22 – 49, and then slowly weaned by decreasing to 1.54 lbs./d d 50 – 56 and 1.32 lbs./d d 57 – 63, weaned d 64. Starter and chopped hay (10.2% CP, 66.8% aNDFom) offered ad lib continuously. BW monitored to d 92. Plasma GLP-2 measured weekly; bull calves slaughtered at weaning (64 d age). Numerically, addition of tributyrin to both CMR and starter increased starter intake pre-wean (avg. 0.31 lbs./d), during transition (2.51 lbs./d), and post-wean (6.9 lbs./d) and the abstract reports addition of tributyrin to both CMR and starter increased (P<0.05) total DMI during the entire study period. No effect on ADG pre-wean, during transition, or post-wean, and no numeric advantage to tributyrin supplementation at any measure. Tributyrin supplementation into CMR decreased crypt depth (P<0.05; 298 vs. 239 micrometer) and increased villus length/crypt depth in ilium (P<0.05; 1.91 vs. 2.22 micrometer) and supplementation into starter grain tended (P=0.08; 290 vs. 248 micrometers) to decrease crypt depth in ileum and increased (P<0.01; 1.84 vs. 2.3 micrometer) or tended (P<0.07; 2.04 vs. 2.22 micrometer) to increase villus height/crypt depth in ileum and jejunum, respectively. No effect on rumen papillae length at any measure in any group. Supplementation of tributyrin via starter increased (P=0.03) GLP-2 concentration post-wean. n=54. ZEN-RAKU-REN, Hiroshima U. YPTECH Co. 2125M.

2. *Sodium butyrate, impact on microbiota?* Newborn heifer calves were assigned to one of four groups: a.) no sodium butyrate, b.) 15 g/d Na butyrate, c.) 30 g/d, or d.) 45 g/d. Respective Na butyrate dose was fed in one feeding of two of CMR daily from d 4 to 60. Starter grain was offered ad lib. Rumen fluid was collected d 2, 14, 28, 42, and 60 of age and fecal samples were collected d 0, 14, 28, 42, and 60 and both were analyzed using rRNA high-throughput sequencing. Na butyrate affected (P<0.05) the alpha-diversity of microbiota in feces but not rumen fluid using Shannon index and Chao index on d 60 only (not on day 14, 28, or 42). Na Butyrate had a positive impact on abundance of *Firmicutes* (d 2 to 28 in both rumen and feces; P<0.05) and *Bacteroides* (d 28 to 42 in both rumen and feces; P<0.05). *Firmicutes* (gram+) and *Bacteroides* (gram-) are organisms naturally found in rectal microbiota in newborn calves (https://doi.org/10.1038%2Fs41598-018-28733-y). Na butyrate promoted growth of 4 kinds of key rumen bacteria that can produce butyric acid or other VFA's such as *Prevotellaceae*, *Clostridium*, *Ruminococcus*, and *Muribaculaceae*. Na butyrate promoted 5 kinds of fecal bacteria abundance such as *Prevotella, Lachnospirceae, Clostridium, Ruminococcus,* and *Muribaculaceae.* As feeding rate of Na butyrate increasd it reduced abundance of *Escherichia-Shigella.* Butyrate also inhibited development of *Proteobacteria* in rumen and feces during the entire experiment (P<0.05). n=40. Institute of An Sci, Chinese Academy of Ag Sciences, Beijing. 1538v.
3. *Phytogenic compound? Functional mineral compound? Monoglyceride product?* Holstein heifer calves 1 – 2 d of age housed in hutches and reared in an upper Midwest calf raising facility between October and December 2018 were provided one of the following: a.) no supplemental additive, b.) phytogenic compound at 100 mg/calf/d, c.) functional mineral compound at 5 g/calf/d, or d.) additional monoglyceride product at 15 g/calf/d. Respective supplement was added to calf's pail and the addition of milk to the pail was reported as adequate to get it to suspend and feed. The monoglyceride product was reported as having been already added to the appropriate milk replacer powder and thus was not added to individual calf feeding pails. Respective supplement was fed only in the AM milk feeding from placement until wean. All calves were fed whole milk with added 26:21 CMR to get total solids to 14% upon arrival thru d 26 or a 26:19 CMR to get to 14% solids from d 26 to 55 d wean 55 d wean. Calves were fed 1.5 lbs. and 1.98 lbs. of solids/d for d 1 – 3 ad 4 – 45, respectively, and 0.8 lbs./d from d 46 – 55. Starter (19.25% CP) was offered ad lib and intake measured 2x/week. BW and hip height measures taken at arrival and weeks 2, 4, 6, and 8. Plasma samples collected at beginning and wean on subset of 24 calves/treatment. NEFA, BHBA, and glucose were measured in blood samples of calves receiving phytogenic and functional mineral compound, and IFN-gamma, TGF-beta, and TNF-alpha were measured in blood of calves in the control group and calves receiving phytogenic compound. Blood samples were taken 2 hours post AM meal in both instances. Week 8 calves fed phytogenic or functional mineral compounds had higher (P<0.05) BW as compared to control (169.3, 178.6, and 176.8 lbs. for control, phytogenic, and functional mineral, respectively) and

calves fed monoglyceride noted intermediate (174.8 lbs.) performance. Week 0 – 2 noted improved (P<0.05) ADG for all three supplement groups vs. control, however, NSD in ADG for any additive weeks 0 – 6 or weeks 0 – 8. All three groups fed additives noted 1.63 lbs./d ADG weeks 0 – 8, contrasted to the control group experiencing 1.54 lbs./d ADG during the same period, however, NSD noted. Phytogenic compound noted reduced (P<0.05) ADG week 2 – 4 and improved ADG week 4 – 6 vs. control. Functional mineral noted improved ADG (P<0.05) week 6 – 8 vs. control. Monoglyceride noted improved (P<0.05) ADG week 0 – 2 vs. control. Calves fed phytogenic and monoglyceride compounds noted greater hip height (+approximately 1 inch; P<0.05) vs. control week 8, and calves fed monoglyceride tended (P<0.1) taller vs. control or calves fed the other two additives week 4. Starter intake was greater for calves fed phytogenic or functional mineral compound (P<0.05) starter intake at weaning vs. calves in control or monoglyceride groups (+approximately 18%). Calves fed phytogenic compound noted lesser (P<0.05) scours vs. control, functional mineral, or monoglyceride supplemented groups. Calves supplemented phytogenic compound noted lesser odds of having a scour event. NSD in pneumonia. Phytogenic compound lowered (P<0.0001) BHBA vs. control, and functional mineral reduced (P<0.0001) BHBA vs. both control and phytogenic supplemented groups. Glucose concentration was less (P=0.001) in calves supplemented either phytogenic or functional mineral compounds vs. control. NSD in NEFA, TGF-beta, TNF-alpha, of IFN-gamma. n=200. Nutriquest. 1166.

4. *Combination product: functional mineral, phytogenic compound, yeast cell wall, and mung bean?* Holstein heifer calves (1 – 2 days age) reared in a commercial calf rearing facility in the Upper Midwest from between April 1 to May 26, 2019, were provided in varying combinations either functional mineral compound (bentonite; 5 g/calf/d), phytogenic compound (100 mg), yeast cell wall (2 g) or mung bean (1.8 g). Calves were supplemented for 54 days (weaning) either a.) no additive, b.), a mix of functional mineral, phytogenic compound, and yeast cell wall, c.) a mixture of mung bean, phytogenic compound, and yeast cell wall, or d.) a mixture of mung bean and phytogenic compound, or e.) a mixture of functional mineral and phytogenic compound. Mixtures were added to feeding pails each morning and velocity of milk addition to bucket was reported as adequate for mixing. Calves were fed whole milk supplemented with milk replacer to 14% solids and then fed 103 lbs. of solids in a step-up, step-down fashion over 54 d. Calf starter (19.25% CP) was offered ad lib. BW and hip height was measured at arrival and weeks 2, 4, 6 and 8. Starter intake was measured twice weekly. Plasma was collected in a subset of 24 calves per treatment 2 hours after AM feeding at the beginning and end (54 d) of the trial. Plasma from calves supplemented the control, the combination of functional mineral, phytogenic compound, and yeast cell wall, and the combination of mung bean and phytogenic compound was analyzed for NEFA, BHBA, and glucose. Plasma from calves supplemented the control and the combination of functional mineral, phytogenic compound, and yeast cell wall was analyzed for TNF-alpha. Calves supplemented the combination of functional mineral, phytogenic

compound, and yeast cell wall noted increased BW (162.5 vs. 157.2 lbs., P<0.05) at week 8 vs. control, otherwise, there was NSD between any group at any other weight measure juncture. ADG during weeks 4 – 6 noted a reduction for the combined functional mineral, phytogenic compound supplement compared to the control (1.54 bs. 1.78 lbs./d; P<0.05). ADG during weeks 6 – 8 noted an improvement for the combined functional mineral, phytogenic compound, and yeast cell wall additive mix vs. control (1.21 vs. 0.97 lbs./d; P<0.05), and for the mung bean and phytogenic compound mix and the functional mineral, phytogenic compound, and yeast cell wall combination vs. control (1.26, 1.21, and 0.97 lbs./d ADG for mung bean and phytogenic compound mixture, functional mineral, phytogenic compound, and yeast cell wall combination, and control, respectively; P<0.05). ADG week 0 – 2 noted was reduced (P<0.05; 0.48 vs. 0.81 lbs./d) in calves supplemented the combination of functional mineral, phytogenic compound, and yeast cell wall mixture as compared to the control, and in the calves supplemented functional mineral combined with phytogenic compound, as compared to the control (0.62 vs. 0.81 lbs./d; P<0.05). Otherwise, NSD in ADG weeks 0 – 2, 0 – 4, 0 – 6, or 0 – 8. Hip height did not vary between groups at weaning. Starter intake did not vary between groups at any weekly measure. Calves fed the combination of functional mineral, phytogenic compound, and yeast cell wall noted both lower fecal score (1.25 vs. 1.38; P<0.05) and fewer calves treated for scours (53.5% vs. 82.3%; P<0.05) vs. control, and calves supplemented the combination of mung bean, phytogenic compound, and yeast cell, noted a reduction in fecal score (1.21 vs. 1.38) in comparison to the control, otherwise, NSD in scour or pneumonia incidence between groups (10.4 to 18.75% of the calves were treated for pneumonia). During week 2, the period of peak scours incidence, the % of calves treated was 76%, 44%, 40%, 23% and 12% for control, functional mineral, phytogenic, and yeast cell wall combination, mung bean, phytogenic compound, and yeast cell wall combination, mung bean and phytogenic compound, and functional mineral and phytogenic compound mix, respectively. however, week 3, the tables turned and % treated for scours was 6%, 11%, 27%, 38%, and 59%, for the same respective treatment group listing. Plasma NEFA concentrations were higher for calves supplemented the combination of functional mineral, phytogenic, and yeast cell wall mixture, compared to control and mix of mung beans and phytogenic compound (P<0.05). There was also an increase in glucose and a reduction in TNF-alpha in calves fed the combination of functional mineral, phytogenic compound, and yeast cell wall vs. control (P<0.05). n=250. NutriQuest. 1168.

5. *Lactoferrin supplementation?* From author's intro (translated to gallons): lactoferrin is an iron-binding glycoprotein found in colostrum at approximately 7,570 mg/gallon (Tsugi et al., 1990) and in whole milk at between 76 and 757 mg/gallon (Masson and Heremans, 1971). Lactoferrin is not present in CMR unless supplemented. The study: Holstein heifer calves 2 – 5 d of age from 3 commercial dairies and housed in individual pens in a naturally ventilated calf barn were assigned to one of 4 treatment groups, either a.) CMR w/o lactoferrin, b.) CMR supplemented with 1 g/calf/d lactoferrin, c.)

CMR supplemented with 2 g/calf/d lactoferrin, or d.) CMR supplemented with 4 g/calf/d lactoferrin. NSD in serum total protein between groups. All calves were fed a 24:20 CMR at 1.5 lbs./d from d 1 to 42 and then 0.75 lbs./d day 43 to 49 d wean. Starter (18% CP) with Deccox was offered ad lib from d 1 to 56. Calves were reared Oct 2021 to Feb 2022. BW was measured d 1, 14, 28, 42, 49, and 56. Hip height taken d 1 and 56. Health was monitored daily, including fecal scores. Grain refusals were summarized weekly. NSD in ADG at any juncture, however, there were trends (0.05>P<0.10) d 14, 0.70 lbs. (x,y), 0.66 lbs. (y), 0.62 lbs. (y), 0.77 lbs. (x) per d, d 1 to 14 for control, 1 g, 2 g, and 4 g/d lactoferrin, respectively (x and y's different exhibited a tendency for differences). 56 d ADG was 1.65, 1.68, 1.63, 1.72 lbs./d for control, 1 g, 2g, and 4 g/d lactoferrin, respectively (NSD). NSD in hip height gain. CMR DMI d 1 – 49 (wean) was 65.7 (a), 65.3 (b), 64.8 (b), and 65.3 (a,b) lbs. for control, 1 g, 2 g, and 4 g/d lactoferrin, respectively (a and b's different considered different, P<0.05). Total 56 d DMI noted NSD (166, 162.5, 162.7, 169.8 lbs. for control, 1 g, 2 g, and 4 g/d lactoferrin, respectively). G:F was the same (0.57) for all groups d 1 – 56, however, differences did occur d 1 – 14, 0.48 (a, b), 0.46 (b), 0.42 (c), and 0.52 (a) for control, 1 g, 2 g, and 4 g/d lactoferrin, respectively (a and b's different considered different, P<0.05). NSD in fecal score d 1 to 14, however, d 1 to 56 fecal score averages were 1.41 (b), 1.44 (b), 1.52, (a), and 1.44 (b) for control, 1 g, 2 g, and 4 g/d lactoferrin, respectively. NSD in scouring days (scour score 3 or greater) or treatment costs (ranged from $0.62 to $1.30 per calf). n=103. Hubbard Milling. U of MN, Waseca. MSG. U of MN Twin Cities. 2256T.

6. *Guanidinoacetic acid (GAA), a direct precursor to creatine fed in CMR?* Holstein x Angus cross steer calves averaging 90.2 lbs. BW and 5 – 9 d old were fed CMR with either a.) no GAA, b.) 1 g/d GAA, or c.) 2 g/d GAA (Creamino, Alzchem, Trostberg, Germany). CMR contained 25% CP, 24% fat with Deccox and 0.5 g/d Certillus probiotic. CMR was fed at 3 quarts twice daily (solids not reported, I assume 1.5 lbs. of CMR solids daily) d 1 – 41 and then gradually weaned by d 56. Starter contained 20.6% CP. Calves were weighed d 0, 14, 28, 42, and 59. NSD except d 59 (P=0.09) when both groups fed GAA noted a trend toward improved BW. Hip height was greater (P=0.005) d 14 for calves fed 2 g/d GAA with calves fed 1 g/d GAA intermediary. NSD in hip height d 0, 28 or 42, however, numeric improvement sustained for either GAA treatment group vs. control during the d 28 and 42 measures. ADG during the milk feeding period (d 0 – 42) was 1.52, 1.70, and 1.74 lbs./d for calves fed 0, 1, and 2 g/d GAA, respectively (NSD) and was 1.9, 2.14, and 2.16 lbs./d during the study (d 0 – 59; P=0.09 linear effect for GAA treatment). Starter DMI prewean d 0 – 42 was 0.44, 0.62, and 0.64 lbs./d for 0, 1, and 2 g/d GAA, respectively, and GAA supplementation tended (P=0.06) a linear improvement. Starter DMI d 0 – 59 was 1.39, 1.7, 1.57 lbs./d for 0, 1, and 2 g/d GAA, respectively, and GAA supplementation tended (P= 0.06) linear improvement. NSD in G:F either pre-wean or during the entire study (P=0.55). NSD in respiratory or fecal health scores and calves were relatively healthy reporting minimal respiratory disease and fecal scores 0 or 1 approximately 85 – 90% of the days. 4 mortalities occurred and data on these calves

was reported as withdrawn from the study. n=45. K-State. Alzchem Trostberg GmbH Trostberg, Germany. 2257T.

7. *Probiotics fed pre- and post-wean*. Holstein heifer calves reared on a commercial dairy (Oct to Dec 2021) fed or not fed DFM 1x/d composed of *B. subtilis, B. lichenformis, L. animalis,* and *P.* freudenreichii both in milk d 1 – 60 and top-dressed on grain post-wean. Calves were randomized by birth order. Calves were monitored for health (fecal score, 1 – 3, d 1 – 60; mortality d 1 – 180) and growth (birth, d 90 and d 180). Calves were housed in hutches for 60 d and then moved to pens. By the image shown on the poster, it appears the DFM's were injected into the nipples of each bottle when administered with milk. 50 calves in each treatment group were monitored for intake (individual starter intake d 21 – 25, d 42 – 46, d 60 – 64, and d 74 – 78; pen intakes d 91, 112, 133, 157, and 175). NSD in 180 d ADG (4.48 vs. 4.43 lbs/d; P=0.60), NSD in d 1 – 180 frame growth (37 vs. 38 cm, a combined shoulder and hip height measure; P=0.65). Probiotic increased (P=0.01) total intake d 1 – 74 (191.8 vs. 211.6 lbs.). F:G d 1 – 91 improved (P=0.04) from 2.06 to 1.94. NSD in diarrhea frequency (% of days with loose or watery feces divided by days in trial; 7.3% for control, 8.2% for DFM; P=0.17). NSD in % to sick pen (2.0 vs. 3.1%; P=0.54). NSD in mortality (6.5% vs. 6.7%; P=0.93). Kaplan-Meier survival days to first diarrhea was 9 d for both groups (NSD; n=320, events= 310). Solid feed intake was greater (P=0.03) d 74, otherwise NSD in solid feed intake. n=300. UC-Davis. Ca Polytechnic San Luis Obispo. Funded by Chris Hansen Labs. 2313W.
8. *Polyphenol additive as antioxidant in weaned dairy calves*? Dairy bull calves (approximately 8 weeks old, 229.3 lbs. ±5.51 lbs.) were fed for 28 d grower pellet (16% CP ad lib once daily) either with 185 ppm of Fe and 330 IU/kg of vitamin E (positive control diet; 2 pens of calves, n=17) or 11 IU/kg of vitamin E and 1200 ppm Fe (negative control diet, induced oxidative stress; 6 pens of calves, n=50). In period two (d 28 – 56), calves fed the induced oxidative stress diet (negative control, n=50 split 3 ways) were fed either a.) 2 pens staying on as negative control (11 IU E & 1200 ppm Fe), b.) 2 pens negative control pellet supplemented with AOX-50 antioxidant supplement (Promote, Lewisburg, OH), or c.) 2 pens the negative control pellet supplemented with another antioxidant supplement, BOREOX BX50 (Hanley International, Belmont, MA). The AOX and BX50 met the equivalent antioxidant capacity as the high vitamin E (330 IU E/kg) positive control diet. During the first 4-week period, the oxidative stress reduced body weight from 255.7 to 249 lbs. (P≤0.05) and reduced feed intake from 229.3 to 198.9 lbs. (P≤0.05). During the next 4 weeks (stage 2) calves fed negative control pellet with AOX noted improved final body weight (P≤0.05; 330.7 lbs.) vs. negative control pellet w/o antioxidants (306.4 lbs.) and vs. negative control with BX50 (P≤0.05; 310.8 lbs.). Calves fed positive control (high vitamin E, low Fe pellet) noted the same bodyweight (NSD; 321.9 lbs.) as the negative control pellet with AOX or BX50 while resulting in increased body weight (P≤0.05) vs. the negative control (high Fe, low vitamin E pellet; 282.2 lbs.) void of added antioxidant. Calves fed the negative control pellet with BX50 noted a 4.54-fold increase in ADG comparing period 2 to period 1 which was a greater fold increase

than any other group (P≤0.05). G:F during the entire 8 week study was 0.21, 0.211, 0.263, and 0.248 for positive control (high E and low Fe), negative control (low E and high Fe), negative control plus AOX, and negative control plus BX50, respectively (NSD; P=0.14 between the both AOX and BX50 and the positive control). Blood samples were drawn at the ends of both periods and plasma assayed for superoxide dismutase (SOD). (editor's note: SOD is an enzyme and low SOD levels predispose tissues to pathological damage resulting from oxidative stress). SOD concentrations in plasma tended less (P=0.10) for calves fed negative control pellet with BX50 when compared to negative control pellet with AOX, otherwise, NSD between treatment groups. BX50 was reported to increase economic return by $15/calf compared to the positive control. Kalmbach Feeds, OH. Hanley International, MA. Probiotech International. n=67Quebec. 2350W.

9. *Megasphaera elsdenii oral probiotic capsule (MS Biotec). Effect on rumen development, foregut pH, and growth*. Individually housed Holstein x Angus cross calves (99.9 lbs. ±15.7 lbs.; 8.2 d ±2.0 d) were assigned to one of 3 treatments, a.) placebo, b.) single capsule (dose) of probiotic on d 15, or c.) capsule of probiotic on both d 15 and 39. Each 1.25-inch capsule contained 5 B CFU of *Megasphaera elsdenii* (NCIMB 41125). Calves were fed 7 L/d (15% solids) until d 42 and then fed half rate to wean d 56. Pelleted starter (18% CP) was offered ad lib. Daily DMI and weekly body weight measures were taken on all calves. Calves harvested starting d 77 and the individual weights of the rumen, abomasum and visceral organs were recorded. Reticulorumen fluid was collected d 14, 35, 49, 58, and 70 via esophageal tubing. NSD (P=0.38) in reticulorumen pH: 6.05 ±0.28, 5.97 ±0.28, and 5.85 ±0.28 for placebo, single dose d 15, and dose d 15 and 39, respectively. Full rumen weight tended (P=0.06) greater for calves dosed with probiotic (24.5 vs. 29.9 and 31.2 lbs. for placebo, one dose, and two doses, respectively). Probiotic treatment also effected (P=0.01) empty rumen weight (6.1 vs. 7.8 and 6.6 lbs. for placebo, one dose, and two doses, respectively). Probiotic also effected (P=0.02) liver weight (4.7 vs. 5.7 and 6 lbs. for placebo, one dose, and two doses, respectively). No effect on abomasum (P=0.29) weight or of other visceral organs (P>0.49). ADG improved (p value not shown but reported as significant) from probiotic supplementation (1.67 vs. 2.4 and 2.38 lbs./d for placebo, one dose, and two doses, respectively), as did starter DMI (2.58 vs. 3.57 and 3.7 lbs./d for placebo, one dose, and two doses, respectively). n=31. U of KY, Lexington. 2352W.
10. *Lactobacillus and Bacillus supplementation.* Holstein x Angus heifer calves (60 to 100 lbs.) and blocked by birthdate were randomly assigned to either a.) supplementation of 1.25 B CFU of combined lactobacillus and bacillus via 1x/d supplementation in the milk replacer, or b.) no DFM supplementation. All calves were fed 5.6 L/d of 14.5% solids 24:20 CMR and gradually weaned d 60 - 70. Grain w/o DFM was fed ad lib commencing d 15. BW taken d 0, 30, 60, 70, 80, and 90 and health measures assessed daily using UW calf health scoring chart. Feed intake measured daily. Calves were harvested d 30, 60, or 90 (±2 d of age), 20 calves per harvest date. DFM-supplemented calves noted decreased

grain intake after 60 d of age post-wean (P<0.01), otherwise, NSD in ADG, G:F, or any health parameters. n=60. K-State U. Church and Dwight. Michigan State U. 2354W.

