



## Awards and Recognitions

Associate Professor **Dr. Ruthanne (Rudi) Thompson** was selected as a University Distinguished Teaching Professor. This honor recognizes tenured faculty at UNT who perform outstanding teaching, instruct at the introductory levels of their disciplines, and promote continuous development of teaching excellence and improvement among their colleagues in the UNT community.



Dr. Ruthanne Thompson



Dr. Warren Burggren

**Dr. Warren Burggren** was selected as University Distinguished Research Professor. This award recognizes tenured faculty at the rank of Professor at UNT who have achieved an exceptional record of creative activities or research productivity and who demonstrate a record of continued extraordinary productivity.

University Distinguished Research Professor **Dr. Richard Dixon** was elected to serve as a Chief Scientist in the Beijing Advanced Innovation Center for Tree Breeding by Molecular Design at the Beijing Forestry University, Beijing, China. Dr. Dixon was also elected Faculty Fellow of the Hagler Institute of Advanced Study, Eminent Scholar in Residence, Visiting Professor in the College of Science, and Timothy C. Hall-Heep Distinguished Faculty Chair at Texas A&M University, for the period 2017-2022.



Dr. Richard Dixon



Shirley Gulley

Congratulations to **Shirley (Shirl) Gulley**, Administrative Specialist for the Department of Biological Sciences, for receiving a 2017 UNT Star Performer Award. This competitive award recognizes staff members who have made outstanding contributions to the University in meeting its' strategic goals.

## Tenure and Promotion

Congratulations to **Drs. Pamela Padilla, Ed Dzialowski** and **Brian Ayre** for their promotion to Full Professor, and **Dr. Rajeev Azad** for promotion to Associate Professor with tenure.

**Dr. Padilla's** research focuses on environmental stresses that are relevant to human health (oxygen deprivation, hyperglycemia). Using the genetic model system *Caenorhabditis elegans*, to model disease processes, her work has led to an understanding of the molecular changes associated with stress and ways to mitigate the impact of stress. Her work has impacted the field of organ function, cell division, metabolism, and gene expression. Grants from the National Science Foundation and National Institutes of Health support her research projects. She serves on the Board of Directors and is Treasurer-elect for SACNAS and is the Associate Dean of Research and Graduate Studies for the College of Science.



Dr. Pamela Padilla



Dr. Ed Dzialowski

**Dr. Dzialowski's** research is broadly focused on the development of endothermy in birds. Endothermy is the ability to regulate body temperature through internal heat production. Birds begin life unable to thermoregulate on their own and develop endothermy after hatching. His research focuses on ontogeny of skeletal muscle mitochondria, the cardiovascular and respiratory systems, and metabolism associated with attaining endothermy.



Dr. Brian Ayre



Dr. Rajeev Azad

**Dr. Ayre's** plant biology research revolves around the phloem transport system and how it functions as a whole-plant communication network to enable disparate organs to function as an integrated, complete organism. He has projects in two main areas: 1) The role of phloem in coordinating carbon metabolism and nutrient utilization between photosynthetic source leaves and heterotrophic sink organs and 2) the role of the phloem in transporting signaling molecules to mediate source control of sink growth and development. Together, these trajectories contribute to understanding how plants control yield, biomass partitioning, and growth patterns on a whole-plant level.

**Dr. Azad's** research in the area of Bioinformatics and Computational Biology focusses on the development and application of mathematical and computational methods to understand how organisms, specifically microbes, innovate to adapt to changes in environment. In addition, he studies large omics datasets to determine how organisms respond to stress at the molecular and physiological level, and develops novel approaches to decipher structural and functional features in genomes and elucidate their relationships in the context of evolution.

## Other News

Regents Professor **Dr. James Kennedy** was appointed as the UNT representative on the Board of Directors of the Sub-Antarctic Cape Horn Foundation. He was also appointed to a 3-year term to the Mansfield University Foundation Board.

**Dr. Mrunmay Giri**, former postdoctoral fellow in University Distinguished Research Professor Dr. Jyoti Shah's group, joined KIIT University, formerly Kalinga Institute of Industrial Technology, Bhubaneswar, India, as Assistant Professor. Dr. Giri's research expertise is in the area of plant adaptation to stress.



