CHANG CAO, PH.D.

Postdoctoral Research Associate
Carl R. Woese Institute for Genomic Biology | Beckman Institute for Advanced Science and Technology | Department of Animal Sciences, University of Illinois at Urbana-Champaign
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EDUCATION

2018-2021 **Virginia Polytechnic Institute and State University (VT), Blacksburg, VA**
Ph.D. in Animal and Poultry Science (Focusing on Neuroendocrinology. Advisor: Mark A. Cline, Co-Advisor: Elizabeth R. Gilbert)
Dissertation: Hypothalamic mechanisms of appetite regulation involve stress response and epigenetic modification

2014-2017 **Minzu University of China (MUC), Beijing, China**
M.S. with Distinction in Neurophysiology (Advisor: Xiaoyan Qin)
Thesis: Protective effects of FGF2 on rat neurons and the intervention of CE on FGF2 pathway

2009-2013 **Huazhong Agricultural University (HZAU), Wuhan, China**
B.A. with Distinction in Animal Science
Thesis: Tissue expression profile of *Krüppel-like factor 9* gene in pigs and its expression pattern in adipogenesis

RESEARCH FIELDS OF INTEREST

1. **Epigenetic and Developmental Programming of Poultry Metabolism and Resilience**
2. **Integrative Physiology of Metabolic, Immune, and Environmental Stress Responses**
3. **Precision Nutrition and Epigenetic Interventions for Sustainable Poultry Production**

My research program establishes leadership at the interface of epigenetic regulation, metabolism, and environmental physiology to address how nutritional quality, inflammatory stress, and production-relevant environmental exposures shape metabolic health, resilience, and performance in poultry. Building on my interdisciplinary training, I investigate how DNA methylation dynamics coordinate gene regulation and immune–metabolic interactions in response to diet, microbial signals, and environmental stressors common to commercial production systems. By integrating epigenomic and transcriptomic analyses with cross-tissue physiological assessments, my work aims to identify regulatory mechanisms that link environmental conditions to variation in feed efficiency, stress tolerance, and disease susceptibility. An innovative component of my program is the application of epigenetic MRI (eMRI), a noninvasive approach for monitoring DNA methylation dynamics in vivo, enabling early biomarker discovery and longitudinal assessment of physiological adaptation. Together, this research framework is designed to generate mechanistically grounded insights that support precision nutrition, improved welfare, and sustainable poultry production, aligning directly with Purdue's strengths in animal sciences and its One Health mission.

PROFESSIONAL POSITIONS

2021- **Postdoctoral Research Associate** (Focusing on Neuroimaging and Epigenetics)
Advisors: Fan Lam and Ryan N. Dilger, Co-advisor: Gene E. Robinson
Carl R. Woese Institute for Genomic Biology | Beckman Institute | Department of Animal Sciences, University of Illinois at Urbana-Champaign, Urbana, IL

2018-2021 **Graduate Research & Teaching Assistant**
School of Animal Sciences, Virginia Tech, Blacksburg, VA

2014-2017 **Graduate Research Assistant**
College of Life and Environmental Sciences, Minzu University of China, Beijing, China

2014 **Undergraduate Research Assistant**
Ministry of Agriculture Feed Industry Centre, China Agriculture University, Beijing, China

2011-2013 **Undergraduate Research Assistant**
Department of Animal Sciences, Huazhong Agricultural University, Wuhan, China

2011-2012 **Undergraduate Industrial Internship**
Commercial Animal farms | Hubei Academy of Agricultural Sciences animal farm, China

HONORS AND AWARDS

2022-2025 **Beckman Institute Postdoctoral Fellow,** Beckman Institute for Advanced Science and Technology, USA

2022 **Travel Award,** Swine in Biomedical Research Conference, USA

2022 **Cozzarelli Prize Finalist** (Co-author), Proceedings of the National Academy of Sciences, USA

2017 **Beijing Outstanding Graduates,** Ministry of Education of Beijing, China

2016 **National Scholarship,** Ministry of Education of the People's Republic of China, China

2011 **National Scholarship for Encouragement,** Ministry of Education of the People's Republic of China, China

2010 **National Scholarship,** Ministry of Education of the People's Republic of China, China

GRANTS

In preparation

2026 Defining Spatiotemporal DNA Methylation Dynamics in Familial and Sporadic Alzheimer's Disease Using High-Resolution Epigenetic MRI. (*GFMR, USD 80,000, to be submitted in Jan. 2026*)
-- The Glenn Foundation for Medical Research Postdoctoral Fellowship in Aging Research, in partnership with the American Federation for Aging Research (AFAR), supports innovative postdoctoral research on the biology of aging. The applicant is preparing an independently conceived proposal entitled as above for submission to this highly competitive program.

Completed

2022-2025 In Vivo Imaging of Epigenetic Basis for Alzheimer's Disease. Beckman Institute (*USD 189,000 with USD 25,000 merit fund w/ benefits*)
-- The Beckman Institute, endowed by the Arnold and Mabel Beckman Foundation, offers an internationally competitive three-year interdisciplinary fellowship to outstanding scientists. The applicant's proposal was independently conceptualized and authored, ranking top 5 overall and receiving the top award (named fellow) in the selection cycle (2022).

