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Dr. Reynolds is a founding Director of the [Center for Nutrition and Pregnancy](#) at NDSU. For more than 40 years, his research program has focused on improving both fertility (the ability to conceive and to establish a pregnancy) and pregnancy outcomes (i.e., postnatal survival and long-term health of offspring) in livestock. These 'problems of pregnancy' have major scientific, socioeconomic, and health implications for humans as well, which is why his program has been funded by various federal agencies since 1986.

Along with numerous collaborators throughout the world, Dr. Reynolds helped establish that placental (uterine and umbilical) blood flows are key to normal placental function (i.e., transport capacity) throughout gestation. Subsequently, they were the first to show that the placenta produces angiogenic factors, which drive its dramatic vascular development. Recognizing that placental growth also is critical, they were among the first to develop methods to evaluate the rate of cell turnover (cell proliferation and apoptosis) of tissues *in vivo*. More recently, Dr. Reynolds and co-workers have shown that placental vascular development and function are key mediators by which maternal stressors such as malnutrition, environmental factors, age, assisted reproductive technologies, etc., affect pre- and postnatal well-being, and were among the first to recognize and investigate the potential impact of 'developmental programming' in livestock. They also have shown profound effects of maternal nutrition and assisted reproductive technologies on placental development very early in pregnancy. They currently are investigating therapeutic and management strategies to improve fertility and pregnancy outcomes, and the role of the fetal and maternal steroid metabolomes in the processes of fetal organ maturation, birth, and postnatal survival (see **Contributions to Science**, below).

Dr. Reynolds has been PI or Co-I on 39 federal grants from agencies including NIH, NSF, and USDA (~ \$13.1 million total), including a Fulbright Senior Scholar award in 2017 to teach and establish research collaborations at the University of Murcia in Spain. He has published more than 220 books, book chapters and journal articles including 27 invited reviews (see [My Bibliography at NCBI](#)). His publications have been cited more than 12,000 times (h-index 57). He has received the American Society of Animal Science (ASAS) Animal Growth and Development Award, the ASAS Animal Physiology and Endocrinology Award, the Eugene R. Dahl Excellence in Research Award at NDSU, and the 51st NDSU Faculty Lectureship. In 2016, he was named Fellow of the American Society of Animal Science.

Dr. Reynolds has taught more than 20 different undergraduate and graduate courses in cell biology, endocrinology, growth biology, nutritional science, and reproductive biology. He has mentored more than 35 undergraduate research interns, 13 graduate students, and 30 postdoctoral fellows, visiting scientists and junior faculty. From 2012 to 2016 he was Co-Director of the [Frontiers in Reproduction](#) advanced summer course at the Marine Biological Lab in Woods Hole, MA, where he continues to serve as Scientific Course Consultant.

Dr. Reynolds has co-organized or spoken at more than 60 national/international symposia and held 16 Visiting Professorships and Keynote Speakerships throughout the world. Since 1986, he has served on 56 federal grant-review panels for NIH (49, chair of 5) and USDA (7, chair of 2). From 2005 to 2008, Dr. Reynolds served as Editor-in-Chief of the *Journal of Animal Science*, the world's top-ranked Animal Science journal. He was named 'University Distinguished Professor of Animal Sciences' at NDSU in 2008.

Dr. Reynolds is involved with a national effort [promoting farm animals as dual-use models for agricultural and biomedical research](#). He also is involved with national/international efforts to highlight the importance of funding for livestock research, which is critical to solving problems of pregnancy, food security and agricultural sustainability.

Contributions to Science

With collaborators in the U.S., Australia, Europe, and South America, he has made the following contributions to the field:

1. Early in his career, Dr. Reynolds and colleagues helped establish that placental (uterine and umbilical) blood flows are key to normal placental function (i.e., transport capacity) throughout gestation.
 - a. [Reynolds, L.P.](#), C.L. Ferrell and S.P. Ford. 1985. Transplacental diffusion and blood flow of gravid bovine uterus. *Am. J. Physiol.* 249:R539-R543.
 - b. [Reynolds, L.P.](#), C.L. Ferrell, D.A. Robertson and S.P. Ford. 1986. Metabolism of the gravid uterus, foetus and uteroplacenta at several stages of gestation in cows. *J. Agric. Sci., Cambridge* 106:437-444.
 - c. [Reynolds, L.P.](#) and C.L. Ferrell. 1987. Transplacental clearance and blood flows of bovine gravid uterus at several stages of gestation. *Am. J. Physiol.* 253:R735-R739.
 - d. [Reynolds LP](#), Caton JS, Redmer DA, Grazul-Bilska AT, Vonnahme KA, Borowicz PP, Luther JS, Wallace JM, Wu G, Spencer TE. Topical Review: Evidence for altered placental blood flow and vascularity in compromised pregnancies. *Invited (Topical) review. J Physiol* 2006; 572:51-58.
2. Subsequently, they were the first to show that the placenta produces angiogenic factors, which drive the dramatic vascular development of the placenta.

- a. Reynolds, L.P., D.S. Millaway, J.D. Kirsch, J.E. Infeld and D.A. Redmer. 1987. Angiogenic activity of placental tissues of cows. *J. Reprod. Fertil.* 81:233-240.
 - b. Reynolds, L.P., S.D. Killilea and D.A. Redmer. 1992. Angiogenesis in the female reproductive system. *Review Article*. *FASEB J.* 6:886-892. **Over 400 citations.**
 - c. Reynolds, L.P. and D.A. Redmer. 2001. Mini-review: Angiogenesis in the placenta. *Review Article*. *Biol. Reprod.* 64:1033-1040. **Over 350 citations; in the top-50 most-cited articles for Biology of Reproduction.**
 - d. Reynolds LP, Borowicz PP, Caton JS, Vonnahme KA, Luther JS, Buchanan DS, Hafez SA, Grazul-Bilska AT, Redmer DA. Utero-placental vascular development and placental function: An update. *Invited review*. *Internat J Develop Biol, Special Issue 'Placental Developmental Biology,'* JS Hunt and KL Thornburg (eds.) 2010; 54:355-366. **79 citations.**
3. Recognizing that placental growth also is critical, Dr. Reynolds and colleagues were among the first to develop methods to evaluate the rate of cell turnover (cell proliferation and apoptosis) in tissues in vivo.
 - a. Reynolds, L.P. and D.A. Redmer. 1992. Growth and microvascular development of the uterus during early pregnancy in ewes. *Biol. Reprod.* 47:698-708. **115 citations.**
 - b. Jablonka-Shariff, A., A.T. Grazul-Bilska, D.A. Redmer and L.P. Reynolds. 1993. Growth and cellular proliferation of ovine corpora lutea throughout the estrous cycle. *Endocrinology* 133:1871-1879. **Over 150 citations.**
 - c. Jin, L., L.P. Reynolds, D.A. Redmer, J.S. Caton and J.D. Crenshaw. 1994. Effects of dietary fiber on intestinal growth, cell proliferation, and morphology in growing pigs. *J. Anim. Sci.* 72:2270-2278. **Over 200 citations.**
 - d. Grazul-Bilska AT, Johnson ML, Borowicz PP, Baranko L, Redmer DA, Reynolds LP. Placental development during early pregnancy in sheep: Effects of embryo origin on fetal and placental growth and global methylation. *Theriogenology* 2013; 79:94-102.
 4. Later in his career, Dr. Reynolds and co-workers were among the first to recognize and investigate the potential impact of 'developmental programming' on livestock production.
 - a. Borowicz PP, Reynolds LP. Placental programming: More may still be less. *Perspective*. *J. Physiol.* 2010; 588:393.
 - b. Reynolds LP, Borowicz PP, Caton JS, Vonnahme KA, Luther JS, Hammer CJ, Maddock Carlin KR, Grazul-Bilska AT, Redmer DA. Developmental programming: The concept, large animal models, and the key role of utero-placental vascular development. *Invited review*. *J Anim Sci* 2010; 88 (Suppl. 13):E61-E72.
 - c. Reynolds LP, Caton JS. Role of the pre- and post-natal environment in developmental programming of health and productivity. *Invited review*. *Molecular and Cellular Endocrinology, Special Issue 'Environment, Epigenetics and Reproduction,'* MK Skinner (ed.) 2012; 354:54-59.
 - d. Caton JS, Neville TL, Reynolds LP, Hammer CJ, Vonnahme KA, Meyer AM, Taylor JB. 2014. Biofortification of maternal diets with selenium: Postnatal growth outcomes. In: *Selenium in the Environment and Human Health* (Banuelos GS, Lin Z-Q, and Yin X, eds.), CRC Press, Taylor & Francis Group, London (ISBN 978-1-138-00017-9).
 5. More recently, they have shown profound effects of assisted reproductive technologies (i.e., embryo transfer, in vitro fertilization, cloning) on placental vascular development very early in pregnancy.
 - a. Grazul-Bilska AT, Johnson ML, Borowicz PP, Baranko L, Redmer DA, Reynolds LP. Placental development during early pregnancy in sheep: Effects of embryo origin on fetal and placental growth and global methylation. *Theriogenology* 2013; 79:94-102.
 - b. Grazul-Bilska AT, Johnson ML, Borowicz PP, Bilski JJ, Cymbaluk T, Norberg S, Redmer DA, Reynolds LP. Placental development during early pregnancy in sheep: Effects of embryo origin on vascularization. *Reproduction* 2014; 147:639-648.
 - c. Reynolds LP, Borowicz PP, Palmieri C, Grazul-Bilska AT. 2014. Placental Vascular Defects in Compromised Pregnancies: Effects of Assisted Reproductive Technologies and Other Maternal Stressors. In: *Advances in Fetal and Neonatal Physiology* (Zhang L & Ducsay CA, eds.), *Advances in Experimental Medicine and Biology* 814, Springer Science+Business Media, NY, pp. 193-204. (ISBN 978-1-4939-1031-1).
 - d. Reynolds LP, Haring JS, Johnson ML, Ashley RL, Redmer DA, Borowicz PP, Grazul-Bilska AT. Placental development during early pregnancy in sheep: Estrogen and progesterone receptor mRNA expression in pregnancies derived from in vivo and in vitro produced embryos. *Domestic Animal Endocrinology* 2015; 53:60-69.