Dr. James Kennedy



Dr. Mrunmay Giri

Congratulations to **Drs. Dane Crossely** and **Ed Dzialowski**, and their research group, whose recent publication titled '*Developmental plasticity of mitochondrial function in American alligators, Alligator mississippiensis*' that was published in the American Journal of Physiology-Regulatory, Integrative and Comparative Physiology (doi: 10.1152/ajpregu.00107.2016), won the Louisiana Association of Professional Biologists Publication Award in the Basic Research category for 2017.



Amy Rommel

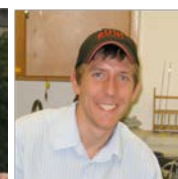
**Amy Rommel**, former MS student in Regents Professor Dr. Kent Chapman's lab and 2015 SalkExcellerator Fellowship recipient, presented her research on novel treatment strategies for glioblastoma at the March 24th Salk Women and Science Symposium.

## Thesis and Dissertations

**Tushar Sirsat**, graduate student in Professor Ed Dzialowski's lab, successfully defended his PhD dissertation titled "*The role of thyroid hormone across avian development spectrum: investigations on systemic development, metabolism and Ontogeny of endothermy*".



Tushar Sirsat



Christopher Maller

**Christopher Maller**, graduate student in Professor Ed Dzialowski's lab, successfully defended his PhD dissertation titled "*Reproduction and metabolic responses to acute and chronic hypoxia in ovoviviparous blaberid cockroaches, with a focus on Blaptica dubia*".

**Elizabeth McClinchie**, a master's student in Regents Professor Dr. Kent Chapman's lab, successfully defended her thesis entitled "*Homologs of Mammalian Lysosomal Lipase in Arabidopsis and their roles in lipid droplet dynamics*".



Elizabeth McClinchie



Danyang Shao

**Danyang Shao** successfully defended her MS thesis "*Generating molecular biology tools to investigate the Ca<sup>2+</sup> binding ability of Arabidopsis TON2*". Danyang's advisor was Dr. Amanda Wright.

## Recent Publications

Chumchal, M.M., Drenner, R.W., Greenhill, F., Kennedy, J.H. Courville, A., and Lossau, L. (2017) Recovery of Aquatic Insect-Mediated Methylmercury Flux from Ponds Following Drying Disturbance. *Environmental Toxicology and Chemistry*. 36(8):1986-1990.

Docampo, M., Olubu, A., Wang, X., Pasinetti, G. and Dixon, R.A. (2017) Glucuronidated flavonoids in neurological protection: structural analysis and approaches for chemical and biological synthesis. *Journal of Agricultural and Food Chemistry*. 65:7607-7623. doi: 10.1021/acs.jafc.7b02633

Disdier, C., Chalansonnet, M., Gagnaire, F., Gaté, L., Cosnier, F., Devoy, J., Saba, W., Lund, A.K., Brun, E., Mabondzo, A. (2017) Brain inflammation, blood brain barrier dysfunction and neuronal synaptophysin decrease after inhalation exposure to Titanium dioxide nano-aerosol in aging rats. *Sci Rep*. 7(1):12196. doi: 10.1038/s41598-017-12404-5.

Donegan-Quick, R., Gibbs, Z.A., Amaku, P.O., Bernal, J.T., Boyd, D.A.M., Burr, A.R., Coelho, R.E., Dossou, A.S., Henry, R.M., Huynh, M., Kanani-Kendijani, T.A., Martinez, G., McClendon-Moss, T.O., Orozco, S., San Martin, J.M., Stoddart, K.E., Stringer, M.M., Villegas, R.L., Nayek, S., Suri, N., Garlena, R.A., Russell, D.A., and Hughes, L.E. (2017) Genome sequences of five *Streptomyces* bacteriophages forming Cluster BG. *Genome Announcements* 5(28):e00502-17. DOI: 10.1128/genomeA.00502-17.