Contributed (Assisted in protocol and proposal development)

2025 Noninvasive Mapping of Age-Dependent Brain DNA Methylation in Alzheimer's Disease. (*NIH-R21, USD 275,000*)

2025 Noninvasive Mapping of Brain DNA Methylation for New Biomarker Discovery in Alzheimer's Disease (*Falk Medical Research Trust Catalyst Awards, USD 341,129*)

2024 Noninvasive Mapping of Brain DNA Methylation for New Biomarker Discovery in Alzheimer's Disease (*Falk Medical Research Trust Catalyst Awards, USD 341,129*)

2022 In Vivo Imaging of DNA Methylation in Living Human Brains (*W.M. Keck Foundation Research Program, USD 1.5M*)

PEER REVIEWED PUBLICATIONS

Total citations = 1520, h-index = 11, i10-index = 12 [Dec. 2025).

Listed in reverse chronological order (first: 9, co-author: 14, corresponding: 3. *co-first authors, #co-corresponding authors)

1. Gu, R. Z., Tursun, A., Zhong, S. J., Cheng, J. B., Qin, Q.Y.[#], **Cao, C.[#]** (2025). Protective effects of 2,3,5,4'-tetrahydroxystilbene-2-O-β-D-glucoside against cadmium toxicity involve BDNF/TrkB and PI3K/Akt signaling pathways. ***Biomedicine & Pharmacotherapy***, 192, 118602. doi.org/10.1016/j.biopha.2025.118602
2. **Cao, C.**, Yuan, J., Gilbert, E. R., Cline, M. A., Lam, F., Li, K. C., & Dilger, R. N. (2025). Increased circulating interleukin concentrations in type 2 diabetes: A systematic review and meta-analysis. ***Obesity Reviews***, e13971. doi.org/10.1111/obr.13971 (**Corresponding author**)
3. Cao, M. M., Guo, Z., Lu, Y. T., Zhong, S. J., Ma, H. Y., Liu, M. H., Qin, X. Y.[#], Hu, Y.[#], & **Cao, C.[#]** (2024). Astragalin protects against lipopolysaccharide-triggered acute liver injury through suppression of necroptosis and inflammation and improvement of energy metabolism. ***Journal of Functional Foods***, 118, 106298. doi.org/10.1016/j.jff.2024.106298
4. Gorenz, B., Oelschlager, M. L., Jespersen, J. C., **Cao, C.**, Smith, A. H., Mackie, R. I., & Dilger, R. N. (2024). Organ growth and fermentation profiles of broilers differing in body growth rate. ***Poultry Science***, 103(5), 103628. doi.org/10.1016/j.psj.2024.103628
5. Wang, Z., Li, Y., **Cao, C.**, Anderson, A., Huesmann, G., & Lam, F. (2024). Multi-parametric molecular imaging of the brain using optimized multi-TE subspace MRSI. ***IEEE Transactions on Biomedical Engineering***. doi.org/10.1109/TBME.2023.3349375
6. Failor, M., Bohler, M., **Cao, C.**, Gilbert, E., & Cline, M. (2023). Elucidating the central anorexigenic mechanism of glucagon-like peptide 1 in Japanese quail (Coturnix japonica). ***General and Comparative Endocrinology***, 339, 114292. doi.org/10.1016/j.ygcen.2023.114292
7. **Cao, C.**, Siegel, P. B., Gilbert, E. R., & Cline, M. A. (2022). Epigenetic modifiers identified as regulators of food intake in a unique hypophagic chicken model. ***animal***, 16(6), 100549. doi.org/10.1016/j.animal.2022.100549
8. Lam, F., Chu, J., Choi, J. S., **Cao, C.**, Hitchens, T. K., Silverman, S. K., … & Li, K. C. (2022). Epigenetic MRI: Noninvasive imaging of DNA methylation in the brain. ***Proceedings of the National Academy of Sciences***, 119(10), e2119891119. doi.org/10.1073/pnas.2119891119 (**Cozzarelli Prize finalist 2022**)
9. **Cao, C.**, Gilbert, E. R., & Cline, M. A. (2021). DNA methylation-modifiers reduced food intake in juvenile chickens (Gallus gallus) and Japanese quail (Coturnix japonica). ***Neuroscience Letters***, 764, 136230. doi.org/10.1016/j.neulet.2021.136230
10. **Cao, C.**, Chowdhury, V. S., Cline, M. A., & Gilbert, E. R. (2021). The microbiota-gut-brain axis during heat stress in chickens: A review. ***Frontiers in Physiology***, 12, 752265. doi.org/10.3389/fphys.2021.752265
11. **Cao, C.**, Tachibana, T., Gilbert, E. R., & Cline, M. A. (2021). Prostaglandin E2-induced anorexia

involves hypothalamic brain-derived neurotrophic factor and ghrelin in chicks. ***Prostaglandins & Other Lipid Mediators***, 156, 106574. doi.org/10.1016/j.prostaglandins.2021.106574

