

Dae Kwan Ko

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RESEARCH INTERESTS

I am an early-career researcher who is passionate about addressing critical biological questions at the systems-level with a hypothesis-driven approach using the power of genomics. Do genes and proteins interact with each other in cells as we do in society? Then, what could be the functional consequences of those interactions in regulating biological pathways? These molecular interactions, called “biological networks”, are crucial for all living organisms to maintain cellular homeostasis. My long-term research goal is to characterize gene networks underlying significant biological pathways and apply the findings to translational research.

PROFESSIONAL APPOINTMENTS

Assistant Professor - Fixed Term

Dec 2020 - present

MSU-DOE Plant Research Laboratories
Great Lakes Bioenergy Research Center

Department of Plant Biology, Michigan State University, MI, USA.

- Hosted by Dr. Federica Brandizzi
- Research summary: Investigating how genes respond to environmental stresses through a comprehensive systems-level approach involving gene regulatory network modeling and functional characterization. This research spans both model and non-model plant species.

Postdoctoral Research Associate

Dec 2017 – Nov 2022

MSU-DOE Plant Research Laboratories

Great Lakes Bioenergy Research Center, Michigan State University, MI, USA.

- Advisor: Dr. Federica Brandizzi
- Research summary: (1) Understanding gene regulatory networks in plant unfolded protein response: utilizing multi-omics approaches combined with forward genetics, my work focused on unraveling the intricate gene regulatory networks governing the unfolded protein response in plants. This research aimed to provide a systems-level understanding of this critical cellular process. (2) Cell wall biogenesis and differentiation in bioenergy crops: employing gene regulatory network modeling and functional characterization, I investigated the mechanisms behind cell wall biogenesis and differentiation during the growth of bioenergy crops.

Postdoctoral Research Associate

June 2016 – Nov 2017

Department of Plant Biology, Michigan State University, MI, USA.

- Advisor: Dr. C. Robin Buell
- Research summary: Identifying unintended consequences of genome modification methods in clonally propagated diploid potato. This work addressed critical concerns related to genome editing and its implications within the context of crop improvement.

EDUCATION

Ph.D. The University of Texas at Austin (Plant Biology), TX, USA.

2009 – 2016

- Advisor: Dr. Z. Jeffrey Chen
- Thesis title: Clock-regulatory networks contribute to growth vigor in maize hybrids
- Research summary: Investigating the molecular link of the circadian clock with growth vigor in maize hybrids using a functional genomics approach covering a broad array of molecular techniques

M.S. Seoul National University (Biological Sciences), Seoul, South Korea. 2006 - 2008

- Advisor: Dr. Choo Bong Hong
- Thesis title: Submergence-inducible and circadian rhythmic transcriptional networks in *Nicotiana tabacum*
- Research summary: Characterizing clock-regulated transcription factor genes in response to abiotic stress in *Nicotiana tabacum*

B.S. Konkuk University (Crop Science), Seoul, South Korea. 2000 - 2006

PUBLICATIONS

Published in Peer-Reviewed Articles (16 total: 8 first authorships; 8 co-authorships)

1. **Ko DK**, Kim JY, Thibault EA, Brandizzi F (2023). A signaling cohort of IRE1 and proteasome system controls cell fate determination in unresolved proteotoxic stress of the plant endoplasmic reticulum. ***Nature Plants*** 9 (8), 1333-1346.
 - Featured in Spotlight by Varshney et al. (2023), Trends Plant Sci. 2023 Dec 14:S1360-1385(23)00388-6.
 - Highlight in MSUTODAY (<https://rb.gy/7oapjq>)
 - Interview video (<https://shorturl.at/kwL36>)
2. Bhandari DD, **Ko DK**, Kim SJ, Nomura K, He SY, Brandizzi F (2023). Defense against phytopathogens relies on efficient anti-microbial protein secretion mediated by the microtubule-binding protein TGNap1. ***Nature Communications*** 14, 6357.
3. **Ko DK**, Brandizzi F (2022). Transcriptional competition shapes proteotoxic ER stress resolution. ***Nature Plants*** 8 (5), 481-490.
 - Highlight in MSU-PRL Bulletin (<https://shorturl.at/vAHS6>)
4. **Ko DK**, Brandizzi F (2022). Advanced genomics identifies growth effectors for proteotoxic ER stress recovery in *Arabidopsis thaliana*. ***Communications Biology*** 5, 16.
 - Highlight in MSU-PRL Bulletin (<https://shorturl.at/esuR1>)
 - Interview video (<https://shorturl.at/lpMQ2>)
5. York LM, Cumming JR, Trusiak A **Ko DK** Yang WH (2022). Bioenergy Belowground: challenges and opportunities for phenotyping roots and the microbiome for sustainable bioenergy crop production. ***Plant Phenome Journal*** 5: e20028.
6. Plant Cell Atlas Consortium, Ghosh Jha S, Borowsky AT **Ko DK** ... Rhee SY (2021). Science Forum: Vision, challenges and opportunities for a Plant Cell Atlas. ***eLife*** 10:e66877.
7. Angelos E, **Ko DK**, Zemelis-Durfee S, Brandizzi F (2021). Relevance of the Unfolded Protein Response to Spaceflight-Induced Transcriptional Reprogramming in *Arabidopsis*. ***Astrobiology*** 1;21(3);367-380.