Hoeinghaus, D.J. (2017) Dams and river fragmentation. *in* Volume 3 (*Biodiversity*; Lacher Jr., T.E., and Pyare, S., Editors) of Volumes 1-5 in the *Encyclopedia of the Anthropocene* (D.A. DellaSala and M.I. Goldstein, Editors-in-Chief). Elsevier, Oxford, UK. DOI: 10.1016/B978-0-12-409548-9.09826-2 (also included in Elsevier's Reference Module in Earth Systems and Environmental Science) <http://www.sciencedirect.com/science/article/pii/B9780124095489098262>

Ivarson, E., Iven, T., Sturtevant, D., Ahlman, A., Cai, Y., Chapman, K., Feussner, I. and Zhu, L.H. (2017) Production of wax esters in the wild oil species *Lepidium campestre*. *Industrial Crops and Products*, 108:535-542. doi:10.1016/j.indcrop.2017.07.002

Klyczek, K.K., Bonilla, J.A., Jacobs-Sera, D., Adair, T.L., Afram, P., Allen, K.G., Archambault, M.L., \*Aziz, R.M., Bagnasco, F.G., Ball, S.L., Barrett, N.A., Benjamin, R.C., Blasi, C.J., Borst, K., Braun, M.A., Broomell, H., Brown, C.B., Brynell, Z.S., Bue, A.B., Burke, S.O., Casazza, W., Cautela, J.A., Chen, K., Chimalakonda, N.S., Chudoff, D., Connor, J.A., Cross, T.S., Curtis, K.N., Dahlke, J.A., Deaton, B.M., Degroote, S.J., DeNigris, D.M., DeRuff, K.C., Dolan, M., Dunbar, D., Egan, M.S., Evans, D.R., Fahnestock, A.K., Farroq, M.A.,

Finn, G., Fratus, C.R., Gaffney, B.L., Garlena, R.A., Garrigan, K.E., Gibbon, B.C., Goedde, M.A., Guerrero Bustamante, C.A., Harrison, M., Hartwell, M.C., Heckman, E.L., Huang, J., Hughes, L.E., ; Hyduchak, K.M., Jacob, A.E., Kaku, M., Karstens, A.W., Kenna, M.A., Khetarpal, S., King, R.A., Kobokovich, A.L., Kolev, H., Konde, S.A., Kriese, E., Lamey, M.E., Lantz, C.N., Lapin, J.S., Lawson, T.O., Lee, I.Y., Lee, S.M., Lee-Soety, J.Y., Lehmann, E.M., London, S.C., Lopez, A.J., Lynch, K.C., Mageeney, C.M., Martynyuk, T., Mathew, K.J., Mavrich, T.N., McDaniel, C.M., McDonald, H., McManus, C.J., Medrano, J.E., Mele, F.E., Menninger, J.E., Miller, S.N., Minnick, J.E., Nabua, C.T., Napoli, C.K., Nkangabwa, M., Oates, E.A., Ott, C.T., Pellerino, S.K., Pinamont, W.J., Pirnie, R.T., Pizzorno, M.C., Plautz, E.J., Pope, W.H., Pruett, K.M., Rickstrew, G., Rimple, P.A., Rinehart, C.A., Robinson, K.M., Rose, V.A., Russell, D.A., Schick, A.M., Schlossman, J., Schneider, V.M., Sells, C.A., Sieker, J.W., Silva, M.P., Silvi, M.M., Simon, S.E., Staples, A.K., Steed, I.L., Stowe, E.L., Stueven, N.A., Swartz, P.T., Sweet, E.T., Sweetman, A.T., Tender, C., Terry, K., Thomas, C., Thomas, D.S., Thompson, A.R., Vanderveen, L., Varma, R., Vaught, H.L., Vo, Q.D., Vonberg, Z.T., Ware, V.C., Warrad, Y.M., Wathen, K.E., Weinstein, J.L., Wyper, J.F., Yankauskas, J.R., Zhang, C., and Hatfull, G.F. (2017) Genomic and morphological characteristics of forty-six *Arthrobacter* phages. PLOS ONE 12(7): e0180517. <https://doi.org/10.1371/journal.pone.0180517>

Lucero, J., Suwannasual, U., Herbert, L.M., McDonald, J.D., and Lund, A.K. (2017) The role of the lectin-like oxLDL receptor (LOX-1) in traffic-generated air pollution exposure-mediated alteration of the brain microvasculature in Apolipoprotein (Apo) E knockout mice. *Inhal Toxicol.* 26:266-281. doi: 10.1080/08958378.2017.1357774.