12. Cai, Z. P.*, **Cao, C.***, Guo, Z., Yu, Y., Zhong, S. J., Pan, R. Y., ... & Qin, X. Y. (2021). Coeloglossum viride var. bracteatum extract attenuates staurosporine induced neurotoxicity by restoring the FGF2-PI3K/Akt signaling axis and Dnmt3. ***Heliyon***, 7(7), e07503. doi.org/10.1016/j.heliyon.2021.e07503
13. Webster, A. N., **Cao, C.**, Chowdhury, V. S., Gilbert, E. R., & Cline, M. A. (2020). The hypothalamic mechanism of neuropeptide S-induced satiety in Japanese quail (Coturnix japonica) involves the paraventricular nucleus and corticotropin-releasing factor. ***General and Comparative Endocrinology***, 299, 113558. doi.org/10.1016/j.ygcen.2020.113558
14. **Cao, C.**, Gilbert, E. R., & Cline, M. A. (2020). The anorexigenic effect of beta-melanocyte-stimulating hormone involves corticotrophin-releasing factor and mesotocin in birds. ***Neuroscience Letters***, 736, 135282. doi.org/10.1016/j.neulet.2020.135282
15. Du, Y., Wu, H. T., Qin, X. Y., **Cao, C.**, Liu, Y., Cao, Z. Z., & Cheng, Y. (2018). Postmortem brain, cerebrospinal fluid, and blood neurotrophic factor levels in Alzheimer's disease: a systematic review and meta-analysis. ***Journal of Molecular Neuroscience***, 65(3), 289-300. doi.org/10.1007/s12031-018-1100-8
16. Zhang, Y., Che, M., Yuan, J., Yu, Y., **Cao, C.**, Qin, X. Y., & Cheng, Y. (2017). Aberrations in circulating inflammatory cytokine levels in patients with Down syndrome: a meta-analysis. ***Oncotarget***, 8(48), 84489. doi.org/10.18632/oncotarget.21060
17. Qin, X. Y., Wu, H. T., **Cao, C.**, Loh, Y. P., & Cheng, Y. (2017). A meta-analysis of peripheral blood nerve growth factor levels in patients with schizophrenia. ***Molecular Psychiatry***, 22(9), 1306-1312. doi.org/10.1038/mp.2016.235
18. Hu, Y., **Cao, C.**, Qin, X. Y., Yu, Y., Yuan, J., Zhao, Y., & Cheng, Y. (2017). Increased peripheral blood inflammatory cytokine levels in amyotrophic lateral sclerosis: a meta-analysis study. ***Scientific Reports***, 7(1), 9094. doi.org/10.1038/s41598-017-09097-1
19. Qin, X. Y.*, **Cao, C.***, Cawley, N. X., Liu, T. T., Yuan, J., Loh, Y. P., & Cheng, Y. (2017). Decreased peripheral brain-derived neurotrophic factor levels in Alzheimer's disease: a meta-analysis study (N= 7277). ***Molecular Psychiatry***, 22(2), 312-320. doi.org/10.1038/mp.2016.62
20. Qin, X. Y., Zhang, S. P., **Cao, C.**, Loh, Y. P., & Cheng, Y. (2016). Aberrations in peripheral inflammatory cytokine levels in Parkinson disease: a systematic review and meta-analysis. ***JAMA Neurology***, 73(11), 1316-1324. doi.org/10.1001/jamaneurol.2016.2742
21. Qin, X. Y., Feng, J. C., **Cao, C.**, Wu, H. T., Loh, Y. P., & Cheng, Y. (2016). Association of peripheral blood levels of brain-derived neurotrophic factor with autism spectrum disorder in children: a systematic review and meta-analysis. ***JAMA Pediatrics***, 170(11), 1079-1086. doi.org/10.1001/jamapediatrics.2016.1626
22. Cong, L., **Cao, C.**, Cheng, Y., & Qin, X. Y. (2016). Green tea polyphenols attenuated glutamate excitotoxicity via antioxidative and antiapoptotic pathway in the primary cultured cortical neurons. ***Oxidative Medicine and Cellular Longevity***, 2016(1), 2050435. doi.org/10.1155/2016/2050435
23. **Cao, C.**, Liu, T., Cai, Z., Zhang, S., & Qin, X. (2015). ERK1/2 mediated inhibitory role of curcumin on STS-induced neurons toxic injury. ***Chinese Journal of Biochemical Pharmaceutics***, 37(4), 1-4.