11. *Sodium butyrate? Phytogenic compounds? Egg yolk antibodies?* 2 studies were conducted on 2 commercial farms, same methodology and treatments. 10 d old calves (half heifers, half bulls) were fed the same DFM (B. licheniformis, B. subtillis, & E. Faecium) containing CMR with either a.) no further additives/control, b.) Phytogenic compound additive, 0.5 kg/ton of Digestarom, Biomin, c.) sodium butyrate, 3.4 kg/ton Adimix Easy, Nutriad, or 4.) egg yolk antibodies, 3 kg/ton Globigen Life Start, EW Nutrition. Calves were fed 6 L/d of CMR containing 900 g of powder. Starter grain was offered ad lib. Individual body weights were taken every 10 d to d 60 of life and fecal (scale 1 – 4) and health scores were taken daily. Results on each farm were analyzed separately. On farm A: NSD in ADG d 1 – 20 (P=0.17), d 21 to 50 or day 1 – 50 (calves gained 1.4, 1.31, 1.39, and 1.37 for control, sodium butyrate, phytogenic compounds, and egg yolk AB, respectively). Fecal scores were greater for calves fed sodium butyrate (P=0.02) vs. control/DFM (1.2 vs. 1.16), otherwise, NSD. Number of calves treated tended (P=0.09) less in calves fed egg AB vs control (14 vs. 8 calves). On farm B: ADG d 1 to 20 was less (1.51 vs. 1.31 lbs./d; P=0.01) in calves fed sodium butyrate and tended less (1.51 vs. 1.25 lbs./d; P=0.06) in calves fed egg yolk AB vs. control, and d 21 to 50, calves fed egg yolk AB noted improved (2.2 vs. 2.03 lbs./d; P=0.03) ADG vs. control, otherwise, NSD across treatments d 1 – 20, d 21 to 50, and d 1 to 50. ADG d 1 to 50 was 1.86, 1.78, 1.82, and 1.86 lbs./d for control, sodium butyrate, phytogenic compound, and egg yolk antibody-supplemented calves, respectively. Starter intake was reduced (P=0.01) and tended less (P=0.09) for calves fed phytogenic compound and sodium butyrate, respectively, vs. control/DFM. Gain:feed tended (756g:1000 g, ADG:g DM; P=0.08) greater for calves fed phytogenic compound vs. control. U of Ag Krakow, Poland. U of Sci and Tech in Bydogoszcz, Poland. Vetbovis Zydowo, Poland. n=96. 2510V
12. *Phytogenic compounds? Egg yolk antibodies? Combination of both?* 2 studies were conducted on 2 commercial farms, same methodology and treatments. 10 d old calves (half heifers, half bulls) were fed the same DFM (B. licheniformis and B. subtillis at 1.3 x 10^6 cfu/g, & E. Faecium at 1.2 x 10^6 cfu/g) containing CMR (21.5% CP, 18% fat) with either a.) no further additives/control, b.) Phytogenic compound additive, 0.5 kg/ton of Digestarom, Biomin, c.) egg yolk antibodies, 3 kg/ton Globigen Life Start, EW Nutrition, or 4.) a combination of both additives: Digestarom phytogenic compound + Globigen Life Start egg yolk antibodies. Calves were fed 6 L/d of CMR containing 900 g of powder divided into 3 equal feedings daily. Starter grain was offered ad lib. Individual body weights were taken every 10 d to d 60 of life and fecal (scale 1 – 4) and health scores were taken daily. Results on each farm were analyzed separately. On farm A: supplementing CMR with phytogenic compound increased ADG d 21 – 50 and during the entire study period (d 1 to 50 of study), however, no P value was provided on either measure. However, supplementing the phytogenic compound in tandem with egg yolk antibody resulted in a trend towards reduced ADG d 21 to 50 (P=0.07) and a reduction

in ADG d 1 to 50 of study (P=0.05). ADG d 1 to 50 was 1.31, 1.36, 1.33, and 1.27 lbs./d for control, +phytogenic compound, +egg yolk antibody, and +combined phytogenic compound and egg yolk antibody, respectively. Combining phytogenic compound + egg yolk antibody also resulted in less (P=0.03) cumulative starter intake (31.3, 32.8, 34.1, and 30 lbs. for control, +phytogenic compound, +egg yolk antibody, and combined phytogenic compound + egg yolk antibody, respectively). On farm B, the combination of phytogenic compound + egg yolk antibody increased ADG d 1 to 20 (P<0.01), however, during d 21 to 50 and during the entire growth period of d 1 to 50 NSD was noted. ADG d 1 to 50 was 1.68, 1.74, 1.72, and 1.78 lbs./d for control, +phytogenic compound, +egg yolk antibody, and combined phytogenic compound + egg yolk antibody, respectively. The combination of phytogenic compound + egg yolk antibody also tended (P=0.07) to improve feed efficiency. NSD in any other measure was noted in this study. U of Ag Krakow, Poland. U of Sci and Tech in Bydogoszcz, Poland. Vetbovis Zydowo, Poland. n=96. 2511V

13. *Does sodium butyrate affect gut microbiota?* Holstein heifer calves were supplemented via CMR from d 4 to 60 with either 0, 15, 30, or 45 g/d of sodium butyrate. Rumen fluid was collected on d 2, 14, 28, 42, and 60 and feces on d 0, 14, 28, 42, and 60. Samples were analyzed for 16s rRNA high-throughput sequencing. The alpha-diversity (Shannon index and Chao index) was different (P<0.05) in the feces but not the rumen fluid in the d 60 samples from calves fed sodium butyrate. Sodium butyrate enhanced growth (P<0.05) of *Firmicutes* from d 2 to 28 and abundance (P<0.05) of *Bacteroides* from d 28 to 42 in both feces and rumen fluid. Sodium butyrate inhibited (P<0.05) development of *Protecbacteria* in rumen and feces. Sodium butyrate increased abundance (P<0.05) of *Prevotellaceae, clostridium, ruminococcus,* and *Muribaculaceae* rumen bacteria which can produce butyric acid or other VFAs. Sodium butyrate also increased abundance of *Prevotella*, *Lachnospirceae*, *Clostridium*, *Ruminococcus*, and *Muribaculaceae* in feces. Abundance of Escherichia-Shigella and daily feeding rate of sodium butyrate were negatively correlated (P<0.05; sodium butyrate decreased risk of disease caused by harmful bacteria). Inst An Sci Chinese Academy of Ag Sci Beijing. U College Dublin Belfield, Ireland. n=40. 1538V.
14. *Effect of neomycin on intestinal permeability, bile acid metabolism, and transcript abundance of genes involved with lipid metabolism and immunity*. Gorjidooz et al, 2017 showed that calves treated with antimicrobials during preweaning period noted lower conception rates, increased time to first calving, and increased risk of culling. Heinrichs et al, 2011, showed treating with antimicrobials during preweaning period noted reduced 1st lactation milk production. Holstein bull calves (7 ±2 d of age) were fed either nonmedicated CMR, CMR with neomycin at 20 mg/kg BW for 14 days, or CMR with neomycin at 20 mg/kg BW for 28 days. A subset of 36 calves (n=12/treatment) were dissected and gastrointestinal permeability using chromium-EDTA for 12 hours was measured. A companion publication to this one (Buss et al, 2021, JDS) reported that there was no effect on ADG (P=0.40) or days to first diarrhea (P=0.77) from either

neomycin strategy, however, peak fecal scores were reduced (P<0.01) from both neomycin strategies (NSD between neomycin strategies). In this portion of the study gut permeability was shown to increase week 2 (P=0.05) but not week 4 (P=0.69) from either neomycin supplementation strategy. It was hypothesized this was due to a reduction in gut microbial diversity. Bile acids emulsify lipids and prevent bacterial overgrowth after milk ingestion and microbes hydrolyze and transform bile acids into secondary bile acids because they are toxic to some microorganisms. Bile acids also influence tissue function and their concentration during transport in the calf are tightly regulated by endogenous and dedicated receptors TGR5 and FXR. These two receptors control its circulation in the enterohepatic system back to the liver where it works with receptors there to inhibit bile acid synthesis. Some bile acids may also spill into circulation resulting in nutrient sensing molecules that confer information from the gut environment to peripheral tissues, mainly blocking lipolysis and possibly influencing immune function. Bile acid concentration in the ileum and the colon noted no differences in primary or secondary bile acids from either neomycin supplementation strategy, however in the short-term treatment, but not the long term one, increased (no P value reported) preferential uptake of total bile acid concentration was noted in the ileum tissue but not in the colon tissue. The ileum is where most of the bile acid uptake occurs for recirculation to the liver. Bile acid gene expression was also increased due to short term (14 d) feeding of neomycin in the distal jejunum (P=0.04) and in the ilium (P<0.01) for both the short and long term (28 d) neomycin strategies. There were no increases in bile acid concentration in the liver, however, there was an increase in bile acid metabolism (P<0.01) from short term (but not long term) neomycin supplementation. There was effect on immunity and inflammation markers in the liver in one marker (TLR10 no effect, TLR4 was reduced P<0.01 in the long-term neomycin strategy, and TNF alpha no effect) from any neomycin strategy. Bile acid concentration that spills into circulation at very low concentrations showed both short and long-term neomycin supplementation resulted in lower (P<0.04) bile acid concentration in plasma. Genes related to lipid metabolism (FABP4 & GPAT1) were reduced in calves fed the short-term neomycin strategy vs. control suggesting lipolysis. Also, there was reduction of FBP1, a key rate limiting enzyme on gluconeogenesis pathways dealing with glucose metabolism. Finally, several immune function markers (ITGAM3, FUT3) were increased (P<0.05) when calves were fed the short-term neomycin strategy vs. either the control or the long-term strategy. In summary, neomycin increased intestinal permeability, altered bile acid metabolism, and altered gene expression. n=160. U of Guelph. 1340.

15. *Live yeast?* Holstein heifer calves with successful passive transfer and reared on a commercial dairy were +/- supplemented (23 mg 2x/d) with *Boulardii* live yeast (app. 15 B cfu/gram) via CMR and were +/- stressed with variabl2-houring times 3 days per week (2-hour delay in AM fdg) in a 2 x 2 factorial study design from d 5 – 89 of life. Fecal glucocorticoid metabolites (fGCM) were measured d 5, 19, 33, 47, 61, 75, and 89 as a measure of stress. Results: age had no effect on fGCM concentration, however, stress

increased fGCM and supplementation of live yeast reduced fGCM. Both were reported as statistically sig differences (no p-value provided in video). Stress reduced starter intake (reported as significant) on 17 days in the study and the graph presented showed them clustered between d 70 and 89. Yeast supplementation increased starter intake on 8 days in the study and in the graph presented, 5 of these days were clustered between d 70 and 80 and the final 3 were d 85, 86, and 89. Stressed calves receiving the yeast supplement had significantly greater starter intake as compared to the stressed calves not receiving the yeast supplement (no p value reported). Bottom line: yeast supplementation mitigated chronic stress and increased starter intake. Stress reduced growth. Yeast did not affect growth except in the group that was stressed where it mitigated the statistically sig (no p value reported) reduction in BW growth. Each group's mean calf BW more than doubled (graph reported 198 to 220.5 lbs.) from d 5 to d 89 d age. Red cell distribution width, mean corpuscular hemoglobin, mean corpuscular hemoglobin concentration, mean corpuscular volume, and full blood count were with expected normal range for prewean dairy calves and were not different between groups as measured d 5, 19, 33, 47, 61, 75, or 89. Hematocrit was not different between groups except d 19 when stressed calves noted significantly higher concentrations (1.7 L/L for stressed calves, 0.5 L/L for yeast fed calves, and 0.3 L/L for both control and stressed with yeast), and yeast mitigated this spike in hematocrit that occurred with stress. White blood cell parameters decreased with age and were within normal range for prewean dairy calves. Platelet counts were higher in stressed calves that received yeast than in stressed calves that did not (again, no p value reported, however, author noted statistical sig). The author speculated that yeast stimulated the bone marrow to produce more platelets when stressed. Basophils, Eosinophil, Lymphocytes, and Neutrophils had a day effect but no differences between groups were reported. Yeast increased lymphocyte concentration (no p value reported) and the author reported this indicates yeast stimulated a stronger immune response. White cell count increased over time as was expected with the normal physiological development of calves and in stressed calves yeast stimulated increased WBC production. n=80. Lallemand. Stellenbosch University. 1345.

16. *Does sodium butyrate improve duodenal development in diarrheic calves?* Calves were either supplemented with sodium butyrate (Adimix, Adisseo) or not (quantity supplemented not reported) and evaluated as either getting diarrhea or not. Half were euthanized d 15 and the other half d 30 of life. Duodenal expression of lactase gene (marker of intestinal immaturity) and glucagon gene-like peptide 2 (related to tissue repair) were measured. Duodenal villous height and crypt depth were also measured. Sodium butyrate improved villus length ($P<0.01$) and crypt depth ($P<0.01$), however, incidence of diarrhea did not impact either measure ($P=0.51$ on villus height and $P=0.73$ on crypt depth), nor was there an interaction between butyrate and diarrhea ($P=0.68$ for villus length and $P=0.95$ for crypt depth). Incidence of diarrhea increased measure of lactase gene, indicating poorer intestinal maturity, and, interestingly, feeding butyrate

ameliorated this increase in lactase gene (no stat provided). Also, glucagon-like peptide 2 gene increased in diarrheic calves, and, again, supplementing butyrate ameliorated this increase (no stat provided). The researcher also reported results of a "larger" study reporting morbidity 50% in control vs. 30% in butyrate group (P=0.04), recurrence of morbidity 60% in the control group and 26.7% in the butyrate group (P=0.04), ADG 1.14 lbs./d in the control group and 1.22 lbs./d in the butyrate group (P=0.09), and, finally, the butyrate group noted increased development of ruminal papillae (no details or stats provided). No details of this "larger" study's design or number of calves were reported. No details were reported of the quantity of sodium butyrate fed in either study. n=24 in the initial gut morphology study. Brazil U Fed de Pelotas. Adisseo. nupeec. 2349W.

Amino acid supplementation (1 abstract):

1. *Glutamine regulates tight junction proteins in calf epithelial cells.* A major component of the epithelial barrier are tight junctions made up of proteins such as occludins and claudins that provide a critical barrier that prevent microbes and antigens from entering the subepithelial layers of the intestinal epithelium resulting in intestinal inflammation. Feed restriction (abrupt weaning) in young dairy calves results in increased paracellular permeability of the intestinal epithelium and supplementation of glutamine has been shown to mitigate this problem (Wickramasinghe et al., 2022). Glutamine is a non-essential amino acid, meaning the calf can generate it (de novo synthesis). Glutamine also serves as a major energy substrate in the intestinal epithelium, and it was hypothesized supplementing it could improve cellular energy status. Three concentrations (0, 5, or 10 mM) of glutamine were examined in a media of tight juncture proteins cultured for 48 h and these researchers found the tight juncture proteins claudin-3 and occludin both increased (P=0.02 and P=0.01, respectively) with glutamine presence in the culture. AMPK is a marker that indicates cellular energy (phosphorylation) status, and it too was increased (P=0.03) with presence of glutamine in the media. Also, as AMPK increased and thus phosphorylation occurred, tight juncture proteins decreased (P<0.01 for claudin-3 and P=0.01 for occludin). These researchers also found that extracellular supplementation of glutamine did not increase tight juncture protein abundance unless de novo synthesis of glutamine was inhibited. Finally, these researchers found that "tight juncture protein abundances were associated with decreased AMPK phosphorylation suggesting improved energy status in response to glutamine supplementations." SDSU & Iowa State University. 1434.

Colostrum, Colostrum Replacers (CR), and feeding Transition Milk (8 abstracts):

1. *Effect of bovine derived direct fed microbials and transition milk on growth and immune development.* Holstein calves were fed diets from d 1 – 7 in a 2x2 factorial design containing either 100% milk replacer or 50% milk replacer and 50% colostrum replacer, and, either with or w/o bovine-derived DFM consisting of 5 *Lactobacillus* species dosed at 1 billion cfu. Day 8 onward all calves were fed the same high plane of nutrition CMR

and provided free access to grain w/gradual wean d 49 to 63. Calves were individually housed to d 21 and then group-housed. Weekly body measures were taken, and blood and feces sampled wk 1, 4, 6, and 9. Blood was analyzed for IgA and IgG, cortisol, haptoglobin, glucose & BHBA. Feces were tested for VFA and total *E coli* content. NSD in ADG, but G:F d 1 – 7 improved in calves supplemented the colostrum replacer in combination with bovine-derived DFM (P=0.05). Fecal VFA increased (P value not reported) in DFM group. Plasma glucose and BHB increased by week (P<0.01) but was unaffected by feeding colostrum replacer. Fecal E coli was reduced week one in calves fed colostrum replacer (P<0.01) and feeding colostrum replacer in tandem with DFM continued E coli reduction through week 4 (P=0.01). Serum haptoglobin was affected by milk type and feeding of DFM and their interaction (P<0.01; I assume reduced by colostrum replacer feeding, abstract unclear). Cortisol concentration not affected by colostrum replacer or DFM (P=0.14). Serum IgG and IgA was not affected by colostrum replacer or DFM feeding. n=40. U of Alberta, Edmonton. U of Guelph. 1170.

2. Holstein male calves 22 (±4.8 d) d and 106.3 lbs. (±13.2 lbs.) BW were restricted in feed intake for 3 d, fed only rehydrating solution (2 L, 2x/d), and fasted for 19 h to simulate staying at an assembly center and being transported. Calves were then fed 3 L (2x/d) of either a.) control milk replacer, b.) transition milk for 4 d, and then milk replacer, c.) transition milk for 10 d, d.) colostrum for 4 d, and then milk replacer, or e.) colostrum for 10 d. All 3 diets were standardized to 1.59 lbs./d solids intake. Water was added to colostrum and transition milk to standardize DM content. Post d 10 all calves were fed the same milk replacer until transition to wean on d 42. Ad lib grain and straw were offered. BW measured weekly and feed intake daily. Blood samples taken d 1, 2, 5, and 11, and BHB and citrulline measurements taken, and fecal samples d 1, 5, and 11 and tested for IgA concentration. NSD in ADG in any treatment. Calves offered control (CMR only) noted increased DMI intake compared to all other groups during the 10-d period (stated in the oral presentation) and 10 d colostrum feeding noted sig (P<0.001) reductions in intake during most individual days in the 10-d period. BHB concentrations were greater (P<0.001) in calves fed transition milk or colostrum on d 2 and 5, and in calves fed transition milk for 10 d or either of the colostrum strategies tested on d 11, also, either colostrum feeding was greater on d 11 compared to transition milk fed for 4 d. Author hypothesizes that reduced lactose feeding in the two colostrum groups resulted in increased breakdown of fat reserves. Citrulline was used to test intestinal permeability and calves supplemented either transition milk or colostrum noted increased (P=0.01) citrulline concentrations in the blood d 2 and in colostrum fed calves d 5 but not between any groups d 11. This indicates a benefit to colostrum and transition milk on gut health. Fecal IgA was used as a local immune marker representing possible effect on preservation of gut epithelial barrier function and feeding colostrum increased fecal IgA concentrations d 5 and 11 (P=0.05 with treatment by day interaction P=0.01). "Feeding either bovine colostrum or transition milk after an episode of feed restriction and fasting helped to recover the intestinal absorptive function (citrulline)

and provide gut immune protection (IgA). However, when calves are fed either bovine colostrum or transition milk, they might increase fatty acids oxidation compared to CMR fed calves." n=35. IRTA, Spain. 1171.

3. *Post gut closure feeding of colostrum powder.* Holstein heifer calves were fed colostrum-based colostrum replacer at birth (205 g IgG) and again at 12 hours (205 g IgG) and then assigned to one of four treatment groups: a.) control, went directly to milk replacer, b.) fed 50:50 mixture of colostrum replacer and milk replacer for 2 days mimicking transition milk and then switched to milk replacer day 3, c.) fed milk replacer + 10% colostrum replacer for 14 days a.k.a. extended feeding of colostrum, and, d.) fed 50:50 colostrum replacer and milk replacer mixture for 2 days and then moved to the milk replacer with 10% colostrum replacer i.e. mimicking both transition milk and extended feeding of colostrum. From day 15 onward all calves were fed 3 L/fdg, 2x/d of 15% solids milk replacer solution until d 21 when moved to 4 L/fdg, 2x/d of 15% solids until week 6 and transitioned to being weaned week 7. Calves were weighed at birth and weekly to week 7, blood samples drawn at birth and weekly thereafter. Fecal score and respiratory score taken daily. Results: NSD in ADG at end of study, and the only differences in ADG in the 7-week period occurred week 2 when calves fed either extended colostrum fdg for 14 days or the mixture of extended feeding of colostrum + mimicking transition milk noted increases ($P<0.05$) compared to the control diet. NSD in digestive health, however, probability of maintaining healthy during the 7-week study was greater ($P<0.01$) in calves fed transition milk compared to control. NSD in respiratory health, however, in the subset of calves with most severe BRD as measured by days of BRD score of >10 as a severe respiratory bout, calves fed extended feeding of colostrum or extended colostrum feeding + transition milk noted a greater probability of maintaining health, specifically, 1.6 x less likely to be severe compared to the control with $P=0.04$ for 14 d extended feeding of colostrum and $P=0.07$ for calves fed colostrum replacer mimicking transition milk + 14 d extended feeding of colostrum. Calf mortality was 20%, 8.2%, 6.1%, and 14% for control, mimicking transition milk ($P=0.08$ vs. control), extended feeding of colostrum ($P=0.08$ vs. control) and, both mimicking transition milk and extended feeding of colostrum (NSD), respectively. Probability of survival to the end of the study was reported as greater for calves fed diet mimicking transition milk and the calves fed extended feeding of colostrum vs. the control group, however, no P value was reported. Serum IgG over the first 7 days of life was not affected by treatment group but was affected over time (it decreased over time in all groups; note abstract 2314W). Ditto serum IgG during the 49-d study, no effect by treatment group, but there was an effect over time ($P<0.01$; serum IgG decreased from 25 mg/mL directly after administering 410 g IgG of colostrum replacer (total) in the first 12 hours to a trough of 10 mg/mL (weeks 2 and 3) and then gradually increased each week to approximately 15 mg/mL by d 49). This was a high disease challenge group with 12% total mortality and 20% of production days, on average, with a positive score for diarrhea and 19% of

production days, on average, with a positive BRD score. n=200. U of Guelph. Saskatoon Colostrum Co. 1174.

4. *Accuracy of Brix to estimate IgG content in colostrum?* This study compared the accuracy of Brix estimates in colostrum samples compared with Fourier-transform infrared spectroscopy (fTIR). Bovine colostrum samples were tested under both methods, a.) a digital Brix refractometer, and b.) fTIR. All samples were also analyzed for moisture content. "Colostrum was either pooled collections from single dairies (n=137) or pooled collections from multiple dairies (n=142). IgG content in whole colostrum (n=441) ranged from 1.2 to 63.8 with a mean of 23.66 ±42 g/L. Based on IgG levels (g/L) analyzed with fTIR, samples were assigned IgG scores of 0 – 6." "While each category was different (P<0.05) when comparing IgG levels, Brix underestimated IgG level in samples with IgG >40 g/L, which is the most critical range for colostrum. Brix was highly correlated (0.74) to solids content and to IgG content on an as is basis (0.70) but poorly correlated to actual IgG content on dry matter basis (0.40). Score zero: 6.0 ±0.26 (a) for fTIR IgG g/L measure, and 9.9 ±0.33 (a) for Brix estimates; Score 1: 15.8 ±0.16 (b) for IgG g/L, and 13.3 ±0.33 (b) for Brix; Score 2: 24.5 ±0.18 (c) for IgG g/L, and 15.1 ±0.22 (c) for Brix; Score 3: 34.6 ±0.24 (d) for IgG g/L and 17.8 ±0.3 (d) for Brix; Score 4: 44.4 ±0.34 (e) for IgG g/L and 19.4 ±0.43 (e) for Brix; Score 5 54.2 ±0.45 (f) and 21.5 ±0.56 (e) for Brix; Score 6 62.0 ±1.61 (g) and 23.8 ±2.0 (e) for Brix. Means with different small-cap letters are different (P<0.05). "Brix was highly correlated (0.74) to solids content and to IgG content on an as-is basis (0.70) but poorly correlated to actual IgG content on dry matter basis (0.40)." n=997 colostrum samples. Nouriche Nutrition. La Belle Colostrum. 2258T.
5. *Health Management of calves – from intrauterine life to successful weaning*. Summary of 41st Discover Conference on Health Management of calves (Oct. 2021). Sabine Mann (Cornell) co-chair, discussion on **colostrum**: Colostrum is complex to provide water, nutrition, IgG, growth factors, immune cells, antimicrobial peptides, complement proteins, enzymes, protease inhibitors and miRNA (Mann et al, 2020, Niekerk et al, 2021, Godden et al, 2019, Carter et al, 2021). Dr. Hammon reported Insulin and insulin like growth factor are critical and many fold more concentrated in colostrum as compared to cow's milk. Mann et al 2016 data showed oversupplying energy in the dry period (+50%) resulted in lesser IgG concentration (g/L; down from about 95 to 75 g/L), whereas colostrum yield increased numerically with more energy fed during the dry period (but NSD; P values not shown). Overfeed energy: make more colostrum volume that is lesser in IgG concentration. Variability is about 14% and some is dilution, but cows fed controlled energy diet may have better IgG transfer from bloodstream to mammary gland. Cow's over-fed energy (+50%) had higher fat yield (P=0.08). Restricting protein intake in beef cows (60 – 70% of requirement) noted lesser colostrum production, but what about slightly more protein than requirement in dairy cattle during dry period, any effect on the colostrum? Dr. Mann reported on sig effect on colostrum yield or IgG concentration from slight modifications of crude protein in the

dry period. Omega-3 FA's added to dry cow supplementation noted transfer of these FA's to the colostrum, however, no effect on the calf was found. Organic TM fed to dam noted increased concentrations of elemental TM in the colostrum, but no strong evidence to show merit to the calf. (Mann et al 2015 on energy/starch, Fischer-Tlustos et al 2021, abstract on energy/starch, Uken et al 2021 on FA supplementation, Garcia et al 2014 on fatty acid supplementation, Van Emon et al 2020 on org TM's). Colostrum yield has a seasonality effect with more produced in the summer and less in the fall (Westhoff et al, unpublished, sample of 18 NY farms, 18,929 records); Jerseys are even more affected by this phenomenon. Why seasonality? No effect from photoperiod (melatonin, prolactin; Morin et al, 2010). Heat stress has a mixed effect (Tao et al, 2019 & Shivley et al, 2018) on colostrogenesis. Mixed effects on IgG concentrations if cows were cooled or not cooled under heat stress (Tao et al, 2019). Maternal metabolic status may affect colostrum production and negative liver health indicators were linked with lower colostrum quality (Immler et al, 2021). Cows with high colostrum yield had higher prepartum serum BHB, BUN and lower glucose (Rossi et al, 2020 ADSA abstract). There may not be a timepoint when colostral IgG concentration lessens, but rather, it may be an inflection point when it declines – data from Conneely et al 2013, n=704 colostrum samples noted time interval from calving was different between 0 – 3, 3 – 6 and 6 – 9 hours (all were the same in IgG g/L concentration) and later periods (9 – 12, 12 – 15, 15 – 18, and 18 – 21 h post-calving; I assume $P<0.05$, but actual P value not shown). Also, Quigley et al 2013, n=176 noted an inflection point of 8 hours post calving when colostrum was collected when the inflection point of lower IgG concentration occurred. German research (Suttler et al, 2019) demonstrated that presence of calf and/or use of oxytocin had no effect on the yield of colostrum, but both resulted in higher IgG concentrations (no P-value shown). Further data verbally mentioned in the presentation was that IgG concentration of colostrum was shown in one study to be greater when harvested on Sundays, a slow and less stressful day on most dairies, and the absence of stress was hypothesized to result in increased IgG concentration. Heat treatment of colostrum: 140 F for 60 m, reduces but does not sterilize (Godden et al, 2019), improves storability 8 d when stored at 39 F (Bey et al, 2007). Pasteurization may improve IgG uptake (Godden et al, 2019 & Shivley et al, 2018) and controls mycoplasma, salmonella, E coli, and reduces MAP that causes Johne's disease (Godden et al, 2006). Use rapid cool down, i.e., use ice for bags, frozen bottles of water in colostrum buckets, this practice reduces overgrowth of heat-stable bacteria. Median reduction in total bacteria count = 93% (45 – 100%), highest reduction is in coliforms and lowest reduction is for Staphylococcus spp., and concentrations of insulin, IgF-1, IgA, complement proteins, fibrinogen, trypsin inhibitors, enzymes, and transport proteins involved in iron, lipid, steroids, hormones and vitamin A were all reduced due to pasteurization, while protease inhibitors, milk protein (casein) and acute phase proteins all increased (Mann et al. 2020: Bacterial counts of 5 paired heat-treated (60 C, 60 m) vs. raw colostrum). Dr. Hammon's presentation looked at increased villus height from feeding colostrum 6 times vs. milk replacer only or 1x colostrum (P<0.01; Buhler et al, 1998), as was cell proliferation of the gut crypt cells from calves fed colostrum instead of a nutrient matched formula w/o the same growth factors (IGF-1) (Blattler et al, 2001). Baumrucker et al, 1994 showed CMR with added IgF-1 noted increases in cell proliferation. He also reported calves fed colostrum had increased glucose absorption and increased glucose storage (Steinhoff-Wagner et al, 2011). Liermann et al, 2020 showed IgF-1 is likely not absorbed in colostrum, rather, it has local effects. Leptin and adiponectin are absorbed but it's not sure why, and this data also showed that calves fed colostrum had less heat expenditure d 2 – 3 and d 7 – 8 (no P values shown) as compared to calves fed CMR. Immune cells (neutrophils, macrophages, and lymphocytes) confer pathogen-recall to calves (Reber et al, 2006, Langel et al, 2016, and Meganck et al, 2016). Immune cells decrease in transition milk, and decrease again when the mammary gland produces mature milk, and the cell type proportion of lymphocytes increases (P=0.006) , neutrophils decreases (P=0.05) and macrophage does not change (P=0.47) (Chandler et al, unpublished; linear score and leukocyte proportions in first milk, milk at 3 – 4 DIM, i.e. transition, and at 6 – 7 DIM, i.e. mature milk, n=13). Norrman et al, 2003 found calves fed formula noted increased follicular cell proliferation and increased B-lymphocytes in the interfollicular area, domes, and follicular association epithelium, as compared to colostrum fed calves. Presented by Sabine Mann PhD, Cornell. 1216.

