Station Reports
NCCC210 Mtg., San Diego 2014
Sean Adams (Chair), Brynn Voy (Co-Chair)

General Highlights

- NCCC210 member and *ad hoc* Attendees: Kola Ajuwon, Min Du, Werner Bergen, Stone Ding, Brynn Voy, James Kinder, Sean Adams, Kim Barnes, Theo Van Kempen, Jack Odle. An especially positive note is that ten (10) students/postdocs were in attendance.

- NCCC210 meeting was supported in part by the American Society for Nutrition (ASN).

- It was highlighted that the NCCC210 group spearheaded the development of a symposium "Adipose and Lipid Biology: Crossing Taxonomic Boundaries" held at the Experimental Biology 2013 meeting, 4/19/2013 in Boston, MA. This symposium led to several papers in Advances in Nutrition. The symposium was sponsored by the American Society for Nutrition and supported in part by Proctor & Gamble Pet Care, Nutreco, the North Central Regional Association (NCRA) of Agricultural Experiment Station Directors (NCCC-210 Multi-State Project), the USDA-ARS WHNRC and Human Nutrition National Program NP-107.

- The Committee renewal was submitted and approved prior to the meeting, and thanks go to Werner Bergen and James Kinder for spearheading that important effort.

- The Committee agreed that a target should be that each year, whenever possible there be an Incoming Chair and Chair, and that the Incoming Chair rotate into the Chair position the following year. For the 2015 meeting, by unanimous vote Theo van Kempen was chosen as Incoming Chair, with Brynn Voy as Chair. Dr. Kinder shall continue in the role of NCCC210 Administrative Lead.

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Report 1

USDA-ARS Western Human Nutrition Research Center and UC Davis (WHNRC; Sean H. Adams)

Project Report: The Davis group has leveraged metabolomics to determine metabolic "signatures" specific to metabolic health and disease in obesity, insulin resistance, and type 2 diabetes. Recently, studies have been conducted to determine if blood metabolite patterns in humans track magnitude of weight loss following intervention with a calorie-restricted, fully-controlled diet. Those metabolites that correlate to high- vs. low-weight loss phenotypes were described. In addition, experiments highlighting that resistant-starch-associated changes in the gut microbiome correlate with host liver metabolome in diet-induced obese mice were presented. The results suggest that signals from the gut can act on the liver (directly or indirectly) to alter metabolic physiology, and that diet can strongly influence these signals.

Published or Accepted papers (since last NCCC210 meeting):

1. **S.H. Adams***, K.M. Barnes, and J. Odle*. Comparative Metabolic Physiology in the 'omics' Era: A Call to Arms, Paws, Flippers, and Claws (Chairs' Summary, "Adipose and Lipid Biology: Crossing Taxonomic Boundaries" Symposium, Experimental Biology 2013, in Boston, MA). *Advances in Nutrition*, 4(5):568-9, 2013
2. C. Aguer, O. Fiehn, E.L. Seifert, V. Bezaire, J. Meissen, A. Daniels, K. Scott, J-M. Renaud, M. Padilla, D. Bickel, M. Dysart, **S.H. Adams***, M-E. Harper*. Muscle UCP3 overexpression mimics endurance training and reduces circulating biomarkers of incomplete beta-oxidation. *FASEBJ.*, 27(10):4213-25, 2013
3. Y. Kadota, Y. Kitaura, **S.H. Adams**, S. Yoshiharu. Regulation of hepatic branched-chain α-keto acid dehydrogenase complex in rats fed a high-fat diet. *Obesity Res. & Clinical Practice*, 7(6):e439-44, 2013
4. B.D. Piccolo, G. Dolnikowski, E. Seyoum, A.P. Thomas, E.R. Gertz, E.C. Souza, L.R. Woodhouse, J.W. Newman, N.L. Keim, **S.H. Adams**, M.D. Van Loan. Association between subcutaneous white adipose tissue and serum 25-hydroxyvitamin D in overweight and obese adults. *Nutrients*, 5(9):3352-66, 2013
5. D.E. Lackey, D.H. Burk, M.R. Ali, R. Mostaedi, W.H. Smith, J. Park, P.E. Scherer, S.A. Seay, CS. McCoin, P. Bonaldo, **S.H. Adams***. Contributions of adipose tissue architectural and tensile properties toward defining healthy and unhealthy obesity. *Am. J. Physiol. Endocrin. Metab.*, 306(3):E233-46, 2014
6. C. Campbell, D. Grapov, O. Fiehn*, C.J. Chandler, D.J. Burnett, E.C. Souza, G.A. Casazza, M.B. Gustafson, N.L. Keim, J.W. Newman, G.R. Hunter, J.R. Fernandez, W.T. Garvey, M-E. Harper, C.L. Hoppel, J.K. Meissen, K. Take, **S.H. Adams***. Improved metabolic health alters host metabolism in parallel with changes in systemic xeno-metabolites of gut origin. *PLoS One*, 9(1): e84260, 2014
7. J. Odle, **S.H. Adams**, J. Vockley. Carnitine. *Advances in Nutrition*, 5(3):289-90, 2014
8. R. Mostaedi, D.E. Lackey, **S.H. Adams**, S.A. Dada, Z.A. Hoda, M.R. Ali. Limited efficacy of pharmacotherapy to treat diabetes mellitus, hypertension, and dyslipidemia in morbidly obese patients. *Obesity Surg.*, 24: 927–935, 2014
9. K.M. Hirahatake, J. Slavin, K.C. Maki, **S.H. Adams***. Associations between dairy foods, diabetes, and metabolic health: potential mechanisms and future directions. *Metabolism: Clinical & Experimental*, 63(5):618-627, 2014

10. M.A. Labouesse, E.R. Gertz, B.D. Piccolo, E. Souza, G.U. Schuster, M. Witbracht, **S.H. Adams**, N.L. Keim, M.D. Van Loan. Adequate dairy intake in a moderate energy-restricted diet prevents weight loss induced bone loss in overweight and obese adults. *Bone*, 64:138-46, 2014