Manuscripts under review or in preparation

1. Senthil, P., Li, Z. M., **Cao, C.**, Li, J. G., Condotta, I. C. F. S., Green-Miller, A., & Dilger, R. N.

Development of the Animal Video Annotation Tool for applied behavior research (Under review)

2. Ma, H. Y., Zhong, S. J., Qin, X. Y.[#], & **Cao, C.**[#] Dactylorhin A alleviates dopaminergic neurotoxicity and microglial inflammation in Parkinson's disease via BDNF/TrkB, PI3K/Akt, and Akt/mTOR/HIF-1α signaling (expected to submit in Jan. 2026)
3. **Cao, C.**, Vijayakumar, A., Boua, K., Hitchens, T. K., Dilger, R. N., Silverman, S. K., Liang, Z-P., Li, K. C., Robinson, G. E., Gabel, H. W., & Lam, F. Noninvasive epigenetic MRI of global DNA methylation reveals early biomarker signatures in a neurodevelopmental disorder model of Tatton-Brown–Rahman Syndrome (expected to submit in Jan. 2026)
4. **Cao, C.**, Vijayakumar, A., Hitchens, T. K., Dilger, R. N., Silverman, S. K., Liang, Z-P., Li, K. C., Robinson, G. E., Llano, D. A., & Lam, F. High-resolution epigenetic MRI reveals distinct spatiotemporal DNA methylation dynamics in familial and sporadic Alzheimer's disease mouse models (expected to submit in Feb. 2026)

CONFERENCE PROCEEDINGS

1. **Cao, C.**, Dilger, R. N., Silverman, S. K., Liang, Z-P., Li, K. C., Robinson, G. E., Llano, D. A., & Lam, F. Distinct spatiotemporal dynamics of DNA methylation in familial and sporadic Alzheimer's disease mouse models. Neuroscience 2025
2. **Cao, C.**, Lam, F., Llano, D., Dilger, R. N., Silverman, S. K., Liang, Z-P., Li, K. C., & Robinson, G. E. Global DNA methylation as an early biomarker for Alzheimer's disease. Neuroscience 2024
3. **Cao, C.**, Lam, F., Silverman, S. K., Liang, Z-P., Robinson, G. E., Li, K. C., & Dilger, R. N. Establishing an adult pig model for in vivo brain DNA methylation labeling and imaging. Swine in Biomedical Research Conference 2022

TEACHING EXPERIENCE

Virginia Tech - Animal Physiology and Anatomy (ALS 2304)

- Teaching Assistant - Responsible for lecture section including grading quizzes and exams and holding in-person office hours, and 5 out of 10 laboratory sections including lab lectures, quizzes, setup, exams, and grades (approx. 750 students). Taught 7 semesters from Fall 2018 to Spring 2021.

Virginia Tech - Introduction to Neuroscience (NEUR 2025)

- Teaching Assistant - Responsible for lecture section including grading quizzes and exams and holding in-person office hours (approx. 350 students). Taught 3 semesters each Fall from 2018 to 2020.

MENTORING EXPERIENCE

Mentored 6+ graduate students and 7+ undergraduate students on various research projects across multiple disciplines, including neuroscience, metabolism and nutrition, imaging, and computational biology. Selected projects include:

Multi-omics-related Projects
Imaging and Computational Neurology Projects

2025-2026	Noninvasive epigenetic MRI of global DNA methylation reveals early biomarker signatures in a neurodevelopmental disorder model of Tatton-Brown–Rahman Syndrome (*mentee: graduate student*)	UIUC

2025-2026	High-resolution epigenetic MRI reveals distinct spatiotemporal DNA methylation dynamics in familial and sporadic Alzheimer's disease (*mentee:graduate student*)	UIUC

Appetite Regulation & Metabolism Projects

2022-2023	Organ growth and fermentation profiles of broilers differing in body growth rate (*mentee: graduate student*)	UIUC
2020-2021	The hypothalamic mechanism of neuropeptide S-induced satiety in Japanese quail (Coturnix japonica) involves the paraventricular nucleus and corticotropin-releasing factor (*mentee: undergraduate student*)	VT
2020-2021	Elucidating the central anorexigenic mechanism of glucagon-like peptide 1 in Japanese quail (Coturnix japonica) (*mentee: undergraduate student*)	VT
2020-2021	Oxyntomodulin induces satiety and activates the arcuate nucleus of the hypothalamus in Japanese quail (*mentee: graduate student*)	VT

Plant Bioactives Health Protection Projects

2025-2026	Dactylorhin A alleviates dopaminergic neurotoxicity and microglial inflammation in Parkinson's disease (*mentee: graduate student*)	MUC
2024-2025	Protective effects of 2,3,5,4'-tetrahydroxystilbene-2-O-β-D-glucoside against cadmium toxicity involve BDNF/TrkB and PI3K/Akt signaling pathways (*mentee: graduate student*)	MUC
2023-2024	Astragalin protects against lipopolysaccharide-triggered acute liver injury through suppression of necroptosis and inflammation and improvement of energy metabolism (*mentee: graduate student*)	MUC

PROFESSIONAL AFFILIATIONS

2022- Society for Neuroscience

PROFESSIONAL SERVICE

Ad hoc Peer Reviewer for Scientific Journals

animal; Arabian Journal of Chemistry; Comparative Biochemistry and Physiology, Part A; FASEB Journal; Frontiers in Immunology; Frontiers in Nutrition; Frontiers in Physiology; Frontiers in Pharmacology; IEEE Journal of Biomedical and Health Informatics; Journal of Animal Science; Journal of Ethnopharmacology; Journal of Nutrition; Neuroscience Letters; Nutritional Neuroscience; Poultry Science