6. *Health Management of calves – from intrauterine life to successful weaning*. Summary of 41st Discover Conference on Health Management of calves (Oct. 2021). Dave Renaud DVM, U of Guelph. Colostrum - Malmuthuge et al, 2015, showed intestinal microbiota are affected by colostrum feeding. The study compared calves fed either no, fresh, or heat-treated colostrum and researchers measured total bacteria and proportion of Bifidobacterium (important for protecting calf from scours) in the gut 6 – 12 hours post colostrum feeding period. Calves that received no colostrum had very little bacteria, fresh colostrum, and heat-treated colostrum significantly more, and proportion of Bifidobacterium were greatest at 6 h in heat treated colostrum, and by 12 h the fresh colostrum-fed calves had caught up. Calves fed no colostrum had significantly less Bifidobacterium at both 6 and 12 h. Proportion of E coli were much higher in tissues and in gut contents when calves were fed no colostrum as compared to calves fed either fresh colostrum or heat-treated colostrum. Sig differences started at 6 h in the gut contents and then transferred to significance in tissues at the 12 h measure. Godden et al, 2012, reported that heat treated colostrum resulted in sig reductions in scours treatments specifically but also in disease treatments in aggregate. Gomez et al 2022 compared fecal microbiota of healthy and diarrheic calves and found much richer and diverse bacterial species in the gut of healthy calves, and these bacteria can fight pathogens and prevent infection. The study also showed that abundance of beneficial bacteria are greater in healthy calves vs. diarrheic ones. 1218.
7. *What is the maximum age to sample a calf for IgG status?* Particularly considering the new passive transfer guidelines, i.e., poor < 10 g/L, fair 10 – 17.9 g/L, good 18 – 24.9 g/L

or excellent >25 g/L. All calves in the study were on a concurrent nutritional trial where fed 3.2 L of colostrum (205 g IgG) both at birth and at 12 h postnatal and were then randomly assigned to either a.) CMR, b.) 10% colostrum replacer + CMR, c.) 2 days transition milk then CMR, or d.) 2 days on transition milk + 12 d 10% colostrum replacer + CMR. Blood samples were drawn at 0, 24, 48, and 72 h and then in the AM days 4, 5, 6, and 7. At 24 h calves had 58% (114/195), 32% (63/195), and 9% (17/195) IgG status as excellent, good, and fair, respectively, but by 7 days this declined to 15% (29/192), 58% (112/192), and 28% (45/192) IgG status as good, fair, and poor, respectively. Total IgG (g/L) was 26.3, 24.3, 20.4, 18.1, 16.6, 15.3, and 14.2 for days 1, 2, 3, 4, 5, 6, and 7, respectively. Ordinal logistic regression analysis showed that time was associated with lower total IgG (P<0.01). Compared to day 1 IgG status, using ordinal logistic regression by day 3 calves were 6.6x more likely (P<0.01 ,CI: 4.6-9.6) to fall a category in colostrum status, by d 4 they were 15.4x more likely (P<0.01, CI: 10.0 – 23.6) to fall a category in colostrum status, and by d 7 they were 84.3x more likely (P<0.01, CI: 47.0-151.1) to fall a category in colostrum status. Current guidelines say you can measure passive immunity up to 9 d of age when you use a pass/fail test. Controlling for diarrhea, there was a tendency (P=0.06) for calves fed the 2 days of transition milk + 12 d 10% colostrum replacer + CMR to resist IgG decay compared to other treatments, otherwise, NSD due to other treatments. U of Guelph. n=195. 2314w.

8. *Prevalence of failure of passive transfer of dam's immunity and overview of colostrum management in Shaanxi Province, China.* Blood was collected, weight assessments made, records reviewed, and a health score assessment made on calves that were 24 h to 10 days age. The health score was based on McGuirk & Peek 2014 and Renaud et al 2018, measuring nasal discharge, eye score, ear score, cough score, rectal temperature, and fecal score. Body weight was estimated using Heinrichsetal 2007 formula using heart girth measures. The survey was conducted in March to June 2021 on 33 dairy farms total 72,893 head accounting for 52.4% of dairy cow inventory in Guanzhong area of Shaanxi Province. The average size farm was 1000 lactating cows. 12.6% were males, 87.4% were females. Also, a questionnaire was conducted on those providing calf care. Results: no calves had respiratory score ≥5, 7% noted scour score of 2 and 2.9% noted scour score of 3. Age, weight, sex, and colostrum status were not associated with overall health scores or respiratory scores. Average body weight was 86.4 lbs. (SD 17.6 lbs., range 46.3 to 135.4 lbs.). The average age at body weight measure was 4.6 days (SD 2.54 days). Serum total protein average was 6.63 g/dL (SD 1.06, range 4.3 to 15.3). Incidence of failure of passive transfer using a cut point of <5.2 g/dL was 8.8%. Serum total protein was not related to gender, age, or weight. The mean time of first colostrum feeding was 1.4 hours (range 0 to 14 h) with farms providing an average of 3.6, 2.3, and 2.8 L of colostrum at 0 to 6, 6 to 12, and 12 to 24 h after birth. 78.8% of all farms used colostrum from other dams as their main source of colostrum. An esophageal tube was used on 66.7% of farms. 21.2% had differing colostrum management for male calves. No farms fed colostrum replacer. 6 farms of 33 fed colostrum from the calf's dam and 7 of 33 fed

colostrum from another dam. None pooled colostrum. One third of farms fed fresh colostrum, 42.4% fed frozen, none fed fermented, and 66.7% of farms fed heat-treated colostrum. 30% of farms allowed suckling the dam, 33.3% used an esophageal tube feeder, 69.7% used nipple bottle or bucket with a nipple and 93.9% used a bucket for their first meal on at least some calves. Male calves were sold within one week of age or less on 27 of the 33 farms. n=254. Northwest A & F University, Veterinary College, Yangling Shaanxi, China. 1494v.

CMR and Milk Feeding Rates and Strategies (2 abstracts):

1. *Health Management of calves – from intrauterine life to successful weaning*. Summary of 41st Discover Conference on Health Management of calves (Oct. 2021). Michael Steele PhD, U of Guelph, a summary of new concepts in preweaning and weaning nutrition and management presented at the Discovery Conference: early life growth and health is related to lifetime production. **Milk feeding phase:** There is also much development plasticity from embryo, fetus, pre-wean, post-wean, heifer and cow, yet we focus mostly on the pre-wean period. There are maternal effects prenatal, lactocrine effects and endocrine control in addition to mixed feeding (milk and dry feed) postnatal (adapted from Bartol et al, 2013, & van Niekerk et al, 2021). The transition from first colostrum feeding to end of week 1 shows slow transition off colostrum to whole milk over the first week. 50% colostrum/50% milk days 2 – 3, thus even when the gut is closed to IgG absorption, notes increased intestinal development, increased IgG after 12 h of life, and decreased risk of mortality, and 10% colostrum replacer, 90% CMR days 2 – 14 noted increased body weight, increased ADG and decreased risk of mortality (no P values provided; Pyo et al, 2020; Hare et al, 2021; McCarthy et al, 2022). Supplementing colostrum post-gut closure is one of many ways to look at the concept of "phase feeding." Four speakers in the Discover conference discussed phase feeding. Data presented: Haisan et al, 2018 demonstrated that feeding 10 L whole milk out gained calves fed 5 L of whole milk week 1 (P<0.1), week 2 (P<0.10), week 3 (P<0.05), week 4, (P<0.05) but not week 5 onward. Calves cannot consume much grain to provide good growth in the first weeks of life, particularly the first 3 weeks. Are we missing an opportunity to increase growth? Soberon and Van Amburgh, 2011 compared restricted (1.32 lbs./d) vs. enhanced (2.9 lbs./d) CMR supply resulted in 134.4 vs. 183.4 lbs. BW at 54 d (P<0.01), respectively, and MJ of energy above maintenance comparing these strategies was 3.7 vs. 15.7 (P<0.01). Calves in this study were sacrificed and the following was noted: calves fed enhanced diet had larger livers (3 vs. 5.2 lbs.; P<0.01), greater proportion of liver to total BW (2.23 vs. 2.84%; P<0.01), larger kidneys (184 vs. 320 g; P=0.02) and a trend (P=0.09) towards the kidneys being a greater proportion of the body, increased mammary gland (76 vs. 338 g; P<0.01), and increased parenchyma (1.1 vs. 6.5 g; P<0.01) and increased parenchyma as % of BW (P<0.01). Offering more milk increases the physiology of the calf. But are there gene expression alterations? Tissues from the Van Amburgh/Soberon study were examined to see if gene expression

was altered, and it was learned genes changed (turned on or off, P<0.01) included 654 from the mammary gland, 1045 in adipose tissue, 176 in the liver, 435 in bone marrow, 651 in muscle, and 103 in the pancreas (Hare et al, 2019; Leal et al, 2019). This study stopped at d 54, what happens beyond that period? Leal et al, 2021 worked with Steele in a study feeding 4 L vs. 8 L of milk weaned abruptly over 1 week d 49 – 56 and the calves responded with increased (P<0.001) BW each week to 70 d if fed the higher volume of milk. These calves were then monitored for a 10-year span. Blood was taken d 2 and d 49 and metabolomic alterations were monitored: at the d 49-mark energy metabolism (VFA and TCA cycle and glucose metabolism), protein metabolism (amino acids and nucleotides), and liver changes (bile acid and heme metabolism) were all effected by plane of nutrition. Total metabolites that changed (P<0.05) comparing the two milk feeding strategies was 426; 147 went up and 279 went down, and the % of metabolites with P<0.05 change was 47%. Metabotypes were monitored again when the calves grew up, were bred, joined the milking string and at 60 days in milk (DIM): methionine, cysteine, SAM and taurine metabolism, fatty acid metabolism, and dipeptide were not affected by pre-wean milk feeding strategy, however, pyrimidine metabolism, TCA cycle, fatty acid metabolism, purine metabolism, guanidino and acetamido metabolism, sphingosines, and pyrimidine metabolism were all affected (1.3 log (P value) (Leal et al, unpublished). Metabolic pathways are imprinted for life. Survival data until 3rd calving noted calves fed elevated milk feeding had trend toward increased survival until 2nd calving (33 vs. 28, 76.7 vs. 65.1% of total; P=0.067) and noted increased (P=0.051) survival until 3rd calving (23 vs. 16; 53.5% vs. 37.2%). 50 animals per treatment. Milk replacers vs. whole milk: most MR are high in lactose and osmolarity, low in fat compared to whole milk. Reported typical milk as 37% lactose, 31% fat, and MR 45% lactose and 18% fat, and whole milk/body fluid 300 mOsm and MR 400 – 600 mOsm. Why the difference between commercial milk replacers and whole milk? Discussed how infant formula had a phase of using higher protein that made them grow faster, but it also made them obese at 5 – 6 years old, and not that this corresponds with heifer calves and milk replacer, but do we know future ramifications later in life of modifying lactose/fat/protein ratios to make short term growth and economics improve in the milk replacer, yet deviate from ratios in natural whole milk? Calves need to be followed thru life on the farm. Hi osmo's coming from hi lactose and ash increase gut permeability. Welboren et al, 2021 compared high lactose (46%) to high fat (26% fat) CMR. Diets weren't isoenergetic, rather, simply replaced lactose with fat in formula. Calves were fed larger meals (15% of bodyweight daily divided over 2 meals/d) and then calves were sacrificed at d 7. ADG in the first week of life was greater in the calves fed high fat (P=0.008; from the graph looks like 1.54 lbs./d for high fat and 0.88 lbs./d for high lactose). Was it because of increased caloric intake? No. Total gain: ME intake was greater (P=0.022) for the calves fed hi fat CMR vs. hi lactose CMR. "Calves fed the high fat MR gained more per unit of ME intake after energy requirements for maintenance were met, more energy was available to be retained." Liver weight (P0.002) and liver glycogen content (P=0.002) were both greater in calves fed hi lactose CMR. "Greater lactose intake in high lactose calves increased supply of precursors for storage in the liver in the form of glycogen." What does this do to the calf long term? Studies are in process to determine this but will require 10 years. Postprandial glucose (pulse dose of glucose IV) measures glucose sensitivity and this same Welboren et al, 2021, study measured this parameter, and authors report "Greater quantities of MR containing more lactose entered the small intestine in high lactose calves," and Steele went on to report that they are finding increased insulin sensitivity in calves fed high lactose CMR, even in the first week of life. Is it a problem long term? Unsure. Echeverry-Munera et al, 2021, compared the same high fat vs. high lactose formulas but did not limit MR intake (ad lib intake). Steele reported this study and others always show increased voluntary intake of high-lactose CMR over the high-fat CMR. However, when you correct for energy, daily intake is the same. BW gain of both diets over 12 weeks noted NSD (P=0.11); both performed well (looks like on the graph they were about 275 lbs. at 12 weeks). Pre-wean, wean, and post-wean performance (ADG) was not different (P=0.47). "Growth rates are remarkable" and very different than those from calf studies even two decades ago, prewean ADG well above 1.76 lbs. and in some points reaching 2.6 lbs. ADG. Wean with ad libitum feeding? Problem, unless you wean at 8 weeks or later and do so gradually, if you do not, all the extra early gains are washed away in losses at transition. Wilms et al, 2022 compared metabolic fingerprint of whole milk, high fat, high lactose, and high protein CMR. ADG was the same across all four diets, however, metabolic fingerprint was very different (reported as significantly different, no P value shown): albumin lesser in high protein, then high lactose then high fat, then whole milk; Urea was greater in whole milk and high-protein, but lesser in high lactose and then high fat; BHB was greater in whole milk, then high fat, then high protein, and finally high lactose; NEFA was greatest in high fat CMR, then whole milk, and then high lactose/high protein both the same; Na higher in high fat, then whole milk, then high lactose, then high-protein; TP higher in high fat, then whole milk, then high protein, then high lactose; hematocrit higher in high fat, high protein next, then high lactose, and whole milk; total carbon dioxide higher in high fat, then high protein, high lactose, and whole milk; bicarbonate higher in high fat, then high protein, high lactose and lastly, whole milk; base deficit higher in high lactose, next high protein, then high fat, and finally whole milk; aspartate transferase higher in high-lactose, high fat next, then high protein and whole milk; IGF-1 higher in high lactose, then high protein, high fat, and whole milk. NSD between diets on Hp, iCa, K, leptin, bilirubin, ceruloplasmin, TG, G/u, Cl, lactate deshydroge, adiponectin, pH, SAA, or GTT. Bottom line: growth may be the same between these diets, but the metabolic fingerprint is quite different. Does this matter? We need to find out. 1217.

2. *NASEM and feeding milk or milk replacer*: Note in-depth details reported of Jim Drackley's excellent presentation on the new NASEM 2021 model in the starter grain section. I encourage viewing the entire presentation posted on the ADSA meetings link

for ADSA annual meeting 2022. His report is equally compelling for both grain and milk/CMR feeding. NASEM committee as reported by Jim Drackley of U of Illinois. 1381.

Dry cow strategies and their impact on the calf (8 abstracts):

1. *What is the impact of cow body condition score on offspring's performance until weaning?* From March to August 2021 on a commercial dairy herd in S. Brazil cows were categorized into one of 3 body condition score groups 21 days prior expected calving date, class 1 BCS (body condition score) ≤3.0, class 2 BCS 3.25 to 3.5, and class 3 BCS ≥3.75. At birth calves received 10.3% of birth BW of high-quality colostrum (BRIX 27.5 ±2.8%). All calves were housed individually and fed 6 L/d of pasteurized whole milk and starter ad lib. Calves were weaned at 96 d. NSD in birth body weight, birth hip width, ADG, weaning weight or weaning hip width, however, class 2 & 3 (calves from higher body condition score cows) noted increased birth withers height (+0.8 inches; P=0.03) and increased (+0.8 inches; P=0.04) weaning withers height. n=71. U Federal do Parana, Brazil. Castrolanda Cooperativea Agroindustrial, Castro, Brazil. U of Illinois.
2. *Supplementing rumen protected choline 24 d prior expected calving. Any effect on calf metabolic measures or growth?* Parous Holstein cows blocked by calving month were top-dressed commencing 24 d prior expected calving date either a.) 45 g/d rumen protected choline (20.4 g/d choline ions), b.) 30 g/d rumen protected choline (13.6 g/d choline ions), or c.) no choline. Blood (d 1, 7, 14, and 21; glucose, BHA, non-esterified FA, reactive oxygen species, antioxidant potential, and haptoglobin) and performance (ADG) measures were taken on the calves the first 21 d of life. Choline supplementation pre-natal was shown to reprogram calf metabolism as measured by calf NEFA amplification post-wean in calves from dams supplemented with either dose of rumen protected choline when dam NEFA was minimal (P=0.02) and reduced (P=0.02) calf NEFA when dam NEFA was maximum. Plasma haptoglobin was lesser (P<0.01) in heifer calves from dams supplemented with 45 g/d of rumen protected choline when compared to control calves, and, interestingly, heifers from choline supplemented dams noted lesser (P=0.05) haptoglobin in comparison to bull calves from dam's supplemented with choline. Supplementing choline to dam at 30 g/d also reduced oxidative stress (P<0.01) in calf. NSD in ADG. n=60. Michigan State U. Balchem Corp.
3. *Clostridiium beijerinckii & Bacillus fed pre-partum?* Clostridium are in feces, fermented feed, soil, and TMR and can contaminate raw milk. C. beijerinckii makes up 10% of the clostridium load in samples of TMR and fermented feeds across the US (March et al, 2018) and this clostridium species is non-toxigenic. Bacillus subtilis strains have antimicrobial activity and are shown to be effective against clostridium perfringens (which makes up 64% of total clostridia load in samples of TMR, corn silage and haylage in the US; March et al, 2018). Multiparous Holstein cows commenced supplementation -25 d ±5 d prepartum of TMR with either a.) no supplement, b.) Certillus (Arm and Hammer) Bacillus fed at 20 g/cow/d (10g 2x/d), c.) Certillus bacillus + C. beijerinckii, or d.) C. beijerinckii. Pre-partum diet consisted of corn silage (32%), wheat straw (36%),

corn gluten feed (5%), soybean meal, soy hulls, midds, rumen protected lysine and methionine, anionic mineral, and VTM supplementation. TMR contained 14% CP, 28% ADF, 45% NDF. Results: NSD in subclinical ketosis, DA's, dystocia, mastitis, or retained placenta, also, NSD in DMI, BW, BW change, condition score or change. Bacillus supplementation tended (P=0.11) to change total colostrum weight (18.1 vs. 13.4 lbs.) and colostrum % Brix (P=0.11; 8.2 vs. 6.1%). Bacillus tended (P=0.10) to increase IgG yield compared to supplementing of the clostrdia strains (469, 420, 567, and 417 grams of total IgG for control, clostridium beijerinckii, bacillus, and combined clostridia beijerinckii and bacillus, respectively). n=71. U of Illinois. Arm and Hammer. 1183.

4. *Increasing dose of prepartum rumen protected choline, effects on in utero exposure to Angus x Holstein beef calves.* The author reports choline concentration is multiple fold greater in amniotic fluid than in maternal blood in humans and has substantial concentration in ruminant placenta. Prepartum Multiparous Holstein cows enrolled 21 d prior expected calving were fed TMR via electronic feeding bins so all cows were housed together and the respective TMR contained either a.) no choline ions daily, b.) targeting 15 g choline ions via ReaShure (Balchem) rumen protected choline, c.) targeting 15 g choline ions via prototype products (similar technology to ReaShure but more concentrated in choline ions), or d.) targeting 22 g choline ions via prototype source. Cows were offered respective TMR ad libitum. Colostrum was administered (1 gallon) to the respective offspring from the same respective treatment group of dams. NSD in initial birth weight. NSD in ADG weeks 1 – 2, however, in males weeks 3 – 8 calves from cows fed 22 g of choline ions per d prepartum of the prototype rumen bypass choline product tended improved ADG (P=0.07) with the other two groups from choline supplemented dams being intermediary (NSD). NSD in ADG in female calves weeks 3 - 8. NSD in final BW or in whole study feed efficiency. ADG/Mcal intake noted NSD weeks 1 – 2, however, weeks 3 – 8 tended (P=0.10) improvements in both male and female calves. Prepartum DMI and thus choline intake was variable based on voluntary intake and ranged from 8 to 24 g/d so in utero choline dose could be analyzed for optimal dose. ADG weeks 3 – 8 weeks of age for male calves noted linear (P<0.01) increase as dam daily choline ion intake increased. For female calves no dose response was noted. Rumen protected choline exposure in utero increased (P=0.04) the proportion of methylated whole blood DNA as measured from a blood sample taken at 3 d age. DNA methylation rates in male Holstein x Angus cross calves increased (P<0.01) from about 30% to about 50%, regardless of the quantity or form of choline ion fed prepartum., however, NSD in methylation rates in female calves. The author hypothesizes that this choline influence on DNA methylation could be influencing gene expression in male calves. n=106 dams. UW Madison. Balchem. 1175.
5. *Follow-up abstract to 1175, Effects on Holstein heifer calves.* Holstein heifer calves from the same set of 106 dams subjected to protocol of the same bypass choline concentrations and sources as were fed in abstract 1175 were monitored after birth to evaluate performance. NSD in birth weight. BW and blood measures taken d 7, 14, 28,

42, and 56. Calves were fed an accelerated growth rate CMR strategy (no details provided) and ad lib access to starter grain. ADG d 1 – 14: high dose of rumen protected choline tended (P=0.08) to improve ADG and tended (P=0.08) to improve G:F during this phase of growth. Weeks 3 – 8 NSD in ADG or G:F. Whole study G:F NSD. Since the cows were fed prepartum TMR ad lib, high dose choline intake ranged from 9.4 to 24 g/d and low-dose choline intake ranged from 8 to 14 g/d. A linear effect was found (P=0.03), i.e., the more choline intake by the dam prepartum, the greater weeks 0 – 2 ADG in the calves. There was also a trend (P>0.10) for a quadratic effect. The same was found with G:F, the more choline intake by the dam pre-partum, the greater (linear effect P=0.02) weeks 0 – 2 ADG in the offspring. No effect from rumen protected choline in gestation on subsequent calf health parameters. No effect on blood fatty acid, beta-hydroxybutyrate, or BUN. All rumen protected choline strategies increased (P<0.03) blood glucose. n=48 calves. UW-Madison. Balchem, New Hampton, NY. 2259T.

6. *Do beef sires affect gestation length and incidence of dystocia when mated to Holsteins?* Annual domestic beef semen sales have increased from an old plateau of approximately 2.5 M units in 2017 ascending steadily to 8.7 M units in 2021, and the author speculates this growth (+6.2 M units annually) is almost exclusively from beef on dairy breeding (reported source: NAAB, 2022). Holstein calving ease scores for sires decreased from a plateau of around 2.7 (0 to 5 scale, 5 being worst) about 20 years ago to approximately 2.1 today, and for dams has steadily decreased from a plateau of 3.4 in the 1990's to 2.2 today. A score 4 or 5 is considered a difficult calving. Source: CDCB, 2022. Calving ease EPD for Angus calving has also improved dramatically since the 1990's increasing from -3 in the early 90s to 6.0 today (higher score = lesser calving difficulty, source: American Angus Assn, 2022). Avg gestation length (days) is 277 for Holstein (USA genetics evaluations for the three reported dairy breeds), 278 Jerseys, 286 Brown Swiss, Angus 283 (Irish gestation length on beef breeds), Simmental 289, Charolais 290, Wagyu 290 days. The study: records from 7 primarily Holstein dairies located in PA collected between 2019 and 2022 from 6,671 calvings were evaluated. Data from non-Holsteins were removed, as were twin data. Gestation length and stillbirth records were available and calving ease score (n=7,001) was available from 4 of the 7 herds. Cows were mated to Holstein (n=5,545 calvings from 394 sires), Angus (n=617 calvings from 53 sires), Charolais (n=114 from 3 sires), Wagyu (n=36 from 4 sires), Simmental or SimAngus cross (n=292, 14 sires), and crossbred beef (n=67, 5 sires) bulls. About 20% of matings were from beef sires. NSD in sire type (P=0.48; Holstein or beef) or sire breed (P=0.38) on calving ease (mean score 1.1 for Holstein, Charolais, Crossbred, and Simmental, and 1.2 for Beef breeds on average, and Angus, and Wagyu specifically). NSD in incidence of still births due to sire type (P=0.73; mean estimate 1.9% and 1.7% for Holstein and beef breeds, respectively) or by sire breed (P=0.42; Holstein 1.9%, Charolais 0.3%, Angus 2%, Crossbred 4.6%, Simmental 1.4%, and Wagyu 2.9%). Regarding gestation length, beef sire calves were carried, on average +2 days longer (P<0.001; Holstein and Beef breeds 276 and 278 days, respectively). Sire breed gestation length in days was Holstein 276 (a),

Charolais 277 (a, b, c), Angus 277 (b), Crossbred 279 (b, c), Simmental 279 (c), and Wagyu 285 (d), respectively (means separation P<0.05). (n=9,507 calving records from 7,724 Holstein cows and 1,693 calving records from beef breeds). Numbers are reported as presented in oral ppt and abstract. Penn State U. 1125.