Publications (selected from more than 220 refereed articles and book chapters including 27 invited review articles)

Complete List of Published Work in MyBibliography at NCBI:

<http://www.ncbi.nlm.nih.gov/sites/myncbi/lawrence.reynolds.1/bibliography/41148831/public/?sort=date&direction=ascending>

Books Published

Longo LD, Reynolds LP. *Wombs with a View: Illustrations of the Gravid Uterus from the Renaissance through the Nineteenth Century*. Cham, Switzerland: Springer International Publishing. 2016. ISBN 978-3-319-23567-7. 2016.

Books Edited

Reproduction in Domestic Ruminants VIII (Juengel JL, Miyamoto A, Price C, Reynolds LP, Smith MF & Webb R, eds.), Society for Reproduction and Fertility (Context Publishing, Pakington UK), (ISBN 978-1-8990-4363-7), 2014.

- Zheng, J., P.M. Fricke, L.P. Reynolds and D.A. Redmer. 1994. Evaluation of growth, cell proliferation, and cell death in bovine corpora lutea throughout the estrous cycle. *Biol. Reprod.* 51:623-632. **140+ citations.**
- Magness, R.R., J.M. Huie, G.L. Hoyer, T.P. Huecksteadt, L.P. Reynolds, G.J. Seperich, G. Whysong and C.W. Weems. 1981. Effect of chronic ipsilateral or contralateral intrauterine infusion of prostaglandin E₂ (PGE₂) on luteal function of unilaterally ovariectomized ewes. *Prostaglandins and Medicine* 6:389-401. **140+ citations.**
- Redmer DA, Doraiswamy V, Bortnem BJ, Fisher K, Jablonka-Shariff A, Grazul-Bilska AT, and Reynolds LP. 2001. Evidence for a role of capillary pericytes in vascular growth of the developing ovine corpus luteum. *Biol. Reprod.* 65:879-889. **130+ citations.**
- Conley, A.J., M.A. Kaminski, S.A. Dubowsky, A. Jablonka-Shariff, D.A. Redmer and L.P. Reynolds. 1995. Immunohistochemical localization of 3 β -hydroxysteroid dehydrogenase and P450 17 α -hydroxylase during follicular and luteal development in pigs, sheep and cows. *Biol. Reprod.* 52:1081-1094. **120+ citations.**
- Reynolds LP, Borowicz PP, Vonnahme KA, Johnson ML, Grazul-Bilska AT, Redmer DA, Caton JS. Topical Review: Placental angiogenesis in sheep models of compromised pregnancy. *Invited review. J Physiol* 2005; 565.1:43-58. **120+ citations.**
- Reynolds, L.P., S.D. Killilea, A.T. Grazul-Bilska and D.A. Redmer. 1994. Mitogenic factors of corpora lutea. *Invited review. Progress Growth Factor Res.* 5:159-175. **120+ citations.**
- Zheng, J., D.A. Redmer and L.P. Reynolds. 1993. Vascular development and heparin-binding growth factors in the bovine corpus luteum at several stages of the estrous cycle. *Biol. Reprod.* 49:1177-1189. **120+ citations.**
- Reynolds LP, Borowicz PP, Caton JS, Vonnahme KA, Luther JS, Buchanan DS, Hafez SA, Grazul-Bilska AT, Redmer DA. Utero-placental vascular development and placental function: An update. *Invited review. Internat J Develop Biol, Special Issue 'Placental Developmental Biology,' JS Hunt and KL Thornburg (eds.)* 2010; 54:355-366. **115+ citations.**
- Borowicz PP, Arnold DR, Johnson ML, Grazul-Bilska AT, Redmer DA, Reynolds LP. Placental growth throughout the last two-thirds of pregnancy in sheep: Vascular development and angiogenic factor expression. *Biol Reprod* 2007; 76:259-267. **115+ citations.**
- Reynolds, L.P. and D.A. Redmer. 1992. Growth and microvascular development of the uterus during early pregnancy in ewes. *Biol. Reprod.* 47:698-708. **115+ citations.**
