

UNIVERSITY OF MISSOURI VETERINARY MEDICAL DIAGNOSTIC LABORATORY ANNUAL REPORT – 2023

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Summary

In 2023, the VMDL processed approximately 64,924 accessions and performed more than 207,026 laboratory tests, which represents a 10.67% increase in diagnostic accessions and 17.54% increase in laboratory tests compared to 2022. The diagnostic service was utilized by veterinarians, owners, and researchers from 110 Missouri counties/independent cities and 28 non-MO states.

The VMDL retained full accreditation by the American Association of Veterinary Laboratory Diagnosticians (AAVLD), NAHLN Level 1 and FDA Vet-LRN Tier 1 lab status, National Poultry Improvement Plan (NPIP) certification, and USDA EIA Lab Certification. VMDL sections successfully completed relevant proficiency tests for regulatory diseases as required by the federal or state government and additional proficiency tests as required for laboratory accreditation and certification.

The VMDL One Health – Rabies Lab was established and began testing pets' samples for rabies vaccination status.

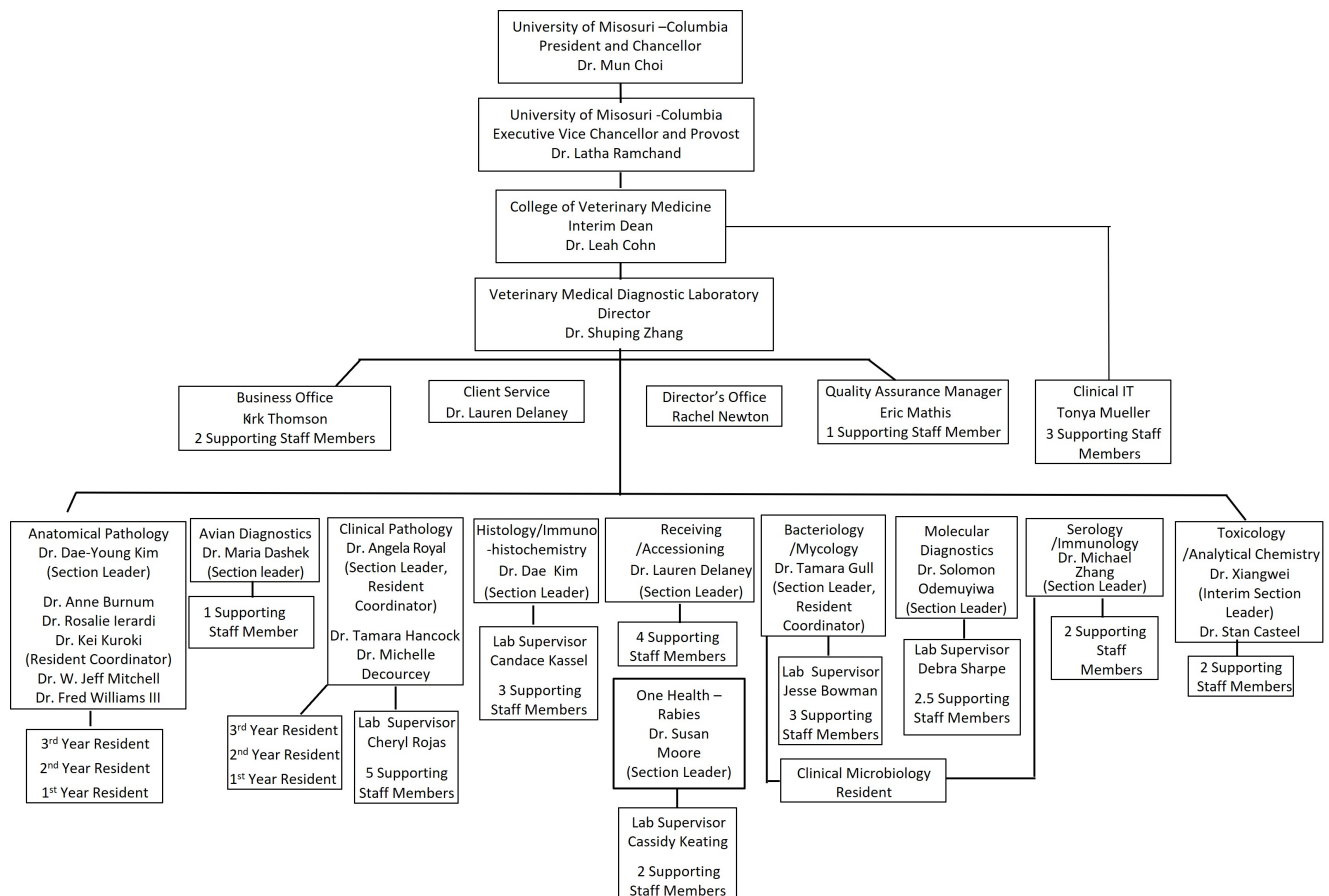
The faculty taught (or co-taught) 28 DVM, graduate, and undergraduate courses and led or participated in 20 clinical/diagnostic rounds.