7. *Health Management of calves – from intrauterine life to successful weaning*. Summary of 41st Discover Conference on Health Management of calves (Oct. 2021). Sabine Mann (Cornell) co-chair, **late-gestation impact on fetal development and colostrum production: fetal origins of adult disease, environmental effects on the fetus have life-long implications**. Dr. Abuela from MSU assembled this presentation but could not attend ADSA. External influences equal programming. Organ growth, cell differentiation, germ line for future generations, metabolism, neoro-endocrine system, these are influenced in utero. Epigenome (genome and environment) adjusts to environmental effect and turns cells on and off to effect phenotype. Late gestation (last third) is the most influential period. Birth defects are associated with in utero deficiencies in TM and vitamins, under-nutrition (lack of calories) resulting in poorer immune response in future calves despite NSD in BW or ADG (Moriel et al 2016), low maternal NEFA resulted in increased birthweight (P=0.032) in calves that carried on thru week 4 and balance of pro and anti-oxidants was effected by NEFA status in the dam, lower maternal blood NEFA concentrations resulted in improved oxidant status and also less haptoglobin concentration (P=0.036) thus less inflammation in the calves born from dam's with low NEFA, also, the dam's with lower maternal oxidant status noted increased birth weight that carried on thru week 4 and calves had improved immune response when measuring TNF alpha after an LPS challenge (Ling et al, 2018, JDS). Supplementing with dietary antioxidant the final 3 weeks of gestation resulted in calves with better health score (P<0.001) and improved titer from BHV-1 challenge (P<0.001). Calves born from dam's that were heat stressed noted lesser survival to 1st calving, and lesser survival through 3, 4 and 5 years; productive life reduced by 5 months and lifespan by 11.7 months when compared to calves from dams that were not heat stressed. Calves from dam's that were heat stressed also noted -4.9 lbs. of milk per d lactation one, similar losses lactation 2, and -14.3 lbs. of milk per d lactation 3 and these calves/cows were in the same environment, feeding, management, etc. This difference carried on with the granddaughters of these heat stressed or not-heat stressed dams, literally showing 25 – 27% lesser survival and almost 3 lbs. lesser mil per day (stats not shown in ppt slide; Laporta et al, 2020). 5 genes are common to heat stressed dairy cattle both in mammary tissue in dam and liver tissue in either intrauterine or 42-day old bull calves subjected to heat stressed – i.e., 5 genes get turned on during heat stress and they reside in males and females and in mammary glands and in livers. Colostrum has the largest influence on calf health and colostrogenesis ramps up the final 4 weeks of gestation (Godden et al, 2019).
8. *A review of the impacts of dairy cow nutrition pre-calving on calf health*. John Mee, Teagasc, Moorepark Research Centre, Ireland. Goff et al characterized the transitional

metabolic disease complex well: decreased DMI around calving, resulting in a negative energy and protein balance creating increased NEFA resulting in ketosis and fatty liver. Displaced abomasum coming from decreased DMI in conjunction with insufficient dietary effective fiber and from hypercalcemia, leading to rumen acidosis and lameness. All of these provide a feedback loop to more decreased DMI, more immune suppression (insufficient VTM's contribute). Meanwhile, high DCAD or low Mg diets also result in hypocalcemia and lost muscle tone also feeding into both milk fever and displaced abomasum and more decreased DMI. Goff et al miss the effect on the calf, and this author reported the transgenerational metabolic disease complex: energy/protein and fat content, macro- and micro-mineral nutrition, and body condition score of the cow pre-calving all impact colostrum quality and quantity and thus effects of FPT and resulting diarrhea/pneumonia and future calf morbidity and mortality and they also impact birth weight which impacts incidence of dystocia, which impacts morbidity and mortality as do macro- and micronutrient nutrition. The author reviewed colostrum quality parameters, perinatal calf mortality (0-48 h) and neonatal calf morbidity and mortality 0 – 6 months. **Data surveying poor quality colostrum**: Australia, 52.5% of samples from 221 cows in 21 herds were of poor quality (Abuelo et al, 2019); Germany, 37.5% of 640 cows in 16 herds (Hassan et al, 2020); Ireland, 21% of samples from 250 cows in 47 herds (Barry et al, 2019); New Zealand, 77.6% of samples representing 580 cows on 29 herds (Denhol et al, 2018), and the USA 22.6% of samples from 1,972 cows on 104 herds (Shivley et al, 2018). **Data surveying incidence of FPT**: Canada, 32% on 818 calves from 61 herds (Morin et al, 2021); New Zealand, 16% of 680 calves in 8 herds (Mason et al, 2022); Scotland, 14.1% of 292 calves in 38 herds (Haggerty et al, 2021); Turkey, 17.3% of 400 calves in 9 herds (Kara et al, 2021), and USA, 12.1% of 1,623 calves in 104 herds (Shivley et al, 2018). **Survey of perinatal calf mortality (PCM) recent studies**: Ireland 2.4% of 240,640 calves (Ring et al, 2018); Japan 7.7% of 1.3 M calves in 5,172 herds (Kayano et al, 2016); Netherlands 8.5% of calves in 16,750 herds (Santman-Berends et al, 2019); New Zealand 5.7% of 18,437 calves in 30 herds (Cuttance et al, 2017); USA, 5.6% of calves on 1,260 herds (USDA, 2016). **Neonatal calf mortality (NCM)**: China 5.5% of 18,077 calves in 37 herds (Zhang et al, 2019); Estonia 4.9% of 148,323 calves in 119 herds (Reimus et al, 2020); Norway, 6.4% on 416 herds (Johnson et al, 2022); UK, 6% of 21.2 million calves (Hyde et al, 2020); and USA, 5.0% of 2,545 calves in 104 herds (Urie et al, 2018). Causes of mortality in an Irish study are enteric infections (#1), septicemia/bacteriaemia (#2) and respiratory infections (#3). Neonatal calf morbidity, recent 2021 study in Ireland of 6,500 calves on 120 herds (Marie-Claire et al, animals) note 90% of dairies have at least one calf with diarrhea, 42% one calf with respiratory disease, 37% with pyrexia (≥40 C), 95% with high temp (greater than 39.5 C), 100% have one calf or more with enlarged naval, and 53% with naval ill. **Maternal nutrition as a mediator of calf health**: colostrogenesis (quality and quantity), perinatal calf mortality, and neonatal calf health. Effect of body condition score on colostrum Ig show conflicting results: High vs. low, NS effect, Bland et al, 2007; Hi body condition increases colostrum Ig, Smith and Stockdale, 2004; Hi body condition score decreases colostrum Ig, Shearer et al, 1992. Effect of body condition score on colostrogenesis: increased body condition score increased colostrum Ig, Mulder et al, 2018; increased body condition score increased colostrum Ig, Shearer et al, 1992; body condition score decreased colostrum Ig, while colostrum yield was not changed, Mann et al, 2016. **Author's bottom line**: increased body condition score tended to increase Ig but not across all studies and the number of studies is limited. **Maternal energy in diet and colostrum yield**: higher concentrate in the diet increased colostrum yield, Gulliksen et al, 2008; Mannan-OS increased colostrum yield, Westland et al, 2017; Concentrate increased colostrum yield, Dunn et al, 2017; increased dietary energy and DMI had no effect on colostrum yield, Nowak et al, 2019; excess vs. recommended dietary energy resulted in no difference in colostrum yield, Mann et al, 2016. **Energy content of cow diet effect on colostrum Ig**: excess vs. recommended dietary energy decreased Ig, Mann et al, 2016; higher concentrate concentration in diet, decreased colostrum Ig, Guilliksen et al, 2008; higher energy and higher plane of nutrition decreased colostrum Ig, Smith and Stockdale, 2004; and increased concentrate resulted in NSD in colostrum Ig, Dunn al, 2017. **Bottom line according to the author**: increased dietary energy resulted in decreased colostrum Ig. **Protein content in cow diet and colostrum yield**: higher UDP NSD in colostrum yield, Bland et al, 2007; higher CP, NSD in colostrum yield, Quigley and Drewrey, 1998; higher CP NSD in colostrum yield, Hook et al, 1989. **Higher protein in diet effect on colostrum Ig?** NSD from higher CP or UDP in 4 studies (Toghyani et al, 2015; Bland et al, 2007; Santos et al, 2001; Hook et al, 1989, and Smith and Stockdale, 2004), an increase in Ig from higher CP or increased RP aa (lys, met) in cow diet in 2 studies (Smith and Stockdale, 2004; Wang et al, 2021), an increase in colostrum Ig from tannins (Prodanovic et al, 2021). No studies on effect of increased fat in cow diets on colostrum Ig. **What about micronutrient nutrition in cow diets and effect on colostrum Ig?** 4 studies show increased colostrum Ig from feeding cows organic TM's vs. inorganic ones (Roshanzamir et al, 2020; Nayeri et al, 2014; Formigonia et al, 2011; Kincaid & Socha, 2004) while 2 show no effect (Juniper et al, 2019; Kinal et al, 2007). 2 show increased colostrum Ig from selenium or Se/E (Pavlata et al, 2004; Illek et al, 2019) while one shows NSD (Mohrekesh et al, 2019). Cr-met (Gultepe et al, 2018), vitamin A (Kadek et al, 2021a) and Antioxidant micronutrients, Alhussein et al, 2021 show no effect on Colostral Ig. **Calcium status and colostrum yield?** Only 2 studies: Rajaeerad et al, 2020 showed hi DCAD/lo calcium increased colostrum yield while a second (Lopera et al, 2018) studied lo DCAD and noted a decrease in colostrum yield. Too few studies. **Effect of calcium status of the cow and colostrum Ig?** 4 studies, three on DCAD (Zimpel et al, 2021; Rajaeerad et al, 2020, and Lopera et al, 2018) show NSD, and one low calcium study also showed no effect (Kari & Staufenbiel, 2017). **Author's mini-conclusions on colostrogenesis**: 1.) once dietary energy, protein and micronutrients are met, limited impact (the Goldilocks principle); 2.) colostrum Ig increased with supplementary micronutrients but reduced by supplemental energy (dilution effect); 3.) colostrum yield increased with supplementary energy, but data was conflicting about body condition score effects; 4.) inadequate evidence for effects of fat, micronutrient and calcium on colostrum yield. What about the effect of body condition score on perinatal calf mortality? As body condition score increased perinatal calf mortality also increased in 3 studies (Vernooy et al, 2007; Chassagne et al, 1999; Gundelach et al, 2009) and had NSD in two (Drew, 1988; Berry et al, 2007). High NEFAs resulted in increased perinatal calf mortality in one study (Menichetti et al, 2020) and high metabolites noted NSD in perinatal calf mortality in one study (Szenci et al, 2018). High energy and protein density in the diet noted increased birth weight (Micke et al, 2020; Gao et al, 2012), increased perinatal calf mortality (Benjaminsson, 2007; Streit & Ernst, 1992) and decreased perinatal calf mortality in one study (Logan et al, 1991). Low CP (Carstens et al, 1987) and low fat (Lammoglia et al, 1999) noted increased perinatal calf mortality noted increased hypothermia. **Micronutrient effect on perinatal calf mortality?** Mineral imbalance causes increased perinatal mortality (Ejalbert et al; Micheloud et al, Murray et al). Organic TM's (Formigonia et al, 2011) and vitamin E (Pontes et al, 2015) decrease perinatal calf mortality. Oral micronutrients had no effect on perinatal calf mortality (Mee et al, 1995). **Calcium and perinatal calf mortality?** Low calcium resulted in increased dystocia and increased perinatal calf mortality (Bahrami-Yekdangi et al, 2022) while have NSD in two studies (Wilhelm et al, 2021; Szenci et al, 2018). Low DCAD diet increased perinatal calf mortality in one study (Melendez et al, 2021). **Mini conclusions on perinatal calf mortality**: 1.) "over-condition of heifers increases risks, 2.) feeding practices that lead to fetal oversize, bradytocia (slow delivery), dystocia, micronutrient imbalance or hypothermia increase the risk of perinatal calf mortality." Effect of body condition score or condition score change on neonatal calf Ig/health? Low body condition score resulted in increased calf Ig (Immler et al, 2022); loss in body condition score had no change on calf Ig or calf health (Wonfor & Rose, 2020); optimum body condition score at dry off increased calf health (Kara, 2020). **Effect of energy concentration in feed for cow effect on calf immunity?** Low energy decreased calf immunity in two studies (Osorio et al, 2013; Gao et al, 2012) and high NEFA increased calf Ig (Immler et al, 2022). Energy DMI had NSD in calf Ig (Nowak et al, 2019) and nutrient restriction decreased calf Ig absorption (Burton et al, 1984). Higher UDP or CP had NSD in calf Ig in three studies (Bland et al, 2007; Santos et al, 2001; Hook et al, 1989) while one showed increased dietary CP in cow diet decreased calf Ig (Van Hese et al, 2021) and two showed increases in calf Ig (Toghyani et al, 2015; Wang et al, 2021). Very few studies show effects of neonatal calf health in relation to cow feed energy/protein, but one showing calves born from dam's fed grass silage alone vs. grass silage + concentrate noted increased diarrhea (Dunn et al, 2017) and another study showed low energy and protein resulted in increased incidence of weak calf syndrome (Nakao et al, 2000). **Effect of fat in maternal diet on neonatal calf immunity?** Hi fat cow diets resulted in improved calf antioxidant status (Liermann et al, 2021), improved calf Ig and ADG (Jolazadeh et al, 2019), and increased calf Ig absorption (Carcia et al, 2014).

Hi NEFA or oxidative stress index status in the dam resulted in increased incidence of compromised calf immunity and decreased birth weight (Ling et al, 2018). Se supplementation in the dam's diet increased calf immunity in 3 studies, increasing Ig absorption and Ig status (Hall et al, 2014), increased calf antioxidant/Ig/health status (Roshanzamir et al, 2020), and increased calf antioxidant status (Jaaf et al, 2020), while having NSD in one study (Mohrekesh et al, 2019) and decreasing calf Ig in one study (Leyan et al, 2004). Beta carotene fed orally to dam decreasd calf IgG absorption in one study (Aragona et al, 2021). A & E administered parental noted NSD in calf Ig or white blood cell concentration. One study showed antioxidant micronutrient supplementation noted increased calf Ig (Alhussien et al, 2021). **Effect of micronutrients in dam diets on neonatal calf health?** Mineral imbalance noted increased micronutrient disorders and decreased calf immunity/health (Enjalbert et al, 2006). Organic Se increased calf antioxidant status/Ig/health (Roshanzamier et al, 2020) and high Iodine in the cow diet had NSD in calf health (Conneely et al, 2014). **Calcium status effect on neonatal calf immunity?** Low DCAD had NSD on calf Ig absorption (Zimpel et al, 2021; Callazo et al, 2017) while one study showed decreased calf Ig absorption (Rajaeerad et al, 2020). Anionic diet had NSD in calf IgG absorption or calf Ig in one study (Morrill et al, 2010) while noting decreased in calf Ig in another (Quigley and Drewry, 1998). **Effect of calcium status of the dam on neonatal calf health?** Low calcium noted increased diarrhea (Hunter, 2015), increased BRD (Wilhelm et al, 2017). Low DCAD noted an increase in diarrhea (Rajaeerad et al, 2020) and NSD in calf health or ADG in two studies (Zimpel et al, 2021 and Collazo et al, 2017). **Mini conclusions between dam diet and effect on calf immunity and health**: 1.) supplementing energy, fat and micronutrients increase calf Ig and health, 2.) conflicting results on effects of protein and calcium on calf Ig and health, 3.) inadequate evidence on effects of body condition score on calf Ig and health. **Overall conclusions**: COLOSTRUM Ig: "colostrum Ig can be increased by supplementing micronutrients, reduced by supplementary energy; effects of body condition score and protein are conflicting; limited evidence for fat and calcium." COLOSTRUM YIELD: "associated with supplementary energy; conflicting evidence for body condition score, limited evidence for fat, protein, micronutrients and calcium." PERINATAL CALF MORTALITY: "can be reduced by optimum body condition score, and adequate dietary energy, protein, fat, micronutrients and calcium." **Overall conclusions:** CALF Ig: "associated with supplemental energy, fat and micronutrients; effects of protein and calcium are conflicting and evidence of effects of body condition score is limited." CALF HEALTH: "associated with supplementary energy, protein and micronutrients; effects of calcium are conflicting and evidence of effects of body condition score is limited." **IMPLICATIONS**: "target optimum dry cow body condition score and body condition score change (scale-dependent) to limit impacts on colostrogenesis, perinatal calf mortality and neonatal calf health. Apply the 'Goldilocks principle' to dietary energy, protein, and fat content to optimize impacts on colostrogenesis, perinatal calf mortality and neonatal calf health. Consider organic micronutrients and selenium supplementation to improve colostrum quality and neonatal calf health." Provide adequate protein 2 – 3 weeks pre-calving (200 – 300 g of soy). Mange colostrum properly. J.F. Mee. John.mee@teagasc.ie. Moorepark Research Centre, Ireland. 1341.

Fats and oils nutrition (2 abstracts):

1. *Supplementing palmitic, stearic, or oleic fatty acids?* Just 6 calves per treatment group. Holstein and Belgian Blue cross bull calves were provided either a.) skim-milk based CMR containing 24% CP and 16% fat or the same CMR supplemented with either b.) 5% of DMI as BoviLM fatty acid supplement (40-55% palmitic acid, and 40-55% stearic acid; primarily "saturated" fatty acid supplement), or c.) 5% of DMI as Bovi85 supplement (45% palmitic acid and 40% oleic acid; primarily "unsaturated" fatty acid supplement). The two fat products were reported to increase the fat content from 16% to 21% fat in the finished formula. Also, the two fat products look like protein encapsulated fat powders in the image of the presentation, but neither the presentation nor the abstract shared adequate details to explain details of the powders. The calves were pail-fed 6 L/d of milk replacer and offered free choice starter feed and haylage. Calves were 34 ±8d age and weighed app. 154 lbs. at study onset. Body dimensions, rectal temps, rectal temps, fecal score, body condition score, DMI and body weight measures taken d 0, 7, 14, and 21. Bovi85 tended (P=0.096) to reduce hip height. Withers height (P=0.008) and body length (P=0.048) were reduced in calves supplemented either added fat. Heart girth, body condition score, fecal supplementation, body temperature, ADG, DMI, reported NSD between the three groups. ADG was 1.67, 1.20, and 1.48 lbs./d for control, +Bovi85 saturated fatty acid and +BoviLM unsaturated fatty acid supplemented calves, respectively. No effect on any blood metabolite (26 measures taken) from fatty acid supplementation. n=18. U of Copenhagen. U of Reading. U of Vet and An Sci Lahore, Pakistan. Laboratorio de Zootecnia U Estadual do Norte Flumineses Campos dos Goytacazes, Brazil. 1079.
2. *Continuation of abstract 1079: supplementing palmitic, stearic, or oleic fatty acids, is there any effect on microbiome?* Same study as 1079, instead, evaluating effect on microbiome. I will not re-describe the study parameters, instead, review prior abstract no. 1079. Days 0, 7, 14, and 21, fecal samples were taken from the rectum, DNA extracted, and PCR test and analysis conducted. Alpha-diversity metrics, Evennes and Shannon's diversity and Faith's Phylogenetic Diversity analyses were conducted. No differences found at the phylum, order, family, or genus level based on relative abundances. Alpha and Beta diversity noted changes to Archaea over the 21-d period, however, no differences noted by treatment. At the bacterial taxa level there were some differences between supplementing extra saturated or unsaturated fatty acids. Conclusions: fat supplements of differing saturation degree did not provoke significant differences in the calf's microbiome, but unsaturated fatty acids are advantageous for archaea development. n=18. U of Copenhagen. U of Reading. U of Vet and An Sci

Lahore, Pakistan. Laboratorio de Zootecnia U Estadual do Norte Flumineses Campos dos Goytacazes, Brazil. 1172.

Genetics (1 Abstracts):

1. *Feed efficiency in the prewean stage of Canadian Holstein heifers.* Calves born on the Ontario Dairy Research Centre from 2016 to 2022 were weighed at birth, 30, and 60 d (abstract reports 65 d). Five generations of pedigree information were extracted on each calf. The calves were fed 15% DM milk replacer solution and 88% DM pelleted grain. M.E. for milk replacer was 3.88 Mcal/kg and for starter was 2.51 Mcal/kg. Calves peaked at 10+ liters of milk at app. 20 d age and were fully weaned post 60 d. Starter intake was minimal until weaning process was in earnest app. d 50. Mean birth weight was 89.9 lbs. (min. 52.9 and max. 126.8 lbs.), mean 30 d weight was 145.3 lbs. (min. 92.6 and max. 196 lbs.), mean 60 d weight was 205.9 lbs. (min. 140 and max. 271.2 lbs.) with ADG d 0 – 30 mean 1.83 lbs. (min. 0.62 and max. 3.3 lbs./d) and ADG d 30 – 60 mean 2 lbs. (min. 0.66 and max. 3.0 lbs./d). Feed conversion ratios and residual feed intake will be calculated to estimate genetic parameters for both feed conversion and residual feed intake. Evidently reported in subsequent abstract. n=715 (abstract reported n=675). U of Guelph. U of Bern. 2043M.

Health, respiratory Disease (BRD), enteric disease, and immune function (8 abstracts):

1. *Survey of bacterial pathogens in calves from dairies across the USA.* November 2015 to June 2021, 3,221 fresh fecal grab samples were taken from calves on 97 farms in 18 states. Fecal samples were analyzed for presence of *C. perfringens* and *E coli* using multiplex PCR analysis and *salmonella* presence using agar plates. 69.6% of fecal samples noted detectable levels (greater than 1 CFU/gram) of *C. perfringens alpha toxin gene* and calves <1 week and 1 – 2 weeks old noted higher (P<0.01) levels compared to older calves (3 – 4 wks, 4 – 8 wks, 8 – 12 wks, or 12 – 20 wks of age) and calves 2 – 3 wks age had greater (P<0.01) levels than calves 3 – 4 wks or 12 – 20 wks age. Levels of clostridium were also higher (P<0.05) in calves 12 – 20 wks as compared to 8 – 12 wks. Highest prevalence of clostridium were in calves 1 - 2 wks (78.2% of samples). 73% of fecal samples had detectable levels of pathogenic E coli (greater than 1 CFU/g) and calves <1 wk had higher (P<0.01) levels than calves 1 – 2, 8 – 12, or 12 – 20 wks. The highest prevalence of pathogenic E coli was at 1 – 2 wks (80% of fecal samples). Salmonella was detected in 8.5% of fecal samples and the highest prevalence was detected in samples from calves <1 wk age (19% positive), while the lowest prevalence (3.4%) was in calves 3 – 4 wks age. n=3,221 fecal samples. Arm & Hammer. 2040M.
2. *What hematological variables are associated with BRD during the prewean period?* Jersey and Jersey cross heifer calves with negative BRD test and no clinical symptoms (including rectal temp below 102.5 F), and from 13 MN farms were transported to NM. Calves were transported 3 days prior to enrollment at approximately 7 d age. Blood samples were collected at 7, 17, 34, and 56 d of age. Calves were weaned at 56 d. NSD

in spring or winter transport/rearing (P=0.69), number dead/euthanized (P=0.42), average body weight at enrollment (P=0.44), or dam's gestation length (P=0.25) between calves that broke with BRD (11.1% of total) and those that did not (88.9% of total). Calves that experienced BRD noted a.) lower blood magnesium (1.9 vs. 1.94 mEq/L; P=0.04), and b.) lower creatinine (0.79 vs. 0.82 mg/dL; P=0.08). Blood parameters with a BRD*Time interaction included total protein (reduced with BRD; P=0.06), albumin (reduced; P=0.08), calcium (reduced; P=0.07), Phosphorous (reduced, P=0.03), Log BUN (increased, P=0.04), Log GLDH (increased, P=0.07), Sodium (decreased, P=0.05), Potassium (decreased; P=0.04), Chloride (increased, P<0.01), Log Zinc (reduced, P=0.02), and Log Hp (reduced; P<0.01). Oftentimes the magnitude of average change in the specific blood parameter between calves that had BRD and did not was miniscule, yet statistical difference or trend was achieved. NSD in Glucose, Log Bilirubin, Log CK, AST, Globulins, A/G, GGT, NaK, Insulin, Log Insulin:Glucose, Log SAA, white blood cells, Log Neutrophils, Monocytes, lymphocytes, or log neutrophils in calves that had BRD and those that did not. Haptaglobin was higher in BRD calves at d 7 but lower in BRD calves on d 34 (BRD*time P<0.01); NSD d 17 and 56. Potassium was higher in non-BRD calves on d 17, otherwise NSD at any other measure. P was higher in BRD calves d 7, but NSD yet always numerically lesser d 17, 34, and 56 (BRD*time P=0.03). Chloride was higher in BRD calves d 17 but NSD d 7, 34, or 45 (BRD*time P<0.01). Zinc was higher in non-BRD calves d 17, but NSD d 7, 34, or 56 (BRD*time, P=0.02). The author reports other data shows change in mineral metabolism with stress and disease. LogBUN was higher in BRD calves d 17, but NSD d 7, 34, or 56 (BRD*time P=0.04). The author points out that other research has shown BUN higher in heat stressed animals, so perhaps stress of transport creates this too (increased protein degradation and protein metabolism). n=305. TX Tech. Purdue. 2035M.

3. *Health Management of calves – from intrauterine life to successful weaning*. Summary of 41st Discover Conference on Health Management of calves (Oct. 2021). Dave Renaud DVM, U of Guelph. Calf health. Innate immunity (physical barriers, innate immune cells) in the respiratory tract – main barriers are in the upper respiratory tract such as the nasal cavity, trachea, and bronchials that all help to eliminate some pathogens by impacting air flow and providing mucus for protection and cilia that rid the system of particles, and in aggregate these physical barriers can prevent up to 90% of the infections of the upper respiratory tract. Innate immune cells play a bigger role in the lower parts of the respiratory tract. Mucus, antimicrobial peptides, and microbiota are a good first barrier. Neutrophils can destroy bacteria but also cause inflammation and tissue damage. Alveolar macrophage can come in and kill bacterial cells. All of these work prior to the adaptive system making a more targeted response (Zeineldin et al, 2019; Lambert & Culley, 2017). Netea et al. 2016 showed that the innate immune system can have some memory response, but not as responsive as the adaptive immune system. These researchers reported it can be modulated through 2nd and 3rd exposures thru epigenetic programming that prime the innate system. Infection and vaccination

can enhance innate immune function over time. Internasal or injectable vaccines, or via yeast or yeast cell wall, or via mycobacterium cell wall all show ability to modulate immune function. Next presentation was "is your calf program working?" by Terri Olivett DVM. Cow-calf separation is the first stress, and little is understood of that impact, and of course colostrum management is paramount. Twice daily feeding is not in nature and is a stressor compared to 10 – 12 feedings daily which is biologically normal. Housing indoors or with no social interactions are also stressors. Treatment records should monitor stress and its impact. However, most on-farm records are difficult to manage and inaccurate, particularly if using paper records. WeanClean approach, scanning lungs at 4 strategic points, can effectively monitor whether the farm's calf program is working. The goal is <15% of the calves in each of the 4 strategic measure points to have some level of lung consolidations detected. If you have excellent respiratory health, you are likely managing colostrum well, have good housing and a good feeding regiment. Suggestions are to scan with a lung ultrasound at 1.) the start of weaning, 2.) at the start of treatment (if treating a calf, what % score >3 or <2 at 1st treatment?), 3.) at 7 – 10 days post treatment to measure efficacy of our BRD therapies (% lesions after 1st treatment), and, finally, 4.) scan 12 calves at 7 d intervals commencing d 7 of age to see when BRD is developing, the goal being that if you know when BRD is starting, hopefully you can implement strategies to reduce incidence. Renaud DVM. 1218.

4. *Is serum lactulose to mannitol ratio a better indicator of intestinal permeability than chromium-EDTA and haptoglobin?* Prior studies have shown that the ratio of serum lactulose to mannitol increases in diarrheic calves compared to healthy ones (Araujo et al, 2015), in calves during the weaning process as compared to pre-wean (Wickramasinghe et al, 2022), and in heat stressed calves compared to those reared in a thermoneutral environment (Rius et al, 2022). Holstein heifer calves 5 months of age (445.3 lbs. BW) were exposed to diurnal heat stress of 91.4 F and THI of 85 from 9 am to 9 pm and 78.8 F and THI of 79 from 9 pm to 9 am over 3 consecutive days. Pre- and post-heat stress challenge calves were dosed with Cr-EDTA (0.15 g/kg of BW), lactulose (0.24 g/kg of BW) and mannitol (0.06 g/kg of BW) and blood was drawn 2 hours later. Rectal temps (103.1 to 105.3 F) and respiration rates (77 to 127 breaths per minute) increased during the heat stress period (P<0.01). DMI reduced from 8.69 to 6.9 lbs./d (P=0.02) and ADG reductions due to heat stress followed (2.67 reduced to 0.55 lbs./d). The calves experienced severe hypothermia during heat stress. Serum lactulose increased from 0.11 to 0.37 micrograms/mL (P<0.01). Serum mannitol was unchanged (0.84 micrograms/mL; P=0.81). The serum lactulose to mannitol ratio increased from 0.14 to 0.47 (P=0.02) during the heat stress period. "Plasma chromium increased numerically (186.2 vs. 156.1 microgram/L, P=0.14) and had a weak correlation with serum lactulose to mannitol ratio (r=0.29, P=0.25)." Serum haptoglobin tended to increase during heat stress (455.3 increased to 3030.7 ng/mL; P=0.06) and was not correlated with serum lactulose to mannitol ratio (r=0.01; P=0.25) or Cr-EDTA (r=0.03,

P=0.92). “Serum lactulose to mannitol ratio could be a better marker to assess the intestinal paracellular permeability of heifers compared to chromium-EDTA and haptoglobin.” The authors cautioned that the lactulose concentrations and the lactulose to mannitol ratio were lower in this study compared to those of pre-weaned calves in the literature and experiments should be conducted that include more oral doses of lactulose and mannitol and more blood sampling times to optimize the procedure. n=9. Iowa State University. 2353W.