8. **Ko DK**, Brandizzi F (2021). A temporal hierarchy underpins the transcription factor-DNA interactome of the maize UPR. *The Plant Journal* 105(1);254-270.
 - Highlight in MSU-PRL Bulletin (<https://rb.gy/hvc1s4>)
9. **Ko DK**, Brandizzi F (2020). Network-based approaches for understanding gene regulation and function in plants. *The Plant Journal* Oct;104(2):302-317.
 - Featured in the Society for Experimental Biology's Spring Bulletin (<https://shorturl.at/qBQU8>)
10. Rice S, Fryer E, Ghosh Jha S...The Plant Cell Atlas Consortium (including **Ko DK**) (2020). First plant cell atlas workshop report. *Plant Direct* 00:1–10.
11. Pastor-Cantizano N, **Ko DK**, Angelos E, Pu Y, Brandizzi F (2019). Functional diversification of ER stress responses in Arabidopsis. *Trends in Biochemical Sciences* 18;45(2):123-136.
12. Nadakuduti SS, Starker CG, **Ko DK**, Jayakody TB, Buell CR, Voytas DF, Douches DS (2019). Evaluation of Methods to Assess in vivo Activity of Engineered Genome-Editing Nucleases in Protoplasts. *Frontiers Plant Science* 8;10:110.
13. **Ko DK**, Nadakuduti SS, Douches DS, Buell CR (2018). Transcriptome profiling of transgenic potato plants provides insights into variability caused by plant transformation. *PLoS One* 8;13(11):e0206055.
14. ***Ko DK**, *Rohozinski D, Song Q, Taylor SH, Juenger TE, Harmon FG, *Chen ZJ (2016). Temporal shift of circadian-mediated gene expression and carbon fixation contributes to biomass heterosis in maize hybrids. *PLoS Genetics* 28;12(7):e1006197. *These authors contributed equally to this work.
15. Shi X, Zhang C, **Ko DK**, Chen ZJ (2015). Genome-wide dosage-dependent and -independent regulation contributes to gene expression and evolutionary novelty in plant polyploids. *Molecular Biology and Evolution* 32(9):2351-66.
16. **Ko DK**, Lee MO, Hahn JS, Kim BG, Hong CB (2009). Submergence-inducible and circadian rhythmic basic helix-loop-helix protein gene in Nicotiana tabacum. *Journal of Plant Physiology* 1;166(10):1090-100.

Book Chapters and Editorial.

1. **Ko DK**, Brandizzi F (2023). Multi-omics resources for understanding gene regulation in response to ER stress in plants. Plant Endoplasmic Reticulum: Methods and Protocols, Second Edition. Methods in Molecular Biology *In press*
2. **Ko DK**[#], Sanchez-Ballesta MT (2023). Editorial: methods, applications, and protocols in plant science: network modeling-guided understanding of gene regulation in plants. *Frontiers in Plant Science* 14:1171846. [#]Corresponding author.
3. **Ko DK**, Brandizzi F (2022). Coexpression network construction and visualization from transcriptomes underlying ER stress responses. In: Lois, L.M., Trujillo, M. (eds) Plant Proteostasis. Methods in Molecular Biology, vol 2581. Humana, New York, NY.

