Nathaniel D. Collins, DVM, Ph.D., DACVP

SENIOR CONSULTANT

CONTACT INFORMATION

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PROFESSIONAL PROFILE

Dr. Nate Collins is a Senior Consultant in ToxStrategies' Biopharmaceuticals/Pharmaceuticals Practice. He has 25 years' experience in the industry, working at four major pharmaceutical companies. He is a trained veterinary clinical pathologist and has held leadership roles in diverse areas, including pathology, immunotoxicology, investigative/mechanistic toxicology, and genetic toxicology. Most recently, Dr. Collins served as vice president for nonclinical safety, where he was responsible for the nonclinical strategy for his company's development portfolio. In this capacity, he oversaw a team of 35 toxicologists, advising and approving nonclinical testing strategy and data interpretation, and managing regulatory interactions with international health authorities.

Dr. Collins holds a Doctor of Veterinary Medicine degree from Colorado State University, and a Doctor of Philosophy degree from The Ohio State University. He is also a Diplomate of the American College of Veterinary Pathologists (Clinical Pathology).

Dr. Collins has experience across multiple therapy areas (including oncology, immunology, neurology, anti-viral, fibrosis, and cardiovascular) and modalities (including small molecules, mAbs, fusion proteins, TCEs, cell therapy, gene therapy, ASOs, and macromolecular peptides). He has made substantial contributions to developing and/or securing approvals for CLARINEX (desloratidine), NOXAFIL (posaconazole), ZETIA (ezetimibe), VYTORIN (ezeteimbe + simvastatin), VICTRELIS (boceprivir), REBETOL (ribavirin), PEGINTRON (pegylated interferon), KEYTRUDA (pembrolizumab), ABRAXANE (paclitaxel), INREBIC (fedratinib), POMALYST (pomalidomide), ZEPOSIA (ozanimod), IDHIFA (enasidenib), REBLOZYL (luspatercept-aamt), OPDUALAG (nivolumab and relatlimab-rmbw), CAMZYOS (mavacamten), SOTYKTU (deucravacitinib), ABECMA (idecabtagene vicleucel), and BREYANZI (lisocabtagene maraleucel), as well as numerous other development candidates, from preclinical through Phase 3 clinical development and post-marketing commitments. He has also served on committees and/or leadership roles for several professional organizations and consortia, including ACVP, ILSI-HESI, PhRMA, and PSTC.

EDUCATION AND DEGREES EARNED

1999 Doctor of Philosophy, Experimental Pathology/Retrovirology
Department of Veterinary Biosciences
The Ohio State University, Columbus

1994 Doctor of Veterinary Medicine (*cum laude*)
College of Veterinary Medicine and Biomedical Sciences
Colorado State University, Fort Collins

1990 Bachelor of Science, Microbiology (*summa cum laude*)
College of Veterinary Medicine and Biomedical Sciences
Colorado State University, Fort Collins

PROFESSIONAL HONORS/AWARDS

1998	Diplomate, American College of Veterinary Pathologists (Clinical Pathology)
2015	Living Our Values Award, Celgene Corporation
2005	President's Award for Development, Schering-Plough Research Institute
1999	National Phi Zeta Outstanding Manuscript Award, Basic Research
1999	Roche Molecular Biochemicals Graduate Publication Award, Ohio State University College of Veterinary Medicine
1998	C.L. Davis Foundation Student Scholarship Award
1998	Awarded Oral Presentation, Cold Spring Harbor Meeting on Retroviruses
1995	Young Investigator's Award, $300, American College of Veterinary Pathologists Annual Meeting
1995	Travel Grant from Amgen, Genentech, and Searle for AIDS-Related Research, $750, American College of Veterinary Pathologists Annual Meeting
1994	Merck Small Animal Medicine Award, Colorado State University
1993	Phi Zeta Veterinary Honor Society, Colorado State University
1991	NIH Summer Research Program Fellow and Outstanding Seminar Awardee, Colorado State University
1991–1993	Annual Scholarship Recipient, Achievement Rewards for College Scientists, Denver, Colorado Chapter
1989	Phi Kappa Phi, Colorado State University

