



## Awards and Recognition

University Distinguished Research Professor **Dr. Warren Burggren** was elected Fellow of the American Physiological Society. This award honors Dr. Burggren for his outstanding leadership and service to the society and for his noteworthy professional and scientific accomplishments in Comparative & Evolutionary Physiology. The fellows of the Society are featured at <https://www.the-aps.org/community/aps-membership/aps-fellows/FAPS-Awardees?SSO=Y>



Warren Burggren

The Biology Graduate Student Association hosted Graduate Research Day on April 12, 2019. **Dr. Neil Shubin**, Robert R. Bensley Professor in Organismal Biology and Anatomy at the University of Chicago and author of the national bestseller 'Your Inner Fish', delivered the keynote address 'Fossils, Genes, and the Origin of Limbs', and a lecture 'Finding your inner fish' that was open to the general public.



Dr. Neil Shubin and some of the winners at the Graduate Research Day with BGSA committee members

As part of the Graduate Research Day activities, more than 40 talks and posters were presented by students who competed for awards in different categories. **Rachel Reeds** was awarded the Best Oral Presentation by a Graduate Student award. **Monika Patel** received honorable mention for her oral presentation in this category. **Ian Rapp** and **Coral James** tied for first place for the Best Poster presentation by an undergraduate student. The award for the Best Poster by a graduate student was awarded to **Christine Gulye**. **John Evers** and **Dhiraj Dokwal** received honorable mention in the Graduate Poster category. A silent Art competition was also held. **Brittany Harried** received first place, while **Cheryl Rhoades** and **Dr. Ione Hunt von Herbing** shared the second place award. **Amanda Reynolds** received the third place award in the Art contest.

## Other News

University Distinguished Teaching Professor, Dr. Lee Hughes and the UNT Student Chapter of the American Society for Microbiology hosted the 3<sup>rd</sup> Annual South-Central USA SEA-PHAGES Research Symposium at the UNT Campus on April 12-13, 2019. Over 80 students, including more than 30 UNT freshmen, and faculty from seven regional universities and colleges attended the symposium and presented their research on bacteriophages.

Drs. Mark Burluson and Lee Hughes hosted the 3<sup>rd</sup> UNT Mobile Summer Institute on Scientific Teaching from May 13-17, 2019. The institute, which was attended by 13 faculty, staff, and graduate students from UNT and other nearby colleges, was featured on the UNT College of Science website <https://cos.unt.edu/news/biology-faculty-host-unt%E2%80%99s-third-mobile-summer-institute-scientific-teaching>.

The Ecology program's Pecan Creek Pollinative Prairie was featured on NBC 5 DFW in June. Seth Voorhees interviewed Dr. Jaime Baxter-Slye and undergraduates Molly Burke and Jordan Curtis to understand the prairie reconstruction work conducted by our UNT Ecology students. The Prairie has received \$163,000 to date from the We Mean Green Fund to turn four acres of Bermuda grass dominated field at Discovery Park into a native Texas tallgrass prairie. Over 500 UNT students have volunteered over 1000 hours working on the project since 2016. One acre is complete with over 200 species of plants, birds, insects, spiders, reptiles, and fungi have been documented in the habitat, including a nesting pair of American Kestrels. The Prairie has been recognized as part of UNT Bee Campus USA, Xerces Society Million Pollinator Garden, Monarch Watch Weigh Station, and a Texan By Nature site. Several classes have held field trips to the Prairie.



Participants at the SEA-PHAGES Research Symposium (top) and the Pecan Creek Pollinative Prairie project (bottom)

## Faculty and Staff Appointments

**Carol Gagnon** joined the department as Budget Officer. Carol graduated from University of Houston-Clear Lake with a BS in Accounting. She has over 20 years of work experience in Government and Higher Education. She has been with UNT since January of 2010, working in the Campus Budget office and as Budget Analyst for UNT System, prior to joining the Department of Biological Sciences. As Budget Officer, Carol will work closely with the faculty, students and staff on Budget related matters and Computer rollouts.



Carol Gagnon



Novita Rahman

**Novita Rahman** joined the department as Research Analyst. She will assist the Biology faculty with reconciliation and account information. Prior to joining the department, she worked with UNT System's IT Shared Services Department as a Business Analyst to support UNT System campuses. In this role, she acted as a liaison between the business users and finance technical team to communicate requirements, test plans and appropriate project information. Novita graduated from Stevens Institute of Technology in Hoboken, New Jersey, with a Bachelor's degree in Chemical and Environmental Engineering, and subsequently a Master's Degree in Management Information Systems.