The faculty and staff led or contributed to 19 funded research projects, published 26 peer-reviewed research and diagnostic papers, presented 25 conference posters and oral presentations. The faculty and staff also actively participated in extension and outreach events and provided leadership services to many international, national, state, and local organizations.

Introduction

The Veterinary Medical Diagnostic Laboratory (VMDL) is one of two clinical units in the College of Veterinary Medicine. The VMDL is Missouri’s only full-service diagnostic lab for all animal species and is also the only lab in the state accredited by the American Association of Veterinary Laboratory Diagnosticians (AAVLD). The VMDL is also a Level 1 lab of the USDA National Animal Health Laboratory Network (NAHLN) and Tier I lab of the FDA Veterinary Laboratory Investigation and Response Network (Vet-LIRN). The faculty and staff are committed to excellence in diagnostic service, teaching, and research. The VMDL provides relevant, timely, and cost-effective diagnostic services to its clients and maintains a positive learning environment for the students. The 2023 VMDL Annual Report outlines the major diagnostic, teaching, research, and university service activities. To track the diagnostic caseload for professional DVM education and improve service to the state of Missouri, 5-year data are presented. The diagnostic data for years 2019 to 2022 are slightly different but more accurate than those included in previous annual reports.

VMDL Organizational Structure



External Advisory Board

Mission Statement

To advise VMDL management on policies, services, strategies, and partnerships with stakeholders.

Advisory Board Membership

The Advisory Board consists of 12 members representing the Missouri Department of Agriculture, USDA, Missouri Department of Conservation, commodity groups, private practice, animal health industry, and the University of Missouri Veterinary Health Center.

Advisory Board Members

Steve Strubberg, DVM, Missouri State Veterinarian

Terry Gosch, DVM, USDA Area Veterinarian in Charge

Sherri Russell, DVM, Missouri Wildlife Veterinarian

Clark Fobian, DVM, Sedalia, MO, Past President, AVMA

Bruce Addison, MS, President, Addison Biological Laboratory, Inc.

Tony Martin, DVM, Director of Animal Health Division, MFA, Inc.

Don Nikodim, Executive Vice President, Missouri Pork Association

Sydney Thummel, Executive Director, Missouri Beef Industry Council

John Bryan, Vice President, Poultry Federation

Joan Coates, DVM, MS, DACVIM–Neurology, MU VHC Small Animal Service

Austin Hinds, DVM, MS, DACVIM-LA, MU VHC Food Animal Service

Philip Johnson, BVSc, MS, MRCVS, DACVIM-LA, DECEIM, MU VHC Equine Service

VMDL Client Outreach Programs

A Client Care Veterinarian is available for consultation (573-882-6811).

The VMDL website (<https://vmdl.missouri.edu/>) provides useful content and information, such as Tests and Fees, Submission Forms, How to Submit Samples, Test Results (Online Lab Results and Global VetLink for EIA), VMDL Newsletter, VMDL Annual Report, Potential Open Positions, Pathology Externship Opportunities, Residency program descriptions, etc.