PROFESSIONAL ASSOCIATIONS

1998–Present Member, The C.L. Davis, D.V.M. Foundation

1994–Present Member, American Society of Veterinary Clinical Pathologists

1994–Present Member, American College of Veterinary Pathologists (ACVP)

2009–Present	Member, Society of Toxicology (SOT)
2016–2024	Member, PhRMA PSLG
2016–2024	Member, PhRMA Preclin-KIT
2017–2022	Editorial Board, *Veterinary Pathology*
2013–2018	Member, Celgene Promotion Committee Grades 7-9
2012–2014	Member, Celgene Innovation Committee (2013-2014, Committee Chair)
2011–2014	Member, Predictive Safety Testing Consortium, Advisory Committee (Celgene)
2008–2012	Member, American College of Veterinary Pathologists (ACVP) Education Committee (2010 Committee Chair and 2011 Program Chair)
2008–2010	Member, ECVAM Drug-Induced Liver Injury Consortium
2008–2010	Member, ILSI-HESI Genomics Biomarkers Qualification Group
2008–2011	Official Representative (Schering-Plough 2008-2009, Merck 2010-2011), International Life Sciences Institute, Health and Environmental Sciences Institute (ILSI-HESI)
2008–2010	Member, Predictive Safety Testing Consortium, Advisory Committee (Schering-Plough)
2007–2010	Member, Biotechnology Technical Group Subcommittee, Preclinical Safety Leadership Committee, PhRMA
2006–2009	Member, ACVP Externship Committee
2005–2008	Member-at-large, ACVP Education Committee
2004–2008	Member, ILSI HESI Immunotoxicology Technical Committee Nonhuman Primate Immunotoxicology Program Group
2002–2004	Member, Membership Committee, American Society for Veterinary Clinical Pathology
2001	Chair, Toxicologic Pathology Specialty Group Program, American College of Veterinary Pathologists 52nd Annual Meeting
2000–2004	Editorial Board, Veterinary Clinical Pathology
2000	Chair, Clinical Pathology Specialty Group Program, American College of Veterinary Pathologists 51st Annual Meeting
1997–1998	President, Graduate Student Association of the Department of Veterinary Biosciences, The Ohio State University
1997–1998	Representative, Graduate Studies Committee, Department of Veterinary Biosciences, The Ohio State University
1992–1993	President, Professional Veterinary Medicine Class of 1994, College of Veterinary Medicine and Biomedical Sciences, Colorado State University

PEER REVIEWER

Chemical Research in Toxicology
Toxicology Mechanisms and Methods
International Journal of Molecular Sciences

The Veterinary Journal
Veterinary Pathology
Birth Defects Research Part B: Developmental and Reproductive Toxicology
Toxicologic Pathology
Veterinary Clinical Pathology
Journal of Veterinary Internal Medicine

SELECTED PROFESSIONAL EXPERIENCE

Nonclinical Safety, Research/Development

Portfolio Leadership

Fulfilled a senior leadership role across the development portfolio of two major pharmaceutical manufacturers. Provided in-depth knowledge in safety evaluation of new chemical, biological, and cellular therapies. Developed and executed development strategy in collaboration with peer functions. Had overall responsibility for the group producing high-quality dossiers, guided interactions with global health authorities, and ensured progress of development programs to successful marketing authorizations.

Worked collaboratively with discovery toxicology department to ensure smooth transition of early drug candidates from discovery through development. Worked closely with nonclinical safety evaluators to design and interpret safety studies. Collaborated with early and late clinical development teams by providing input into clinical study designs and prospective safety monitoring strategies. Interacted with governmental, academic, and industry colleagues on matters ranging from philosophical approaches to investigative toxicology to human risk assessment.