11. J.M. Rutkowsky, T.A. Knotts, K.D. Ono-Moore, C.S. McCoin, S. Huang, D. Schneider, S. Singh, **S.H. Adams***, D.H. Hwang*. Acylcarnitines activate pro-inflammatory signaling pathways. *Am. J. Physiol. Endocrin. Metab.*, 306(12):E1378-87, 2014 (*co-corresponding)

12. T.N. Dunn, A.H. Keenan, A.P. Thomas, J.W. Newman*, **S.H. Adams***. A diet containing a nonfat dry milk matrix significantly alters systemic endocannabinoids and oxylipins in diet-induced obese mice. *Nutr. & Metab.* 11:24, 2014 (*co-corresponding)

13. T.N. Dunn and **S.H. Adams***. Relationships among metabolic homeostasis, diet, and peripheral afferent neuron biology. *Advances in Nutrition*, 14;5(4):386-393, 2014

14. D.K. Layman, T.G. Anthony, B.B. Rasmussen, **S.H. Adams**, C.J. Lynch, G.D. Brinkworth, T.A. Davis. Defining meal requirements for protein to optimize metabolic roles of amino acids. in press, *Am. J. Clin. Nutr.*

Book Chapter

Sean H. Adams* and John W. Newman. Metabolomics: Insulin Resistance and Type 2 Diabetes Mellitus. *International Textbook of Diabetes Mellitus (ITDM), 4th Edition*. Ele Ferrannini, Paul Zimmet, Ralph DeFronzo, George Alberti, Editors. Wiley: Oxford, U.K., *in press*

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Report 2

Washington State University (Michael Dodson, Min Du)

Du Laboratory. My lab continues to focus on studying epigenetic regulation of early adipogenic commitment, focusing on the impact of maternal nutrition on Zfp423 expression and adipogenic commitment, and its long-term impact on the adipose tissue function of offspring. In addition, recently, we also initiate studies on brown and beige adipogenesis. Brown fat burns fatty acids, which has a critical role in preventing obesity.

Dodson Laboratory. The main focus of the Dodson laboratory is to develop isolation methods for mature adipocytes so that individual cells may be cloned in a manner to insure that no (potential) "rider" stem cell may exist in ceiling cultures. His lab continues to study the dedifferentiation of mature adipocytes into proliferative-competent cells.

Publications:

Schmidt, T. B., and M. Du. (2014). Meat Science and Muscle Biology Symposium: Pre-harvest factors affecting the prevalence of *E. coli* O157:H7 in livestock and meat. *Journal of Animal Science*, In press.

Hausman, G.J., U. Basu, M. Du, M.E. Fernyhough-Culver and M.V. Dodson. 2014. Intermuscular (INTMF) and intramuscular (IMF) adipose tissue: Good vs bad adipose tissue. *Adipocyte* 3(3): dx.doi.org/10.4161/adip.28546

Dodson, M.V., M. Du, S. Wang, W. Bergen, M.E. Fernyhough-Culver, Urmila Basu, S.Y. Poulos and G.J. Hausman. 2014. Adipose depots differ in cellularity, adipokines produced, gene expression and cell systems. *Adipocyte* 3(3): dx.doi.org/10.4161/adip.28321

Hausman, G.J., U. Basu, S. Wei, D.B. Hausman and M.V. Dodson. 2014. Preadipocyte and adipose tissue differentiation in meat animals: Influence of species and anatomical location. *Annual Review of Animal Biosciences* 2:323-351

Du, M. (2014). Meat Science and Muscle Biology Symposium – Implants, muscle development and meat quality. Journal of Animal Science, 92: 1-2.

Wei, S., L. Zhang, X. Zhou, M. Du, Z. Jiang, G.J. Hausman, W.G. Bergen, L. Zan and M.V. Dodson. 2013. Emerging roles of zinc finger proteins in regulating adipogenesis. *Cellular and Molecular Life Sciences* 70(23):4569-4584

Fu, X., J.-X. Zhao, M.-J. Zhu, M. Foretz, B. Viollet, M.V. Dodson and M. Du. 2013. AMP-activated protein kinase α1 but not α2 catalytic subunit potentiates myogenin expression and myogenesis. *Molecular and Cellular Biology* 33(22):4517-4525

Fu, X., J. X. Zhao, J. F. Liang, M. J. Zhu, M. Foretz, B. Viollet, and M. Du. (2013). AMP-activated protein kinase mediates myogenin expression and myogenesis via histone deacetylase 5. *American Journal of Physiology – Cell Physiology,* 305: C887-895.

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Yang, Q. Y., J .F. Liang, C. J. Rogers, J. X. Zhao, M. J. Zhu, and M. Du. (2013). Maternal obesity induces epigenetic modifications to facilitate Zfp423 expression and enhance adipogenic differentiation in fetal mice. *Diabetes*, 62: 3727-3735.

Wei, S., M. Du, Z. Jiang, M.S. Duarte, M. Fernyhough-Culver, E. Albrecht, K. Will, L. Zan, G.J. Hausman, E. Elabd, W.G. Bergen, U. Basu and M.V. Dodson. 2013. Bovine dedifferentiated adipose tissue [DFAT] cells: DFAT cell isolation. *Adipocyte* 2(3):148-159

Wei, S., L. Zan, G.J. Hausman, T.P. Rasmussen, W.G. Bergen and M.V. Dodson. 2013. Dedifferentiated adipocyte-derived progeny cells [DFAT cells]: Potential stem cells of adipose tissue. *Adipocyte* 2(3):122-126

Dodson, M.V., S. Boudina, E. Albrecht, L. Bucci, M. Fernyhough-Culver, S. Wei, W.G. Bergen, A.J. Amaral, N. Moustaid-Moussa, S.Poulos and G.J. Hausman. 2013. A long journey to effective obesity treatments: Is there light at the end of the tunnel? *Experimental Biology and Medicine* 238(5):491-501