In Review/In Revision

1. **Ko DK**, Brandizzi F. Dynamic gene regulation in the plant unfolded protein response. Review article invited by *Nature Reviews Genetics*. Under 2nd round of review.

2. **Ko DK**, Brandizzi F. NEEDLE: network-enabled gene discovery pipeline for non-model plant species. *Under revision*.
3. Choi D, **Ko DK**, Kim DH. Transcriptome analysis revealed that Arabidopsis model plants invokes the activation of heat shock proteins and ER stress response against cesium stress. *Under review*.
4. Choi D, Lee SW, **Ko DK**, Kim DH. Dynamic histone modifications establish dual modes of transcriptional response of Arabidopsis glucosinolate pathway genes under wounding stress. *Under review*.

In Preparation

1. **Ko DK**, Brandizzi F. Defining transcriptomic dynamics in sorghum in multiple abiotic stresses. The anticipated submission is in Jan 2024.
2. **Ko DK**, Sun X, Kim SJ, Brandizzi F. Understanding trade-off between mixed-linkage glucan production and growth fitness in *Brachypodium*. The anticipated submission is in Feb 2024.

FUNDING AND FELLOWSHIPS

DOE-JGI Bioenergy Research Center grant (proposal ID: 509513)

- Project title: “The DNA Binding Landscape of Sorghum TFs in Response to Abiotic Stress”
- Description: Supporting DNA synthesis of 142 TF genes and DNA Affinity Purification and sequencing.
- Role: PI
- Award year: 2023

Project GREEN (Generating Research and Extension to meet Economic and Environmental Needs) **Award**, Michigan State University

- Project title: “Assessing the Impact of Abiotic Stress on Activities of Gene Regulatory DNA Sequences in Sorghum at Single-cell Resolution”
- Role: PI
- Amount: \$30,000
- Starting-Ending date: 07/01/2022 – 12/31/2023

DOE-JGI Bioenergy Research Center grant (proposal ID: 508271)

- Project title: “Transcriptome Analysis Under Abiotic Stress in Sorghum”
- Description: Supporting RNA-seq library construction of 104 samples and next-generation sequencing.
- Role: PI
- Award year: 2021

MSU Cloud Computing Fellowship

- Description: Supporting a cloud computing system (Microsoft Azure) for the awardee’s research projects and providing hands-on training and participating in public activities)
- Starting-Ending date: 11/01/2020 – 04/30/2021
- Public Announcement: <https://rb.gy/z56d0g>

Travel grant , The Plant Resilience Institute, Michigan State University (\$1,000).	2020
NSF travel grant for Plant Cell Dynamics VIII 22nd Plant Biology Symposium (\$405).	2019
Bennett Memorial Graduate Fellowship , The University of Texas at Austin (\$1,000).	2015

Travel award , Graduate School, The University of Texas at Austin (\$500).	2014
Summer Research Fellowship , The University of Texas at Austin.	2013 - 2014
Pre-emptive Fellowship , The University of Texas at Austin.	2009 - 2010

HONORS

The 2 nd place prize for Best Poster, the 2 nd Plant Cell Atlas Symposium.	2002
Nomination for Teaching Assistant Award, The University of Texas at Austin.	2013
Honor in Great Teaching Assistant, School of Biological Sciences, Seoul National University.	2007

LEADERSHIP, SERVICE & PUBLIC OUTREACH

NASA Open Science Data Repository workshop, Washington D.C (<i>Invited</i>).	Nov 2003
Core Member of the Plant Cell Atlas initiative (https://www.plantcellatlas.org).	2021 - present
Active Member of the NASA GeneLab Plants Analysis Working Group.	2023 - present
Active Member of the NASA GeneLab Multi-omics Analysis Working Group.	2023 - present
2024 GLBRC Annual Science Meeting Planning Committee.	2023 - present
2023 GLBRC Annual Science Meeting Session Organizing Committee.	2022 - 2023
2022 GLBRC Annual Science Meeting Session Organizing Committee.	2021 - 2022
DOE-BRC Workshop on AI-ML for Biosystems Design, Washington D.C (<i>Invited</i>).	Feb 2020
MSU Department seminar host, Speaker: Dr. Vladimir Gligorijevic (Flatiron Institute).	Dec 2019
Family Day Weekend in The University of Texas at Austin, Austin, TX.	Oct 2012
UT-Austin Department seminar host, Speaker: Dr. Zachary B. Lippman (CSHL).	Apr 2012