5. *Survey of clostridia in the USA dairy herd and feeds.* Samples were collected from Dec 2015 to Feb 2022 from 882 dairy farms located in 33 states. Fecal samples (n=33,992), TMR’s (n=4,765) and fermented feeds (n=2,644) were sent on ice overnight for clostridia enumeration and characterization. Fecal samples were taken from cows in all phases of production and dry periods. *No fecal samples were reported from dairy calves or developing heifers.* Total clostridia levels were determined, and DNA isolated using Promega Maxwell High Throughput (HT) Viral Total Nucleic acid (TNA) protocol, and then a subset from fecal (8,992) and feed (1,937) were identified via multiplex PCR analysis in order to identify C. perfringens, C. beierinckii, and P. bifermentans. Detectable clostridia were found in 98.6% of fecal samples and 84.7% of feed samples. C. perfringens was detected in 78.5% of fecal and 33.6% of feed samples. Most frequent sp isolated from feces was C. perfringens (51.2%) and from feed was P. bifermentans (37.5%). Other frequently detected clostridia species detected in feces were P bifermentans (28.0%), and C. beijerinckii (12.4%). Other frequently detected clostridia species detected in feed were C. perfringens (25.8%) and C. beijerinckii (16.5%). Clostridia levels were highest in the fresh group (P<0.0004) compared to all other production groups. C. perfringens counts were also highest in the fresh group (P<0.0004). C. perfringens levels in fecal samples were lowest in the far-off dry group (P<0.0002) compared to all other production groups. N=33,992 fecal samples. Church & Dwight. 2283W.
6. *Survey of salmonella in the USA dairy herd.* Samples were collected from Dec 2015 to Dec 2021 from 217 dairy farms located in 21 states. TX, CA, and WI were the top three states for numbers of fecal samples (500+ in each). Individual cow and **calf** fecal samples (n=5,304) were held on ice before enriched 1:10 in detrathionate broth with 2% iodine and 1% brilliant green additives. Samples were enriched, isolated, and harvested. DNA extractions were performed, and salmonella confirmed via PCR analysis. “Of the 2611 cow samples, 843 were Salmonella positive (32.3%). Of the 3,170 calf samples, 251 were Salmonella positive (7.9%). A total of 3,044 Salmonella isolates were collected and identified. The same dominant serovars were found in both cow (n=2,356) and calf (n=688) fecal samples were identified as S. Cerro (33.4% and 11.2% prevalence in cows and calves, respectively), S. Montevideo (26.1% and 25.9%) and S. Meleagridis (25.5% and 13.1%). Serovars S. Kentucky (0.9% in calf) and S. Newport were more abundant in cow fecal samples compared with calves, while S. Dublin (5.2% in calf), S. Muenster (8.0%), and S. Anatum (10.3%) were more abundant in calf fecal samples.” Calves had

more diversity of salmonella than cows (Shannon-Weiner Index of Diversity Index Value 1.59 and 2.25 for cow and calf, respectively; number of serovars 15 and 20 for cow and calf, respectively). Fecal samples taken from calves <1 week of age had greater (P<0.0001) prevalence of salmonella than any other calf age. Attempting to ascertain prevalence from the bar chart provided it looks like 20%, 12%, 8%, 3%, 4%, 8%, and 10%, were salmonella positive for <1 week, 1 – 2 weeks, 2 – 3 weeks, 3 – 4 weeks, 4 – 8 weeks, 8 – 12 weeks, and 12 – 20 weeks age, respectively. Salmonella serovars were more diverse in younger calves vs. older calves. In general, calves less than 2 weeks of age noted higher prevalence of S. Newport, S. Reading, S. Heidelberg, S. Minnesota, S. Montevideo, S. Anatum, S Newport/Muenchen, S. Derby, and S. Bredeny, not necessarily in any order of prevalence, while calves older than 2 weeks noted more prevalence of S. Cerro, Sa. Meleagridis, S. Uganda, S. Senftenberg, S. Kentucky, S. Agona, S. Muenster, S. Dublin, and S. Uganda, again, not necessarily in any order of prevalence. n=5,304 fecal samples. Church & Dwight. 2292W.

7. *Paromomycin effective against crypto?* A randomized double-blind study compared calves fed whole milk either with paromomycin sulphate (50 mg/kg) or with the farm's present medical intervention strategy of sulfa trimethoprim. Either drug was added to whole milk for 7 consecutive days commencing day 7 of age. Each treatment group contained 20 Holstein heifer calves housed in confined elevated crates and 5 Holstein bull calves housed in wood hutches on sand. According to the National Library of Medicine (NIH) website, paromomycin sulfate is a structural "derivative of neomycin, an aminoglycoside antibiotic with amoebicidal and bactericidal effects against predominantly aerobic gram-negative bacteria." Heifer calves were fed 4 L maternal colostrum and bulls were fed 2 L of colostrum replacer day one of life. All calves were fed pasteurized whole milk, heifers at 14% of BW (dispersed over 4 meals/d) and inclusive of a yeast fermentation product additive, while males were fed 10% of BW (dispersed over 2 meals/d) and no yeast product. Calves were evaluated daily for fecal consistency (score 0 to 4) and attitude score to d 35. Weight and height were measured d 0 and 90. *In situ* lab diagnosis for E coli k99, E coli K88, Coronavirus, Rotavirus, and *cryptosporidium spp* were conducted on d 7 (just prior respective drug was administered) and d 14 (at end of metaphylactic treatment) on all calves. No E coli K99 was detected at any measure. E coli K88 was detected in both groups d 7 but none detected d 14 in either group. Rotavirus was detected in both groups d 7 but only in the control d 14. No coronavirus was detected in either group at any measure. *Cryptosporidium* immunodiagnostics detected presence at 7 d in both groups but only in the control group d 14. At the d 7 analysis prevalence of crypto was 30% in females and 80% in males. From d 12 onward the paromomycin-treated group noted significantly less (P≤0.05) crypto noting no scours, oocyst shedding or refused milk. *Cryptosporidium* morphological was detected in both groups d 7 and a lesser concentration (P=0.0411) in the paromomycin-treated group d 14 (0.5 ±0.5 vs. 0.3 ±0.5 HSU MCB). Agreement in results between the two crypto tests was 85 – 90% in the control group at 7 d, 77.5 –

100% for treatment group at 7 d, 35 – 40% for control at 14 d, and 57.5 – 62.5% for treatment group at 14 d. On d 7 rotavirus was detected in 52% of the female (n=21) and 30% of the male calves (n=3); by 14 d rotavirus was detected in 10% of the female control (n=2) and 5% of the male control calves with no cases in the paromomycin treated calves. Starting at 12 days of age (except d 16) heifer calves treated with paromomycin noted significantly less scours while males noted no differences. Clinical manifestations were less in paromomycin-treated females week 1 (P=0.0336) and week 2 (P=0.0178). No differences in clinical manifestations in male calves. NSD d 0 in female calf body weight (91 ±8.2 vs. 90.4 ±10.4 lbs. for control vs. paromomycin-treated group, respectively), however, d 90 weights were +29.1 lbs. heavier (P≤0.05) for heifer calves treated with paromomycin compared to sulfa trimethoprim (175.5 ±45.4 vs. 204.6 ±40 lbs.). Male calves treated with paromomycin were +33 lbs. vs. control (sulfa trimethoprim) but NSD. At 90 d females treated with paromomycin were +1.4 inches in height gain vs. control (P=0.4). n=50. Tecnologico de Monterrey, Mexico. 2493V.

8. *Survey of risk factors associated with diarrhea in calves on a Chinese dairy.* Heifer calves born on a commercial dairy (9,905 lactating cows; farm location Meixian, Shaanxi) from April to July 2021 were monitored until 30 d of age. The twin rate was 2.3% of births (n=22) and average parity of dam was 2.03 (1 to 9, SD = 2.03±0.045). Fecal scores were taken daily, and blood samples taken at 24 h and 48 h to determine STP using a refractometer. BW measures were taken at birth and d 30. 32.1% of the calves had diarrhea and mean STP was 7.04 ±0.76 g/dl. 19 of 953 (2.03%) had FPT (STP <5.5 g/dl). The average quality of colostrum was 23.86 BRIX%. Multivariable logistic regression model found for every 1 g/dL increase in STP the odds of diarrhea decreased (odds ratio 0.78; 95% CI: 0.65 to 0.95). Calves born in May or June had lower odds (odds ratio 0.47 and 0.32, respectively) of diarrhea vs. those born in April. The distribution of fecal score was 83.5%, 9.6%, 5.1%, and 1.8% for fecal score 0, 1, 2, and 3, respectively (0 = normal, 1=semi-solid, pasty, 2= loose, but still attached to the surface, and 3=watery samples, seepage into the surface). ADG d 1 – 30 was 1.72 lbs./d and calves w/diarrhea noted reduced (-0.24 lbs./d) ADG vs those w/o diarrhea. Using a Cox proportional hazard model death was associated with STP (P=0.0036), and odds of death decreased by 60% for each 1 g/dL increase in STP (odd ratio 0.39; 95% confidence interval 0.21 to 0.74; P=0.004). Risk of death was also associated with birth month, with calves born in either May (odds ratio 0.47) or June (odds ratio 0.32) reporting reduced odds of mortality vs. those born in April. n=972. NW A & F University Yangling, Shaanxi, China. U of Guelph. 1539V.
9. *A survey of clostridium across the USA dairy herd.* Clostridium are spore forming bacteria that prior research has shown that 98.6% of cow fecal samples and 84.7% of TMR and fermented feed samples have detectable levels of clostridia. Concentrations of clostridia, however, are shown to be highly variable. Prior survey work has shown *C. perfringens* (toxin and enzyme producing associated with disease that break down gut barrier function creating leaky gut syndrome)*, C beijerinckii,* and *paraclostridium*

bifermentans (commonly detected in feed samples produce solvents that can negatively affect rumen processes but are largely unknown in full impact) to be the three most dominant clostridia populations cultured in dairy samples. Fresh fecal grab samples were drawn from 2,276 cows and 124 calves on 58 different farms dispersed throughout 19 states in 8 dairy producing regions of the USA. Samples were drawn from August 2019 to November 2021. The combined farm size of these 58 herds was 122,875. On each farm samples were drawn from each production sector of the dairy and if calves were reared on the farm, samples were drawn from that production sector too. TMR and fermented feed samples were also collected. The calf samples came from the south-central region (40), the mid-Atlantic region (62), and the Northeast (22). Samples were put on ice and examined within 24 hours, upon arrival at the lab each sample was enumerated to determine the level of clostridia in each sample and from the enumerations clostridia were isolated and extracted to determine clostridia species by sequencing the 16S rDNA gene. Totals were *C. perfringens* 52%, *C. beijerinckii* 21%, *C. bifermentans* 16%, *C. tertium* 4%, *C. butyricum* 2%, *C. sordellii* 1% and all other clostridia 4%. The diversity of the *C. perfringens* isolates was then charted using RAPD PCR genotyping to show the fingerprints, similarities, and diversity of these isolates. Concentration (log10 CFU/g) of total fecal clostridia in cow feces was highly variable from less than 1 B CFU/g to over 6 B CFU/g. The mean varied by region from approximately 2 to 3 B CFU/g in fecal clostridia concentration across the 8 regions of the USA. Concentrations were somewhat higher in the S. Central and I-29 corridor and somewhat lower in CA and the E. Great Lakes region. Regarding C. perfringens specifically, the same variability was experienced as in total clostridia measures with slightly lower prevalence. A CANOCO software program was used to analyze redundancy. This tool measured similarity between regions for clostridia diversity. The Northeast, Mid-Atlantic and CA were statistically different to the S. Central, E. Great Lakes, and I-29 corridor and both of these were different compared to the Northwest and Mid-Atlantic regions in cow fecal clostridia communities as measured by pooling farm data within each region. Church & Dwight. 1415

Management and housing (24 abstracts) (key topics: housing, heat stress, behavior, transport, surveys of calf raisers, genetics, disbudding and pain management):

1. *Does offering a sham nipple reduce pain behaviors after caustic paste disbudding?* Holstein heifer calves disbudded at 1 – 3 d of age were monitored via camera 24 h/d for one week. Calves were grouped as either disbudded with caustic paste (Dr. Naylor's caustic paste) or petroleum jelly applied to hornbud and either provided a sham nipple or not in a 2 x 2 factorial. Disbudded calves were provided Lidocaine block injected in to each hornbud 10 m prior caustic paste application and Meloxicam once given orally after disbudding. Calves were offered CMR in 3 L nipple bottles 2x/d to d 4 and then 3x/d onward. NSD in number of sucks on the sham nipple per day (16.3 vs. 10.8) or number of sucks per calf during the 7-day period (35.7 vs. 26.3), also, NSD in total days

of suck (2.3 vs. 2.4) or first day of suck (4 vs. 2.9) (caustic paste with nipple and petroleum jelly sham with nipple, respectively). Authors hypothesize that NSD was noted due to calves being too young, being fed large quantities of milk via nipple bottle or lack of familiarity with sham nipple. n=54. UW River Falls. 2017M.

2. *What is the best placement for a lidocaine injection to minimize pain from disbudding?* Cornual nerve in six dead Holstein calves (age 1 – 2 weeks) were identified and a system set up to track the dispersion of lidocaine injection. Two sites, one on each side of each individual dead calf, were compared. Lidocaine was infused with a dye to track its movement. The first site was advocated by UW Madison inserting an 18-gauge, 35 mm needle caudal to the eye and ventral to the temporal ridge. 5 cc was injected at a 90-degree angle. The second injection site was chosen based on farm employee experiences an identical needle was inserted proximal to the corner of the eye where there is a depression then pointed up toward the horn bud. 5 cc was injected at a 45-degree angle. Both injected sites resulted in wasted lidocaine going into the nasal cavities, however, both also resulted in covering the cornual nerve successfully. Live calf research needs to be conducted as a follow-up comparison. They found the injection process more difficult in calves nearer 2 weeks old than less than 1 week old, as skin was thicker, skull more formed. The cornual nerve moves more to the left as the calf ages. n=6. UW River Falls. 2018M.
3. *Pain management for disbudding: a review.* There is "little understanding of the central nervous system's ability to process and perceive pain signals, especially in livestock species." Being able to connect pain feelings with specific behaviors may enhance calf management. Caustic paste or hot iron destroys the corium tissue present on the horn buds preventing future horn growth and making worker and future cow safety much better, but either procedure results in pain expressed by the calf in behavior patterns during and post the process. Nonsteroidal anti-inflammatory drugs, lidocaine blocks, topical anesthetics, and transdermal pain relief are all options for consideration. UW-River Falls. 1014.
4. *Health Management of calves – from intrauterine life to successful weaning*. Summary of 41st Discover Conference on Health Management of calves (Oct. 2021). Dave Renaud DVM, U of Guelph. Calf health – disbudding and pain control; surplus calves. Saraceni et al, 2021. Survey of 217 WI dairy producers showed 61% use paste, 6% surgical, and 32% cautery for dehorning. Anesthetic was used in 20 – 30% of farms depending on use of cautery, surgical or paste (17%). About 30% used a long-acting analgesic if using cautery to dehorn. Room for improvement. Winder et al, 2018, metanalysis looked at a local anesthetic and local analgesic and determined that lower levels of plasma cortisol occurred if the calf was given a local anesthetic when dehorning, and using pressure sensitivity testing, determined that pressure sensitivity was lessened if the calf was given a local long-acting analgesic (such as Meloxicam). Reedman et al, 2020, determined that calves that were administered paste w/o pain mitigation had the highest cortisol levels. Use of Meloxicam, Lidocaine (local anesthetic), or a combination

of both, significantly reduced cortisol concentrations. Lidocaine or the combination outperformed Meloxicam alone at the 13, 30, 45, and 60 m marks (post paste administration), but not at the 90 m mark and onward, when use of Meloxicam was best (120- and 180-minute marks). Saraceni et al, 2020, interview of 29 Ontario dairy producers found that calf comfort and post-operative recovery, and public perception, were the two main motivations for implementing pain control. Cost and training were two major reasons to not use pain control, but also concern with the technique being so close to the eye and risks associated with application. Dr. Renaud spoke on surplus dairy calves, i.e., defined as calves not used to produce milk. 5.2 million male calves produced in USA and Canadian dairy industry in 2020. In the EU and the UK, about 11 million male dairy calves produced in 2020. Challenges these calves face: mortality and morbidity, commonly 45% treated for scours, and in some studies 30 – 50% treated for respiratory disease. Treatment incidence in the Netherlands on UDD (user defined daily doses) reported on an animals/1000 daily treated basis, noted the highest incidence with veal (approximately 300), whereas dairy, beef, goat, and sheep were nearly zero. Housing (isolation) and nutrition (minimal) are also concerns. Bolton and von Keyserlingk; Creutzinger et al., 2021; Canadian Dairy Information Center, 2020. USDA, 2020; ADHB, 2020. Renaud DVM. 2018.

5. *What are the conditions of surplus dairy calves at livestock dealers in Ohio?* Incidence of FPT, signs of naval infection, dehydration, depression, arthritis, enteric and respiratory disease were evaluated on calves at two livestock dealers visited 2 – 3x per wk between May and September 2021. 78% were male, 22% female. Calves were from 180 sources. 65% were from dairy farms, 35% from auctions or other dealers indicating they were sold multiple times. 21.4% had FPT (<5.2 g/dL STP), 40.2% had fair to poor (<5.8 g/dL). Calves with optimal colostrum status (≥6.2 g/dL STP) were 38% and 53% of calves sourced from dairy farms and from auctions, respectively. Calves had lower odds of FPT if BW greater than 90 lbs. Author reported approximately 25% of calves had naval infections and although a majority were dehydrated as measured by skin tenting few were moderately or severely dehydrated. The author also reported 7% were depressed and showed signs of eye discharge, very few showed signs of arthritis, naval discharge, or ear droop, 13% were experiencing diarrhea and 21% had fever. Males had greater odds of naval inflammation (P=0.003), eye discharge (P=0.06), and depression (P=0.07). n=1,119. The OH State U. U of Guelph. U of PEI. 2023M.
6. *Does dexamethasone (dex) inhibit heat-stress associated inflammation?* 41 d old, 151 lbs. male Holstein calves were acclimatized for 4 d housed in thermoneutral (68 F, 24 h) environmentally controlled room and then for subsequent 5 d either maintained at 68F (24 h) or subjected to 104F for 11 h per d (8 am to 7 pm) with evening cool down. Each group was injected with either 0.5 mg/kg of dexamethasone or equivalent saline solution on days 1 & 3 in a 2 x 2 factorial design. Dexamethasone prevented ADG depression associated with heat stress, noting 1.65 vs. 1.0 lbs./d ADG for heat stressed calves given dexamethasone vs. saline, respectively (P=0.048) with calves reared in

thermoneutral environment noting no difference in ADG from administration of dexamethasone (1.52 vs. 1.43 lbs. ADG, NSD). Feed efficiency followed the same trend with 23.6% and 40.5% FE for saline and dexamethasone, respectively, in heat stressed calves, P=0.096, with both groups reared in thermoneutral environ converting similarly (NSD) to dex treated heat stressed calves. DMI did not differ between groups. Lactulose: Mannitol ratio, used to measure gut permeability, was determined on d 1 and 5 of the treatment period. Calves given dex during heat stress noted reduced (P=0.025) gut permeability compared to heat stressed calves administered saline solution. NSD was noted between either dex or saline group reared in thermoneutral housing on d 1 of the test period. There was NSD in gut permeability between any group d 5. n=32. U of TN. 2031M.

7. *Would a beneficial biofilm solution applied after cleaning and disinfection reduce pathogen concentration on calf hutches?* 30 plastic hutches were cleaned, sanitized, and bedded with fresh sawdust. After 24 hours of drying time hutches were either a.) provided no application, b.) distilled water applied uniformly to the hutch interior, or c.) a Lallemand biofilm solution applied uniformly at a calculated rate of 0.04 g/m^2. Distilled water and Lallemand biofilm solution was also applied to 15 x 15 cm hutch pieces (6/treatment) and incubated at 82°F to observe biofilm development over a 24 – 72 h period. Calves (17 ±2 d) were placed in the hutches after the 24 h drying period. Sampling was performed on 15 x 15 cm squares using 3M Sponge-Stick in 5 unique locations in each hutch at 24 h post cleaning, 24 h post treatment application, and at 7, 14, and 21 d post-treatment application. Total plate count on each sample site and hutch piece was conducted and DNA from hutch sponge samples extracted. qPCR analysis for *E coli*, *salmonella,* and *cryptosporidium parvum* was conducted. Biofilm was detected on hutch pieces treated with Lallemand solution at 24, 48, and 72 h with 24 and 48 h concentrations greater (P<0.001) than at 72 h. Negative control (distilled water) treated pieces noted no biofilm formation. Total LOG CFU/cm^2 increased over time (P<0.001) in all groups from 24 h, 7d, 14d, and 21d, indicative of increased competition from environmental microbial presence. Colonies of bacteria from biofilm-treated hutches noted visually less diversity when plated as compared to the bacteria plated and grown from the hutch treated with distilled water. E coli and crypto, but not salmonella, pathogen concentration was reduced (P=0.05) in samples taken from the Lallemand biofilm treated hutches as compared to the non-treated hutches. Treating hutch material with distilled water noted intermediary results (NSD). (n=18 hutch pieces and 30 hutches). Miner Institute. U of VT. Lallemand. 2023M.
8. *How does transport duration, age, sex, breed, and colostrum status effect growth post arrival in a commercial veal facility?* Calves were enrolled at birth on 5 dairy farms visited daily by a technician over a 14-d period. Calves were transported for either 6, 12, or 16 h continuous road transportation. Calves were weighed at birth, prior loading, and 24, 48, and 72 h, and at 14 and 50 d post-transport. In 7 transportation cohorts between Oct 2020 and June 2021 in a total of 175 male and female Holstein and crossbred dairy

calves (age 2 – 19 d) increasing transport duration noted increased % weight loss. Calves transported 16 h noted a median of 7.45% BW loss (-3.5 lbs. compared to 6 h, P=0.04; NSD between other durations), followed by 12 h (6.67% loss) and 6 h (4.6% loss). Female (-2.7 lbs., P=0.04) vs. male, and Holstein (-3.4 lbs., P=0.02) vs. dairy-beef cross noted greater BW losses during transport. No effect of transport time on subsequent growth. However, transporting calves at older ages resulted in increased ADG. Calves transported at 7 – 11 days noted +5.6 lbs. (P<0.01), at 12 – 14 d noted +11.6 lbs. (P<0.01), and at 15 – 19 d age noted +13.44 lbs. (P<0.01) BW gain over 50 days post transport compared to calves transported at 2 – 6 d age. Calves with excellent colostrum status (IgG ≥25.0 g/L) improved 50 d growth +5.2 lbs. (P=0.02) compared to calves of poor colostrum status. n=175. U of Guelph. U of KY, Lexington. UW-RF. 2034M.

9. *An assessment of antimicrobial use in pre-weaned dairy calves in Canada.* Calf management practices and medical treatment records were monitored by technicians on calves d 0 – 60 on 147 farms across 5 provinces. Complete records were obtained on 74 farms with 7,817 newborn calves including 2,310 calves treated with 7,307 antimicrobial treatments. "Defined daily doses (DDD/calf-year) was calculated for each antimicrobial class." Primary reasons cited for antimicrobial intervention were respiratory (54%), diarrhea (20%), with N/A being next in proportion (pie chart proportion looks similar to diarrhea) and fever, naval treatments and "others" having small slivers of the pie-graph. Florfenicol (Nuflor; category 3) was the leading drug used on 33% of calf treatments. Penicillin, Trimethoprim-sulfamethoxazole, and Macrolide (Draxxin) were next at 23%, 18%, and 10%, respectively (all three categorized as category 2 by Canadian officials). Fluoroquinolone (4%, Baytril, category 1), Aminoglycoside (3%, Spectinomycin, category 2), sulfonamide (2%, category 2), neomycin-sulfonamide (category 2), tetracycline (category 3) and ceftiofur (Excenel, category 1) were each less than 5% of the proportion of all antimicrobial treatments. Category 1 are of very high importance for human health, categories 2 and 3 are of high to medium importance. Bull calf sale age had significant association with antimicrobial use (1 – 7d > 8 – 14d). "Farms that fed transition milk had less than half the number (3.9 vs. 9.3 treatments/calf-year) of antimicrobial treatments than those that did not feed transition milk to calves." n=74 farms with complete surveys. U of Guelph. U of Calgary. U of Montreal. U of PEI. 2037M.
10. *Navel healing across the 1st 14 days of life.* Holstein calves were monitored from birth to 14 d, measuring time for navel to heal and various caliper measures (distal, proximal, cord remnant, and cord length) taken every 24 h. Of calves in the study, 30% required calving assistance, mean birthweight was 91.5 lbs., 37% were males, 15% had poor vitality scores, 4.4% experienced FPT, and morbidity rates in the first 14d of life were 53%. The mean time to navel cord drying was 2.4 d (±0.1 d) and all were dry by 5 d. 56% retained dry naval remnant beyond 14 d and shedding of remnant began on d 2 of life. No association was found on navel healing and dam parity, calving or calf factors. Proximal navel stump diameter decreased from d 5 – 14 (P<0.01), was larger in male

calves 3 – 7, 9, and 12 d (P=0.04), and was greater (P=0.04) in heavier birthweight calves. Naval stump length was greater in calves born overnight vs. in the morning (P=0.04) and was greater in heavier birthweight calves (P=0.04). A proximal navel diameter greater than 13 mm is the diameter proposed in a scoring system to ID navel infection in calves greater than 1 d of age. Distal naval diameter was greater in male calves (P=0.02) and in untreated male calves (P<0.01), but NSD found between male or female calves that had received a medical treatment. The authors hypothesize that external factors like pen hygiene, housing, bedding, and naval care practices have greater influence on navel healing as compared to dam, calving, or calf factors. The researchers also report that many calves noted navel diameters greater than 13 mm with no other indications of navel infection and this may warrant reevaluation of this criterion as threshold point for navel infection. n=68. Cornell. U of Guelph. 2038M.