Zhang, L., X.L. Wu, J.J. Michal, X. Zhou, B. Ding, M.V. Dodson and Z. Jiang. 2013. A genome wide survey of SNPs variation and genetic structure view in Suffolk, Rambouillet, Columbia, Polypay and Targhee sheep. *PloS ONE* 8(6):e65942

Duarte, M.S., P.V.R. Paulino, A. Das, S. Wei, N.V.L. Serao, X. Fu, S. Harris, M.V. Dodson and M. Du. 2013. Enhancement of adipogenesis and fibrogenesis in skeletal muscle of Wagyu compared to Angus cattle. *Journal of Animal Science* 91:2938-2946

Wei, S., W.G. Bergen, G.J. Hausman, L.Zan and M.V. Dodson. 2013. Cell culture purity issues and DFAT cells. *Biochemical and Biophysical Research Communications* 433:273-275

Duarte, M.S., M.P. Gionbelli, P.V.R. Paulino, N.V.L. Serao, T.S. Martins, P.I.S. Totaro, S.C. Valdares-Filho, M.V. Dodson and M. Du. 2013. Effects of maternal nutrition on development of gastrointestinal tract of bovine fetus. *Livestock Science* 153:60-65

Du, M., Y. Huang, A.K. Das, Q. Yang, M.S. Duarte, M.V. Dodson and M-Y. Zhu. 2013. Manipulating mesenchymal progenitor cell differentiation to optimize performance and carcass value of beef cattle. *Journal of Animal Science* 91:1419-1427

Wei, S., L. Zan, H. Wang, G. Cheng, M. Du, Z. Jiang, G.J. Hausman, D.C. McFarland and M.V. Dodson. 2013. FABP4 regulates ADIPOQ, LEP and LEPR expression in bovine preadipocytes. *Genetics and Molecular Research* 12(1):494-505

Duarte, M.S., M.P. Gionbelli, P.V.R. Paulino, N.V.L. Serao, R. Mezzomo, M.V. Dodson, M. Du, J. Busboom and S.E.F. Guimaraes. 2013. Effects of pregnancy and feeding level on carcass and meat quality traits of Nellore cows. *Meat Science* 94:139-144

Yan, X.,Y. Huang, J. X. Zhao, C. J. Rogers, M. J. Zhu, S. P. Ford, P. W. Nathanielsz, and M. Du. (2013). Maternal obesity down-regulates microRNA (miRNA) let-7g expression, a possible mechanism for enhanced adipogenesis during ovine fetal skeletal muscle development. *International Journal of Obesity*, 37: 568-575.

Wang, H., Y. Xue, H. Zhang, Y. Huang, G Yang, **M. Du**, and M. J. Zhu. (2013). Dietary grape seed extract ameliorates symptoms of inflammatory bowel disease in interleukin-10 deficient mice. *Molecular Nutrition &*

Food Research, 57: 2253-2257.

Book chapters:

Fernyhough-Culver, M.E. and M.V. Dodson. 2014. Cell, Tissue and Organ Culture: Use of Coulter counter in enumeration of fat stem cells. In: Stem Cells with Fat Transfer in Aesthetic Procedures: Science, Art and Clinical Techniques. (Chapter 19) M.A. Shiffman, A. Di Guiseppe and F. Bassetto (ed). Springer (Berlin/Heidelberg); 6 pp ISBN 978-3-642-45206-2

Dodson, M.V., M. Du, S.G. Velleman, D.C. McFarland, M.E. Fernyhough-Culver, S. Wei, M.S. Duarte, Z. Jiang and G.J. Hausman. 2014. Adipose cell precursors: Stem cells in medicine, tissue engineering and reconstructive surgery. In: Stem Cells with Fat Transfer in Aesthetic Procedures: Science, Art and Clinical Techniques. (Chapter 2) M.A. Shiffman, A. Di Guiseppe and F. Bassetto (ed). Springer (Berlin/Heidelberg); 5 pp ISBN 978-3-642-45206-2

Shen, Q. W., and **M. Du**. (2014). Postmortem conversion of muscle and meat, in "*The Effect of Genetic and Environmental Factors on the Quality of Meat*". Edited by David Hopkins, Taylor & Francis Publishing Group. Boca Raton, FL.

Yin, J. (Editor in Chief), **M. Du** (Associate Editor in Chief), and Y. Jin (Associate Editor in Chief). (2013). Animal Muscle Biology and Meat Science (动物肌肉生物学与肉品科学). *China Agricultural University Press*, Beijing, China.

Editorials:

Dodson, M.V. and G.J. Hausman. 2014. Cellularity of adipose depots. Adipocyte 3(3): dx.doi.org/10.4161/adip.27801

Dodson, M.V. 2013. Professor Ugo Carraro and BAM: Friends for life. European Journal of Translational Biology 23(4):121

Teaching/advising/learning/career papers:

Harris, C.L., M. Du, Z. Jiang, G.J. Hausman and M.V. Dodson. Calcification in white muscle disease in calves and lambs: The Sepn1-/- mouse. Biochemical Biophysical Research Communications

Drake, S.D., L. Hansen, C. Harris, B. Moranville, W. Lewis, M. Blyzka, E. Miller, W.G. Bergen, K.H. McKeever, G.J. Hausman and M.V. Dodson. 2013. Effects of clenbuterol on horses. Comparative Exercise Physiology 9(3-4):181-187

Lewis, W.C. and M.V. Dodson. 2013. The frustrations of learning how to write a scientific paper. NACTA Journal 57(4):79-80

Dodson, M.V. 2013. It is only about the science. NACTA Journal 57(3):72

Dodson, M.V. 2013. A hint of things to come. NACTA Journal 57(3):75-76

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Bowie, J.M., H.K. Floren, J.K.B. Gentry, L.E. Hansen, C.L. Harris, M.A. Jackson, W.C. Lewis, J.L. Mutch and M.V. Dodson. 2013. Sarcomere in the classroom: Learning with undergraduate groups. NACTA Journal 57(2):83-85

Dodson, M.V. and S. Wei. 2013. What are we doing right? NACTA Journal 57(1):96-97