## Thesis and Dissertations

**Skylar King** defended her PhD dissertation titled "*Ceramides and NEET Proteins Influence Development, Function and Maintenance of the C. elegans Germline*" on June 7, 2019. Dr. King's major professor is Dr. Pamela Padilla.



Skylar King

## Extramural Grants and Contracts

Molecular approaches to improved protein utilization in alfalfa. Forage Genetics International. PI: Richard Dixon, \$150,000.

Embryogenic Cell Culture Screening System for Herbicide Tolerance. BASF Plant Sciences LLC. PI: Kent D Chapman, \$73,557.

Engineering Seed Value in Cotton. Cotton Incorporated. PI: Kent D. Chapman, \$85,000.

## Publications

Alderman, SI, Crossley II, D.A., Elsey, R.M. and Gillis, T.E. (2019). Hypoxia-induced reprogramming of the cardiac phenotype in American alligators (*Alligator mississippiensis*) revealed by quantitative proteomics. *Scientific Reports* 9: 8592.

Arantes, C.C., Fitzgerald, D.B., Hoeninghaus, D.J., and Winemiller, K.O. (2019). Impacts of hydroelectric dams on fishes and fisheries in tropical rivers through the lens of functional traits. *Current Opinion in Environmental Sustainability* 37: 28-40. <https://www.sciencedirect.com/science/article/pii/S1877343518301003>

Ayre B.G., Turgeon R. (2018). Export of Photosynthates from the Leaf. In: Adams III W., Terashima I. (eds) *The Leaf: A Platform for Performing Photosynthesis*. *Advances in Photosynthesis and Respiration*, Springer, Vol 44: Chap 3, 55-79. . [https://link.springer.com/chapter/10.1007%2F978-3-319-93594-2\\_3](https://link.springer.com/chapter/10.1007%2F978-3-319-93594-2_3)

Barros-Rios, J., Escamilla-Trevino. L., Engle, N., Tschaplinski, T.J., Feroza K. Choudhury, F.K., Song, L., Mittler, R., Barney Venables, B. and Dixon, R.A. (2019). 4-Coumarate 3-hydroxylase in the lignin biosynthesis pathway is a cytosolic ascorbate peroxidase. *Nature Communications* 10:1994.

Bednarz, J.C. (2019) Urban raptors: ecology and conservation of birds of prey in cities (book review). *Journal of Raptor Research* 53: 234-236.

Burggren, W. Inadequacy of typical physiological experimental protocols for investigating consequences of stochastic weather events emerging from global warming. *American Journal of Physiology. Regulatory, Comparative and Integrative*. 316(4):R318-R322

Burggren, W.W., Mendez-Sanchez, J.F., Martínez Bautista, G., Peña, E., Martínez García, R., and Alvarez González, C.A. Developmental changes in oxygen consumption and hypoxia, tolerance in the heat and hypoxia-adapted tabasco line of the Nile tilapia, *Oreochromis niloticus*, with a survey of the metabolic literature for the genus *Oreochromis*. *Journal of Fish Biology*. doi: 10.1111/jfb.13945

Cai Y, Whitehead P, Chappell J, Chapman KD (2019) Mouse lipogenic proteins promote the co-accumulation of triacylglycerols and sesquiterpenes in plant cells. *Planta*. 250(1): 79–94.

Codd, J, Rose, K., Tickle, P., Sellers, W., Brocklehurst, R., Elsey, R., and Crossley, D.A. II (2019). Muscle recruitment circumvents a functional constraint in the evolution of aspiration breathing. Accepted. *Biology Letters*. Impact Factor 3.345.

Crego, R.D., Jiménez J.E., and Rozzi, R.. (2018). Fur trade and the biotic homogenization of sub-polar ecosystems. Pp. 233-243, *in* Rozzi, R., J.R. May Jr., S.R. Chapin, F. Massardo, M. Gavin, I. Klaver, A. Pauchard, M. Núñez, P. Groffman & D. Simberloff (eds.). *From biocultural homogenization to biocultural conservation*. Dordrecht, Netherlands: Springer.

de Fátima, Â., Docampo-Palacios, M., Alvarez-Hernandez, A., Pasinetti, G. and Dixon, R.A. (2019). An efficient synthesis of deoxyrhapontigenin-3-O-β-D-glucuronide, a brain-targeted derivative of dietary resveratrol, and its precursor 4'-O-Me-resveratrol. *ACS Omega* 4 (5), 8222-8230, DOI 10.1021/acsomega.9b00722.