Associate Editor for Scientific Journal

Medical Physics

Grant Review

2024 National Science Center, Poland. Panel: NZ1 (Molecular biology, structural biology, biotechnology)

OUTREACH/LEADERSHIP EXPERIENCES

2023 – Beckman Institute Open House (*Annually, collaborate w/ some K-12 schools*)
Beckman Institute, University of Illinois Urbana-Champaign, Champaign, IL

DETAILED RESEARCH EXPERIENCES

Postdoctoral Research in Neuroimaging and Epigenetics (UIUC)

- Co-development of epigenetic MRI (eMRI), the first noninvasive imaging method capable of visualizing DNA methylation dynamics in vivo.
- Evaluating global DNA methylation changes in human and pig brains by epigenetic MRI.
- Establishing a genetically-modified mouse model for studying human Tatton Brown Rahman Syndrome and detecting global DNA methylation changes in these mice brains using eMRI.
- Evaluating global DNA methylation changes in Alzheimer's disease animal brains using APOE and 5xFAD mouse models through eMRI.

Doctorate Research in Neuroendocrinology, Metabolism and Stress Mechanisms (VT)

- Investigated the effect of epigenetic modifiers on feeding behavior and stress mechanisms in different chicken models and Japanese quail.
- Elucidated the hypothalamic mechanism of central administration of prostaglandin E2 (PGE2) on food intake.
- Elucidated the hypothalamic mechanism underlying the anorexigenic effect of beta-melanocyte-stimulating hormone (β-MSH) in broiler chicken.

Master's Research in Neurophysiology and Neuropharmacology (MUC)

- Research on the protective effects of plant extracts on primary cultured rat embryo neurons injured by cytotoxic substances.
- Investigated variation of the levels of neurotrophic factors and inflammatory factors in patients with different nervous system diseases and pediatric psychiatric disorders.

Undergraduate Research in Microbiology, Nutrition, and Toxicology (CAU & HZAU)

- Assisted with experiments on effects of *Bacillus licheniformis*, flavomycin, and enramycin on performance, nutrient digestibility, gut morphology and the intestinal microflora of broilers.
- Studied *KLF9* gene expression in the laboratory of Molecular Nutrition.
- Studied the degradation of Aflatoxin B1 in the laboratory of Feed Toxicology.

ADDITIONAL INFORMATION

Experimental Skills

- **Molecular and cellular experiments:** LC-MS/MS, HPLC, gel electrophoresis, RT-PCR, qRT-PCR, Western blots, primary neuron culture, cell viability and cytotoxicity assays, immunofluorescence, immunohistochemistry, microbial culture, enzyme activity, bisulfite sequencing, 16S rRNA sequencing, metagenomic sequencing, and RNA-seq.
- **Behavioral assessments**: water maze; open field; spatial T-maze; tonic immobility; feeding, drinking, and motion.
- **Traditional husbandry work and veterinary skills**: assisting sows in delivering piglets; hatching chicken and Japanese quail eggs; raising swine, chicks, and quail; artificial

insemination; body measuring for weight and height; sampling of blood and intestine; medicine injection and vaccination.

Data analyses skills

- GraphPad Prism, Meta-Analysis, SAS, JMP, Qiime2, R, Python.

Language

- Mandarin - Native
- English - Professional Proficiency

Chang Cao | Research Statement

Background & Vision for One Health Poultry Resilience and Sustainability

Modern poultry production, especially in states like Indiana, which leads the nation in duck production and ranks among the top producers of eggs and turkeys, faces intensifying biological and environmental pressures that directly affect performance, health, and sustainability. Commercial operations routinely encounter intersecting challenges such as heat stress, nutrient variability, pathogen exposure, microbiome disruption, and management-related stressors. These diverse pressures ultimately converge on shared biological pathways that regulate energy metabolism, immune competence, tissue growth, and stress resilience. Emerging evidence indicates that epigenetic mechanisms, heritable yet reversible modifications to DNA and chromatin, serve as integrative regulators of these adaptive responses. However, despite their clear potential to explain variation in feed efficiency, meat yield, disease resistance, and welfare outcomes, the mechanistic links between epigenetic regulation, metabolic pathways, and whole-animal physiological performance in poultry remain poorly defined. This knowledge gap limits our ability to develop predictive biomarkers of resilience, design precision nutrition strategies, and optimize management practices in ways that enhance productivity while reducing antimicrobial use, economic losses, and environmental impacts. Addressing this gap presents a timely opportunity to **advance Indiana's poultry sector through a One Health framework** that improves animal performance and welfare while supporting sustainable, data-driven production systems.

My **long-term vision** is to build a research program that clarifies how regulatory mechanisms at the molecular and epigenetic levels shape metabolic efficiency, immune competence, and resilience to environmental and production stressors in poultry. My training in molecular physiology, nutritional modulation, immunometabolic responses, and avian biology provides a strong foundation for investigating how early-life and lifelong exposures influence biological pathways that ultimately determine performance and health in commercial systems. By approaching these questions through integrative and systems-oriented frameworks, my work aims to generate insights that can translate into practical strategies for improving productivity, welfare, and sustainability across Indiana's poultry sector.