Provided input to create long-term functional strategy and help execute it. Led or supervised the following functions:

- Project Toxicology: Provided nonclinical safety representation for all post-candidate nomination multidisciplinary drug development teams and strategic oversight of regulatory toxicology strategy within individual thematic research centers.
- Investigative Toxicology: Characterized and solved emerging safety issues on assets in development.
- Cell Therapy Safety: Worked with industry-leading group responsible for the development of novel strategies in nonclinical safety assessment of cellular therapies.
- Immuno- and Molecular Toxicology: Responsible for assessing immunotoxicology risk and developing translatable immunology PD biomarkers for development assets.
- Nonclinical Scientific Writing: Worked with pharmacology scientists and toxicologists to develop high-quality content for global regulatory submissions, Health Authority responses, and dossiers, including IBs, INDs, CTAs and NDA/BLA/MAAs.

Project Toxicologist

Represented non-clinical development on drug development project teams. Provided toxicology and preclinical drug metabolism expertise to the project teams, as well as external alliances, ensuring preclinical safety development needs were met and facilitating efficient and accurate exchange of information and strategy. Responsible for design and execution of nonclinical safety programs to support project development. Interpreted nonclinical safety data, communicated results, and conducted hazard identification and human safety risk assessment. Interacted with contract research organizations (CROs) to ensure successful study conduct and

review study data reports. Wrote regulatory submission documents, including INDs, IBs, IMPDs, NDAs, and responses to HA questions.

Scientific and Laboratory Functional Leadership

Directed scientific line functions at four major pharmaceutical manufacturers in the areas of regulatory toxicology, clinical pathology, immunotoxicology, molecular toxicology, investigative toxicology, and genetic toxicology. Responsible for ensuring the quality, compliance, and scientific rigor of all activities in these departments. Responsibilities included supporting intellectual and scientific efforts, utilizing skill sets, and interacting with colleagues in other units as necessary. Responsible for overall direction and scope of work, as well as project prioritization and alignment with development and discovery goals. Guided the evaluation and interpretation of data for GLP and non-GLP toxicology studies. Reviewed internal documents, CRO reports, and regulatory toxicology submissions. Managed and directed personnel; developed budgets; oversaw personnel, facility, and equipment requirements; ensured GLP compliance; provided intellectual and scientific support to the laboratories—including providing overall direction and scope of work for these departments, reviewing their scientific and regulatory reports, and mentoring technical scientists.

Immunology/Immunotoxicology Expert

Served as nonclinical development representative on a corporate center for immunology and inflammation. Provided preclinical toxicology perspective on internal and external assets, as well as diligence, risk assessment, and input on prioritization decisions. Helped steer strategic decision making to position assets for successful development.

Developed and led an immunotoxicity and immunopathology assessment laboratory. Responsible for the identification and development of assays, supervision and scientific direction of technicians, interpretation of immunotoxicity data, and provision of expertise for the interpretation of regulatory guidelines. Also guided technical development and departmental scientific policy, including the selection and monitoring of contract research organizations and participation in external collaborations and committees.

Clinical Pathologist

Provided consultative support to pathologists and project toxicologists in the interpretation and risk assessment of clinical pathology data. Helped identify and apply appropriate assays and biomarkers to best enable the diagnosis and monitoring of drug-induced toxicity in preclinical species. Interacted with and assisted those conducting exploratory toxicology in the design and interpretation of mechanistic toxicity investigations and design of novel biomarkers. Interacted with translational medicine to develop and recommend translatable safety biomarkers.

- Evaluated and interpreted data for routine toxicologic studies to determine toxicity and/or human risk potential of pharmaceuticals under development
- Wrote clinical pathology reports documenting findings; participated in the preparation, review, and approval of all final reports for assigned studies
- Reviewed clinical pathology data and reports from contract laboratories
- Provided scientific support and guidance to medical technologists within the clinical pathology laboratory
- Designed and conducted investigative studies to determine mechanism(s) and/or relevance to human risk of selected test-article-related changes in clinical pathology parameters
- Provided expert advice, opinion, consultation, and education related to clinical pathology, physiology, and medicine to scientific and technical staff.

Business Development

Coordinated due diligence of business development opportunities on behalf of nonclinical development. Directed all toxicology and DMPK assessments of potential in-licensing assets and collaborative partnerships to enable scientifically informed go/no-go decisions.