Mager, E.M., Pasparakis, C., Schlenker, L., Yao, Z., Bodinier, C., Stieglitz, J., Hoenig, R., Morris, J., Benetti, D., and Grosell, M. (2017) Assessment of early life stage Mahi-Mahi windows of sensitivity during acute exposures to Deepwater Horizon crude oil. *Environmental Toxicology and Chemistry.* 36:1887-1895. <http://onlinelibrary.wiley.com/doi/10.1002/etc.3713/abstract>

Marpu, S., Kolailat, S.S., Korir, D., Kamras, B.L., Chaturvedi, R., Joseph, A., Smith, C.M., Palma, M.C., Shah, J., and Omary, M.A. (2017) Photochemical formation of chitosan-stabilized near-infrared-absorbing silver *Nanoworms*: A "Green" synthetic strategy and activity on Gram-negative pathogenic bacteria. *Journal Colloid Interface Sci.* 507:437-452. doi: 10.1016/j.jcis.2017.08.009.

Pan, T-C F. and I. Hunt von Herbing (2017) Metabolic Plasticity in development: Synergistic responses to high temperature and hypoxia in zebrafish, *Danio rerio*. *Journal of Experimental Zoology-A (Ecological and Integrative Physiology)* 201:1-11.

Shah, J., and Walling, L. (2017) Editorial: Advances in plant-hemipteran interactions. *Frontiers Plant Sci.* 8:1652. doi: 10.3389/fpls.2017.01652

Usher, S., Han, L., Haslam, R.P., Michaelson, L.V., Sturtevant, D., Aziz, M., Chapman, K.D., Sayanova, O. and Napier, J.A., (2017) Tailoring seed oil composition in the real world: optimising omega-3 long chain polyunsaturated fatty acid accumulation in transgenic *Camelina sativa*. *Scientific Reports*, 7(1):6570. doi: 10.1038/s41598-017-06838-0

Xu, E., Mager, E.M., Grosell, M., Stieglitz, J., Hazard, E., Hardiman, G., and Schlenk, D. (2017) Developmental transcriptomic analyses for mechanistic insights into critical pathways involved in embryogenesis of pelagic Mahi-Mahi (*Coryphaena hippurus*). PLOS ONE. 12(7): e0180454. <http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0180454>

Yu, X.-H., Cahoon, R. E., Horn, P. J., Shi, H., Prakash, R. R., Cai, Y., Hearney, M., Chapman, K. D., Cahoon, E. B., Schwender, J. and Shanklin, J. (2017) Identification of bottlenecks in the accumulation of cyclic fatty acids in camelina seed oil. *Plant Biotechnol J.* Accepted Author Manuscript. doi:10.1111/pbi.12839

## Extramural Grants and Contracts

*Collaborative Research: Evaluating a data-driven approach to teaching technical writing to STEM majors.* National Science Foundation; PI: Ryan Boettger, Co-PIs: David Hoeninghaus and Aaron Roberts. \$290,768, UNT budget \$185,141.

*The Center for Bioenergy Innovation- Lignin Design and Valorization.* United States Department of Energy. PI: Richard A. Dixon. Co-PI: Fang Chen. \$2,290,000.

*The Renin-Angiotensin System in Air Pollution-Mediated Exacerbation of Obesity.* National Institute of Health (NIH)/National Institute of Environmental Health & Safety (NIEHS) – R15 AREA Award. PI: Amie Lund, co-PI: Brain McFarlin. \$437,964.

*Wheat Variants Deficient in a FHB Susceptibility Factor.* United States Department of Agriculture. PI: Jyoti Shah, co-PI: Nidhi Rawat (University of Maryland), \$45,000.

## Patents

Manipulation of proanthocyanidin (PA) composition by affecting anthocyanidin synthase (ANS) and leucoanthocyanidin dioxygenase (LDOX). R.A. Dixon and J.H. Jun. US Provisional Patent Application.

## Seminars/Talks

*Acute and latent effects of Deepwater Horizon crude oil exposure on the early life stages of Mahi-Mahi.* Department of Biology, University of Saskatchewan. August 25, 2017. Invited seminar by E.M. Mager.

*Discovery of unexpected new pathways facilitates the engineering of proanthocyanidins.* 4<sup>th</sup> International Conference on Plant Metabolism, Dalian, China, July 18, 2017. Plenary Lecture, Richard. A. Dixon.

*Decifrando la diversidad en la ruta para la biosíntesis de lignin en diferentes especies de plantas (Unraveling the diversity in the lignin biosynthesis pathway in different plant species)*. IV Congreso Internacional de Química e Ingeniería Verde (IV International Congress of Green Chemistry and Engineering). Monterrey, Nuevo León, México. September 7, 2017. Invited talk by Luis L. Escamilla-Trevino.