Filogonio, R., and Crossley, D.A. II (2019). Long term effects of chronic prenatal exposure to hypercarbia on organ plasticity and cardiovascular responses to adrenaline and hypoxia in common snapping turtles. *Journal of Comparative Biochemistry and Physiology A* 234:10-17

Greer, J., Mager, E., and Fieber, L. (2019). Altered expression of ionotropic L-Glutamate receptors in aged sensory neurons of *Aplysia californica*. *PLoS ONE*. 14(5), e0217300. <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0217300>

Jara, R.F., Crego, R.D., Arellano, F.J., Altamirano, T.A., Ibarra, J.T., Rozzi, R., and Jiménez, J.E. (2019). Breeding strategies of open-cup-nesting birds in Sub-Antarctic forests of Navarino Island, Chile. *Revista Chilena de Historia Natural* 92. DOI: 10.1186/s40693-019-0082-4

Price, E.R., Sotherland, P.R., Wallace, B.P., Spotila, J.R., and Dzialowski, E.M. (2019) Physiological determinants of the interesting interval in sea turtles: a novel 'water-limitation' hypothesis. *Biology Letters*. 15: 20190248. <http://dx.doi.org/10.1098/rsbl.2019.0248>

Perrichon, P., Stieglitz, J.D., Xu, E.G., Magnuson, J.T., Pasparakis, C., Mager, E.M., Wang, Y., Schlenk, D., Benetti, D.D., Roberts, A.P., Grosell, M., Burggren, W.W. Mahi-mahi (*Coryphaena hippurus*) life development: morphological, physiological, behavioral and molecular phenotypes. *Developmental Dynamics*. doi: 10.1002/dvdy.27.

Price, E.R., Sirsat, T.S., Sirsat, S.K.G., and Dzialowski, E.M. (2019). Sarcoplasmic reticulum Ca<sup>2+</sup>-ATPase (SERCA) activity during the transition to endothermy in an altricial bird. *Journal of Experimental Biology*. 222: jeb201111.

Ruhr I, H McCourty, A Bajjig, D Crossley, H Shiels, G Galli 2019. Developmental plasticity of cardiac anoxia-tolerance in juvenile common snapping turtles *Chelydra serpentina*. Published:26 June 2019 <https://doi.org/10.1098/rspb.2019.1072>. *Proceedings of the Royal Society B*. Impact factor 4.847.

Schüttler, E., Crego, R.D. Saavedra-Aracena, L., Silva-Rodríguez, E.A., Rozzi, R., Soto, N. and Jiménez, J.E. (2019). New records of invasive mammals from the sub-Antarctic Cape Horn Archipelago. *Polar Biology* 42: 1092-1105. DOI: 10.1007/s00300

Suwannasual, U., Lucero, J., Davis, G., McDonald, J.D., Lund, A.K. (2019). Mixed vehicle emissions induces angiotensin II and cerebral microvascular angiotensin receptor expression in C57Bl/6 mice and promotes alterations in integrity in a blood-brain barrier co-culture model. *Toxicol. Sci.* May 27. pii: kfz121. doi: 10.1093/toxsci/kfz121. [Epub ahead of print]. <https://academic.oup.com/toxsci/advance-article/doi/10.1093/toxsci/kfz121/5498875>

Thompson CN, Hendon BR, Mishra D, Rieff JM, Lowery CC, Lambert KC, Witt TW, Oswalt SJ, Bechere E, Smith CW, Cantrell RG, Kelly BR, Imel-Vise RK, Chapman KD, Dowd MK, Auld DL (2019) Cotton (*Gossypium hirsutum* L.) mutants with reduced levels of palmitic acid (C16:0) in seed lipids. *Euphytica* 215: 112- 122.

Yadav U.P., Shaikh M.A., Evers J., Regmi K.C., Gaxiola R.A., Ayre B.G. (2019) Assessing Long-distance Carbon Partitioning from Photosynthetic Source Leaves to Heterotrophic Sink Organs with Photoassimilated [<sup>14</sup>C]CO<sub>2</sub>. In: Liesche J. (ed) *Phloem, Methods and Protocols*, Series: *Methods in Molecular Biology*, Springer Humana Press, Vol 2014: Chap 19, 223-233. [https://link.springer.com/protocol/10.1007%2F978-1-4939-9562-2\\_19](https://link.springer.com/protocol/10.1007%2F978-1-4939-9562-2_19)

Wynia, A.L., and Jiménez, J.E. (2019). Preliminary assessment of the influence of larvae availability on the foraging behavior of Magellanic woodpeckers. *Bosque* 40: 81-86.