Equally important to this vision is a commitment to collaborative science. Purdue's strengths in animal physiology, nutrition, genetics, and digital agriculture, combined with its campus-wide One Health initiatives, offer exceptional opportunities for cross-disciplinary partnerships. I plan to actively engage with colleagues within Animal Sciences, connect with researchers across agriculture, veterinary medicine, and engineering, and work with industry partners to co-develop research directions that address real-world challenges. Through these collaborations, my goal is to contribute to a research environment that advances both scientific understanding and practical solutions for a more resilient and sustainable poultry industry.

Research Accomplishments

My research has consistently focused on understanding how epigenetic regulation integrates environmental, nutritional, and metabolic signals to influence physiological outcomes, a perspective directly relevant to improving poultry health, resilience, and productivity.

Regulatory mechanisms of epigenetics across central and peripheral systems My PhD research investigated how epigenetic modifiers regulate appetite and energy metabolism in chickens, using methyl donors and inhibitors to manipulate DNA methylation. Experiments in distinct chicken lines with divergent growth and metabolic phenotypes revealed dynamic crosstalk between nutritional status, epigenetic regulation, and feeding behavior. This work provided a mechanistic framework for understanding how molecular regulation integrates environmental and metabolic signals to shape growth and health outcomes in poultry. These insights directly inform strategies to enhance feed efficiency, metabolic resilience, and overall production performance in commercial systems, aligning with a One Health perspective by linking animal physiology with nutritional and environmental management.

Epigenetic modulation to promote cellular resilience During my master's research, I explored how natural bioactive compounds, including plant-derived polyphenols, can protect against cellular stress

through epigenetic regulation. Treatments altered DNA methylation-related enzyme activity, demonstrating that nutrition can reprogram the epigenome to enhance cellular resilience. This experience strengthened my understanding of diet–gene interactions and stress adaptation, principles that are broadly applicable to improving health, performance, and disease resistance in poultry and livestock systems, supporting sustainable production and animal welfare under a One Health framework.

Epigenetic biomarkers for early detection and systems-level insights My postdoctoral work expanded these questions to mammalian models, identifying DNA methylation signatures that precede metabolic and structural abnormalities. I contributed to the development of epigenetic MRI (eMRI), a noninvasive imaging technique capable of mapping DNA methylation in vivo. While developed for neurological studies, eMRI exemplifies a systems-level, noninvasive approach exemplifies tools and concepts that can translate to poultry research, enabling early detection of stress or disease and supporting precision management strategies to improve production efficiency, animal welfare, and sustainability.

Together, this trajectory, from molecular mechanisms in poultry to integrative systems approaches, provides a strong foundation to establish a research program that advances both fundamental understanding and practical solutions for sustainable, resilient poultry production aligned with One Health principles.

Future Research Directions

My future research seeks to understand how metabolic, immune, and environmental responses interact to influence growth, nutrient efficiency, and health throughout the lifespan in poultry. Commercial production faces growing pressures from heat stress, disease challenges, antimicrobial resistance, and feed variability, yet the epigenetic pathways linking these stressors to long-term physiological outcomes remain largely unexplored. My overarching goal is to delineate the spatiotemporal dynamics of the avian epigenome and determine how these regulatory events shape metabolic programming, immune development, and welfare, thereby supporting sustainable poultry production and One Health outcomes.

Temporal dimension: Developmental and transgenerational programming. Early-life environments can have long-lasting effects on poultry performance, resilience, and health. I will identify DNA methylation and transcriptional signatures associated with feed efficiency, thermotolerance, immune competence, and stress susceptibility using whole-genome and single-cell sequencing, coupled with stable isotope tracing and noninvasive eMRI. Mapping these changes from embryo through post-hatch development will pinpoint critical windows during which nutrition, hatchery practices, or environmental exposures influence growth trajectories and disease resistance. These findings will guide precision breeding, nutritional interventions, and management strategies for broilers and layers.

Spatial dimension: Cross-tissue regulation of metabolic and stress responses. Systemic resilience depends on coordinated regulation across tissues such as muscle, liver, adipose, gut, and the central nervous system. I will employ tissue-specific epigenomic assays, metabolomics, and integrative transcriptomics to investigate how nutrient availability, heat stress, and gut-brain communication reshape regulatory networks across tissues. In addition, I will explore cell-type–specific responses to environmental and nutritional stressors to identify molecular hubs that coordinate metabolism, immune function, and stress adaptation. Comparative analyses across different poultry lines or species will reveal conserved and divergent regulatory mechanisms, providing a mechanistic basis for optimizing growth, feed efficiency, and disease resistance. These studies will generate actionable knowledge for both experimental and commercial production systems, supporting One Health goals by linking animal physiology, nutrition, and environmental resilience.

Translational potential: Precision interventions for health and productivity: Building on mechanistic insights, I will develop and evaluate targeted nutritional, microbial, and epigenome-modulating strategies to restore metabolic balance, enhance thermotolerance, and improve welfare. This includes testing feed additives, probiotics, or epigenetic modulators in controlled trials and commercial settings, monitoring growth, immune competence, stress biomarkers, and production outcomes. Collaborations with Purdue's poultry facilities, Cooperative Extension, and industry partners will allow these interventions to be implemented and refined in practical production contexts. By integrating molecular, physiological, and

management-level insights, this work will provide evidence-based strategies to reduce economic losses, improve animal welfare, and support sustainable, resilient poultry production systems aligned with One Health principles.