- Wallace JM, Luther JS, Milne JS, Aitken RP, Redmer DA, Reynolds LP, Hay WW Jr. Nutritional modulation of adolescent pregnancy outcome – A review. *Invited review. Placenta* 2006; 27 (Suppl. 1 [Trophoblast Research Vol. 20]): S61-S68. **105+ citations**
- Bairagi S, Grazul-Bilska AT, Borowicz PP, Reyaz A, Reynolds LP. Placental development during early pregnancy in sheep: Estrogen and progesterone receptor protein expression. *Theriogenology* 2018; (In press).
- McLean KJ, Crouse MS, Crosswhite MR, Negrin Pereira N, Dahlen CR, Borowicz PP, Reynolds LP, Ward AK, Neville BW, Caton JS. The effects of nutrient restriction on mRNA expression of endogenous retroviruses, interferon-tau, and pregnancy specific protein-B during the establishment of pregnancy in beef heifers. *Journal of Animal Science* 2018; 96:950-963. <https://doi.org/10.1093/jas/skx001>
- Reynolds LP, Legacki EL, Corbin CJ, Caton JS, Vonnahme KA, Stanley S, Conley, AJ. Ovine placental steroid synthesis and metabolism in late gestation. *Biol Reprod* 2018; In press, published 14-Apr-18, <https://doi.org/10.1093/biolre/iov089>
- Crouse MS, McLean KJ, Greseth NP, Crosswhite MR, Negrin Pereira N, Ward AK, Reynolds LP, Dahlen CR, Neville BW, Borowicz PP, Caton JS. Maternal nutrition and stage of early pregnancy in beef heifers: Impacts on expression of glucose, fructose, and cationic amino acid transporters in utero-placental tissues. *J Anim Sci* 2017; 95: 5563–72
- Greseth NP, Crouse MS, McLean KJ, Crosswhite MR, Negrin Pereira N, Dahlen CR, Borowicz PP, Reynolds LP, Ward AK, Neville BW, Caton JS. The effects of maternal nutrition on the mRNA expression of neutral and acidic amino acid transporters in bovine uteroplacental tissues from day 16 to 50 of gestation. *J. Anim Sci* 2017; 95: 4668-76.
- Johnson ML, Redmer DA, Bilski JJ, Reynolds LP, Grazul-Bilska AT. Gap junctional connexin mRNA expression in the ovine uterus and placenta: Effects of estradiol-17 β -treatment, early pregnancy stages and embryo origin. *Domestic Anim Endocrinol* 2017; 58:104-112.
- McLean KJ, Crouse MS, Crosswhite MR, Black DN, Dahlen CR, Borowicz PP, Reynolds LP, Ward AK, Neville BW, Caton JS. Endogenous retroviruses (*syncytin-Rum1* and *BERV-K1*), and pregnancy hormones (*interferon- τ* , and *pregnancy specific protein-B*) are differentially expressed in maternal and fetal tissues during the first 50 days of gestation in beef heifers. *Translational Anim Sci* 2017; 1:239-49.
- McLean KJ, Crouse MS, Crosswhite MR, Negrin Pereira N, Dahlen CR, Borowicz PP, Reynolds LP, Ward AK, Neville BW, Caton JS. Impacts of maternal nutrition on placental vascularity and mRNA expression of angiogenic factors during the establishment of pregnancy in beef heifers. *Transl Anim Sci* 2017; 1:160-67.
- Reynolds LP, Vonnahme KA. Livestock as models for developmental programming. *Invited Review. Animal Frontiers* 2017; 7:12-17.
- Reynolds LP, Ward AK, Caton JS. 2017. Epigenetics and developmental programming in ruminants – long-term impacts on growth and development. In: *Biology of Domestic Animals* (Scanes CG and Hill R, eds.), CRC Press/Taylor & Francis Group, Milton Park UK. (ISBN 9781498747851)