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Report 3

Univ. of Tennessee (Brynn Voy)

Our lab uses domestic broiler chickens as a dual purpose model to 1.) identify new means to reduce fatness and improve feed efficiency for the poultry industry, and 2.) understand how diet alters adipocyte development and metabolism and contributes to susceptibility/resistance to obesity. Current studies in our lab are designed to follow-up previous studies in which transcriptomics data suggested that fasting increased fatty acid oxidation in white adipose tissue, and that heritable differences in leanness were associated with increased expression of genes that catalyze fatty acid oxidation. Recently, we performed enzymatic assays across a time course of fasting, and these confirmed that complete fatty acid oxidation significantly increased in adipose tissue harvested from fasted chicks. Adipose tissue from these birds is being characterized at the molecular level to identify mechanisms through which this pathway responds to energy restriction. Ongoing studies test the hypothesis that fatty acid oxidation can be enhanced and adipose deposition attenuated by using dietary fat sources rich in select long chain polyunsaturated fatty acids.

Papers published since last NCCC210 meeting:

1. Ji B, Middleton JL, Ernest B, Saxton AM, Lamont SJ, Campagna SR, **Voy BH**. Molecular and metabolic profiles suggest that increased lipid catabolism in adipose tissue contributes to leanness in domestic chickens. *Physiol Genomics*. 46(9):315-27, 2014.

2. Kolker E, Özdemir V, Martens L, Hancock W, Anderson G, Anderson N, Aynacioglu S, Baranova A, Campagna SR, Chen R, Choiniere J, Dearth SP, Feng WC, Ferguson L, Fox G, Frishman D, Grossman R, Heath A, Higdon R, Hutz MH, Janko I, Jiang L, Joshi S, Kel A, Kemnitz JW, Kohane IS, Kolker N, Lancet D, Lee E, Li W, Lisitsa A, Llerena A, Macnealy-Koch C, Marshall JC, Masuzzo P, May A, Mias G, Monroe M, Montague E, Mooney S, Nesvizhskii A, Noronha S, Omenn G, Rajasimha H, Ramamoorthy P, Sheehan J, Smarr L, Smith CV, Smith T, Snyder M, Rapole S, Srivastava S, Stanberry L, Stewart E, Toppo S, Uetz P, Verheggen K, **Voy BH**, Warnich L, Wilhelm SW, Yandl G. Toward more transparent and reproducible omics studies through a common metadata checklist and data publications. OMICS 18(1):10-4, 2014.

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Report 4

Auburn University (Werner Bergen, Terry Brandebourg)

The Bergen Laboratory

Global gene expression in cattle or pigs using tools such as microarrays have become more frequent as sequencing resources became available. We took a different approach using target/sentinel genes for expression studies in muscle and fat of beef cattle. We hypothesized target gene expression profiles of individual animals may be used to measure the metabolic "phenotype" of individual cattle. This concept is based on blood metabolite and hormone profiling of individual animals for various assessments. Further it was shown that for regulatory purposes in food animals administered illegal anabolics, increases in skeletal muscle alpha actin or myosin gene expression measured in muscle biopsies (quantitative real time PCR) were clearly noted in steroid and beta agonist administered cattle. Thus we completed three separate trials to test our hypothesis utilizing biopsies, in time course manner from loin muscle and subcutaneous fat. These studies included first (study A) an assessment of expression of certain protein and energy metabolism genes in a first generation of bulls and steers from a now discontinued RFI selection program at an off-campus AL-Ag Ext Station facility. Loin muscle and subcutaneous fat samples were obtained by biopsies. A second study (study B) was conducted with feedlot heifers that were administered a beta agonist for one month (Optaflexx) starting after 79, 100, 121 and 142 days on feed. Each group was slaughtered one month later for loin muscle and subcutaneous samples. Obviously with this design of beta agonist administration, the younger heifers started with Optaflexx were slaughtered before attaining finished weights. A third study (study C) explored putative relationships between gene expression profiles and performance differences in three pasture use regimen (Ryegrass 126 days; Dormant pasture 41 days, Ryegrass 83 days; Dormant pasture 83 days, Ryegrass 41 days and Dormant pasture-no ryegrass , 126 days).

Expression of the following genes were determined: Study A, Adipose, PPARγ, Fatty acid synthase, leptin, polyubiquitin; Skeletal muscle, Ubiquitin ligase E2, carnitine parmitoyl transferase 1b, polyubiquitin, PPARα, uncoupling protein 2 ; Study B, Adipose, PPARγ, Pref-1/DLK-1, glycerol-phosphate acyltranferase (GPAT), FABP4, UCP2; Skeletal muscle, PPARα, Pref-1, GPAT, CPT-1b, PPARγ, UCP-2, UE2, polyubiquitin, proteasome 26s subunit non-ATPase subunit 1 (PSMD -1); Study C: Adipose, GPAT, zinc-finger protein-427, UCP-2, leptin, adiponectin; Skeletal muscle, PPARγ, CEBP/α, FABP4, Pref-1, CPT, UCP2, PGC1-α, PSMD-11. All expression assays included a cDNA dilution, efficiency assay and technical replication either 3 or 4 times. All assays used the Life Sciences (Roche) custom TaqMan qRT-PCR gene expression assay and a 18s rRNA probe (treatments did not affect 18s expression).
All gene expression results from skeletal muscle and adipose tissue, within each study, were evaluated with regards to performance, impact on protein metabolism, fat metabolism and adipogenesis using expressions of genes involved in protein synthesis, turnover, mitochondrial function, fatty acid oxidation, fatty acid and triacylglycerol synthesis and adipogenesis as sentinels. While technical replications and efficiency values for all PCR assays were acceptable and highly repeatable, wide fluctuations in gene expression in biopsies between the cattle were quite obvious. How much of this variation was related to specific sampling sites (that is adipose

tissue and muscle anatomical micro-locations; timing since last feed consumption for example) or a reflection of the apparent wide variation in expression of major metabolic genes among highly unrelated individual animals was not evaluated; however, these findings do not bode well for our hypothesis that sentinel/target gene expression profiling from single biopsies would be useful for predicting phenotypic characteristics of individual animals. Global gene expression and gene wide associations studies using adequate animals (including stringently followed protocols), will likely provide much insight to food animal molecular regulation of metabolism, food intake, RFI etc., but at this point our work would indicate that all these tools are likely not robust indicators of individual phenotypic characteristics. Finally we conclude that Pref-1/DLK-1 does not seem to be a principal regulator involved with the time-course of IMF adipogenesis vs. other adipose depots in beef cattle.