These research directions draw on my **interdisciplinary training** across poultry and mammalian models, integrating metabolism, neuroendocrine regulation, and epigenetic mechanisms. My background positions me to contribute to Purdue's Department of Animal Sciences by establishing a **collaborative program** that links fundamental discovery with practical solutions for sustainable and resilient poultry production.

Funding Strategy and Sustainability

Looking ahead, I plan to pursue a diverse and strategically phased funding portfolio to support a competitive, internationally recognized research program in poultry health, metabolism, and resilience. My experience securing a highly competitive Beckman Postdoctoral Fellowship and contributing to NIH R21 and foundation-level proposals has prepared me to navigate federal and foundation funding landscapes and to develop projects with clear translational value. In the short term (1–3 years), I will leverage my existing expertise in molecular and epigenetic regulation, nutritional modulation, and integrative physiology to initiate foundational projects exploring developmental and stress-related epigenetic programming in poultry. Funding targets include USDA-NIFA AFRI foundational programs, state-level seed grants, and collaborative industry partnerships focused on broiler and layer production. In the mid-term (3–5 years), I aim to expand to integrated systems studies combining cross-tissue physiology, metabolomics, and predictive epigenetic markers, seeking support from USDA-NIFA, the U.S. Poultry & Egg Association, FFAR, and complementary federal programs. Over the long term (5–10 years), I envision establishing large-scale, multidisciplinary initiatives that advance One Health–driven precision nutrition and resilience strategies, incorporating imaging, integrated physiological and behavioral monitoring, and data-driven modeling, supported by major federal agencies, foundations, and industry consortia. Together, this trajectory positions me to develop and sustain a robust, extramurally funded research program that strengthens Purdue's leadership in poultry science.

Collaboration, Fit, and Vision for a Sustainable, Extramurally Funded Program

A central theme throughout my training has been the use of interdisciplinary approaches to understand how metabolic, nutritional, and epigenetic mechanisms shape organismal health. This perspective positions me to contribute meaningfully to Purdue's Department of Animal Sciences, where physiology, nutrition, genetics, welfare, and production biology intersect to address challenges facing modern poultry systems. Indiana's poultry sector, diverse, economically essential, and increasingly impacted by environmental pressures, requires research programs that integrate molecular mechanisms with applied outcomes. My long-term vision is to build such a program: one that advances mechanistic discovery while generating practical, scalable insights that benefit commercial broiler, turkey, and layer production.

Realizing this vision requires a collaborative environment, and Purdue offers an exceptional ecosystem for integrative, team-based research. Within Animal Sciences, I anticipate strong partnerships with faculty working in poultry nutrition, immunology, muscle biology, and reproductive physiology to link epigenetic regulation with measurable performance outcomes. Collaborations with Veterinary Medicine, Agriculture and Biological Engineering, and Nutrition Science will allow us to connect molecular physiology with health management, welfare assessment, environmental stress mitigation, and feed efficiency optimization. I also look forward to contributing to Purdue's One Health initiative, where understanding how environmental, nutritional, and microbial factors shape metabolic and immune function in poultry aligns naturally with broader goals of sustainability and public health.

My prior interdisciplinary experience has prepared me well for this collaborative model. During my PhD and postdoctoral training, I worked closely with experts in metabolism, neuroendocrinology, nutritional epigenetics, and imaging sciences; experiences that taught me how to coordinate complex projects across

wet labs, analytics cores, and computational teams. These collaborations resulted in tools such as epigenetic MRI, and they strengthened my ability to communicate across fields and translate mechanistic findings into broader biological insights. At Purdue, I will apply these skills to build research teams that connect molecular biology with applied poultry systems, ensuring that our discoveries remain grounded in real-world production needs.

Equally important, I am committed to fostering partnerships with Indiana's poultry industry. By engaging with producers, allied companies, and Extension, I aim to co-develop research priorities, test interventions in commercial-relevant settings, and generate data that directly informs breeding, nutrition, and management strategies. Through interdisciplinary collaboration, stakeholder engagement, and a clear scientific vision, I will work to build a research program that strengthens Purdue's leadership in poultry science and contributes to sustainable, resilient production systems aligned with One Health principles.

References

1. **Cao, C.**, Siegel, P. B., Gilbert, E. R., & Cline, M. A. (2022). Epigenetic modifiers identified as regulators of food intake in a unique hypophagic chicken model. animal, 16(6), 100549.

2. **Cao, C.**, Gilbert, E. R., & Cline, M. A. (2021). DNA methylation-modifiers reduced food intake in juvenile chickens (Gallus gallus) and Japanese quail (Coturnix japonica). Neuroscience Letters, 764, 136230.