*Early steps of lignin biosynthesis revisited*. DOE BioEnergy Science Center Annual Meeting, Chattanooga, TN. July 11, 2017. Invited Talk, Jaime Barros-Rios.

*Gulf of Mexico oil pollution and larval fish physiology*. Larval Fish Conference component of the Joint Meeting of Ichthyologists & Herpetologists, Austin, TX. July 16, 2017. Invited talk by E.M. Mager.

*Imaging Mass Spectrometry: What Can Metabolite Location Suggest About Pathways of Lipid Metabolism in Oilseeds?* Australasian meeting of the American Oil Chemists Society, Barossa Valley, South Australia, September 12, 2017. Invited Keynote Lecture, Plant Biotechnology Section, by Dr. Kent D. Chapman.

*N-Acylethanolamine Metabolism and the Regulation of Seedling Development in Arabidopsis thaliana*. 8th European Symposium on Plant Lipids, Malmoe, Sweden, July 3, 2017. Invited Keynote Lecture by Dr. Kent D. Chapman.

*New Protein Players in Plant Lipid Droplet Biology*. Invited Seminar presented to The Commonwealth Scientific and Industrial Research Organisation (CSIRO), Canberra, Australia, September 15, 2017. Given by Dr. Kent D. Chapman

*New twists in the biosynthesis of condensed tannins*. Tsinghua University, Beijing, China. July 14, 2017. Invited Seminar, Richard A. Dixon.

*New twists in the biosynthesis of condensed tannins*. Beijing Forestry University, Beijing, China. July 15, 2017. Invited Seminar, Richard A. Dixon.

*Sustentabilidad y Biocombustibles Lignocelulósicos (Sustainability and Lignocellulosic Biofuels)*. IV Congreso Internacional de Química e Ingeniería Verde (IV International Congress of Green Chemistry and Engineering). Monterrey, Nuevo León, México. September 8th 2017. Invited talk by Luis L. Escamilla-Trevino.

## Conference Presentations

Adams, A., Busby, W. Hunt von Herbing, I. Red or Blue: What do we do? Determining Stain Protocol for skeletal development in larval Red Drum (*Sciaenops ocellatus*) treated with Antibiotics and Probiotics. Society for Experimental Biology Meeting, Gothenburg, Sweden. July 2017.

Barros-Rios, J., Serrani-Yarce, J.C. and Dixon, R.A. Coumarate 3-Hydroxylase (C3H) in the Lignin Pathway is a Cytosolic Ascorbate-Dependent Peroxidase. 10<sup>th</sup> DOE BioEnergy Science Center Annual Meeting-2017, Chattanooga, TN.

Brejão, G.L., Hoesinghaus, D.J., Casatti, L., Pérez-Mayorga, M.A., and Ferraz, S.F.B. 2017. Using a deforestation chronosequence to understand changes in stream habitat structure and fish diversity: implications for ecological restoration. Society for Ecological Restoration Annual Meeting; Foz do Iguaçu, Brazil.

Busby, W. and Hunt von Herbing, I. Multi-strain Probiotic effects on growth, mortality, food conversion ratios (FCRs) and behavior in Red Drum (*Sciaenops ocellatus*). Association of Ichthyologists and Herpetologists & Early Life History Society Meeting, Austin Texas. July 2017.

Busby, W., Hunt von Herbing, I. Using a Multi-strain Probiotic to Measure the Effects on Growth, Mortality, Food Conversion Ratios (FCRs), and Behavior in Red drum (*Sciaenops ocellatus*). Society for Experimental Biology Meeting, Gothenburg, Sweden. July 2017.

Chen, F., Zhuo, C., Xiao, X. and Dixon, R.A. Genetic Approaches Towards Understanding C-lignin Biosynthesis in *Cleome hassleriana*, 10<sup>th</sup> DOE BioEnergy Science Center Annual Meeting-2017, Chattanooga, TN.

Chumchal, M, Drenner, R, Greenhill, F, Kennedy J., Courville, A., Gober, C. and Lossau, L. 2017. Recovery of Aquatic Insect-Mediated Methylmercury Flux From Ponds Following Drying Disturbance. 13th International Conference on Mercury as a Global Pollutant, 16-21 July 2017. Providence, Rhode Island.