Corporate Strategy and External Representation

Participated in planning corporate departmental strategy with regard to regulatory toxicology, compliance, finance, and human resources. Guided compound development issues from discovery support through development and into life-cycle management. Provided scientific and creative input for proposals to place findings in drug safety studies within the perspective of human risk. Interacted with government, academic, and industry colleagues as necessary and appropriate on matters ranging from philosophical approaches to investigative toxicology to human risk assessment. Influenced policy and regulatory positions. Participation included PhRMA, IQ, SOT, ACVP, STP, and ILSI-HESI.

PEER-REVIEWED PUBLICATIONS

Belair DG, Sudak K, Connelly K, **Collins ND**, Kopytek SJ, Kolaja KL. 2021. Investigation into the role of ERK in tyrosine kinase inhibitor-induced neuropathy. Toxicol Sci 181:160–174.

Belair DG, Lu G, Waller LE, Gustin JA, **Collins ND**, Kolaja KL. 2020. Thalidomide inhibits human iPSC mesendoderm differentiation by modulating CRBN-dependent degradation of SALL4. Sci Rep 10:2864.

Poulet FM, Penraat K, **Collins N**, Evans E, Thackaberry E, Manfra D, et al. 2010. Drug-induced hemolytic anemia and thrombocytopenia associated with alterations of cell membrane lipids and acanthocyte formation. Toxicol Pathol 38:907–922.

Chen F, Smith R, Gu YZ, **Collins ND**, Nioi P. 2010. Toxicoepigenetic alteration of the Kidney Injury Molecule 1 gene in gentamicin-exposed rat kidney. Toxicol Sci 117:375–380.

Dieterle F, Sistare F, Goodsaid F, Papaluca M, Ozer JS, … **Collins N**, et al. 2010. Renal biomarker qualification submission: A dialog between the FDA-EMEA and Predictive Safety Testing Consortium. Nature Biotechnol 28:455–462.

Sistare FD, Dieterle F, Troth S, Holder DJ, Gerhold D, …, **Collins N**, et al. 2010. Towards consensus practices to qualify safety biomarkers for use in early drug development. Nature Biotechnol 28:446–454.

Enright BP, Compton DR, **Collins N**, Davis T, McIntyre BS. 2009. Comparative effects of interferon alpha-2b and pegylated interferon alpha-2b on menstrual cycles and ovarian hormones in Cynomolgus monkeys. Birth Defects Res B 86:29–39.

Davis II JW, Goodsaid FM, Bral CM, Mandakas G, Obert LA, Garner CE, **Collins N**, et al. 2004. Quantitative gene expression analysis in a nonhuman primate model of antibiotic-induced nephrotoxicity. Toxicol Appl Pharmacol 200:16–26.

Morrissey RE, Horvath C, Snyder EA, Patrick J, **Collins N**, Evans E, MacDonald JS. 2002. Porcine toxicology studies of SCH 58500, an adenoviral vector for the p53 gene. Toxicol Sci 65:256–265.

Albrecht B, **Collins ND**, Burniston MT, Nisbet JW, Ratner L, Green PL, Lairmore MD. 2000. Human T-lymphotropic virus type 1 open reading frame I p12I is required for efficient viral infectivity in primary lymphocytes. J Virol 74:9828–9835.

Newbound GC, O'Rourke JP, **Collins ND**, Andrews JM, DeWille J, Lairmore MD. 2000. Repression of Tax-mediated human T-lymphotropic virus type 1 transcription by inducible cAMP early repressor (ICER) protein in peripheral blood mononuclear cells. J Med Virol 62:286–292.

Bartoe JT, Albrecht B, **Collins ND**, Robek MD, Ratner L, Green PL, Lairmore MD. 2000. Functional role of pX open reading frame II of human T-lymphotropic virus type 1 in maintenance of viral loads in vivo. J Virol 74(3):1094–1100.

Collins ND, D'Souza C, Albrecht B, Robek MD, Ratner L, Ding W, Green PL, Lairmore MD. 1999. Proliferation response to interleukin-2 and Jak/Stat activation of T cells immortalized by human T-cell lymphotropic virus type 1 is independent of open reading frame I expression. J Virol 73(11):9642–9649.