11. *How does the environment effect feeding behavior? How about calf characteristics? And how does feeding behavior correspond to bovine respiratory disease?* Temperature humidity index (THI), birth weight, BRD status, and parity were evaluated in a retrospective cohort study on a 5000 cow (800 calves on autofeeders) commercial dairy located in Plymouth, Indiana from July 2015 to August 2021. 4 barns, 8 Forster Technik feeders, 16 pens, 50 – 60 calves/pen (Homestead Dairy). Milk consumption, drinking speed, rewarded visits, unrewarded visits were monitored on the machines. Calves must have spent 50 d on the feeder and birth weight within 4 SD, a complete birth weight had to be available, and data from 10,019 Holstein female calves was analyzed in 328,343 records. During the first 32 days calves had access to 24 L/d (up to 2 liters/2 hours d 0 – 10, 2.5 L/2 hours d 10 – 21, and 3 L/2 hours d 22 – 32) and then weaning very slowly progressed to 60 days. D 0 – 10 average milk consumption was 6.4 ±2.8 L, with 6.2 ±5.7 visits and 0.8 ±2.9 unrewarded visits daily, and average drinking speed was 418 ml/minute. D 11 – 21 average milk consumption was 9.1 L, rewarded visits 7.1, and unrewarded visits 0.5 per d with average drinking speed of 480 ml/min. Day 22 – 32 milk consumption 11.3, rewarded visits 7.8, unrewarded visits 0.5 and speed 582 ml/minute. Records showed that 1 day prior BRD treatment drinking speed decreased significantly (P=0.05) from the prior day and that reduction carried on the day of treatment. Drinking speed continued to be below baseline (P=0.05; drinking speed prior to being sick) for the subsequent 5 days post treatment for BRD. Daughters from multiparous cows drink more milk (8.99 vs. 8.61 L/d; P<0.05) but also drink slower (479 vs. 501 ml/min; P<0.05) than daughters from primiparous cows. Sick calves drank less milk (the graph showed a decrease from approximately 9.0 to 8.4 L/d; P=0.05) beginning 2 days prior BRD treatment and carrying on until day of BRD medical treatment, however, milk intake bounced back to normal the day after medical treatment. The abstract reported milk consumption decreased by 1.7% from baseline 3 d prior BRD treatment and drinking speed decreased 3.1% 1 d before BRD treatment (P<0.05 in both instances). And that both measures (intake and speed) were not different from baseline the day post BRD treatment. The abstract reported changes in drinking speed were associated with

temperature and humidity index, however, no specific data on this parameter was reported. n=10,019 calves. Purdue. 1167.

12. *Analysis of perinatal (birth to 24 – 48 h of life) calf mortality on Quebec and New Brunswick dairies.* Winder et al. 2018 reported average mortality from stillbirths in Canada was 4.9%. Risk factors are reported as dystocia, primiparity, age at first calving. What herd risk factors make perinatal mortality higher than the 4.9% average? Cross sectional study sampling of 1,832 farms visited once between Feb 2020 and June 2021 and a questionnaire covering management was conducted. Data regarding perinatal morality was also retrieved from the DHI database for a one-year historic period from the last DHI test in 2020. Results: mean average perinatal mortality was 7.6% with standard deviation of 5.6. Key factors associated with perinatal morality included: calving area floor type, calving area ventilation in the summer, herd size, dam-calf contact time, time to first colostrum, proportion of assisted calvings, and the proportion of male calves. Deep bedding or use of mattress decreased (P<0.05) incidence of perinatal mortality compared to use of concrete in the maternity barn. Farms with more than 94 calvings per year noted fewer perinatal mortality (P<0.05) compared to dairies with <49 calvings, and the author hypothesizes larger farms are better staffed to monitor births. Leaving the calf with the dam for 7 – 12 hours noted reduced incidence (P<0.05) of perinatal mortality when compared to leaving the calf with the cow for 1 – 6, hours. Leaving the calf with the dam less than one hour or more than 12 hours was intermediary and noted NSD in perinatal mortality. The author reported this finding as inexplicable and data on this parameter was reported as scarce and an area that needs research. Time to first colostrum intake: receiving colostrum less than one hour from birth noted less incidence of perinatal mortality compared to receiving colostrum in the 1 – 6-hour period and there was NSD between 1 – 6 hours and more than 6 hours. The author hypothesizes this is likely due to differences in energy intake. Data was not analyzed by season. Increased proportion of male calves noted increased incidence of perinatal mortality (P<0.05), but it was quadratic in nature, so larger farms with more known males born likely had bigger staffs to deal with the more difficult births. Proportion of assisted calvings was highly correlated (P<0.05) with just 0.1% to 3% of assisted calvings noting increased incidence of perinatal mortality compared to 0% calving assistance incidence on a farm. n=1,832 farms. U of Guelph. Lactanet , Quebec. 1034.
13. *Social behavioral aspects: Joao Costa, U of Ky.* Oral presentation reviewing key aspects of this topic. An overview: traditionally, calves have been reared individually, fed limited milk allowance, provided few interactions with other calves and caregivers. There is growing evidence that socialization promotes physical, behavioral, and cognitive development that continues into adulthood. Cattle, being a herd species, need further exploration of the effects of socialization on health and performance. Data generated in the past decade shows improved growth, improved behavior (competition at the feed bunk), psychological (reduced fear), and cognitive benefits (improved learning,

important for use of automatic cattle handling equipment) linked to early socialization. Proper milk allowance and more gradual weaning can both optimize performance and minimize incidence of hunger. Improved and facilitated interactions with other cattle and with caregivers can lead to improved performance during challenging production periods. "Future research will focus on positive reinforcement training, provision of more agency to the animal, and harnessing automated technologies;" and these will lead towards more welfare-friendly systems that may lead to improved later performance. U of K, Lexington. Aarhus U, Denmark. 1025.

14. *Does social contact effect a calf's ability to deal with cold stress? Would the shared warmth of being in the hutch with another calf result in increased growth?* Holstein heifer calves housed in hutches in Wisconsin during December thru March were either housed individually (n=16) or in pairs (n=16 pairs). Calves were step-down weaned over 11 days commencing d 42. Weekly body weights measures were taken week 1 – 9 and weekly dry matter intakes were measured commencing week 2 onward with paired calves averaged. Restriction was made midday week 4, 6, and 9 (pre-weaned, weaning, or weaned). The restriction involved calves being placed individually inside the hutch for one-hour periods using hog fence over the hutch entrance and rectal temps were taken before and after that hour, ambient temps inside the hutch were also measured every 5 minutes during that restriction process and paired calves obviously shared the same individual hutch space thus sharing body heat. Pairing calves did not increase the housing temperature during week 4 (paired +2.8 F, individual +2.3 F), but it did week 6 (paired +5 F, individual +2.5 F), and week 8 (paired +4.7 F, individual +2.5 F) and in aggregate housing in pairs increased (P<0.02) ambient temperature inside the hutch and there was a trend for a week of life interaction (P<0.07). NSD in change in rectal temperature due to being housed in pairs or individually (P=0.75) or due to week of life (P=0.57). There was no effect of housing treatment on DMI (P=0.88) or ADG (P<0.001). Paired calves tended (P=0.08) to have greater final body weight (188.1 vs. 177.2 lbs.; P=0.08) and tended (P=0.10) improved ADG during the entire 9-week growing period as compared to individually housed calves. n=48. UW Madison. 21567.
15. *What are veterinarian's opinions of calf welfare/rearing practices?* Veterinarian survey conducted Fall 2019. Designed by 9 experts in calf extension and outreach and was distributed online and in extension events. 129 responses from veterinarians who reported to work 73% (±29%) of working hours serving dairy clients. Avg number of dairy herds served was 63 ±13 representing 18,709 lactating dairy cows. 55 (43%) accept social housing and 80% of these veterinarians preferred maximum age range within groups of <1 week, and 64% preferred calves to enter groups when ≤14 d. 57% of veterinarians prefer calves to be housed individually, 25.8% in groups, and 17.2% in pairs. If paired, 10% preferred >3 weeks at pairing, 22% 15 – 21 days age, and 68.3% preferred 0 – 14 d of age. For groups, 80% preferred less than one week, 16% report 2 weeks or less, and 3.6% 3 weeks or less. % of clients reporting cross sucking behavior prior weaning? 22.3% report never hearing of cross sucking, 48.1% occasionally, 23.3%

sometimes, and 5.4% frequently. Cross socking after weaning? 7.8% never, 54.3% occasionally, 35.7% sometimes, 2.3% frequently. What is the minimum amount of milk to be fed at 4 weeks of age? 6 quarts was considered the minimum. Feeding method? Nipple 51.2%, no nipple 22.3%, Both 25.6%. Weaning process? 98% thought step-down wean process optimal. 18.6% 6 – 7 weeks, 48.8% 8 – 9 weeks, 10.9% 10+ weeks, 1.6% wean by body weight, 17.8% wean by starter intake, 2.3% wean by both BW and starter intake. n=129 veterinary respondents. 2189T.

16. *Does paired housing prewean effect feed efficiency later in the heifer's life?* Holstein heifer calves reared in hutches were housed either a.) individually (n=15), or b.) paired (n=26) in two hutches combined by a shared outdoor run area. Calves were managed identically. "The pairs and individual heifers were randomly assigned to 6 pens (6 to 8 heifers per pen) with Calan gates at 17 to 18 mo of age." They were fed a common TMR for 63 d that was composed of 62.3% corn silage, 36% haylage, 0.7% urea, and 1.0% minerals, that contained 13.4% CP, 56.9% NDF, and 56.2% TDN. BW was measured on 3 consecutive days and body measures taken at the beginning and end of the study. After 6 weeks on study methane and carbon dioxide emissions were measured using a GreenFeed pasture system (C-Lock Tech Inc., Rapid City, SD). NSD in any measure including BW (P=0.24), hip height (P=0.78), heart girth (P=0.30), DMI (P=0.23), ADG (P=0.44), feed conversion (P=0.93), residual feed intake (P=0.28), methane emissions (P=0.76), or carbon dioxide emissions (P=0.73). n=41. U-W Madison. 2260T.
17. *Health Management of calves – from intrauterine life to successful weaning*. Summary of 41st Discover Conference on Health Management of calves (Oct. 2021). Michael Steele PhD, U of Guelph, a summary of new concepts in preweaning and weaning nutrition and management presented at the Discovery Conference: **calf behavior & housing/cow calf separation -** 3 spoke on behavior-based research – Dr. Joao Costa discussed phase 1 first 6 weeks is far different than the weaning phase explaining data showing the tremendous variation between calves in starter intake leading up to and through weaning. Can personality explain some of this individual variability? Autofeeders can help by extending milk feeding to those calves that are not going to grain. Dr. Van Os discussed how we need to understand and possibly deal with early social deprivation, i.e., separation from the dam and how it may result in neurobiological changes, accentuated fear response, and impaired young care (Harlow et al, 1965; Reviewed by Fone et al, 2008). Benefits of social housing (pairing hutches, group settings with auto feeders) include motivated for contact, play behavior, and social development (Broom & Leaver, 1978; Jensen et al, 1997, 1998, 2015; Veissier et al, 1994, 1997; Holm et al, 2002; Ede et al, 2021). Dr. Steele predicts every calf will be reared in paired or group housing in the coming decades. De Paula Vieira et al, 2010 showed that starter intake increased when calves were paired vs. housed individually thus creating earlier rumen development, better transition and making consumers happier. Horvath and Miller-Cushon, 2019, showed providing hay in addition to starter increased feeding time and solid feed intake and increased weight gain during weaning

while reducing pen-directed (non-nutritive) sucking. Dr. Alex Bach reported much about the importance of chopped forage and how it impacts dry feed intake and growth. Horvath et al., 2020, conducted research on providing a small brush alongside one wall/panel in housing and effect on non-nutritive sucking. Calves offered the access to the brush noted less non-nutritive sucking the two periods of the day when milk was delivered. Dr. Steele reported this was an investment of about $10 to enrich the calf's environment. Finally, there were presentations on European interest/implementation of cow/calf pairs rearing systems either out on pasture or intensive in barn, and Dr. Steele challenged these practices are coming, whether we embrace them or not, and we best be prepared with research understanding them. 1217.

18. *Health Management of calves – from intrauterine life to successful weaning*. Summary of 41st Discover Conference on Health Management of calves (Oct. 2021). Dave Renaud DVM, U of Guelph. Final presentation of the Discover Conference was on calf mngt and the public's eye. The consumer perceives dam and calf are together on the pasture, which clearly is not the case. Social housing may help the sustainability of our industry. The social acceptability of early life slaughter is poor (Source Ritter et al, 2022; survey 998 consumers), less than 2 weeks age at slaughter is unacceptable by consumers in this survey, and consumers prefer ≥12 months age at slaughter, and that acceptance goes up if calves were not separated from the dam. Only 16% of consumers found slaughter totally unacceptable, it's just they prefer later age (12 to 18 months) to ensure socially acceptable. Sirovica et al, 2022, 1500 consumers surveyed, found more positive welfare score if the dam was rearing her individual calf, with nurse cow rearing multiple calves not sig better in their perception than individual or group housed situations (both scored poorly). 1218.
19. *Computer vision system to monitor calf heat stress*? Outdoor hutch-housed calves account for 60% of calf housing in the USA. Can monitoring heat stress behaviors (seeking shade, increased standing) accurately detect calf heat stress? Calves 3 – 7 weeks of age housed in individual outdoor hutches for 27 days in the summer (July to August 2021; average THI=69.8) were monitored via trail cameras with night vision capability. Camera was placed 5 m from 3 – 5 hutches and images collected every 5 minutes (27704 images collected). Images classified the calf as either inside or outside and standing or lying. Images were used to train and validate the algorithms and Python was used to implement analysis. The effect of THI (temperature humidity index) was analyzed against calf behaviors. Two different deep learning algorithms were evaluated and although both captured the calf lying either inside or outside and either during the day or at night with 90% or greater accuracy, one (YOLOv3) was more accurate than the other (tiny YOLOv3). At a THI greater than 70 calves spent 127 fewer minutes (P=0.03) inside, 75 fewer minutes (P=0.09) lying outside, and 19 more minutes (P=0.08) standing outside compared to calves exposed to THI less than 70. Calves spent less time (P≤0.05) lying outside as relative humidity % increased, however, they spent more time (P≤0.05) lying outside as temperature and THI increased. n=12. U of W Madison. 2331W.

20. *Impact of season on birth weight and growth in the Midwest USA*. Calves do not use extra energy in their thermoneutral zone of 55 to 74 F. Outside this zone metabolic rates rise attempting to maintain optimal body temp. Summer and winter born calves have been shown to have lower first lactation milk yields (Van Eetvelde, 2017). Holstein heifer calves born at the U of Illinois Dairy Research Unit from July 2018 to February 2022 were monitored. Calves were housed in hutches, fed the same feeding rates and weaned at 56 d and then group housed until approximately 175 d and then moved to heifer lots. Seasons analyzed were winter (Dec Jan Feb), spring (Mar Apr May), summer (June Jul Aug), and fall (Sept Oct Nov). Weight was measured at birth, wean (56 d), and transfer to heifer lots (app. 175 d). Birth weight was 90, 91.2, 84.7, and 86.9 lbs. for winter, spring, summer, and fall, respectively, with winter being greater (P=0.02) than summer, summer being lesser (P=0.0021) than combined non-summer (the other 3) seasons, and winter tending (P=0.0756) to be greater than combined non-winter (the other 3) seasons. Wean weight was 199.6, 176.1, 183.6, and 185.3 lbs. for winter, spring, summer, and fall, respectively, with winter being greater (P=0.0003) than summer, and summer being NSD (P=0.3521) compared to non-summer seasons, and winter being greater (P<0.001) than non-winter seasons. Prewean ADG was 2.0, 1.6, 1.72, and 1.74 lbs. for winter, spring, summer, and fall, with winter being greater (P=0.003) than summer, summer being NSD (P=0.3595) compared to non-summer seasons, and winter being greater (P<0.001) than non-winter seasons. Post-wean weight was 328.1, 366, 355.4, and 329.6 for winter, spring, summer, and fall, with winter being less (P=0.0008) than summer, summer being greater (P=0.0412) than non-summer seasons, and winter being less (P=0.0013) than non-winter seasons. Total 175 d ADG was 2.16, 2.27, 2.22, and 2.09 lbs./d for winter, spring, summer, and fall, with winter being NSD (P=0.3031) than summer, summer being NSD (P=0.311) than non-summer, and winter being NSD (P=0.573) than non-winter seasons. Average weight differences for winter vs. summer were +5.3 lbs. at birth, +16 lbs. at wean, and -27.3 lbs. at the move (approximately 175 d). Average weight differences for summer vs. non-summer were -4.7 lbs. at birth, -3.4 lbs. at wean, and +14.2 lbs. at move. Average differences for winter vs. non-winter months were +2.4 lbs. at birth, +18 lbs. at wean and -22.2 lbs. at move (app. 175 d). Conclusions: calf birth weight thru weaning is greater during cooler seasons; summer born calves have lesser bodyweight at birth through weaning but once they reach cooler seasons, they excelled post-weaning. Birth season may direct birth weight but does not necessarily pre-determine overall performance. Calves up to 175 d struggle more in warm seasons indicating need for more research on the effect of heat stress on calves. n=216. U of Illinois. 2355W.
21. *Behavior of pair housed calves*. Cohorts of 10 to 24 pair-housed calves approximately 2 d of age and born from between February and May 2021 housed on a commercial calf ranch were equipped with electronic data loggers (pedometer; IceQube, IceRobotics, Edinburgh, UK) on a rear leg to monitor activity. "Calves were born 1 km away from the calf ranch and moved to a nursery facility for their first 12 h of life where they had their

first and second feeding of quality (Brix value >22%) colostrum fed within 2 h and 10 h after calving, respectively. At the calf ranch, calves were housed in adjacent hutches with a shared outdoor area of 13 m^2" (140 square feet). Calves were fed 3 quarts of milk 3x/d out of a nipple bottle and had access to starter ad lib. Calves were monitored for lying time, lying bouts and steps to 12 weeks of age. Lying bout duration was calculated. Mean lying time was 18.3 hours/d with SD of 1.5 h and minimum of 13.5 hours and maximum 22.7 hours. The mean number of lying bouts was 21.5 per day with a median of 22 and SD of 4.9 (minimum 5 and maximum 31 lying bouts per day). The mean lying bout duration was 55 minutes with a SD of 27 m, minimum 13 m and maximum 4.62 hours. The mean daily step count was 540 with SD 281 and a minimum of 23 and maximum of 1,450 steps per day logged. The daily lying time decreased with age out to 6 weeks with the bulk of the reduction in lying time occurring in the first two weeks of life. The number of daily lying bouts were not different by week, however, the lying bout duration decreased with age. Step count decreased with age and researchers attributed this to a sizable % of calves in this study being impacted by sporadic winter weather, including winter storms. Asterisks indicative of statistical significance were indicated on the graphs where it was reported in the video to reach statistical differences, however, no P values were provided. n=72. TX A & M. The OSU, Columbus. Cornell. 2414V.

22. *Can autofeeder records assess calf relationships prewean*? Data was collected on a commercial dairy farm (Homestead Dairy; 5000 cows, 800 calves) located in Plymouth Indiana from between January 2020 and April 2021. Calves were offered up to 24 L/d of milk to d 32 and then gradually weaned d 32 – 60. Starter offered ad lib. Calves were housed 50 – 60 calves/pen and each pen had 2 feeder stations. Data analyzed was from 5 groups (51 – 58 Holstein calves, ≥85% female), 60 d of visit records, calves enrolled in feeder at birth and pen filled within 8 – 10 d. Observations started when last calf is introduced and end when first calf is 60 d old (51.2 ±2 days) divided into 4 stages. Conclusions: "Calves arriving first to the pen have less selective interactions than those arriving later. Smaller groups of calves may be more constant over time, explore nearest neighbors as an alternative to clustering. Calves may perform better in stable groups that fill within a short time." Put another way, "calves introduced first were more connected with pen mates than the calves introduced later ($P<0.05$). However, birthweight was not associated with degree at any time." Similarity of communities was not different ($P>0.15$) across the 4 stages. Purdue. 1319.
23. *Calf diarrhea case definitions*. The author (Devon Wilson DVM) reported four published studies spanning 4 different calf production systems (calf rearing facility, a dairy, a veal production setting, and cow/calf rearing) and highlighted how the four different authors used dramatically different criteria to report the level of diarrhea present in the study, ranging from "manure is of looser consistency than normal calves for ≥ 2 days old," (23% scours incidence, Windeyer et al., 2014), "true morbidity was estimated by the farmers treatments for disease," (20% scours incidence, Waltner-Toews et al., 1986), "the case definition for neonatal calf diarrhea was presence of diarrhea (partial) anorexia and

depression," (15% diarrhea incidence, Pardon et al., 2015), and "producers were asked to estimate the herd-level treatment risk for preweaned calf diarrhea," (5% diarrhea incidence, Murray et al, 2015). Clearly these various definitions make it difficult to compare cases of diarrhea across studies. The objective of this study was to characterize the case definitions used for neonatal calf diarrhea in calf research studies. The author coordinated a scope interview of 3 databases (CABI, Medline, & Agricola) and one search engine (Google Scholar). 27,000 articles were found. Artificial intelligence screening trained by the author's team was used. 10,913 records were evaluated manually. Records were sifted for duplication and screened for relevance (full text available, in English, published after 1977, primary research, investigated bovine diarrhea at the calf level and during the neonatal period, and used a case study definition for diarrhea). In the end, the study sorted 557 records to include in the review. By far, the lead study populations in these 557 records were dairy calves reared on research facilities and dairy farms. Dairy calves reared on rearing facilities were a distant third, and next in size and scope was beef breed calves reared on ranches. A sizable share of dairy calf studies did not report the type of rearing facility. How did articles diagnose neonatal calf diarrhea (NCD)? 523 (93.9%) reported NCD via fecal consistency, however, in 34.6% of these incidences, fecal consistency was not fully defined, or a "normal" comparison was not included. Of the 342 (61.4%) that defined fecal consistency and included a "normal" case definition, 72 (21%) reported diarrhea in 2 – 3 levels, 208 (60.8%) reported diarrhea in 4 levels, and 62 (18.1%) reported diarrhea in 5 – 6 levels. The two most common fecal consistency evaluations systems were from Larson et al, 1977 (n=85) and McGuirk, 2008 (n=59). Larson's system reported as level 1, "normal, firm but not hard. Original form is distorted slightly after dropping to floor and settling," whereas McGuirk reported level 1 as "normal consistency." For level 2, Larson reported it as "soft – does not hold form, piles but spreads slightly, (i.e., soft serve ice milk)," whereas McGuirk reported level 2 as "semi-formed or pasty." For level 3, Larson reported it as "runny – spreads readily to about 6 mm depth, (i.e., pancake batter)," whereas McGuirk reported level 3 as "loose but enough consistency to remain on bedding." Level 4, Larson, "watery – liquid consistency, splatters, (i.e., orange juice)," while McGuirk "watery feces that sift through bedding material." In the 342 studies reporting fecal consistency, when was a case considered "diarrhea"? i.e., what was the diarrhea cut-off in the study? For the articles using the Larson method, the cut-off to be labeled diarrhea was ≥level 2 in 11%, ≥level 3 in 75%, level 4 in 13%, and some other measure (like an average score) in 1%. For the articles using the McGuirk method, the cut off diarrhea label was ≥level 2 for 25%, ≥level 3 for 66%, level 4 for 5%, and other at 3%. Other metrics used to diagnose neonatal calf diarrhea were physical exam (n=79 studies), time with abnormal feces (n=67), abnormal contents (n=61), farm treatment records (n=54), fecal color (n=41), fecal volume (n=35), fecal odor (n=22), fecal dry matter (n=12), and other (n=41). The leading physical exam parameters were hydration (n=28 studies), attitude (n=25), body temp (n=24), cleanliness (n=22), and appetite (n=17). There is great variation in diarrhea diagnostics in the data. Five studies reported corresponding fecal dry matter with fecal consistency scoring and normal stools ranged from 20 – 25% dry matter, mild diarrhea 20% ±5%, moderate diarrhea 10 – 15%, and severe 5 – 10% dry matter. Within studies, dry matter content corresponded well with fecal consistency scoring, however, between studies there was significant variation obviously showing the variability due to discretion of the research observers. Can fecal consistency scoring be replicated? 33 studies monitored the diarrhea diagnoses qualitatively (veterinarian monitored) and 5 diagnosed quantitatively. When using the two level McGuirk 2008, scale, Renaud et al 2020 found an inter-rater reliability (how well different researchers correspond in their ability to diagnose diarrhea) of k=0.72, while Wilson et al., 2020 found k=0.86. Both indicate decent reliability, however, when a 4-scale system was used, the author reported reliability was diminished (no stat provided). Does a scoring system matter? i.e., does a higher diarrhea score correspond with poorer growth? Schinwald et al, 2022 found direct correlation between % of days with diarrhea (d 0 to 77) using the Larson et al scale, and predicted body weight. The author concluded with remarks from Larson et al in 1977 that reported methods of measuring diarrhea "vary widely" and are "incomplete" and "standardizing techniques" would be "beneficial" in "interpreting results" and "comparing between studies." U of Guelph. 1346.

24. *Pain mitigation using Lidocaine + "Dull-it" or Lidocaine + oral Salix for disbudding*. Disbudding dairy calves using a hot iron results in pain sensitivity for at least 24 hours (Stafford and Mellor, 2011) and up to 9 weeks (Adcock and Tucker, 2018). The most effective way to mitigate pain is using local anesthetic and NSAID (Winder et al, 2018). The local anesthetic numbs the horn bud and the NSAID reduces inflammation resulting in less long-term pain. Only 26% of organic producers use local anesthetics or NSAID to relieve disbudding pain. Two plant-based alternatives are used by organic producers: 1.) willow bark contains salicin that is converted to salicylic acid in the calf and may reduce perceived pain in humans, 2.) "Dr. Paul's Dull It" which contains alcohol, willow bark, St. John's Wort, chamomile, arnica, and fennel and is administered 3 – 5 cc under the tongue. Heart rate, salivary cortisol and lying behavior were monitored in 5- to 7-week-old (mean 44 d) organic Holstein and crossbred dairy calves disbudded and administered either a.) lidocaine (5 mL per horn bud), b.) lidocaine and Salix extract bolus (200 mg/kg 20 minutes prior to disbudding), or, c.) lidocaine and "Dull It" oral tincture (5 cc under the tongue immediately after, 5 cc 1 hour after). Continuous recording of heart rate and lying behavior were monitored 1 h before and ended 4 h after disbudding. Saliva samples were collected from 30 randomly selected "minimally invasive" calves 1 h before, at disbudding and 5 m, 10 m, and every 30 m until 240 m after disbudding. The remaining 23 calves served as a "non-invasive" control for sampling stress. No effect of treatment on heart rate. No effect on salivary cortisol concentrations except cortisol concentrations were higher in the Dull It group than in the Salix group. No effect on lying bout by study day or lying time by study day. No

effect on lying bouts or lying time by group. Dull It and Salix offered no analgesic effect when compared to lidocaine alone. n=53. U of MN St. Paul. 1324.

25. *Effect of social contact on social bonds in calves*. Social bonds occur as early as 2 days of age (Duve and Jensen, 2012). Previous housing type where full contact can occur affects calf social behavior development. Social housing has been shown to better develop social behavior (Faerevik et al, 2007), result in reduced avoidance of novel objects (Meagher et al, 2015), increase acceptance of novel feeds (Whalin et al, 2018), result in greater behavioral flexibility (Gaillard et al, 2014) and increase solid feed intake and improve weight gain (Warnick et al, 1997). Calves were either pair-housed or individually-housed from birth to 8 weeks of age. Milk intake, starter intake, health and weight gain were monitored. Starter intake tended (P=0.09) to be greater in paired calves vs. individually housed calves. Differences were most pronounced during weaning. NSD in overall ADG but differences were noted during weaning (week 7 and 8) with the pair-housed calves noting improved ADG during those final weeks (SE=0.039). Social preference test occurred week 4, using a 10 minute test with 5 minute familiarization period entering an arena. Two "stimulus" calves were placed in hog-wire pens to the left and right and ahead of the test calf. One of the two was the calf's pen-mate and the other was a less familiar calf that they had visual contact with but no direct contact with. Close proximity of test calf to stimulus calf and also direct contact was monitored. Individually housed and pair housed calves noted no differences (P=0.91) in the total minutes of attention or (P=0.55) in minutes of contact, however, individually housed calves noted less (P=0.03) minutes of close proximity to stimulus calves. When looking at how either individually housed or pair housed calves interacted with only the "more familiar" calf (their pen mate or calf next to them), there was NSD (P=0.29) for calves coming from either housing treatment, however there was a trend (P=0.07) for paired calves to have more contact than individually housed calves, and, finally, pair housed calves noted an increased (P=0.05) % of close proximity to their pen mates than did individually housed calves to their adjacent calf. n=40. U of Florida. 1323.