Xie, H., Engle, N.L., Venketachalam, S., Yoo, C.G., Barros, J., Lecoultre, M., Howard, N., Li, G., Sun, L., Srivastava, A.C., Pattathil, S., Pu, Y., Hahn, M.G., Ragauskas, A.J., Nelson, R.S., Dixon, R.A., Tschaplinski, T.J., Blancaflor, E. and Tang, Y. (2019). Combined effects of loss of function of *FOLYLPOLYGLUTAMATE SYNTHETASE1* and *CAFFEOYL-COA 3-O-METHYLTRANSFERASE1* on lignin and saccharification efficiency in *Arabidopsis thaliana*. *Biotechnology for Biofuels*, 12, 108.

Yu, K., Jun, J. H., Duan, C. and Dixon, R.A. (2019). VvLAR1 and VvLAR2 are bi-functional enzymes for proanthocyanidin biosynthesis in grapevine. *Plant Physiology*. DOI: <https://doi.org/10.1104/pp.19.00447>

Zhuo, C., Rao, X., Azad, R., Pandey, R., Xiao, X., Harkelroad, A., Wang, X., Chen, F. and Dixon, R.A. (2019). Enzymatic basis for C-lignin biosynthesis in the seed coat of *Cleome hassleriana*. *Plant Journal*. <https://doi.org/10.1111/tpj.14340>.

## Seminars/Talks

Applications of capillary columns for targeted and untargeted metabolomics analysis. The 43<sup>rd</sup> International Symposium on Capillary Chromatography & the 16th GCxGC Symposium, Fort Worth, Texas, USA, May 13-17, 2019. Invited talk by Dr. Vladimir Shulaev

Are phenotypic modifications resulting from plasticity during developmental critical windows fixed or reversible?. The Society for Experimental Biology. Seville, Spain, July 2-5, 2019. Invited talk by Dr. Warren Burggren.

Deforestation, biofuels, and stream fish diversity in the Neotropics. Department of Biology, University of Texas – Arlington. March 2019. Invited seminar by Dr. David Hoehinghaus

Developmental plasticity, epigenetics and evolution: Implications for pollution and toxicology. International Conference on Marine Pollution and Ecotoxicology. Hong Kong China, June 11-14, 2019. Keynote Lecture by Dr. Warren Burggren.

Domesticated cotton (*Gossypium* spp.) phloem loads from the apoplast using a single member of its nine-member sucrose transporter gene family. *Plant Vascular Biology* 2019, Asilomar, California, June 17-20, 2019. Invited talk presented by Dr. Brian Ayre. Co-authors John Evers (PhD student), Mearaj Shaikh (PhD student) and Umesh Yadav.



Domesticated cotton (*Gossypium* spp.) phloem loads from the apoplast using a single member of its nine-member sucrose transporter gene family. UNT Biology Graduate Students' Association (BGSA) Annual Research Day, Denton, Texas, April 11-12, 2019. Invited talk presented by Mearaj Shaikh (PhD student). Co-authors John Evers (PhD student), Umesh Yadav and Brian Ayre.

Epigenetic inheritance as a bridge for surviving short-term environmental stressors. The Society for Experimental Biology. Seville, Spain, July 2-5, 2019. Invited talk by Dr. Warren Burggren.

Evolution of the ExxER/K motif in the NPF family of plant nitrate/peptide transporters. Institut de Biologie Intégrative de la Cellule, CNRS, Marseille, France. June 18<sup>th</sup> 2019. Invited Talk. By Antonella Longo

Evolution of the ExxER/K motif in the NPF family of plant nitrate/peptide transporters. Institut de Biologie Intégrative des Plantes, Montpellier, France. May 21<sup>st</sup> 2019. Invited Talk. By Antonella Longo

Flow-specific floodplain inundation modeling and Alligator Gar recruitment in the lower Trinity River. Southern Division of the American Fisheries Society; Galveston, Texas; January, 2019. Invited talk by Dr. David Hoeinghaus. Co-authors, J. Jensen, A. Pease, D. Buckmeier, N. Smith, D. Daugherty, K. Winemiller and T. Hardy

Genetic targets for lignin engineering and valorization in lignocellulosic feedstocks. Richard A. Dixon. 41<sup>st</sup> Symposium on Biotechnology for Fuels and Chemicals, Seattle, WA, April 29, 2019.