The Brandebourg Laboratory

My research program aims to facilitate better control of body composition by focusing upon the regulation of feed efficiency and adipose tissue development. A significant part of this effort involves the development of the pig as a translational model for obesity-induced metabolic disease, but other research aims to enhance growth and sustainability in beef cattle. Molecular targets relevant to energy balance are examined in conjunction with feeding trials. Abstracts associated with these studies include:

Grain feeding coordinately alters expression patterns of transcription factor and metabolic genes in subcutaneous adipose tissue of crossbred heifers.

Key CN, Perkins SD, Bratcher CL, Kriese-Anderson LA, and Terry Brandebourg
J Anim Sci. 2013 Jun; 91(6):2616-27 doi: 10.2527/jas.2012-5846.

Residual feed intake studies in Angus-sired cattle reveal a potential role for hypothalamic gene expression in regulating feed efficiency.

Perkins SD[1], Key CN, Garrett CF, Foradori CD, Bratcher CL, Kriese-Anderson LA, and Terry D Brandebourg
J Anim Sci. 2014 Feb; 92(2):549-60. doi: 10.2527/jas.2013-7019.

Effect of residual feed intake on hypothalamic gene expression and meat quality in Angus-sired cattle grown during the hot season.

Perkins SD[1], Key CN, Marvin MN, Garrett CF, Foradori CD, Bratcher CL, Kriese-Anderson LA, and Terry D. Brandebourg
J Anim Sci. 2014 Apr; 92(4):1451-61. doi: 10.2527/jas.2013-7020

Microarray studies in high and low RFI cattle reveal a potential role for gonadotropin releasing hormone (GnRH) in regulating feed efficiency

S.D. Perkins, C.D. Foradori, A.K. McNeel, L. A. Kriese-Anderson, and T. D. Brandebourg*

To be presented at the 2014 joint Mtg. of the ADSA-AMPA-ASAS-CSAS-WSASAS. Kansas City, MO.

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Distribution of Gonadotropin-Releasing Hormone, Kisspeptin, RF-amide Related Peptide 3 and Dynorphin in Diestrus and Estrus Bovine

Chad D. Foradori[2], Valeria M. Tanco[1], Robyn R. Wilborn[3], Terry D. Brandebourg[4], Brian K. Whitlock[1]
[1]Large Animal Clinical Sciences, College of Veterinary Medicine, The University of Tennessee, Knoxville, TN 37996-4545
[2]Department of Anatomy, Physiology and Pharmacology, [3]Department of Clinical Sciences, [4]Department of Animal Sciences, Auburn University, Auburn, AL 36849, USA

To be presented at the 2014 joint meeting of the International Society of Endocrinology and The Endocrine Society: ICE/ENDO (abstract).Chicago, IL.

Mitochondrial DNA sequence and phylogenetic evaluation of geographically disparate Sus scrofa breeds.

M. V. Cannon[1], T. D. Brandebourg[2], M. C. Kohn[1], D. Đikić[3] M. H. Irwin[1], and C. A. Pinkert[1,4]
[1]Department of Pathobiology, Auburn University, Auburn, Alabama, USA [2]Department of Animal Sciences, Auburn University, Auburn, Alabama, USA [3]Department of Animal Physiology, University of Zagreb, Croatia [4]Department of Biological Sciences, The University of Alabama, Tuscaloosa, Alabama, USA
Animal Biotechnology 0: 1–16, 2014. DOI: 10.1080/10495398.2013.875474

Chicken Ovalbumin Upstream Promoter Transcription Factor (COUP-TF) mediates the anti-adipogenic effect of retinoids in 3T3-L1 preadipocytes.

Brodie A.E., Manning, V.A. Liu, C.L., Brandebourg, T.D. and C.Y. Hu.
Manuscript submitted; *revision under review*.

Effect of Incubation Temperature on the Proliferation and Differentiation of Pig Preadipocytes in Primary Culture

A.E. Bohan, J.L. Bartosh, and Terry D. Brandebourg
To be presented at the 2014 joint Mtg. of the ADSA-AMPA-ASAS-CSAS-WSASAS. Kansas City, MO.

Microbiota Diversity is Inversely Related to Adiposity in Mangalica Pigs

J. W. Broady, L.Z. Wang, A.G. Moss, T. D. Brandebourg and E. M. Hiltbold

To be presented at the 2014 joint Mtg. of the ADSA-AMPA-ASAS-CSAS-WSASAS. Kansas City, MO.

Neuropeptide and Adipokine Gene Expression Profiles Differ Between Lean and Obese Mangalica Pigs

Meggan Marvin, Stephanie Perkins, Julia Bartosh, Chad Foradori and Terry D. Brandebourg, Auburn University, Auburn, AL
Presented orally at the 2014 Southern Section of ASAS. Dallas, TX

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Sampling Post-scalding Does Not Effect RNA Integrity or Real-time PCR in Market Weight Yorkshire Pigs.
A.E. Bohan, M. N. Marvin, S. D. Perkins, J. Bartosh, C.L. Bratcher, W.G. Bergen, T.D. Brandebourg, Auburn University, Auburn, AL
Presented orally at the 2014 Southern Section of ASAS. Dallas, TX

Characterizing Growth Performance and Meat Quality in Mangalica Pigs
McMurray, M.N., S.D. Perkins, M.N. Marvin, J. Bartosh, C.L. Bratcher and Terry D Brandebourg, Auburn University, Auburn, AL
Presented orally at the 2014 Southern Section of ASAS. Dallas, TX

Publications

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Report 5

West Virginia University (Kimberly Barnes)

Our lab has the primary focus of the effect of dietary lipids on lipid metabolism and body composition. We have an ongoing project focused on the interaction of dietary CLA with other dietary lipids on body fat, and specifically on lipolysis. We have established that mice fed coconut oil and CLA lose more body fat than those fed soy oil and CLA, and that the greater loss of body fat involves increased lipolysis. We have also established that 3T3-L1 adipocytes exposed to the fatty acids from coconut oil respond to CLA supplementation with a greater increase in lipolysis than those exposed to the fatty acids from soy oil. Work is on-going to identify the signaling pathway(s) that may be responsible for the increased lipolysis but we have little new information to share at this point.