26. *Does social housing affect immune development in the calf*? Early social isolation can result in learning difficulties, abnormal social behaviors, and increased fear response in calves (Fone et al, 2008). 70% of dairy calves are housed individually (USDA, 2016). Holstein heifer calves were assigned at birth to either a.) housed individually in a wire hog fence pen (n=24), b.) paired in double-sized wire hog fence pen (n=20 pairs, 1 focal calf per pair), or c.) group housed 5 pens, 5 focal calves per pen. Calves were fed 8 liters per day via a teat bucket or via an autofeeder in the grouped calves. Post 56 day wean calves were comingled between groups onto pasture. Calves were vaccinated d 14, 28 and 180 with keyhole limpet hemocyanin and heat killed whole cell *C albicans*. Antibody titers were measured day 14, 21, 28, 35, 42 and 187. Blood leukocyte concentrations were measured on day 14, 28, 42, and 187. Leukocyte responsiveness was measured ex-vivo day 42 and 180 by stimulating cells in whole blood with *C. albicans*. NSD between any group in 28 or 56 day body weight or ADG. The percentage of white blood cells was

lower (P=0.01) in the group housed calves. Concentration of monocytes was lower (P=0.05) in pair housed calves. NSD in leukocytes (P=0.12) or granulocyte (P=0.56) counts in blood, however, group housed calves had a greater increase in leukocyte (P=0.02) and tended greater increase in granulocyte (P=0.06) counts from day 14 to 28. Lymphocyte concentration tended (P=0.09) less over time between day 14 and 42 in pair housed calves. Pair housed calves also noted less monocyte count (P=0.05) day 28 and 42. CD4+ lymphocyte T cells NSD (P=0.15). CD4+ CD62L+ T cells noted a 28-d increase (P=0.001) for individual and group housed calves. CD8+ lymphocyte T cells, group housed calves had the greatest increase d 14 to 42 (P<0.001), and CD8+ CD62L T cells were greater in individually housed calves d 28 and were greater in group housed calves day 42 (P=0.002). Cell-mediated responses to C. Albicans (ex-vivo stimulation whole blood compared to blood not stimulated) showed no differences in cytokine gene expression except in IL4, where group housed calves tended (P=0.06) higher concentrations (NSD in IL1B, P=0.21, IL17A, P=0.14, or IFNg, P=0.22). Antibody mediated immunity to KLH IgG noted a reduction in abundance in group housed calves at 21 and 28 days (P=0.03) but then had a greater jump at 35 days and were greater at 42 days of age (P=0.03). n=69. U of Florida. 1322.

27. *Foster cow rearing*? Consumers dislike cow calf separation. Foster cow rearing using high SCC nanny cows might be considered as a viable option. This might be a more natural behavior strategy with a unique milk marketing option, requiring less labor and minimize separation stress on the calf. Foster cow strategy still allows a colostrum feeding period. Calves of mixed dairy and beef breeds, bulls, and heifers, on a commercial spring block calving dairy farm in NW England using a straw bed with ad lib access to grass silage and grain were used. Calves were removed from the dam within 6 hours and fed 4 L of milk from the dam within 12 h of birth. The control group housed in groups of 8 and fed 4 L/d (2 L, 2x/d) of whole milk. Foster group housed in groups, unlimited access to 6 cows (2.8 calves/cow, average annual yield approximately 7,900 lbs. of milk. These were high SCC cows with low milk yield in prior lactation and were destined for culling. McGuirk (2014) health scoring was used on the calves. Heart girth measure weight taken was taken 2x/week. Calves were monitored from birth to 56 d. The foster-reared calves were NSD in calf growth at 8 weeks of age (Control 1.32 vs. foster 1.57 lbs./d ADG 0 – 56), however, there was a time by treatment interaction (P=0.014) for a higher ADG in the foster-fed calves. At 6 months age the foster calves were significantly (P=0.009) heavier than control calves (280, SD 22 lbs. vs. 425, SD 25.1 lbs.), however, the researcher reported the group sizes were not maintained, so fewer calves were in each group and no details on number of calves weighed at 6 months were presented. Foster calves noted improved health scores (P=0.016) over the 8 week study and there was a time x treatment interaction (P=0.041). n=31. Harper Adams U, UK; Devenish Nutrition; Silcock Fellowship for Livestock Research. 1495v.
28. *Heifer calf behavior: Friend, food, or flee*? A T-maze reward study was conducted on 9 week old weaned calves either exposed to a social reward (another heifer calf), a food

reward (grain and chopped hay), or an escape reward (a chance to directly escape the maze). Calves were released into a "T" shaped maze for 3 minutes where the reward was in one of the arms of the "T". Heifers were placed in the maze for 5 sessions per day and until the heifer calf identified the reward for 3 correct choices in a row, then the reward was moved to the opposite side of the maze and the heifer calf re-tested. The number of pass rates to first ID the reward and then to re-find the reward after it was changed, were recorded. During the initial passes (until achieving 3 successful ID's of the reward in a row) calves found the "escape" reward, the "other heifer" reward, and the "food" reward in 100%, 80%, and 80% of the initial passes, respectively. When the reward was switched, the calves found the "escape", "other heifer", and "food", rewards in 60%, 60%, and 40% of the calves passed through the T-maze, respectively. An "escape" reward is equally efficacious as the typical "food" reward used in animal studies when heifers are the subject. This may be useful in future dairy heifer calf behavior studies. n=15. U of Florida. 1492v.

Physiology (particularly gut microbiome) (1 abstract)

1. *Inoculating young calf with adult rumen contents?* Holstein bull calves were dosed with either a.) fresh rumen content or, b.) autoclaved (sterilized) rumen content from a single adult donor cow. Calves were dosed with 50 mL of rumen contents chased with 50 mL McDougal's buffer. Microbial content was analyzed and reported by phylum on three calves before administered with rumen contents and phylum diversity was shown to be comparable between the three. Calves were inoculated with rumen content via esophageal tubing within the first 3 d and then again at 2, 4, and 6 weeks age. Calves were harvested at 8 weeks and microbes collected from epithelial tissue of abomasum, ileum, cecum, rumen, and liver. Microbial communities were analyzed at the genus level, differences in differentially expressed genes determined, and gene ontology analyzed. Results: 1,836 differentially expressed genes were identified between the treatments and 86 were up-regulated and 1,750 down-regulated in the fresh rumen content dosed group. Gene ontology analysis showed that down regulated genes were primarily involved in molecular pathways involving immunity response ($P<0.001$). At the genus-level, 43 had significant (Pearson's $r>0.8$, $P<0.001$) correlation with caecum microbial genera, and 4 genes were associated with highest number of microbial genera SLC16A11 (transports pyruvate across plasma membranes), RAB26 (regulates intracellular membrane trafficking), TSPAN32 (regulates cell mediated immune responses), and RAP1GAP (regulates both positive and negative regulation of cell proliferation and activity). Of top 100 genes expressed in rumen, abomasum, ileum, and caecum, there is distinct differences in differentially expressed genes between the rumen and the other 3 GI tract tissues. In the caecum, gene ontology analysis downregulated genes involved with regulation of catalytic activity, immune response, and protein localization, just to name a few functions that are altered with administration of rumen fluid. Regarding upregulated genes in the caecum,

administering rumen fluid upregulated genes associated with cell structure indicating early dosing of rumen fluid may influence cell structure and proliferation in the caecum. Microbes are retained in the liver, and they are distinct from microbial communities in the other tissues and their concentrations are altered between calves that received autoclaved and fresh rumen contents. Rumen microbes were also very different in concentration between the two groups. Clear distinction was noted between microbes in the rumen and caecum in the calves treated with fresh rumen contents, however, in the calves receiving the sterile rumen fluid, there was far lesser distinction (perhaps none) between rumen and caecum microbes. "Microbial colonies in hindgut were influenced by microbial dosing in the rumen." There is a difference in microbial retention if fresh rumen contents are administered and there is a difference in microbial retention in the hindgut relative to the foregut. n=8. USDA Dairy Forage Research Center, Wisconsin. Oak Ridge Institute for Science and Education, TN. 1176

Starter grain & forage feeding (5 abstracts)

1. *Effect of hydroponically sprouted cereal grains on digestibility and growth in transition calves.* Post-wean Jersey heifer calves averaging 178.6 lbs., 80 d age, and 31.5 inches in wither height were randomly assigned to treatment pens (n=8) and fed either a control diet, or a diet with 11% DM basis HydroGreen wheat sprouts at the expense of grass hay in the TMR. Respective diet offered ad lib and refusal weight recorded daily. HydroGreen wheat is 22.2% DM and contains 15.3% CP of which 31.3% of CP is soluble, 14.12% ADF, 24.6% aNDF, 11.62% starch, and 33.94% total sugar. On a DM basis, control diet was 20% grass hay and 80% calf starter (21.8% forage, 20.8% CP, 7.5% sugar, 42.1% NFC, 28.5% starch), whereas, HydroGreen diet contained 32% grass hay, 10.7% HydroGreen sprouted wheat, 16% ground corn, 8% soybean meal, and 33.3% calf starter, and was composed of 43.4% forage, 19.1% CP, 8.63% sugar, 40.4% NFC, and 25.7% starch. Treatment and control groups were fed by pen for 8 weeks. NSD in ADG (2.5 vs. 2.38 lbs. per day for calves fed HydroGreen and control, respectively), or body length, however, calves fed HydroGreen diet noted improved (P=0.006) height (+1.45 inches), improved (P=0.017) cost of gain ($0.24 vs. $0.34/kg) and tended (P=0.081) improved intake (6.9 vs. 6.46 lbs./d). Blood measure taken at app. 140 days age and calves fed the HydroGreen diet noted increased (P=0.005) BUN (16.1 vs. 13.7 mg dL-1), reduced anion gap (P=0.041; 17.5 vs. 19.7 mmol/L), increased glucose (P=0.006; 94.0 vs. 80.8 mg dL-1), reduced cholesterol (P=0.026; 81.8 vs. 98.8 mg dL-1), and increased NDFD (NDF digestibility; P=0.026; 53.1 vs. 40.7%) and increased starchD (starch digestibility; P=0.037; 97.4 vs. 94.6 %) and tended increased TCO2 (Total carbon dioxide; P=0.071; 33.5 vs. 31 mmol L-1), decreased total bilirubin (P=0.075; 0.13 vs. 0.19 mg dL-1), and NSD in organic matter digestibility or crude protein digestibility. n=80. HydroGreen Inc., Sioux Falls. Dellait Dairy Research Center, Brookings. 2110M.
2. *How do rumen acid inducing diets effect rumen bacteria and the liver in calves at 8 and 17 weeks of age?* Calves were either fed diets creating acidic environment or diets

maintaining normal rumen pH. Treatment diet was pelleted and contained 42.7% starch, 57.8% non-fiber carbohydrate, and 15.1% NDF. Control diet was texturized and contained 35.3% starch, 48.1% non-fiber carbohydrate, and 25.3% NDF. Rumen papillae tissues were collected weeks 8 and 17. Liver tissue collected week 17. Calves fed texturized lower starch higher NDF diet noted increased starter intake throughout 14 weeks (no p value provided) and the gap between the control and treatment (high starch) diets widened as the weeks progressed, ending at 9.1 vs. 6.8 lbs. average weekly starter intake week 14. There was also a significant BW difference noting lesser weight gain in calves fed the higher starch lower NDF diets (no p value provided). Calves ended at 16 weeks age at 350 and 279.8 lbs. for calves fed low starch/higher NDF texturized feed and calves fed high starch/lower NDF pelleted feed, respectively. Rumen pH was lower (P<0.05) in calves fed the acidosis-inducing diet (magnitude not reported). There was a clear separation between the groups in the top 50 most differentially expressed genes at week 17 with the top 1% in the treated group (high starch/low NDF pellet) reported to being involved in hydrogen ion transport. "A total of 100 genes was identified as uniquely, upregulated at 17 weeks of age in the acidotic calves." Gene ontology enrichment analysis noted these genes being involved in molecular pathways of cell signaling and morphogenesis, indicative of their involvement in rumen development. 14 bacteria, mostly gram-negative, were found to be at increased abundance in calves fed the rumen acid-inducing diet. Fusobacterium, a bacterium that is associated with SARA, increased in concentration. Author notes gram-negative bacteria have been associated with SARA (sub-acute ruminal acidosis). 5 genera of primarily gram-positive bacteria noted a significant decrease in abundance in calves fed the rumen acid-inducing diet. 9 bacteria noted increases in concentration in the liver and 10 showed increases in the rumen when fed acid-inducing pelleted feed. 3 noted increases in the rumen at 8 weeks in calves fed rumen acid-inducing diet. Feeding rumen-acidosis inducing diet in calves 8 and 17 weeks of age noted sig reductions in growth, changes in rumen and liver microbial population, decreases in gram-positive and increases in gram-negative bacteria. n=8. USDA Forage Research Center, Madison, WI. Oak Ridge Institute for Sci and Ed, TN. 1169.

3. *Health Management of calves – from intrauterine life to successful weaning*. Summary of 41st Discover Conference on Health Management of calves (Oct. 2021). Michael Steele PhD, U of Guelph, a summary of new concepts in preweaning and weaning nutrition and management presented at the Discovery Conference:

   Concentrate/grain/starter/grower/forage feeding: Tana Dennis' presentation covered these areas: Bateman et al, 2012 summarized results from 20 published trials from 2007 – 2009 and showed dry feed intake was critical for growth. How do we stimulate more grain intake? Why do some calves on high milk regiments consume more grain than others? Stamey et al, 2012, demonstrates that preweaning starter DMI is critical to ADG during the weaning week. Quigley et al, 2019, shows that intake impacts the energy value of calf starter. NRC over-predicts ME when calves are consuming lesser quantities of calf starter, the calf needs to be consuming about 2.4 lbs. of daily calf starter NFC (non-fiber carb) intake before predicted ME in NRC 2001 (metabolizable energy) is accurate. NRC over predicts ME when NFC intakes are lesser (R2=0.7706). Rodrigo Molano presented starter composition in published studies from 2008 to 2019 and reported the large variation in starch content (range 15.6% to 47.2%) with a mean of 37.8% starch and 19.2% NDS. We need to better understand how starch content in grain corresponds to milk feeding regiment and milk replacer composition. Steele commented CP in grain varies from 18 – 28% and there is minimal data on this topic. Dennis et al, 2017, shows how CMR feeding rate and starter grain starch composition are correlated: when feeding low feeding rates of CMR, high starch starter is more readily consumed during transition compared to low starch content starter; when feeding high CMR feeding rates, there was lesser difference but high starch starter still resulted in increased starter DMI during transition compared to low starch starter (milk x starter response: P=0.08). Yohe et al, 2021, studied pelleted starter with either high or low starch grain and high or low milk replacer strategies in a 49 d wean strategy and found that during weaning the low milk replacer strategy performed better with the high starch grain week 7, but was markedly better with the low starch grain week 8, whereas, when feeding high quantities of milk replacer, the low starch strategy performed better in both weeks 7 and 8. Starter grain must be balanced with the milk/milk replacer feeding strategy and this came up in three presentations at the Discovery Conference. The future is precision management doing autofeeders, grain and milk. We need to integrate milk and starter and this needs to be better understood. Successful weaning in context of feeding more milk: Van Niekerk et al, 2021 reported should be weaning >8 weeks with a >2 week step-down with multiple steps (longer is even better), provide a solid feed with >85% concentrate and <30% starch (it looks like if feeding more milk, your starch should be limited, but more work is needed), and provide group housing and avoid changes. Bach et al, 2021, “ADG during the post-weaning period has been positively correlated with future milk production (Shamay et al, 2005; Bach and Ahedo, 2008).” Milk yield first 150 DIM (range 55 to 125 lbs./d) is correlated (P<0.01; n=1,618; R^2=0.02) with ADG d 70 – 120 (range 0.66 to 2.2 lbs./d). This is not spoken of enough. Directly post weaning (60 d post wean) is the most efficient ruminant to convert dry feed to grain: 60 d F:G is 55.2% and cost of gain is $0.70/lb.; 112 d F:G is 31.4%, and cost of gain is $0.34/lb.; 155 d F:G is 26.5% and cost of gain is $0.40; 180 d F:G is 20.4% and cost of gain is $0.41; 230 d F:G is 16.8% and cost of gain is $0.44; 315 d F:G is 13% and cost of gain is $0.57; 400 d F:G is 9.1% and cost of gain is $0.75, and that cost of gain and % G:F stays fairly consistent thru d 650. Steele reports if you let calves select feed during this period it will always be 90% concentrate and only 10% forage and today’s genetics and productivity in dairy cattle require a re-look at post wean feeding strategies. Chopped forages with ad lib concentrate post wean was examined 2 – 4 months post wean, and Dr. Steele reports they saw ADG from 3.3 to 3.85 lbs./d. How much is gut fill? Empty body weight needs to be looked at a lot more. Rosadiuk et al, 2020 looked at either 10 L/d vs. 5 L/d (hi plane starts at 6 L and increases to 10) weeks 1 – 7 and then gradual wean, with post-wean grower diets either high plane (85% concentrate, 15% straw) or low plane (70% concentrate and 30% straw). The same starter grain was offered to both groups pre-wean. Weaning occurred weeks 7 – 9 and calves were acclimated to the grower diet week 10. DMI in grower phase (week 11 to 25) started at approximately 8 – 9 lbs. and slowly ascended to 15 to 17.6 lbs./d in the high plane grower nutrition strategy and were lesser each week (I assume P<0.05, p value not shown, but reported as statistically significant) peaking at around 13 – 14 lbs./d on the low plane of nutrition grower. ADG weeks 10 – 25 ranged from 3.3 to 3.5 lbs./d in the high plane of nutrition and 2.9 to 3.1 lbs./d in the low plane of nutrition. Bruinje et al., 2020 found that an increase of 1 kg BW at 25 weeks means 1.3 lesser days age at puberty. In this study a low plane of nutrition fed post-wean noted 83% of the heifers still prepubertal at 30 weeks of age, whereas a high plane of nutrition post-wean noted a far lesser percent (56%) of heifer still prepubertal at 30 weeks. Dramatic difference. Why do we want these cattle cycling so early? Dr. Steele reported there were LH surges at 6 months and the high plane of nutrition heifers were huge at 6 months and many reached puberty at that point, more cycling there's a greater chance of getting pregnant at first insemination. Body weight is completely related to puberty. But we also need to look more at gut fill. Hemken et al, 1958, compared dimensions of cattle provided 1 kg grain daily and ad lib access to 1st cut hay vs. 2 kg of grain and ad lib access to 1st cut hay. The calf fed 1 kg grain has an obvious big hay belly and the calf fed 2 kg hay had excellent confirmation. Also, need to look more at body composition post wean. We need to look past ADG and examine protein, fat, and water. Molano and Van Amburgh (unpublished) report empty body weight protein and fat invert at about 500 lbs. BW, i.e., carcass is higher protein and lower fat prior to this target weight and then it flips post 500 lbs. where fat content as percent of empty BW exceeds protein. Rodrigo pointed out we need to do a better job reporting full details of starter grain diets in published papers, why more details on lactating cow diets and fewer on growing heifer diets? 3 spoke on behavior-based research – Dr. Joao Costa discussed phase 1 first 6 weeks is far different than the weaning phase explaining data showing the tremendous variation between calves in starter intake leading up to and through weaning. Can personality explain some of this individual variability. 1217 (grain portion of oral)

4. *Whole cottonseed in starters?* Calves were fed CMR at 8 L/d (12.5% solids) from d 2 to 54 and weaned gradually over a 10 d period feeding 4 L/d in one feeding down to 1 L. Calves were offered grain either void or with 8% whole cottonseed. Blood samples and weight measures taken d 0, 2, 7, 21, 65, and 80. TMR and hay was offered from d 56 onward. No further details of CMR, starter grains, TMR, or hay were provided. Calves fed starter containing cottonseed were 13.3 lbs. heavier at weaning (181.8 vs. 168.5 lbs. BW; no P value provided) and were also 14 lbs. heavier at the end of the post-weaning period (224.6 vs. 210.6 lbs. BW; P<0.05). Calves fed starter containing cottonseed consumed more concentrate from d 60 to 72 (5.4 vs. 4.5 lbs./d; P<0.05) and spent more

time ruminating the first week post-weaning (408 vs. 308 ±34 min/d; P<0.05). Calves fed the cottonseed starter noted increased BHB (P<0.05), fructosamine (P<0.05), alkaline phosphatase (P<0.05), beta-carotene (P<0.05), and tocopherol (P<0.05) and tended increased glucose (P=0.08), lesser urea (P=0.07), tended increased paraoxonase (P=0.10), and tended increased ceruloplasmin. Author concludes addition of whole cottonseed in starters fed early in life results in lower oxidative stress and inflammation, better energy metabolism, improved liver functionality and quicker rumen development. Changes occurred post-wean. No effect on ADG suggesting better feed efficiency. n=? (number of calves never mentioned). U degli studi di Messina, Polo U dell'Annunziata, and U Cattolica del Sacro Cuore, Italy. 1081W.

5. *New NASEM starter guidelines: Jim Drackley PhD U of Illinois*: Chapter 10 in Nutrient Requirements of the Young Calf (NASEM). Key changes pertaining to starter grain: 1.) empty body weight is used for all calculations, 2.) starter intake estimation equations are updated, 3.) energy requirements are updated using composition of empty body weight gain, 4.) the calculation of feed energy values is revised, 5.) A new metabolizable protein system is adopted. Empty body weight is 0.94 live body weight when feeding milk only, 0.93 live body weight when milk + starter, and 0.85 live body weight for a weaned calf. Dry Matter Intake: calves less than 143 lbs. consume ~2.25% of BW as milk solids if fed ad lib, and greater than 143.3 lbs. consume ~2.5% of BW as milk solids if fed ad lib. Calves less than 8 weeks of age fed limited amounts of milk and ad lib grain consumed 1.93 ±0.33% of BW as total DM (219 treatment means from 64 studies). Weaned calves greater than 8 weeks of age consumed 3.06 ±0.31% of BW (79 treatment means from 27 studies). Prediction equations of starter intake were compiled from 26,952 observations from 1,356 calves from 28 studies carried out in 4 US states (GA, Ill, Mn, Oh) and the Netherlands (n=2,350). An external data set (n=8,891 individual observations, 9 studies) was developed to evaluate and validate the model using data from 4 USA states (IA, NH, NY, and VA). Equation in temperate conditions: Starter DMI (g/d) = -652.525 (negative intercept) + (BW x 14.734) + MeiLD x 18.896) + (Fpstarter x 73.303) + FP starter^2 x 13.496) – (29.614 x Fpstarter x MEiLD). Explanation of this formula: Negative intercept + (body weight x factor) + (metabolizable energy from the liquid diet, i.e., milk energy intake x factor) + (age in weeks from first presented starter x factor) + (same age in weeks squared x factor) – (a formula and factor that relates to the interaction between metabolizable energy from the liquid diet and age in weeks from first presented starter). Root means square error of this formula is 262 g/d and a concordance correlation coefficient of 0.71. Separate equations were established for subtropical environments from 3,491 observations from 853 calves from 15 studies conducted in Florida, Georgia, or Brazil (n=2,185). An independent data set (n=479 individual observations in 5 studies from data from Georgia (n=96) and Brazil (n=383)) was used to validate the models. Predicted equations for starter intake for calves in subtropical environments defined as greater than 95 F (35 C): Starter dry matter intake (g/d) = 600.053 x (1 + 14863.651 x (exp (-1.553 x first presented (FP) starter)))$^{-1}$ + (9.951

x body weight) – (130.434 x milk energy intake (MeiLD)). Root means square error of this formula is 22 g/d, and concordance correlation coefficient of 0.78. Features of the calf model: based on energy allowable growth, protein requirements are calculated as maintenance + body nitrogen deposition at the energy-allowable growth rate and the prediction of retained energy, i.e., net energy, is central to the performance of the model. Data from 111 treatment means from literature note that in the bottom and medium tertials (i.e., thirds) of ADG values in this data set, there is over-estimation of ADG with the NRC 2001 model, however, estimates are quite accurate for the highest gaining (top third) ADG individuals. In the same 111 treatment means, when the calves in the respective study were fed milk only, the estimates of ADG using the NRC 2001 model were quite accurate, as were the estimates of ADG in weaned calf, however, there was significant over-estimation of ADG when calves were fed milk + starter between observed and predicted ADG values. Why this disparity? Data for the ME equation was derived from Toullec (France) veal studies, i.e., in heavier calves fed milk only, resulting in estimates of efficiency converting metabolizable energy to retained energy is too high for lighter weight growing heifer calves depositing primarily protein (muscle) tissues. This points towards the need to understand the composition of body weight gain to determine retained energy. Comparative slaughter studies were evaluated utilizing the formula: retained energy equals metabolizable energy intake minus heat production (the difference between measured retained energy and metabolizable energy intake). Since NRC 2001 publication, 7 calf studies (Cornell, U of Illinois, VA Tech; 6 Holstein and 1 Jersey; 2 with starter and 5 w/o starter; 6 published and 1 PhD thesis) measured body composition and changes from baseline and these were used to derive new NASEM maintenance energy values, the relationships between retained energy and empty body weight gains and metabolic body size, efficiencies of metabolizable energy use, and rates of nitrogen deposition. To calculate maintenance requirement Ferrell and Jenkins, 1998 formula was used and in this formula these data sets of 7 studies were evaluated. There was correlation between heat production and metabolizable energy intake (both expressed on a metabolic bodyweight basis) within the data set. Bottom line: the observed minus the predicted values are close and the residuals show no sign of mean or slope bias. The resulting net energy (a.k.a. retained energy) of maintenance (NEm) values was 0.077 Mcal per kg of empty body weight raised to 0.75 power. This formula is expressed as NEm, Mcal/kg EBW^0.75=0.077. The metabolizable energy value of maintenance was 0.107 Mcal per kg of empty body weight raised to the 0.75 power and this formula is expressed as MEm, Mcal/kg EBW^0.75=0.107. The net energy values using the same data set of 7 calf studies and putting these values into the Ferrell and Jenkins, 1998, formula, resulted in net energy for maintenance of 0.077 Mcal per kg of empty body weight raised to 0.75 power and this formula is expressed as NEm, Mcal/kg EBW^0.75=0.077, and metabolizable energy used for maintenance of 0.107 Mcal per kg of empty body weight raised to 0.75 power and this formulas is expressed as MEm, Mcal/kg EBW^0.75=0.107. The net energy maintenance values for subtropics are considerably lower than those used in NRC 2001 (0.086 vs. 0.077 Mcal/kg of empty body weight$^{0.75}$) but maintenance ME is very similar to those used in the NRC 2001 model (0.107 vs. 0.101 Mcal/kg BW$^{0.75}$). The new lower NEm is consistent with other systems in the world and with data from Silva et al 2017 (Brazil). For weaned calves NEm=0.097 Mcal/kg EBW$^{0.75}$ and maintenance ME=0.138 Mcal/kg (empty) EBW$^{0.75}$ or 0.117 Mcal/kg BW$^{0.75}$. The maintenance energy in weaned calves is greater than NRC 2001 but lower than in other systems and lower than in the new Beef NASEM (2016). Environmental temperature effect on maintenance requirements: +2.01 kcal/kg$^{0.75}$ per day for each degree of environmental temp (degree C) below the critical lower temp (15 C, which is 59 F for calves less than 3 weeks age or 5 C, which is 41 F for calves greater than 3 weeks of age) or above the upper critical temperature of 25 C (77 F). These adjustments for cold are the same as those used in NRC 2001, however, the heat stress adjustments are new based on the linearization of the qualitative scale used by the NRC 2001 for heifer growth. Examples were shown for heat stressed calves 40 C (104 F) increased maintenance energy needs +524 kcal of NEm/d which is +28% for calves less than 3 weeks old and +30% for calves greater than 3 weeks old when compared to NRC 2001. 35 C (95 F) was +19% for calves less than 3 weeks old and +20% for calves older than 3 weeks old. What about smaller calves like Jerseys? Smaller calves have a greater surface are to mass ratio and those lose more heat and must have a higher metabolic rate. A formula from Brody, 1945, reports surface area = 0.14 x BW$^{0.57}$. However, in absence of data the committee chose not to make separate recommendations for small breed calves. Retained energy gain (Net energy gain) to body weight gain, what equation links these two? The committee selected this: retained energy, Mcal/d=(empty body weight gain$^{1.100}$, kg/d) x (empty body weight$^{0.205}$). In an analysis of observed values and predicted values of retained energy, the R^2 was 0.8502, thus this equation is a good fit with the least bias and lowest root mean square error and the calculations included the random effect of study. If we compare these same studies in the NRC 2001 model equation the observed vs. predicted results are far less correlated and quite poor, so the calculations of retained energy in the new NASEM model are a real step up in young calves. The data points from the 7 studies that were fed milk only were used to plot the correlation between retained energy (Mcal/d) and metabolizable energy (Mcal/d) used for gain and R^2 was 0.8682 and efficiency was 43.8% and if corrected for metabolic body weight was 46%. A summary of older studies that were used as the basis for NRC 2001 was 69% and INRA (France) in 2019 used 55%. The committee chose 55% to represent all calves, i.e., a compromise between the findings in the data set evaluated for NASEM 2021 and the INRA findings in 2019. It was pointed out efficiency from calves fed milk + starter is lower. Efficiency of ME use is reported as NEg/ME and the formula used in NASEM for starter grain is NEg, Mcal/kg DM = (1.1376 x ME) – (0.1198 x ME^2) + (0.0076 x ME^3) – 1.2979 (this formula is from Galyean et al, 2016, which is also the foundation for the beef NASEM requirements). Over a typical starter grain energy value range of 2.5 to 3.5