Through the VMDL VetView Portal, clients can check diagnostic results and charges in real-time. Online Bill Pay is also available to clients.

The VMDL FedEx Billable Stamps program enables inexpensive next day delivery of samples to the lab.

The VMDL Courier Service is available for convenient transport of samples within the Columbia area.

The VMDL After-hours Sample Drop-Off is located at the VHC Small Animal Emergency Clinic. Samples are securely stored prior to testing the next business day.

The VMDL personnel maintain attendance at district VMA meetings.

VMDL One Health – Rabies Serology Lab

The One Health – Rabies Lab performs two primary assays are the Rapid Fluorescent Focus Inhibition test (RFFIT) and the Fluorescent Antibody Virus Neutralization test (FAVN) to verify rabies vaccination status in humans and animals.

The One Health – Rabies Lab meets qualification standards of the Clinical Laboratory Improvement Amendments (CLIA) and American Association of Veterinary Laboratory Diagnosticians (AAVLD). The One Health – Rabies Lab is recognized by the USDA to perform rabies serology for the purpose of pet export/travel.

The Lab is operated under the leadership of Dr. Susan Moore, a world-renowned rabies expert with more than 30 years of experience.

VMDL Diagnostic Service Activities

Table 1. Five-Year VMDL (Main Lab and Clinical Pathology) Accessions*

Year	Total Acc.	Main Lab	Clin Path	OH-Rabies	Main Lab-VHC (%)	Clin Path-VHC (%)	OH-Rabies-VHC (%)	VMDL Total-VHC (%)
2019	51,830	27,142	24,688	N/A	4,353 (16.04)	23,954 (97.03)	N/A	28,307 (54.62)
2020	52,214	27,189	25,025	N/A	4,264 (15.68)	23,768 (94.98)	N/A	28,032 (53.69)
2021	55,756	29,015	26,741	N/A	4,340 (17.59)	26,043 (97.39)	N/A	30,383 (54.59)
2022	58,681	30,691	27,875	N/A	4,070 (13.26)	27,409 (98.33)	N/A	31,479 (53.75)
2023	64,942	33,091	31,678	173	4,411 (13.33)	31,247 (98.64)	5 (2.89)	35,663 (54.92)

*A Main Lab accession may include samples for various tests whereas most Clinical Pathology and One Health Rabies (OH-Rabies) accessions include a single sample. From 2022 to 2023, total accessions increased 10.67%.

Table 2. Distribution of 2023 VMDL Accessions in 110 MO Counties/Independent City

County	#	County	#	County	#	County	#
Boone	35,993	Monroe	167	Crawford	62	Dallas	10
Not Specified	5,626	Lincoln	162	Taney	61	Barton	9
Saint Louis	1,506	Howell	158	Texas	61	Chariton	8
Saint Charles	1,302	McDonald	157	Wright	61	Maries	8
Jackson	1,012	Lafayette	150	Vernon	53	Andrew	7
Moniteau	964	Buchanan	149	Linn	52	Dekalb	6
Greene	701	Putnam	148	Madison	49	Sullivan	6

Johnson	664	Lawrence	144	Sainte Genevieve	49	Warren	5
Cole	584	Laclede	137	Macon	46	Knox	4
Franklin	562	Miller	137	Morgan	36	Schuyler	4
Callaway	527	Howard	125	Platte	32	Wayne	3
Cape Girardeau	331	Phelps	119	Bates	31	Dade	2
Saint Louis City	317	Livingston	118	Caldwell	30	Daviess	2
Marion	305	Camden	117	Cedar	30	Iron	2
Randolph	298	Grundy	113	Lewis	29	Ripley	2
Webster	292	Cooper	112	Bollinger	27	Audrain	1
Jefferson	291	Nodaway	100	Henry	27	Clinton	1
Jasper	246	Oregon	96	Stoddard	26	Douglas	1
Butler	221	Osage	86	Mercer	25	Harrison	1
Polk	221	Audrain	82	Carroll	25	Ozark	1
Cass	214	Scott	80	Montgomery	24	Phelps	1
Pike	212	Pulaski	79	Dent	21	Pulaski	1
Gasconade	199	Barry	77	Saint Clair	21	Ralls	1
Christian	195	Shelby	76	Benton	17	Reynolds	1
Newton	190	Adair	74	Atchison	14	Scotland	1
Saint Francois	188	Saline	70	Perry	14	Washington	1
Ray	185	Clay	68	Shannon	14		
Pettis	180	Dunklin	65	Clark	10	Total	57,728