In addition, we have done some work recently with a horse model as a collaborative project with Middle Tennessee State University, focused on the metabolic effects of weight loss in overweight horses. Horses in an overweight/obese body condition (BCS 7-8 on a 9-point scale) were calorically restricted until they lost 3 BCS (~12 weeks for most horses). Markers of lipid metabolism, insulin sensitivity, oxidative stress, and mitochondrial function were monitored throughout the weight loss period. The results from this project have been submitted/presented in several abstracts this year:

Influence of weight loss on skeletal muscle mitochondrial function and metabolism in the mature horse.

J.L. Zambito[1], H.S. Spooner[2], C.E. Nichols[3], R.M. Hoffman[2], J.M. Hollander[3], K.M. Barnes[1]
[1]Division of Animal and Nutritional Sciences, West Virginia University; [2]School of Agribusiness and Agriscience, Middle Tennessee State University; [3]Department of Exercise Physiology, West Virginia University
ASAS Young Scholar Award and Invited Oral Presentation at Midwest ASAS/ADSA Meetings, Des Moines, IA, March 18, 2014.

Effect of weight loss on markers of oxidant status in the mature horse

E. Hannah Hoblitzell[1], Jennie L. Zambito[1], Holly S. Spooner[2], Kimberly M. Barnes[1],
[1]Division of Animal and Nutritional Sciences, West Virginia University, Morgantown, WV 26506; [2]School of Agribusiness and Agriscience, Middle Tennessee State University, Murfreesboro, TN 37132
Orally presented at Midwest ASAS/ADSA Meetings, Des Moines, IA, March 17, 2014.

Effect of weight loss on lipid metabolism in the mature horse

Morgan L. Bush[1], Jennie L. Zambito[1], Holly S. Spooner[2], Kimberly M. Barnes[1]
[1]Davis College of Agriculture, Natural Resource and Design, West Virginia University, Morgantown, WV 26506, [2]School of Agribusiness and Agriscience, Middle Tennessee State University, Murfreesboro, TN 37129
Poster to be presented at Experimental Biology, San Diego, CA, April 28, 2014 (Abst. #814.4)

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Influence of weight loss on insulin sensitivity in the mature horse
Jennie L. Zambito[1], Holly S. Spooner[2], Rhonda M. Hoffman[2], Kimberly M. Barnes[1]
[1]West Virginia University, Morgantown, WV 26508, [2]Middle Tennessee State University, Murfreesboro, TN 37129
Oral to be presented at Experimental Biology, San Diego, CA, April 28, 2014 (Abst. #246.4)

Influence of Weight Loss on Skeletal Muscle Mitochondrial Function in the Mature Horse
Jennie Zambito[1], Cody Nichols[1], Kimberly Barnes[1], Holly Spooner[2], John Hollander[1]
[1]West Virginia University, Morgantown, WV, USA
[2]Middle Tennessee State University, Murfreesboro, TN, USA.
To be presented at ICEEP (International Conference on Equine Exercise Physiology), London, UK, June 2014.

Publications

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Report 6

Purdue University (Kolapu Ajuwon)

Our station engaged in many research activities in the year 2013. Although we primarily focus on the study of adipose tissue metabolism, some our collaborative activities were in other areas. Our first report was on a study in which we investigated the effects of dietary phytase on mucosa gene expression profile in chickens. The conclusion from this study was that, though phytase was effective in enhancing growth of broiler chickens receiving a phosphorus deficient diet, phytase did not affect intestinal gene expression pattern. In the second study, we studied the potential interaction between wnt and TGFB signaling in differentiating adipocytes. This experiment showed distinct signaling cascades initiated by the two ligands, even though a few overlaps exist in the activation of AKT and p44/42 MAPK pathways. In the third experiment, we investigated the impact of dietary fiber on metabolic genes in the pig. This experiment showed that fermentable fiber significantly altered hindgut microbial profile and induced gees for poeroxisomal fatty acid oxidation in the liver and adipose tissue. The last study was on the effect of dietary linolenic acid on markers of inflammation in the pig. Results from this study shows that that lowering the content of α-linolenic acid in the context of a high fat diet could lead to mitigation of development of hyperinsulinemia and dyslipidemia without significant effects on adipose tissue inflammation.

Publications

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Report 7

National Taiwan University (Shih-Torng [Stone] Ding)

In the last year, the Ding laboratory continued to work on adipocyte biology and adipokines, outlined in several abstracts presented at the EB2014 meeting:

Adiponectin receptor 1 regulating bone formation and osteoblasts differentiation by GSK-3β/β-Catenin signaling

Yuan Yu Lin[1], Ching Yi Chen[1], Shinn Chih Wu[1,2], Harry John Mersmann[1] and Shih Torng Ding[1,2,1]Department of Animal Science and Technology, National Taiwan University.