Newbound GC, O'Rourke JP, **Collins ND**, Andrews JM, DeWille J, Lairmore MD. 1999. Comparison of HTLV-I basal transcription and expression of CREB/ATF-1/CREM family members in peripheral blood mononuclear cells and Jurkat T cells. J Acquired Immune Deficiency Synd Hum Retrovirol 20(1):1–10.

Collins ND, Newbound GC, Albrecht B, Beard JL, Ratner L, Lairmore MD. 1998. Selective ablation of human T-cell lymphotropic virus type 1 p12I reduces viral infectivity in vivo. Blood 91(12):4701–4707.

Collins ND, LeRoy BE, Vap L. 1998. Artifactually increased serum bicarbonate values in two horses and a calf with severe muscle disease. Vet Clin Pathol 27(3):85–90.

Albrecht B, **Collins ND**, Newbound GC, Ratner L, Lairmore MD. 1998. Quantification of human T-cell lymphotropic virus type 1 (HTLV-1) proviral load by quantitative competitive polymerase chain reaction. J Virol Meth 75(2):123–140.

Collins ND, Newbound GC, Ratner L, Lairmore MD. 1996. In vitro CD4+ lymphocyte transformation and infection in a rabbit model with a molecular clone of human T-cell lymphotropic virus type 1. J Virol 70(10):7241–7246.

SELECTED ABSTRACTS AND PRESENTATIONS

Belair DG, Waller L, Gustin J, **Collins N**, Kolaja K. 2019. Thalidomide inhibits human iPSC mesendoderm differentiation by modulating cereblon-dependent degradation of SALL4. Podium presentation at 58th Annual Meeting of the Society of Toxicology, Baltimore, MD. The Toxicologist: Suppl Toxicol Sci 168(1), Abstract #3296.

Visconti R, Foy J, Brennan S, **Collins N**, Kolaja K. 2019. An in vitro model of il-2-mediated Type 2 innate lymphoid cell proinflammatory cytokine secretion. Presented at the 58th annual meeting of the Society of Toxicology, Baltimore, MD. The Toxicologist: Late-Breaking Suppl, Suppl to Toxicol Sci 168(1), Abstract #3377.

Belair DG, **Collins N,** Kolaja K. 2018. An *in vitro* assay of limb bud formation to study thalidomide-induced teratogenicity. Abstract and poster presented at the Gordon Research Conference — Signal Transduction by Engineered Extracellular Matrices, Proctor Academy, Andover, NH.

Collins N. 2016. My training didn't cover this: The importance of on the job learning for personnel management and leadership. Invited speaker, presented as part of Career Development Session: Personnel Management. At the 67th annual meeting of the American College of Veterinary Pathologists, New Orleans, LA.

Collins N. 2011. Preladenant: preclinical development case study. Early Development Course, A Merck Polytechnic Institute Premier Course, Princeton, NJ.

Nguyen T, Smith RJ, Poulet F, Niu X, Lundell D, **Collins ND**. 2010. Investigative studies on the mechanism of toxicity of a TNF-alpha converting enzyme (TACE) inhibitor. Presented at the 61st annual meeting of the American College of Veterinary Pathologists, Baltimore, MD. Vet Pathol 47(6 suppl):57S.

Collins N. 2010. Preladenant: Preclinical development case study. Early Development Course, A Merck Polytechnic Institute Premier Course, Princeton, NJ.

Murillo M, Prevete K, **Collins N**, Evans E, Piccotti JR. 2010. Effects of RBC lyse procedure on accurate measurement of $CD16^{+}$ NK cells. Presented at the 49th annual meeting of the Society of Toxicology, Salt Lake City, UT. The Toxicologist, Suppl to Toxicol Sci 114(1), Abstract #1987.

Piccotti JR, Wardrope JL, Ling L, **Collins ND.** 2010. Evaluating the immunotoxicity potential of drugs by flow cytometry. Presented at the 49th annual meeting of the Society of Toxicology, Salt Lake City, UT. The Toxicologist, Suppl to Toxicol Sci 114(1), Abstract #1982.