Dzialowski, E.M., Sirsat, S.K.G., and Sirsat, T.S. Influence of thyroid hormones on development of endothermy and ventilation in altricial and precocial birds. Society of Experimental Biology annual meeting, Gothenburg, Sweden. July 2017.

Escamilla-Treviño, L.L., Barros-Rios, J. Ha, C.M., Cavazos, R. and Dixon, R.A. (2017). Is the 3-O-methylation of caffeic acid a step in the biosynthesis of monolignols? 10<sup>th</sup> DOE BioEnergy Research Center Annual Meeting-2017. Chattanooga, TN.

Faraji, M., Fonseca, L.L., Barros-Rios, J., Chen, F., Engle, N., Tschaplinski, T., Dixon, R.A. and Voit, E.O. Model Analysis of Compartmentalized Lignin Biosynthesis Using Labeled Phenylalanine or Tyrosine in *Brachypodium distachyon*. 10<sup>th</sup> DOE BioEnergy Research Center Annual Meeting-2017. Chattanooga, TN.

Gallego-Giraldo, L., Pose-Albacete, S., Pattathil, S., Peralta, A.G., Hahn, M., Knox, J.P. and Dixon, R.A. Differential lignin modification reveals diversity of cell wall-derived signals for activation of plant defense genes. 10<sup>th</sup> DOE BioEnergy Science Center Annual Meeting-2017, Chattanooga, TN.

Hoeinghaus, D.J., Ferrari-Hoeinghaus, A.P., Gomes, L.C., and Agostinho, A.A. Thresholds and legacy effects of fish assemblages of the Upper Paraná River floodplain to timing, magnitude, duration and variation in flood conditions. International Symposium on Flood Pulse Ecosystems; Siem Reap, Cambodia. July 2017.

Hughes, L.E. Establishing and maintaining course-based undergraduate research experiences: An institutional case study. Gordon Conference on Undergraduate Biology Education Research, Easton, MA. July 2017.

Hunt von Herbing, I. Anderson M. & W. Busby. Our Inner Oceans: Understanding the origins of the gut microbiome. Association of Ichthyologists and Herpetologists & Early Life History Society Meeting, Austin, Texas. July 2017.

Lusk, H.J., Colter, M., Shiva, S., Roth, M., Sarowar, S., Shah, J., Durrett, T., and Welti, R. Identification of Arabidopsis Mutant Lacking Glycerolipid Assembly in the Chloroplast. Phytochemical Society of North America annual meeting, Columbia, MO. Aug 5-9, 2017.

Olubu A., Docampo, M., Wang, X., Pasinetti, G. and Dixon, R.A. Characterization and Engineering of UDP-Glucuronosyltransferases (UGATs) from Medicago Towards (Iso) flavonoid Glucuronide Synthesis. Gordon Research Conference (GRC) on Plant Metabolic Engineering (*Plant Engineering in the Synthetic Biology Era*). July 8-14, 2017, Waterville Valley, New Hampshire.

Ortega-Rodriguez, C., Chumchall, M., Drenner, R., Kennedy, J., Lauck, K., Polk, K., Hall, M., Barst, B., Santa Rios, A., Basu, N. 2017. Mercury and Stable Isotopes of Nitrogen Reveal An Aquatic Diet for Seven Taxa of Shore line Spiders. 13th International Conference on Mercury as a Global Pollutant, Providence, Rhode Island. July 2017.

Pu, Y., Li, M. Yoo, C. G., Chen, F., Dixon, R.A. and Ragauskas, A. J. C-lignin in vanilla seeds during pretreatments. 10<sup>th</sup> DOE BioEnergy Science Center Annual Meeting-2017, Chattanooga, TN.

Rao, X., Chen, X., Shen, H., Ma, Q., Li, G., Tang, Y., and Dixon, R.A. Transcriptional regulatory network of secondary cell wall formation in switchgrass. 10<sup>th</sup> DOE BioEnergy Science Center Annual Meeting-2017, Chattanooga, TN.

Serrani-Yarce, J.C., Barros-Rios, J., Engle, N., Tschaplinski, T. and Dixon, R.A. New Insights on the Lignin Pathway in Grasses. 10<sup>th</sup> DOE BioEnergy Science Center Annual Meeting-2017, Chattanooga, TN.

BIOSphere is a quarterly newsletter of the Department of Biological Sciences, University of North Texas

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