Adiponectin receptor 1 has been demonstrated express in bone. The purpose of this study was used porcine adiponectin receptor 1 transgenic mice (pAdipoR1) as a model to evaluate the role of adipoR1 on bone physiology upon different age status. We found that pAdipoR1 transgenic mice have higher bone mineral density than wild-type mice in elderly stage at both genders. The percent bone volume and trabecular number also significantly higher than wild-type in female mice at young and elderly stage by micro-CT analysis. ELISA analysis revealed that serum osteocalcin (Oc) and osteoprotegrin (OPG) were significantly increased in young pAdipoR1 transgenic mice in both genders. Furthermore, serum OPG also elevated at 8 week and 32 week in female and male pAdipoR1 transgenic mice at young and old status. Serum TRAP5b concentration was reducing in young and old male pAdipoR1 mice compared with wild-type mice. Knock-down AdipoR1 significantly decreased the gene expression of Oc, OPG, alkaline phosphatase and msh homeobox 2 and mineralization in MC3T3-E1 and mesenchymal stem cells. In addition, we speculate that AdipoR1 regulating osteoblasts differentiation through GSK-3β/β-Catenin signaling by pathscan analysis. Consequently, the lack of adipoR1 was impaired osteoblasts differentiation and bone formation. We conclude that adipoR1 is a critical factor for the osteoblasts differentiation and bone homeostasis.

Oxytocin attenuates beta oxidation and fatty acid synthesis through CPT1 and Fabp4

H. J. Lin, H. J. Mersmann, and S. T. Ding. Department of Animal Science and Technology, National Taiwan University, Taipei, Taiwan, R.O.C.

Oxytocin has a role in regulating body energy homeostasis. It's demonstrated that central and subcutaneous oxytocin infusions stimulated lipid metabolism both in standard and high fat diet mice and rats. To study the effects of oxytocin on lipid metabolism, we tested series concentrations of oxytocin (0, 10, 33, 100, 150, 333 nM) to 3T3L1 adipocytes for both long (216 hours) and short (24 hours) time periods. Our results showed that short term treatment of 150 nM oxytocin significantly increased triglyceride accumulation, but decreased mRNA expressions of forkhead box protein O1 (FoxO1), carnitine palmitoyltransferase I (CPT1), fatty acid binding protein 4 (FABP4); however, only CPT1 decreased after long term treatment of 150 nM oxytocin. To expand the *in vitro* results, we further treated oxytocin on adipocytes which was isolated and induced from mesenchymal stem cells of tibia and femur in mice. After short term treatment of oxytocin, the mRNA expression of FABP4 had the same tendency as in 3T3L1 adipocytes. Taken together, oxytocin may modulate lipid metabolism through decreasing beta oxidation and fatty acid synthesis.

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Publications

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3. Lin, Y.Y, Y.C. Chen, Y. Lin, Y. P. Chiu, C. C. Chen, B. H. Liu, H. J. Mersmann, S. C. Wu, and S. T. Ding*. Modulation of glucose and lipid metabolism by porcine adiponectin receptor 1-transgenic mesenchymal stem cells in diet-induced obese mice. Cytotherapy. 15:971-978. (SCI, IF=3.056)
4. Liu, B.H., Y.Y. LIN, Y.C. Wang, C.W. Huang, C.C. Chen, S.C. Wu, H.J. Mersmann, W.T.K. Cheng, and S.T. Ding. 2013. Porcine adiponectin receptor 1 transgene resists high-fat/sucrose diet-induced weight gain, hepatosteatosis and insulin resistance in mice. Exp. Anim. Tokyo. *Exp. Anim.*, 62:347-360. (SCI, IF=1.456)
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10. Chou, I.P., Lin, Y.Y., Ding, S.T., and Chen, C.Y. (2013, Oct). Adiponectin receptor 1 enhances fatty acid metabolism and cell survival in palmitate-treated HepG2 cells through the PI3K/AKT pathway. *European Journal of Nutrition.*
11. Chong, H.H., C. F. Yen and S. T. Ding (coresponding) (2013, Jun). The conversion mechanism of N-3 polyunsaturated fatty acids and its application in poultry production. *Chin. Anim. Sci.*, 42: 173-184.
12. Hsu, H.H., S.T. Ding M.C. Chao, F.T. Chan, L.M. Wang, P.I. Lin, C.H. Chang, H.W. Yuan, C.C. Chen, and Wang, P.H. (2013, Jun). Development of 24 new microsatellite markers in the Crested Serpent Eagle (Spilornis cheela hoya). *Cons. Genet. Res.* , 5:417-420. (SCI).
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Report 6

North Carolina State University (Jack Odle)

Methylated Medium- and Long-Chain Fatty Acids Provide Novel Sources of Anaplerotic Carbon for Fasting or Exercising Mice. J.B. Drayton[1], X. Lin[1], S.K. Jacobi[1], R.A. Shanely[2], M. McIntosh[3], and J. Odle[1] We hypothesized that methylated fatty acids (e.g. 2-methylpentanoic acid (2MeP), phytanic or pristanic acids) would provide anaplerotic carbon to the tricarboxylic acid (TCA) cycle and thereby enhance fatty acid oxidation, especially under conditions when TCA cycle intermediates are depleted. The optimal dose of 2MeP and pristanic acid for increasing *in vitro* [1-^{14}C]-oleic acid oxidation in liver or skeletal muscle homogenates from fasted mice (n=4) was assessed using doses of 0, 0.25, 0.5, 0.75, or 1.0 mM. The minimum dose (0.25 mM) maximally stimulated liver tissue oxidation of [1-^{14}C]-oleate to $^{14}CO_2$ by 2-fold ($P < 0.05$), but no stimulation was detected in muscle. Similar incubations with 0.25 mM 2MeP, hexanoate, palmitate, phytanic acid, or pristanic acid or 0.1 mM malate or propionyl-CoA were conducted with liver and skeletal muscle homogenates from acutely exercised or sedentary mice. Regardless of exercise, incubation of liver homogenates with 2MeP increased [1-^{14}C]-oleate oxidation to $^{14}CO_2$ by 60% over control incubations containing hexanoate ($P < 0.05$). Phytanic acid treatment increased [^{14}C]-acid-soluble product accumulation in liver tissue as compared to palmitate ($P < 0.05$). Anaplerotic stimulation was unaffected by exercised state ($P > 0.05$) and not evidenced in muscle homogenates. Results were consistent with our hypothesis that methyl-branched fatty acids may provide anaplerotic carbon and thereby stimulate *in vitro* fatty acid oxidation. Funding: North Carolina Agricultural Research Service and by USDA-AFRI training grant # 2010-65200-20354. (Late breaking; Wednesday)