DOE panel reviewer: DOE SBIR/STTR

Journal Peer Reviewer: Science Signaling, New Phytologist, The Plant Journal, Communications Biology, Plant Communications, Frontiers in Plant Sciences (serving as a Review Editor), IEEE/ACM Transactions on Computational Biology and Bioinformatics, Genes, Plants, International Journal of Molecular Sciences, Cells, Agronomy, Data in Brief

Special issue topic editor: Frontiers in Plant Science (<https://shorturl.at/elpx4>)

TEACHING EXPERIENCE

Teaching Assistant, Department of Molecular Biosciences, The University of Texas at Austin
 BIO327 Genomics Spring 2016

- Graduate lecture course (30 students)
- Instructor – Dr. Z. Jeffrey Chen
- Responsibilities: Conducted weekly discussion sessions where I delivered concise 10-minute lecture summaries. Evaluated exams containing diverse question formats, including multiple choice, short answer, and essays. Assisted group presentations. Facilitated office hours by appointment.

BIO395 Genetics Spring 2014

- Upper division lecture course (23 students)
- Instructors – Drs. Jeffrey Gross & Z. Jeffrey Chen
- Responsibilities: Conducted weekly discussion sessions where I delivered concise 10-minute lecture summaries. Evaluated exams containing diverse question formats, including multiple choice, short answer, and essays. Facilitated office hours by appointment.

- BIO325 Genetics Fall 2010, Spring/Summer 2011, Spring/Summer/Fall 2012, Spring/Fall 2013
- Sophomore lecture course (121, 83, 56, 77, 52, 109, 49, or 35 students in each semester)
 - Instructor (one per semester): Drs. Inder M. Saxena, Sibum Sung, and Beverly Finklea
 - Responsibilities: Conducted weekly discussion sessions where I delivered concise 10-minute lecture summaries. Evaluated exams containing diverse question formats, including multiple choice, short answer, and essays. Facilitated office hours by appointment.

- BIO205L Laboratory Experiments in Cell and Molecular Biology Spring 2011
- Introductory lab course (29 students)
 - Instructors – Dr. A. William Allen
 - Responsibilities: Conducted weekly lab sessions where I delivered concise 10-minute lecture for specified experiments and demonstrated hands-on experiments. Collaborated with the instructor and undergraduate helpers in designing lab experiments and assessed weekly reports, exams, and term papers.

Teaching Assistant, Department of Biological Sciences, Seoul National University

- 010.323-003 General Biology Experiment Fall 2007
- Introductory lab course (52 students)
 - Responsibilities: Conducted weekly lab sessions where I delivered concise 10-minute lecture for specified experiments and demonstrated hands-on experiments. Assessed weekly reports, exams, and term papers.

Guest Lectures

- Guest speaker for Gene Network Workshop virtual, Chung-Ang Univ., South Korea Apr 2023
- Guest speaker for Coexpression Network Workshop virtual, Chung-Ang Univ., South Korea Oct 2022
- Guest speaker for ChIP-seq Workshop virtual, Chung-Ang Univ., South Korea Apr 2022
- Guest speaker for PLB801 Foundation of Plant Biology (graduate course), MSU Oct 2020
- Instructor: Dr. Jiming Jiang
- Guest speaker for BIO325 Genetics, The University of Texas at Austin Oct 2012
- Instructor: Dr. Inder M. Saxena

MENTORING

- Zachary Smith, GLBRC Research Assistant. 2022 – present
- Joshua Deradoorian, GLBRC Research Assistant. 2022 – 2023
- Chloe Hollidays, MSU Undergraduate Student. 2022 – 2023
- Xiaohe (Sherry) Sun, GLBRC Summer Undergraduate Research Program May – Jul 2022
- Rita E. Barr, MSU Undergraduate Student. 2021 – 2022
- Sara Knapp, GLBRC Research Assistant. 2020 – 2021
- Elizabeth Selby, MSU Research Assistant. 2019 – 2020
- Rebecca Selby, MSU Research Assistant. 2018 – 2019
- Michael Cadell, UT-Austin Undergraduate Student. 2012 – 2014
- Krystal Chi-Shuan Chang, UT-Austin REU. May – Jun 2014