Wang E-J, Knemeyer I, Snyder RD, Brunnert S, Casale R, … **Collins N**, Gu Y-Z. 2009. Evaluation of nephrotoxicity biomarkers in gentamicin-treated rats. Presented at the 48th annual meeting of the Society of Toxicology, Baltimore, MD. The Toxicologist, Suppl to Toxicol Sci 108(1), Abstract #1598.

Collins N. 2008. Immunotoxicology: Principles and practices. Presented at the 59th annual meeting of the American College of Veterinary Pathologists, San Antonio, TX.

Collins N. 2007. CNS tissue cross-reactivity with an anti-IL-5 monoclonal antibody: Follow-up studies and toxicologic implications. Charles River Laboratories Preclinical Symposium on Biotechnology Derived Therapeutics, Lake Tahoe, NV.

Gu Y-Z, Wang E, Smith RJ, Keane K, McIntyre B, **Collins N**, Snyder RD. 2007. Identification of probable biomarkers for phosphodiesterase inhibitor induced vascular injury using toxicogenomics. Presented at the 46th annual meeting of the Society of Toxicology, Charlotte, NC. The Toxicologist, Suppl to Toxicol Sci 96(1), Abstract #49.

Collins N. 2005. Standard and non-standard urinalysis — Part of an integrative toxicogenomic study. At the CL Davis, DVM Foundation NE Division Spring meeting, Bridgewater, NJ.

Collins N. 2004. Immunotoxicology: Clinical pathology and functional assessment. Presented as part of continuing education course: Immunotoxicology for the toxicologic pathologist. At the 23rd annual symposium of the Society of Toxicologic Pathology, Salt Lake City, UT.

Collins N. 2002. Coagulation. Presented as part of continuing education course: An overview and review of clinical pathology and its application in preclinical toxicology. At the 21st annual symposium of the Society of Toxicologic Pathology, Denver, CO

Sharpe NA, **Collins N**, Barat SA, Price R, Dunham KS, Morrissey RE, MacDonald JS. 2002. Effects of a single intramuscular injection of ketamine in cynomolgus monkeys. Presented at the 41st annual meeting of the Society of Toxicology, Nashville, TN. The Toxicologist, Suppl to Toxicol Sci 66(1), Abstract #1280.

Bartoe J, Albrecht B, **Collins N,** Ratner L, Green P, Lairmore M. 1999. Evaluation of HTLV-1 ORF II in a rabbit model of infection. Presented at the 50th annual meeting of the American College of Veterinary Pathologists, Chicago, IL. Vet Pathol 36:514.

Collins ND, Albrecht B, Ding W, Lairmore MD. 1998. The effects of human T-lymphotropic virus type 1 $p12^{I}$ on the IL-2 signaling pathway. Presented at the 49th annual meeting of the American College of Veterinary Pathologists, St. Louis, MO. Vet Pathol 35:452.

Collins ND, Newbound GC, Albrecht B, Beard JL, Ratner L, Lairmore MD. 1998. Selective ablation of human T-cell lymphotropic virus type 1 $p12^{I}$ reduces viral infectivity in vivo. Cold Spring Harbor. Retrovirus Meeting. Cold Spring Harbor, NY.

Collins N, Albrecht B, Newbound G, Ratner L, Lairmore M. 1997. In vitro and in vivo characterization of a p12 mutant of HTLV-1. Presented at the 48th annual meeting of the American College of Veterinary Pathologists, Albuquerque, NM. Vet Pathol 34:514.

Collins N, Newbound G, Ratner L, Lairmore M. 1995. The in vitro and in vivo characterization of an infectious molecular clone of HTLV-1. Presented at the 7th International Conference in Human Retrovirology: HTLV, Paris, France. J Acquired Immune Deficiency Synd Hum Retrovirol 10:270.

Collins N, Newbound G, Ratner L, Lairmore M. 1995. The in vitro and in vivo characterization of an infectious molecular clone of HTLV-1. Presented at the 46th annual meeting of the American College of Veterinary Pathologists, Atlanta, GA. Vet Pathol 32:596.