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Crouse MS, Caton JS, McLean KJ, Borowicz PP, [Reynolds LP](#), Dahlen CR, Neville BW, Ward AK. Rapid Communication: Isolation of glucose transporters GLUT3 and GLUT14 in bovine utero-placental tissues from days 16 to 50 of gestation. *J Anim Sci* 2016; 94:4463-69.

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McLean KJ, Dahlen CR, Borowicz PP, [Reynolds LP](#), Crosswhite MR, Neville BW, Walden SD, Caton JS. Technical note: A new surgical technique for ovariohysterectomy during early pregnancy in beef heifers. *J Anim Sci* 2016; 94:5089-96.

[Reynolds LP](#), Vonnahme KA. Triennial Reproduction Symposium: Developmental programming of fertility. *J Anim Sci* 2016; 94:2699-2704.

Quinn KE, [Reynolds LP](#), Grazul-Bilska AT, Borowicz PP, Ashley RL. Placental development during early pregnancy: effects of embryo origin on expression of chemokine ligand 12 (CXCL12). *Placenta* 2016; 43:77-80.

[Reynolds LP](#), Haring JS, Johnson ML, Ashley RL, Redmer DA, Borowicz PP, Grazul-Bilska AT. Placental development during early pregnancy in sheep: Estrogen and progesterone receptor mRNA expression in pregnancies derived from in vivo and in vitro produced embryos. *Domestic Animal Endocrinology* 2015; 53:60-69.

[Reynolds LP](#), Wulster-Radcliffe M, Aaron DK, Davis TA. Issue and Opinions: Importance of Animals in Agricultural Sustainability and Food Security. *J Nutr* 2015; published ahead of print 13 May 2015, doi: 10.3945/jn.115.212217.

Wallace J, Milne J, Aitken R, Redmer D, [Reynolds LP](#), Luther J, Horgan G, Adam C. Undernutrition and stage of gestation influence fetal adipose tissue gene expression. *J Molec Endocrinol* 2015; preprint posted online 27 April 2015, doi: 10.1530/JME-15-0048.

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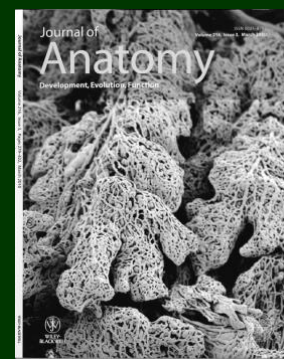
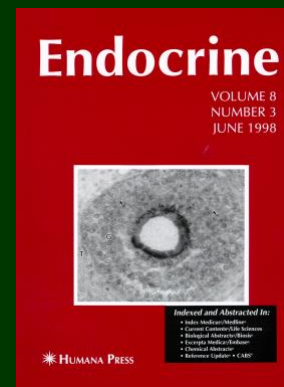
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[Reynolds LP](#), Redmer DA, Grazul-Bilska AT. 2005. The Microvasculature of the Ovary. In: *Microvascular Research: Biology and Pathology* (PA D'Amore et al., eds. [D Shepro, Editor-in-Chief]), Elsevier Academic Press, NY (ISBN 0-12-639510-1).

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