Lignin modification activates signaling pathways for defense gene expression. Richard A. Dixon. International Symposium on Plant Receptor Kinases and Cell Signaling, Beijing, China, June 23, 2019.

Manipulating the CLAVATA-WUSCHEL circuit to generate fasciated cotton bolls for robot harvesting. 2019 Beltwide Cotton Conferences, New Orleans, Louisiana, January 8-11, 2019. Invited talk presented by Dr. Brian Ayre. Co-author Roisin C. McGarry.

NPFs, a versatile family of transporters in plants. Department of Physics, Cagliari, Italy. June 6<sup>th</sup> 2019. Invited Talk. By Antonella Longo

Parental dietary crude oil exposure in the king quail *Coturnix chinensis* leads to effects on offspring respiratory physiology. The Society for Experimental Biology. Seville, Spain, July 2-5, 2019. Invited talk by Ph.D. student Naim Martinez Bautista

Scientific challenges in studying austral birds: and ecological approach. Center of Ecosystems Modelling and Monitoring, Universidad Mayor, Santiago, Chile. March, 2019. Invited talk by DR. Jaime E. Jiménez.

The application of virus-based technologies to rapidly explore gene networks regulating cotton architecture. 1<sup>st</sup> International Forum on Crop Science – Green Crops for Sustainable Agriculture, Huazhong Agricultural University, Wuhan, China, June 2-5, 2019. Invited talk presented by Dr. Brian Ayre. Co-authors Roisin C. McGarry and Xiaolan Rao.

Tracing plant nitrate transporters origin and evolution through genome mining and structural modeling. PhD Program on Cellular and Molecular Biology Workshop. Università di Roma Tor Vergata. June 4<sup>th</sup> 2019. Invited Talk. By Antonella Longo.

XXIII Encontro Brasileiro de Ictiologia; Belem, Brazil; January, 2019. Invited talk by Dr. David Hoeinghaus. Co-authors, Jaqueline Zeni, Gabriel Brejão, Lilian Casatti, Luciano Montag, Lucas Driver, and Dana Infante.

## Conference Presentations

Andrzejczyk, N., Greer, J., Mager, E., Grosell, M., and Schlenk, D. (2019) Transcriptomic analysis of juvenile mahi-mahi (*Coryphaena hippurus*) dermal mucus as a noninvasive monitoring tool for effects of Deepwater Horizon oil exposure. International Symposium on Pollutant Responses in Marine Organisms, Charleston, SC.

Bautista, N., Crespel, A., and Burggren, W. (2019). Dietary Crude Oil Exposure During Sexual Determination Modifies Sex-Ratio in Zebrafish (*Danio rerio*). The Society for Experimental Biology, Seville, Spain, July 2-5, 2019.

Bonatesta, F., Greer, J., Xu, E., Schlenk, D., and Mager, E. (2019) Effects of Deepwater Horizon crude oil exposure on the developing teleost kidney. Society of Environmental Toxicology and Chemistry, South Central Regional Meeting, Waco, TX.

Burggren, W., Bautista, N., Hamilton, T., and Ho, D. (2019) Blood-Brain Barrier as a Novel Link between Crude Oil Exposure and Behavioral Dysfunctions?. Experimental Biology Orlando, FL, USA, April 6-9, 2019.

Green, C., Hoeinghaus, D.J., Agostinho, A.A.A., Gomes, L.C., Chumchal, M.M., and Roberts, A.P. Mercury concentrations in fishes from the Upper Paraná River basin. Southern Division of the American Fisheries Society; Galveston, Texas; January, 2019.

Harried, B., Daugherty, D.J., Neely, D., Sutton, T.M., Soulen, B.K., Venables, B.J., Roberts, A.P., and Hoeinghaus, D.J. Mercury, PCB, and OCP body burden and maternal transfer, egg quality and fecundity of Alligator Gar in the lower Trinity River: Are bigger fish always better for recruitment? Southern Division of the American Fisheries Society; Galveston, Texas; January, 2019.