3. Cai, Z. P.*, **Cao, C.***, Guo, Z., Yu, Y., Zhong, S. J., Pan, R. Y., ... & Qin, X. Y. (2021). Coeloglossum viride var. bracteatum extract attenuates staurosporine induced neurotoxicity by restoring the FGF2-PI3K/Akt signaling axis and Dnmt3. Heliyon, 7(7), e07503. (***Co-first author**)

4. Cong, L., **Cao, C.**, Cheng, Y., & Qin, X. Y. (2016). Green tea polyphenols attenuated glutamate excitotoxicity via antioxidative and antiapoptotic pathway in the primary cultured cortical neurons. Oxidative medicine and cellular longevity, 2016(1), 2050435.

5. **Cao, C.**, Liu, T., Cai, Z., Zhang, S., & Qin, X. (2015). ERK1/2 mediated inhibitory role of curcumin on STS-induced neurons toxic injury. Chinese Journal of Biochemical Pharmaceutics, 37(4), 1-4.

6. Lam, F., Chu, J., Choi, J. S., **Cao, C.**, Hitchens, T. K., Silverman, S. K., … & Li, K. C. (2022). Epigenetic MRI: Noninvasive imaging of DNA methylation in the brain. Proceedings of the National Academy of Sciences, 119(10), e2119891119.

Chang Cao | Teaching Statement

Teaching Philosophy

My primary goal in teaching is to **foster critical thinking**, encouraging students to move beyond memorization and engage deeply with concepts. From my own experience, material understood through independent reasoning is retained far better than rote facts. To cultivate this skill in students, I will design classroom activities that require analyzing real-world animal production challenges. For example, in a poultry physiology or nutrition course, students might be asked to evaluate strategies for improving feed efficiency under heat stress, considering molecular, metabolic, and environmental factors. They would present evidence-based recommendations, weighing trade-offs in growth, welfare, and environmental impact. Such exercises teach students to integrate mechanistic understanding with practical decision-making in poultry and livestock systems. I will also design assignments requiring synthesis of information from multiple sources, encouraging students to internalize knowledge through analysis rather than memorization. Case studies and problem-based scenarios ensure that theoretical concepts are directly connected to production, health, and welfare outcomes.

I believe students are not here to learn, but **to learn how to learn**, a simple yet profound quote I learned from my PhD advisor. In rapidly evolving fields such as animal physiology and agricultural sciences, mastering existing knowledge is insufficient. Students must develop the ability to quickly assimilate new concepts and technologies. To support this, I will introduce strategies such as concept mapping, reflective learning journals, and self-assessment techniques, helping students discover approaches that suit their learning style. I will model lifelong learning by sharing my own engagement with current research, including epigenetics, metabolism, and poultry physiology, to inspire curiosity and adaptability.

Lastly, I recognize that students have diverse learning needs, and that **personalized support** is essential for success. Drawing from my experience as a teaching assistant, I regularly held one-on-one office hours to identify individual challenges and adapt instruction accordingly. I will provide tailored resources such as simplified reading materials, alternative exercises, or guided data-analysis examples to help students master complex concepts. I will also collaborate with peers and learning specialists to develop individualized strategies, ensuring all students receive the guidance needed to thrive.

Lecturing Approach

I view repetition and conceptual scaffolding as essential for learning. Before introducing new topics, I will encourage students to explore key concepts in advance, prompting questions and initial observations. I will teach knowledge as an interconnected narrative: presenting the overarching framework, unpacking each component step-by-step, and showing how these elements integrate into functional systems. For instance, when teaching energy metabolism and nutrient utilization in poultry, I will guide students to trace the flow of nutrients from diet to absorption, transport, cellular metabolism, and growth outcomes, linking molecular regulation to whole-animal physiology. To reinforce comprehension, students will reconstruct these pathways through diagrams, flowcharts, or short reports, fostering active engagement and integrative reasoning.

Teaching Interests

My teaching and mentoring experience span poultry physiology, metabolism, molecular biology, and systems physiology, enabling me to contribute broadly to Purdue's undergraduate and graduate curricula in Animal Sciences. I am prepared to teach foundational courses such as Poultry Science, Animal Physiology, and Animal Nutrition, as well as advanced courses in epigenetics, metabolic regulation, and

stress physiology relevant to poultry production. I also plan to develop new courses such as Epigenetic Regulation in Poultry Production and Health or Metabolic and Environmental Influences on Avian Growth and Welfare, integrating molecular, computational, and systems-level approaches applicable to commercial poultry and livestock systems.

I am deeply committed to mentoring students in laboratory and field settings, fostering skills in experimental design, data analysis, and critical reasoning. My philosophy emphasizes active learning, inclusive participation, and curiosity-driven inquiry, helping students connect molecular and systems principles to animal health, welfare, and production. I have formally and informally mentored several graduate (4) and undergraduate students (7), guiding them through diverse challenges in research. For example, I have helped students balance following protocols with independent reasoning, ensuring they understand the purpose of each experimental step while developing confidence to design and interpret experiments. This approach cultivates independent, reflective researchers capable of integrating mechanistic knowledge with applied outcomes.

By promoting critical thinking, self-directed learning, and personalized mentorship, I aim to create a dynamic and inclusive learning environment at Purdue, preparing students to address complex challenges in poultry production, animal health, and sustainable agriculture.