Table 3. Distribution of 2023 VMDL Accessions in 28 Non-Missouri States

State	#	State	#	State	#	State	#
Arkansas	206	Florida	18	Pennsylvania	5	Alabama	2
Illinois	83	Iowa	11	Tennessee	4	Indiana	2
Kansas	42	New York	10	Arizona	3	S. Dakota	2
Oklahoma	40	Michigan	8	Massachusetts	3	Minnesota	1
Colorado	29	Nebraska	8	New Jersey	3	S. Carolina	1
N. Carolina	25	Washington	7	Puerto Rico	3	Virginia	1
California	20	Manitoba	6	Texas	3	Wyoming	1

Total 547

Table 4. Five-Year VMDL Testing by Animal Species*

Year	Total	Avian	Bovine	Canine	Caprine /Ovine	Cervid/ Exotic	Equine	Feline	Porcine	Misc.
2019	160,998	4,136	16,590	64,001	3,366	42,994	10,234	9,918	3,877	2,963
2020	147,547	4,164	17,029	68,744	2,673	26,541	9,191	10,347	4,887	3,971
2021	166,571	4,228	15,798	70,261	2,474	42,247	9,161	10,666	3,069	8,667
2022	176,126	10,408	16,153	76,029	2,780	44,619	9,852	11,325	3,898	1,062
2023	207,026	16,460	16,313	79,776	2,843	58,031	13,196	12,372	7,179	876

* From 2022 to 2023, the total testing numbers increased 17.54%.

Table 5. Five-Year VMDL Testing by Section

Year	Total (% Change)	Avian Dx.	Anatomic Path	Histo/ IHC	Clinical Path	Micro	Mol/ Vir	Serology	Tox/ Chem	OH-Rabies
2019	160,998 (4.33)	1,604	12,934	42,373	31,797	13,761	8,548	46,646	3,335	N/A
2020	147,547 (-8.35)	1,822	13,051	45,270	35,206	13,720	7,717	27,539	3,222	N/A
2021	166,571 (12.89)	1,586	15,294	44,227	37,151	13,625	8,537	43,364	2,787	N/A
2022	176,126 (5.74)	1,530	13,223	46,319	39,341	13,993	15,239	44,176	1,067	N/A
2023	207,026 (18.54)	3,336	13,368	47,320	52,621	16,050	18,077	47,085	8,775	240

5-Year Total Increase: 14.85%

Table 6. 2023 Foreign Animal Disease and Public Health Surveillance Testing

Test Description	#	#
Influenza PCR		8,874
Avian Influenza (AI) PCR - Domestic Bird	2,865	
H5/H7 Typing - Domestic Bird	38	
AI PCR - Wild Bird	4,141	

H5/H7 Typing - Wild Bird	1,764
Influenza A PCR - Mammal	66
Avian Paramyxovirus (APMV) PCR - Domestic Bird	210
APMV (ND) PCR - Wild Bird	21
African Swine Fever (ASF) PCR	200
Classical Swine Fever (CSF) PCR	200
Foot and Mouth Disease (FMD) PCR	38
Brucella abortus Card Agg	373
Brucella Canis Rapid Ab test	404
Chronic Wasting Disease (CWD) ELISA	36,017
Contagious Equine Metritis (CEM)	92
Pseudorabies ELISA & Brucella abortus card Agg	561
Rabies Titer	240
West Nile ELISA	32
Total	47,262