Hughes, L.E., Acree, W., Gao, S., Mason, D., Padilla, P., and Philipose, U. (2019). Fostering Outstanding Cohorts in Undergraduate Science: A Ten-Year Retrospective. Gordon Research Conference on Undergraduate Biology Education, Lewiston, ME.

Longo, A., Dickstein, R. Structural and functional evolution of the nitrate/peptide family (NPF) in legumes. ICLGG Conference. 13-17 May 2019. Dijon, France. Poster Presentation. By Antonella Longo

Maite Docampo-Palacios, Anislay Alvarez-Hernandez; Angelo de Fatima; Giulio Pasinetti, and Richard A. Dixon. Novel procedures to obtain quercetin and resveratrol glucuronides. NIH Centers for Advancing Research on Botanicals and Other Natural Products (CARBON) Program Annual Meeting 2019, May 6, Rockville, MD.

Meitei, N.S., Gupta, H., Rahlouni, F., Sullivan, D.J., and Shulaev, V. (2019) Lipid profiling of malaria samples using Orbitrap Velos Pro mass spectrometer with SimLipid software. 67th ASMS Conference on Mass Spectrometry and Allied Topics, Atlanta, GA, June 2 - 6, 2019

Montag, L., T. Begot, K. Winemiller, L. Híngara, N. Benone, B. Prudente, N. Torres, D. Hoeinghaus, L. Bower, F. Keppeler, D. Saenz, E. Lopez, Y. Quintana, and L. Juen. Evaluating the effects of different land uses on habitat and fish assemblages in Amazon rainforest streams. XXIII Encontro Brasileiro de Ictiologia; Belem, Brazil; January, 2019.

Pandey, P., Lauren Jones, L., Kunz, D.A., and Shulaev, V. (2019) Using metabolomics to assess physiological changes accompanying cyanide metabolism in *Pseudomonas fluorescens* NCIMB 11764. 67th ASMS Conference on Mass Spectrometry and Allied Topics, Atlanta, GA, June 2 - 6, 2019

Pandey, P., Jones, L.B., Kunz, D.A., and Shulaev, V. (2019) Using GC-MS based metabolomics to assess physiological changes accompanying cyanide metabolism in *Pseudomonas fluorescens*. The 43rd International Symposium on Capillary Chromatography & the 16th GCxGC Symposium, Fort Worth, Texas, USA, May 13-17, 2019.

Possamai, B., Hoeinghaus, D.J., Odebrecht, C., Abreu, P.C., Moraes, L.E., Santos, A.C.A., and Garcia, A.M. Inter-annual variability (2010-2016) in isotopic composition and assimilation of autochthonous and allochthonous basal sources by fishes in a subtropical estuary. Southern Division of the American Fisheries Society; Galveston, Texas; January, 2019.

Prokai, L., Zaman, K., Rahlouni, F., Nguyen, V., Shulaev, V. and Prokai-Tatrai, K. (2019) Identification of estradiol-regulated protein networks and associated biological processes in the rat retina by label-free quantitative proteomics. 67th ASMS Conference on Mass Spectrometry and Allied Topics, Atlanta, GA, June 2 - 6, 2019

Williams, B. and Hughes, L.E. (2019). Examination of Orphans following the Tape Measure of Streptomyces phage Celia, the first member of Subcluster BD6. 11<sup>th</sup> Annual SEA-PHAGES Research Symposium, Ashburn, VA.

Wynia, A.L., V. Rolland & J.E. Jiménez. (2019) A novel device to best detect key woodpeckers: an experiment with the Magellanic Woodpecker. Presented at the 137<sup>th</sup> Annual Meeting of the American Ornithological Society, Anchorage, Alaska, USA, June, 2019.

Zhuo, C., Rao, V., Azad, R., Pandey, R., Xiao, X., Harkelroad, A., Wang, X., Chen, F., and Dixon, R.A. Enzymatic basis for C-lignin monomer biosynthesis in the seed coat of *Cleome hassleriana*. 41<sup>st</sup> Symposium on Biotechnology for Fuels and Chemicals, Seattle, WA, April 29, 2019

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Physical Location

1511 West Sycamore  
Life Sciences Complex  
Denton, TX 76203-5017, USA

Mailing Address

University of North Texas, Department of Biological Sciences  
1155 Union Circle # 305220  
Denton, TX 76203-5017, USA

Phone (940) 565-3591

Web: <https://biology.unt.edu/>

Fax: (940) 565-3821

Facebook: <https://www.facebook.com/untbiology>