Mcal/kg, the retained energy to metabolizable energy (the efficiency value) varies from 0.38 to 0.44. The efficiency of a mixed diet (milk + starter) is additive. Calculating the proportions of fat and protein in gain: fat in empty body weight gain = 0.0786 + 0.0370 x retained energy, Mcal/d; protein in empty body weight gain = 0.1910 – 0.0071 x retained energy, Mcal/d. At the mean retained energy for the data set (1.456 Mcal/d), predicted proportions of fat and protein in empty body weight gain are 0.132 (13% fat) and 0.181 (18% protein). This was reported in strong agreement with literature values. NASEM 2021 adopted the use of metabolizable protein (MP) instead of apparently digestible CP (ADP) as was used in NRC 2001, and this new value equals the true protein digested and absorbed in the gastrointestinal tract. Metabolizable protein for maintenance is relatively small and was calculated similarly to NRC 2001 except for addition of scurf protein and reduced efficiency of use (0.68 vs. 0.80) for scurf and metabolic fecal protein (MFP). Equations used were scurf crude protein, g/d = 0.22 x $BW^{0.60}$, endogenous urinary crude protein, g/d = 2.75 x $BW^{0.50}$, and metabolic fecal protein, g/d = (11.9 x liquid feed DMI, kg/d) + 20.6 x starter feed DMI, kg/d), and these three combines to form metabolizable protein for maintenance. Nitrogen composition of the gain in NRC 2001 used mean value of 30 g N (188 g CP)/kg of liveweight gain from Blaxter and Wood, 1951; Roy, 1970; and Donnelly and Hutton, 1976. The committee reevaluated this using the same development database and using the Beef NRC equation format: Net Protein Gain (NPg) = (166.2 x empty body weight gain, kg/d) + (6.1276 x (ratio of retained energy (RE), Mcal/d / empty body weight gain, kg/d)). The values of this beef equation are like those in NRC, 2001. A review of the literature shows that the efficiency of use of absorbed amino acids for body weight gain decreases with age: efficiency of metabolizable protein for gain = 0.70 – 0.532 x proportion of mature body weight. This compared with 0.8 in NRC, 2001. So, the efficiency of use of metabolizable protein for net protein is significantly reduced in the new NASEM 2021 vs. the old NRC 2001. Conversion of crude protein to metabolizable protein is 0.95 for milk crude protein, 0.75 for starter protein digested postruminally, and 0.70 for dry feed digested with a functioning rumen (weaned calves). "For calves fed milk and starter, conversion is the weighted average of the values for milk and starter." These values were retained from NRC 2001 because of lack of data to justify changing them, particularly considering the need to model rumen degradable and rumen undegradable protein in the rapidly developing rumen of the young calf. Regarding vegetable proteins in CMR, research shows increased endogenous losses of protein in feces. This fecal loss "necessitates re-calculation of metabolic fecal CP to 34.4 g/kg DM from 11.9 g/kg DM from milk replacer," and a switch in the model facilitates automatic calculation if a user chooses to. This results in a slight increase in maintenance protein and a general increase in overall requirements if vegetable proteins are used in milk replacers. Separate tables of requirements regarding different body weight and growth rates are provided for 1.) calves fed milk or milk replacer only, 2.) calves fed both milk and starter, 3.) weaned calves, and 4.) veal calves. Example: a 110 lbs. Holstein calf raised in thermoneutral conditions fed CMR containing 4.57 Mcal/kg DM, based on the NASEM equation CP needs increases from 18.2% to 25.5 (% of DM) comparing a 200 g/d gain and a 1000 g/d gain. In the same scenario, DMI required increases from 560 to 1,240 g/d, ME (Mcal/d) increases from 2.56 to 5.66, and CP (g/d) increases from 102 to 315. Protein requirements are slightly lower in NASEM 2021 as compared to NRC 2001. To calculate the feed metabolizable energy content of milk replacer the following formula is used: Gross energy (GE), Mcal/kg DM = ((FA x 9.3) + (protein x 5.7) + (100 – protein – fatty acids – ash x 4)) / 100. The 100 – protein – fatty acids – ash equation determines the carbohydrate content. Fatty acid content is determined by multiplying fat content by 0.945. Other components than lactose, such as hydrolyzed starch, dextrins, glucose or glycerol, the model assumes gross energy value of ~4 Mcal/kg. The committee recommends that ash content be measured so carb content can be calculated accurately, and a reminder that fat and CP are listed on the label on an "as-is" basis. The model assumes 100% dry matter. Metabolizable energy is found by multiplying gross energy by a factor of 0.91 (digestible energy = 0.95 gross energy, and metabolizable energy = 0.96 digestible energy. Whole milk metabolizable energy value is calculated using 0.93 gross energy, which is a slightly higher digestible energy as compared to CMR. Calculation of feed energy values from solid feed: "DE (digestible energy) is calculated similarly to other classes of cattle, except that fat digestibility is assumed to be 0.81 rather than 0.74." A summary of 7 studies and 37 treatment means where fat digestibility was measured showed a mean of 217.6 lbs., 76 days age, 5.5 lbs. starter intake, 4.0% dietary fat resulted in a fat digestibility of 0.81 (range 0.7 to 0.91, SD 0.05). "ME (metabolizable energy) is calculated as DE x 0.93." Unlike with older cattle, there is no discount on digestible energy for increased intake or starch concentrations. Chapter 3 discusses how starter should be analyzed and a recommendation includes analyzing for digestible NDF (NDFD48, i.e., at 48 hours). An option to use a discounted (10%) metabolizable energy value for calves consuming large amounts of milk (i.e., greater than 1.5% of BW as solids) is inserted into the model. Why? Because research shows (Quigley et al, 2018, 2019) that "actual ME obtained from digestion may be slower than calculated value if rumen is not fully developed." This is common in calves fed large amounts of milk. **Validation of the model**: 397 treatment means from 94 published studies including studies before and after NRC 2001 and that represented a range of milk or milk replacer intakes, starter intakes, forage and no forage, and a range of ADG were evaluated. Predicted ADG using NASEM formulas were compared to actual ADG reported in the published studies. Observed vs. predicated ADG had high correlation: predicted mean = 0.697 kg/d, actual mean = 0.689 kg/d. There was a tight fit to the line in the graph and Jim reported there was no mean bias or slope bias in the data set. The root mean square error was 0.110 kg/d (15.9% of the mean), and the concordance correlation coefficient was 0.95. "A robust prediction of calf gain." The ADG values comparing actual means from 111 treatment groups from literature to those predicted by either the NASEM 2021 or NRC 2001 models, shows a much closer prediction to actual when using NASEM vs. NRC in slower gaining calves (approximately 400 g/d) and also much closer prediction to actual in moderate growth calves (approximately 700 g/d) and the same high level of accuracy for NASEM as is with NRC in high growth calves (approximately 1000 g/d). NASEM is more accurate predicting ADG in lower and moderate growth calves. In the same 111 data set, studies with calves fed milk only or in the case of weaned calves, showed high accuracy of predicting ADG for both NASEM and NRC, and the new NASEM formulas helped bridge the gap of accuracy between estimated ADG that was observed and that of NRC when calves were fed mixed milk + starter diets. Some diet and calf examples: 110 lbs. calf fed 1.21 lbs. 20/20 CMR and consuming 1.23 lbs. grain predicted growth in NASEM is 580 g (1.278 lbs.) vs. in NRC 2001 is 670 g (1.48 lbs.) ADG. Another example: 110 lbs. calf fed 1.0 kg (2.2 lbs.) 28/20 CMR and consuming 200 g (0.44 lbs.) grain, predicted growth using NASEM is 880 grams (1.94 lbs.) and using NRC is 960 grams (2.11 lbs.). NASEM Committee reported by Jim Drackley PhD of U of Illinois. 1381.

Veal (2 Abstracts)

1. *Outdoor veal calf production in Switzerland.* Intervention study comparing health performance on 19 intervention farms implementing “outdoor veal calf guidelines” compared to 19 control farms in the same region implementing present Swiss animal production standards. The “outdoor veal calf guidelines” include: 1.) direct purchase from dairies to fattening farms, no cattle traders that mix calves, 2.) all were offered facility with individual hutches for 3 weeks where they could be quarantined and vaccinated, and 3.) an outdoors facility with a roof but little or no walls for older calves with a bedded and covered igloo like facility to get out of the weather with max of 10 calves per group. 4.) all intervention farms were provided automatic mixing and transport system for feeding milk. Farms were observed for 1 year, compared performance data, and involved a monthly visit by technicians. Intervention farms reared fewer calves per year (p=0.002. 41 vs. 54 annually). % purchased and mean age at purchase (30 and 33 d) were not different, however, mean transport distance was 19 km for intervention group vs. 28 km for control farms (P=0.007). No difference in farms of origin per 10 calves (2.2 vs. 3.0), proportion of male calves (77 vs. 72%), or dairy breeds (33 vs. 27%), or mean duration of fattening period (121 vs. 116 days). Farm treatment incidence was lesser for intervention farms, 5.9 vs. 31.5 (defined daily doses/animal/year; P<0.001), mean farm treatment incidence for individual treatments was reduced in intervention farms at 3.4 vs. 7.9 (mean farm treatment incidence for individual treatments; P=0.025), and mean farm treatment incidence for group treatments was less in intervention farms at 2.5 vs. 23.6 (P<0.001), % calves treated was less at 15.1 vs. 56% (P<0.001) and % mortality was less at 3.1 vs. 6.3% (P=0.02). Mean ADG was NSD at 2.84 vs. 3 lbs. per calf per day for intervention and control groups, respectively. Preslaughter prevalence of respiratory symptoms noted lesser (P<0.001) calves coughing in young calves, lesser (P<0.001) cough in older calves, NSD in incidence

of nasal discharge in young calves but lesser incidence in nasal discharge (P<0.001) in older calves (based on farm visit days by technicians). NSD in depth of bedding, or cleanliness of bedding, but calves in intervention farms were cleaner (P=0.02) and less incidence of slipperiness of floors (P<0.001) (again, data collected by technicians during their monthly visits). Hay was equally available to both farm systems. NSD in emaciation, loss of hair, defective coats, ocular discharge, perianal alopecia, diarrhea, cough, or dirty coat, low incidence of all except diarrhea (data collected from technician visits). Postmortem indicators: 65 to 72% had lesions in abomasum with NSD in groups, % of calves with lesions on lungs were lesser (26% vs. 46%; P<0.001) in calves from intervention farms and signs of pneumonia were lesser (3% vs. 11%) in calves from intervention farms (P<0.001). n=38 farms. U of Bern, Switzerland. Vet Public Health Inst, Switzerland. 1038.

2. *How does antimicrobial susceptibility in E coli and Pasteurella differ at the beginning and end of veal production comparing “outdoor veal” calf and conventional operations?* Same outdoor veal situation as prior abstract (1038). Animal-level treatment recording was collected in the data set from abstract 1038 comparing 19 farms following new “outdoor veal” production system (direct farm purchased, 21-day quarantine in individual hutches, and outdoor fattening maximum 10 calves per group) vs. traditional Swiss method of veal production adhering to present Swiss animal welfare laws. With the 5-fold reduction in antimicrobial and associated mortality cut in half with the “outdoor veal” system (as reported in abstract 1038), is there a difference in antimicrobial resistance? Nasal and rectal swabs were taken on individual calves at calf placement and just prior slaughter. 7012 samples isolated for E coli and Pasteurella. P multocida was identified from nasal swabs at calf placement from 21.1% and 34.2% of the calves in the “outdoor veal” and conventional veal calves (P<0.001), respectively, and at slaughter from 59.6% and 66.7% of the calves in the “outdoor veal” and conventional veal calves, respectively (P<0.001). M. haemolytica was found in 7.2% and 5.2% at calf placement (P=0.004), and in 18.9% and 17.6% at finish in “outdoor veal” and conventional rearing systems (P=0.25), respectively. The prevalence of resistant isolates to E coli was 55.6% and 55.5% for tetracyclines and sulfamethoxazole, respectively. The prevalence of resistant isolates to P. multocida was 71.9% and 57.1% for oxytetracycline and spectinomycin, respectively. The prevalence of resistant isolates to M. haemolytica was 16.7% and 4.2% for oxytetracycline and penicillin, respectively. How did AB resistance vary between “outdoor veal” and conventional production? In fecal swabs taken at slaughter, there were higher odds (logistic regression showed +65%, P=0.022) of E coli being susceptible to the antibiotic treatment (i.e., not resistant) in calves reared in the “outdoor veal” rearing system compared to conventional rearing. Also noted lower odds of multidrug-resistant isolates (-65%, P<0.001) and low number of resistances (-16%, P=0.009) to E coli at slaughter in calves reared in the “outdoor veal” scenario. P multocida followed suit but to a greater extent, and included swabs taken at calf placement, too. Prior slaughter odds were greater for no AB resistance (+990%,

P=0.009) in "outdoor veal" compared to conventional when isolating P. multocida. M. haemolytica noted no differences in AB resistance between the production systems. As the number of antimicrobial treatments increased, regardless of the disease (E coli, M haemolytica), the proportion of resistant isolates increased. If E coli was treated by tetracyclines more than 1x, odds ratio of antimicrobial resistance increased by 1.86 (P<0.001). If E coli was treated with ampicillin more than 1x, then odds ratio of AB resistance was 1.66 (P=0.014) and if P. multocida was treated with spectinomycin more than 1x, odds ratio of resistance increased to 3.66 (P=0.074). n=7,012 isolates analyzed from rectal or nasal swabs. U of Bern, Switzerland. Vet Public Health Inst, Switzerland. 1039.

Vitamin and trace mineral nutrition (3 Abstracts)

1. *How does vitamin A, D3, and E status impact blood parameters in pre-weaned transported calves?* Intro: calves are born virtually deficient in fat-soluble vitamins. Retinol is critical for vision, bone formation, immunity, and tissue growth. Calcidiol is important for calcium metabolism and immune function. Alpha-tocopherol important as an antioxidant and to protect PUFA (polyunsaturated fatty acids). The study: calves originating from 13 different farms in Minnesota were transported to a calf ranch in New Mexico. Blood samples were collected after transport at 7 d age. "Plasma concentrations of beta-carotene, retinol, alpha-tocopherol, and 25-hydroxyvitamin D3 were measured. Calves with concentration of each vitamin in the bottom third range scored 0 point, in the middle third range scored 1 point, and in the top third range scored 2 points. Calves that sum to a total of less than 3 points were classified as having a low vitamin status (LowADE; n=114"; 43% of calves). Calves with score of 3 or greater (n=151; 57%) were classified as HighADE. "Plasma was analyzed for total protein, haptoglobin, serum amyloid A, albumin, globulin, Ca, Mg, P, Na, K, Cl, Zn, insulin, glucose, blood urea nitrogen, creatinine, bilirubin, red blood cells, neutrophils, lymphocytes, and monocytes." The LowADE group averaged 0.048 microgram/mL, 173.2 nanogram/mL, 14.7 nanogram/mL, and 3.0 microgram/mL for beta carotene, retinol, 25-hydroxyvitamin D3, and alpha-tocopherol, respectively. The HighADE group averaged 0.084 microgram/mL, 258.5 nanogram/mL, 19.0 nanogram/mL, and 5.3 microgram/mL for beta carotene, retinol, 25-hydroxyvitamin D3, and alpha-tocopherol, respectively. Haptoglobin was decreased (P=0.02; 117.1 vs. 78.0 mg/dL) in the HighADE group. Also, serum amyloid A was reduced (4.8 vs. 3.3 g/dL; P<0.001) in the HighADE group. ADE status effected these two acute phase proteins that are inflammation markers. Zinc was reduced (20.8 vs. 18.9 microgram/dL; P=0.04) in the HighADE group. Red blood cells were reduced (8.1 vs. 7.8 10^6/microliter; P=0.05) in the HighADE group. Neutrophils were reduced (42.9 vs. 40.7%; P=0.04) in the HighADE group. "Protein metabolism marker, including blood urea nitrogen (11.0 vs. 10.0) and bilirubin (0.27 vs. 0.24) were increased (P<0.05) in LowADE compared with HighADE calves. There was linear (P<0.001) correlation between plasma beta carotene concentration and the

concentration of retinal, 25-hydroxyvitamin D3, and alpha-tocopherol. There was linear (P<0.001) concentration between plasma retinol and alpha-tocopherol. There was linear (P=0.001) concentration between 25-hydroxyvitamin D3 and alpha-tocopherol. There was linear (P=0.04) concentration between plasma retinol concentration and 25-hydroxyvitamin D3. NSD noted in Ca (P=0.52) or Mg (P=0.654) status or in total protein (P=0.80), albumin (P=0.82), globulin (P=0.57), neutrophils (P=0.14), lymphocytes (P=0.18) or monocytes (P=0.16) between HighADE and LowADE status calves. n=265. K-State U. 2205T.

2. *Bypass b-vitamins supplemented during weaning?* Holstein heifer calves sorted by calving date and split into 4 consecutive batches of 20 calves each were supplemented (batch 1 and 3) or not (batch 2 and 4) with 3 g/d at weaning of a b-vitamin blend (Jefo) that contains B1 (thiamine), B5 (pant acid), B6 (pyridoxine), B8 (biotin) and B9 (folic acid). No further details of the b-vitamin product were provided. Calves within each batch were born within 2 weeks. The trial was conducted on a commercial dairy located in Hungary. Dam's milk was fed d 0 – 4 and CMR (17% solids) d 5 – 67 at 6 L/d; 2 x 3 L/fdg, and d 68 – 75 at 3 L/d; 2 x 1.5 L/fdg. Concentrate (20.4% CP, 6.8 Mcal/kg DM; 37% triticale, 30% corn, 23% SBM, balance premix and minerals) was offered ad lib d 10 – 30, and "mash" (18.3% CP, 5.5 Mcal/kg DM; 15% triticale, 15% corn, 22% SBM, 6% premix and minerals, 6% straw, and 37% grass hay) was offered ad lib d 31 – 75. TMR (16.6% CP, 5.98 Mcal/kg DM; 10% triticale, 10% corn, 14% SBM, 4% premix and minerals, 4% wheat straw, 23% grass hay, and 35% corn silage) was provided d 76 to 96. The b-vitamins were added 21 d prior to wean and for 21 d post wean, either in mash prewean or in TMR post wean. Complete weaning occurred d 75. Data was collected during the 6-week period of feeding the B-vitamin supplement. Calves were weighed 3 weeks prior to wean (d 53 STD ±4.9; 158.7 lbs. STD ±19 lbs.) and 3 weeks post wean (d 96). B-vitamin supplemented calves outgained those not supplemented. Total BW gain +26% (P<0.001), +18.6 lbs. ADG +22% (P<0.001), +0.39 lbs./d (178 g/d). Final BW +7% (P<0.001). No details on health provided. No further details on growth provided. No G:F information provided, I assume, intakes not collected. Hungarian U of Ag and Life Sci. ADEXGO, Hungary. AlZahal Innovation and Nutrition, Ontario; Jefo Nutrition, Quebec. n=80. 2312W.
3. *New NASEM 2021 vitamin and trace mineral recommendations*. New requirements should be viewed as "adequate intakes" (a.k.a. AI) rather than requirements. These are the best predictions of an adequate intake that will meet the requirements of most calves. "For recommended concentrations in trace minerals AI were calculated for 20 different body weight and ADG combinations and averaged," and, results were similar to concentrations in whole milk." "For starter, requirements calculated for weaned calves weighing 110 kg and 60 kg and gaining 0.5 to 1.2 kg/d." For CMR macro minerals Ca % was 1.0% and 0.8% for NRC and NASEM, respectively, for P % 0.70% and 0.6% for NRC and NASEM, respectively, for Mg 0.07 and 0.15%, for NRC and NASEM, respectively. For starter grain Ca % was 0.7% and 0.75% for NRC and NASEM, respectively, for P %

was 0.45% and 0.37%, respectively, for Mg % was 0.1 and 0.15%, respectively. Potassium increased substantially in CMR from 0.65 to 1.1% in NRC and NASEM, respectively, whereas Sodium % stayed stable at 0.4% in both. Chloride recommendations in CMR increased from 0.25% to 0.32% in NRC and NASEM, respectively. For the starter, K decreased slightly from 0.65% to 0.60% for NRC and NASEM, respectively, Na % increased from 0.15% to 0.22% for NRC and NASEM, respectively, and chloride decreased from 0.2% to 0.17% for NRC and NASEM, respectively. Cobalt requirement was deleted from the CMR because cobalt is only required to form vitamin B12 in the rumen. Cobalt requirement was doubled in the starter from 0.1 to 0.2 ppm in NRC and NASEM, respectively. Copper requirement was cut in half from 10 to 5 ppm in the CMR due to estimates of increased Cu availability in whole milk and milk ingredients in milk replacer and increased from 10 to 12 ppm in the in the starter grain. Iodine was increased from 0.5 to 0.8 ppm and from 0.25 to 0.8 ppm in starter grains, no explanation offered. Iron slightly decreased in CMR from 100 ppm to 85 ppm in NRC and NASEM, respectively, and slightly increased in starter from 50 to 60 ppm in NRC and NASEM, respectively. Manganese was substantially increased in CMR from 40 ppm to 60 ppm in NRC and NASEM, respectively, and maintained at 40 ppm in starter grain (for both). Se was kept at 0.3 ppm in all feeds. Zinc was increased in CMR from 40 ppm to 65 ppm and in starter from 40 ppm to 55 ppm for NRC and NASEM, respectively. Recommended vitamin allowances were maintained at 11,000 IU/kg in CMR solids, however, 9,900 IU/kg was recommended for calves consuming >1 kg CMR solids per day. For vitamin A the "AI" (adequate intake) is recommended as 110 IU/kg bodyweight. Vitamin D3 is recommended at 3,500 IU/kg milk replacer solids (increased slightly), and the AI = 32 IU/kg bodyweight. Vitamin E recommendation is increased substantially to 200 IU/kg milk replacer solids (125 IU/d) and AI = 2.0 IU/kg body weight. No changes in b-vitamins or choline in milk replacers because of the absence of any new data.

Weaning (1 abstracts)

1. *Oxylipids are created from polyunsaturated fatty acids and promote or resolve inflammation. How does weaning stress impact creation of oxylipids?* Holstein calves housed in hutches were ramped up within 7 d of birth to 2.64 lbs./d CMR and were weaned at either 35 d or 49 d and either abruptly over 3 d (4 step-downs) or gradually (7 step-downs) over two weeks in a 2 x 2 factorial study design. Grain and alfalfa hay was offered ad lib. Blood samples day before starting weaning process and again one day post-weaning. Pro-inflammatory compounds from linoleic acid (9-HODE, 13-HODE, and 12,13-EpOME) were not different between the four groups, however, two anti-inflammatory compounds derived from linoleic acid (9-OxoODE & 13-OxoODE) were lesser in calves that were gradually weaned as compared to those abruptly weaned ($P=0.03$ and $P<0.01$, respectively). 9, 10-EpOME pro-inflammatory compound derived from Linoleic acid tended lesser in gradual weaned calves, and 9,10-DiHOME pro-

inflammatory compound derived from Linoleic acid was greater (P<0.01 and P=0.02, respectively) in gradual weaned and in later weaned calves. Pro-inflammatory 12,13-DiHOME derived from Linoleic acid was greater in later weaned (P=0.02) and gradual weaned (P<0.01) calves. Anti-inflammatory compound 17,18-DiHETE derived from EPA noted lesser concentrations in calves gradual weaned. Anti-inflammatory 11,12-EET compound derived from Arachidonic acid tended (P=0.10) lesser in late weaned calves and in gradual (P=0.09) weaned calves and 11,12-DHET anti-inflammatory tended (P=0.08) lesser in later weaned calves and in gradual weaned calves (P=0.04). No effect in anti-inflammatory derived from Arachidonic acid, however, pro-inflammatory 11-HETE compound noted an age x pace interaction (P=0.09) where abrupt/early noted increased concentrations as compared to late/abrupt weaning. Bottom line: Abrupt weaning increased 4 anti-inflammatory oxylipids and increased one and decreased two pro-inflammatory oxylipids, probably due to more PUFA's available in the system because adipose tissue is being broken down. Early weaned calves noted 2 increased anti-inflammatory oxylipids from arachidonic acid and 2 decreased pro-inflammatory oxylipids derived from linoleic acid. n=72. U of Idaho. U of Alberta, Edmonton. 1040.