Table 7. External Proficiency Tests

<i>Bacteriology/Mycology</i>	Classical Swine Fever Virus rRT-PCR
Contagious Equine Metritis Culture	Foot-and-Mouth Disease Virus rRT-PCR
<i>Listeria</i> and <i>Salmonella</i> in Raw Dog Food	<i>Mycoplasma gallisepticum</i> PCR
<i>Salmonella</i> Group D Culture and Serology	<i>Mycoplamsma synoviae</i> PCR
<i>Clinical Pathology</i>	Swine Influenza Virus rRT-PCR
Chemistry-Routine	<i>One Health – Rabies</i>
Hematology	Rapid Fluorescent Focus Inhibition test
Microscopy	Fluorescent Antibody Virus Neutralization test (FAVN)
Urinalysis	<i>Serology/Immunology</i>
<i>Foreign Animal Disease Data Transmission</i>	Bluetongue ELISA
APMV/vNDV Electronic Messaging	Bovine Leukemia Virus ELISA
ASF Electronic Messaging	Brucellosis Serology
CSF Electronic Messaging	Chronic Wasting Disease ELISA
FMD Electronic Messaging	Equine Infectious Anemia ELISA
IAV-A Electronic Messaging	Johne’s ELISA
IAV-S Electronic Messaging	Pseudorabies Virus gB & gI ELISA
Pseudorabies Electronic Messaging	<i>Toxicology/Analytical Chemistry</i>
<i>Molecular Diagnostics</i>	Aflatoxin in Feedstuffs HPLC

Avian Influenza Virus rRT-PCR

Aflatoxin M1 in Tissues HPLC

Avian Paramyxovirus -1/END Virus rRT-PCR

Copper in Liver ICP

African Swine Fever rPCR

Deoxynivalenol in Feedstuffs HPLC

VMDL Participation in National Programs

1. National Poultry Improvement Plan (NPIP)
2. USDA EIA Testing lab
3. Level I Lab of the USDA National Animal Health Laboratory Network (NAHLN)
- 4.



5. Tier I Lab of FDA Veterinary Laboratory Investigation and Response Network (Vet-LIRN)



VMDL Teaching Activities

Didactic and Laboratory Courses (N = 28; Bold: Coordinated by VMDL Faculty)

BioMed 3200	Comparative Hematology
BioMED 3310	Biomedical Pathophysiology Online
BioMed 4100	Veterinary Clinical Chemistry, Online
BioMed 4110/V_PBIO 7110	Veterinary Cytology
LAB_AN 9437	Lab Animal Pathology
MMI 8050	Mechanisms of Microbial Pathogenesis
V_M_S 6400	Food Animal Medicine & Surgery I
V_M_S 6420	Equine Medicine and Surgery I
V_M_S 6987	Problem-Based Learning Clinic Preparation
V_M_S 6996	Advanced Dermatology
V_M_S 8036	Advanced Physiology of Dog and Cat
V_M_S 8401	Topics in Veterinary Clinical Sciences
V_M_S 8402	Seminar in Veterinary Clinical Sciences
V_M_S 8402 B	Seminar in Veterinary Clinical Sciences
V_M_S 8402 D	Clinicopathologic Case Conference (CPC)
V_M_S 8415	Advanced Veterinary Neurology
V_M_S 8485	Problems in Veterinary Clinical Science
V_PBIO 5552	Veterinary Bacteriology 1
V_PBIO 5553	Veterinary Bacteriology 2
V_PBIO 5554	Veterinary Virology
V_PBIO 5575	General Veterinary Pathology
V_PBIO 5576	Veterinary Systemic and Special Pathology I
V_PBIO 5577	Veterinary Systemic and Special Pathology II
V_PBIO 5578	Veterinary Clinical Pathology
V_PBIO 6647	Diagnostic Pathology and Special Species Medicine I
V_PBIO 8434	Advanced Clinical Pathology
V_PBIO 8435	Advanced Microscopy in Veterinary Clinical Pathology
V_PBIO 9090	Area Veterinary Pathobiology Dissertation Research

Clinical and Diagnostic Rounds and Seminars (N = 20)

Chemistry Rounds
Comparative Orthopaedic Laboratory (COL) journal club
Cytology Rounds
Dermatology Rounds