SEMINAR ORAL PRESENTATIONS

- Center for Sorghum Improvement 2024 Seminar Series. Virtual (Scheduled). Mar 2024
- Title: “Assessing Salt Stress Impact on Sorghum's cis-regulatory Sequences at Single-cell Level”
- NASA GeneLab Plants AWG meeting. Virtual. Nov 2023

- Title: "Network-Enhanced Gene Discovery Pipeline (NEEDLE) for Non-Model Plant Species"
Biological Research Information Center Webinar Series. Virtual. Oct 2023
- Title: "Unleashing Cellular Destiny: IRE1-Proteasome Signaling Governs Plant ER Proteotoxic Stress"
- Record: <https://rb.gy/d6w241>
- Department of Horticulture, Chung-Ang University, South Korea. Virtual. Jul 2021
- Title: "Network-Enabled Understanding of Gene Regulation in Response to Abiotic Stress"
Tuesday Noon Seminar, MSU-DOE Plant Research Laboratories, East Lansing, MI. Feb 2020
- Title: "A Temporal Hierarchy Underpins the Transcription Factor-DNA Interactome of the Maize UPR"
Plant Resilience Brown Bag, MSU, East Lansing, MI. Virtual. Dec 2019
- Title: "A Systems-Level Approach to Understand Transcriptional ER Stress Response in Plants"
Department of Horticulture, Chung-Ang University, South Korea. Jul 2019
- Title: "Systems-Level Approach to Understand UPR Gene Regulation in Arabidopsis"
Systems & Synthetic Agrobiotech Center, Gyeongsang National University, South Korea. Jul 2019
- Title: "Systems-Level Approach to Understand UPR Gene Regulation in Arabidopsis"
Tuesday Noon Seminar, MSU-DOE Plant Research Laboratories, East Lansing, MI. Apr 2019
- Title: "Systems-Level Approach to Discover Architecture and Dynamics of ER Stress Gene Networks"
Monsanto Company, Chesterfield, MO Aug 2017
- Title: "Genome Editing Methods in Potato"
Plant Luncheon Seminar Series, The University of Texas at Austin, Austin, TX Mar 2014
- Title: "Early Establishment of Growth Vigor in Maize Hybrids by Circadian Regulators"

INVITED/SELECTED CONFERENCE TALKS

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- Phytochemical Society of North America (PSNA) Annual Meeting, East Lansing, MI. Jul 2023
 - Selected talk
 - Title: "Unleashing Cellular Destiny: IRE1-Proteasome Signaling Governs Plant ER Proteotoxic Stress"
 - Great Lake Bioenergy Research Center (GLBRC) - Annual Science Meeting, Geneva, WI. May 2023
 - Invited talk
 - Title: "Network-Enabled Gene Discovery Pipeline (NEEDLE) for Bioenergy Research"
 - American Society of Plant Biologists (ASPB) Midwest Conference, Ames, IA. Apr 2023
 - Selected talk
 - Title: "A Signaling Cohort of IRE1 and Proteasome System Controls Cell Fate Determination in Unresolved Proteotoxic Stress of the Plant Endoplasmic Reticulum"
 - Biotechnology and Environmental Technology Symposium, South Korea. Virtual. Dec 2022
 - Invited talk
 - Title: "Network-Enabled Regulatory Dissection of the Mixed-Linkage Glucan Synthase Genes in Grasses"
 - 2nd International Seminar for the Recent Advances in New Agro Food Research. Virtual. July 2022
 - Invited talk
 - Title: "Transcriptional Competition Shapes Proteotoxic ER Stress Resolution"
 - Great Lake Bioenergy Research Center Sustainability Meeting. Virtual. Feb 2022
 - Invited talk
 - Title: "Network Modeling of Dynamic Transcriptomes Underlying the Development of *B. distachyon* and *S. bicolor*"
 - Plant Cell Dynamics VIII 22nd Plant Biology Symposium, State College, PA. Jun 2019

- Selected talk
- Title: “Gene Networks in the Endoplasmic Reticulum Stress”

PROFESSIONAL SOCIETIES

Active member of the American Society of Plant Biologists (ASPB)

Active member of the Phytochemical Society of North America (PSNA)

Active member of the Korean-American Scientists and Engineers Association (KSEA)