Effects of methylating vitamins and docosahexaenoic acid (DHA) supplementation on intra-uterine growth retardation (IUGR) in a feed-restricted swine model. Hope Lima[1], Sheila Jacobi[1], Chaolai Man[1], Kaitlyn Walker[1], Jeffrey Sommer[1], William Flowers[1], Anthony Blikslager[2], Lin Xi[1], Jack Odle[1] IUGR can result from malnourishment during pregnancy and negatively influences the long-term health of offspring; being litter bearing, swine have an increased incidence. Our study exploited this to examine nutritional influences on fetal development in malnourished dams. Control gilts (n=5) received 2.0 kg/d of a corn-isolated soy-protein diet supplemented with a mixture of vitamins (mg/kg feed) containing folic acid (1.3), pyridoxine (1.0), B12 (0.015), riboflavin (3.75), choline (1250) and DHA (2420). Basal diet allotment to restricted sows was reduced progressively from 1.0 to 0.6 kg/d and was supplemented according to a 2 (± vitamins) x 2 (± DHA) factorial design (n = 4-6; vitamin amounts described above). Control dams gained more weight (49.31 ± 6.19 kg) than restricted dams (3.01 ± 3.34; $p < 0.0001$). Average term piglet weight (1.13 ± 0.016 kg; $p = 0.5094$) and percent of IUGR piglets (< 900 g; 17.9 ± 3.76%; $p = 0.6223$) were unaffected. Piglet brain weights were reduced by 3.9% ($p < 0.02$) in restricted treatments lacking vitamin and DHA supplementation. Addition of DHA to restricted sow diets reduced relative liver weight of piglets (2.54 ± 0.06 %BW) vs. control (2.96 ± 0.06) and other restricted dams (2.99 ± 0.04). These results illustrate strong preferential partition of limited maternal resources to developing fetuses during extreme nutrient depravation, with modest effects of micronutrient supplementation. Funding: Bill and Melinda Gates Foundation. (Tuesday pm)

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Dietary Isomers of Sialyllactose Increase Ganglioside Sialic Acid Concentrations in the Corpus Callosum and Cerebellum of Formula-fed Piglets. S.K. Jacobi[1], D. Li[2], S. Dasgupta[2], R.K. Yu[2], B. M. Berg, M. Chichlowski[3], and J. Odle[1] Sialic acid (SA) is a key component of human milk oligosaccharides and neural tissues. SA accumulates in the brain rapidly during neonatal development and is thought to play an important role in brain development . This study aimed to determine if different isomers of sialyllactose (SL) enrich brain SA of developing neonatal piglets. Day-old pigs were randomized among 6 diets (control, 2g/L 3'-SL, 4g/L 3'-SL, 2g/L 6'-SL, or 4g/L 6'-SL, or 2g/L polydextrose + 2g/L galacto-oligosaccharide; n=9) and fed three times per day for 21 d. Pigs were euthanized and the left hemisphere of the brain was dissected into cerebrum, cerebellum, corpus callosum, and hippocampus regions. Total and lipid-bound (ganglioside) SA were assayed following extraction with chloroform:methanol (2:1), and free SA was calculated by difference. Protein-bound SA was measured in the insoluble residue following suspension in PBS containing 1% Triton X-100. SA was determined using a modified periodic acid-resorcinol reaction. Dietary SL did not affect feed intake, growth or fecal consistency. Ganglioside-bound SA in the corpus callosum of pigs fed 2g/L of 3'-SL (359±16 □g SA/g wet tissue) or 6'-SL (361±16 □g SA/g) w increased by 15% over control pigs (314±16 □g SA/g, P<0.05). Similarly cerebellum of pigs fed 4g/L of 3'-SL (416±14 □g SA/g) or 6'-SL (377±14 □g SA/g; P<0.05). In conclusion ganglioside SA in the brain of suckling piglets. Funded by Mead Johnson Nutrition. (Late breaking; Wednesday)

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Publications

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2) Hudson, L.C., B.S. Seabolt, **J. Odle**, K.L. Bost, C.H. Stahl and K.J. Piller 2013. Sublethal staphylococcal enterotoxin B challenge model in pigs to evaluate protection following immunization with a soybean-derived vaccine. *Clin. Vaccine Immunol.* 20: 24-32.

3) Price, K.L., X. Lin, E. van Heugten, R. Odle, G. Willis and **J. Odle**. 2013. Diet physical form, fatty acid chain length, and emulsification alter fat utilization and growth of newly weaned pigs. *J. Anim. Sci.* 91: 783-792.

4) Herfel, T., S. Jacobi, X. Lin, E. van Heugten, V. Fellner and **J. Odle**. 2013. Stabilized rice bran improves weaning pig performance via a prebiotic mechanism. *J. Anim. Sci.* 91: 907-913.

5) Eisemann, J., H. Lewis, A. Broome, K. Sullivan, D. Boyd, **J. Odle** and R. Harrell. 2013. Lysine requirement of 1.5 to 5.5 kg pigs fed liquid diets. *Anim. Prod. Sci.* http://dx.doi.org/10.1071/AN12280. p. 1-8.

6) Adams, S.H., K.M. Barnes and **J. Odle**. 2013. Comparative metabolic physiology in the 'omics' era: A call to arms, paws, flippers, and claws. *Adv. Nutr.* 4: 568-569.

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10) Liu, Y., F. Chen, **J. Odle**, X. Lin, H. Zhu, H. Shi, Y. Hou, and J. Yin. 2013. Fish oil increases muscle protein mass and modulates Akt/FOXO, TLR4, and NOD signaling in weanling piglets after lipopolysaccharide challenge. *J. Nutr.* 143: 1331-1339.

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doi: 10.1016/j.jnutbio.2013.12.006

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