Equine Journal Club
Food for Thought Rounds
Food Animal/ Equine Clinical Case Rounds
Food Animal Journal Club
Gross Pathology Rounds
Hematology Rounds
Human Health and the Environment
Image Review
Joint Pathology Center Wednesday Slide Conference
Mentoring International Students
Mentoring Pre-Vet Students (Including Pre-Vet Scholars)
Mentoring Veterinary Professional Students at VET Orientation for VM-1s
Neurology Rounds
Ophthalmic Pathology Rounds
Slide Treats
VMDL-Food Animal Monthly Rounds

Residency Training Programs

Anatomical Pathology
Clinical Pathology
Clinical and Diagnostic Microbiology (Bacteriology, Immunology and Virology)

VMDL Scholarly Activities

Active and New Grants (N = 19)

1. **Dashek MK (Subcontract)**, Fisher T (PI), Baughman C. NCR-SARE Professional Development Program; Developing Veterinary and Extension Professionals' Capacity to Support Small-Scale Poultry Farming in Missouri. 10-01-2023 to 09-30-2026; MKD: \$45,000
2. **Du X (PI)**, **Zhang S (Co-I)**; FDA Vet-LIRN U18FD007511; Enhancing Food Contaminant Surveillance Capacity using Ultra-Performance Liquid Chromatography with UV/Fluorescence Detection; 09-06-2021 to 08/31/2023; Total: \$224,277 (Direct: \$149,356).
3. **Gull T (Co-I)**, **Odemuyiwa S (Co-I)**, Lim TT (PI). Swine Health Info CTR; Development of an Effective and Practical Biosecurity Entrance System; Total: \$179,933 (\$179,933), GT: 20% Shared Credit, OS: 20% Shared Credit.
4. **Hancock T (Co-I)**, Franklin C (PI), Baines, C (Co-I), Bryda, E (Co-I), Donnelly, L (Co-I), Boehringer Ingelheim Vetmedica Inc.; 2023 Boehringer Ingelheim Veterinary Scholars Program; Total: \$30,800 (Direct: \$30,800), HT: 20% Shared Credit.
5. **Ierardi, R (PI)**. Animal Health Formula Funds; Surveillance for *Theileria orientalis* Ikeda, an

Emerging Agent of Infectious Anemia in Cattle, and its Vector the Invasive Longhorned Tick (*Haemaphysalis longicornis*) in Three Missouri Beef Herds; 11-1-2023 to 10-30-2024; \$9,976

6. **Kim DY (Co-I), Wells KD (PI)**. NIH NIH Office of the Director 5U42OD027090-04S1; LATC Collaborative Project 2: Swine Somatic Cell Genome Editing (SCGE) Center; 06-01-2022; Total: \$66,108; KDY: 5% Shared credit (\$3,305)
7. **Kim DY (Co-I), Wells KD (PI)**. NIH U42OD027090; Swine Somatic Cell Genome Editing Center - Year 4; 06-01-2022 to 08018-2023; Total: \$198,944 (Direct: \$ 128,351); KDY: 5% Shared Credit (\$9,947)
8. **Kim DY (Co-I); Wells, KD (PI)**. NIH U42OD027090; Testing Component - Year 4; 06-01-2022 to 10-20-2023; Total: \$1,502,555 (Direct: \$987,132); KDY: 5% Shared Credit (\$75,128)
9. **Kim DY (Co-I); Wells, KD (PI)**. U42OD027090; Resource Component - Year 4; 06-01-2022 to -9-27-2023; Total: \$593,624 (Direct: \$382,983); KDY: 5% Shared Credit (\$29,681)
10. **Shen Z (PI), Zhang S (Co-PI), Odemuyiwa S (Co-PI)**. FDA 1U18FD007720-02; Development of Metagenomic RNA-Seq Standard Operating Procedure for Variant Agnostic Whole Genome Sequencing of SARS-CoV-2; 09-01-2022 to 08-31-2024; Total: \$160,095 (Direct: \$74,977).
11. **Zhang S (Key Personnel), Almasri M (PI), Li H (Co-PI), Safranski T (Co-PI), Trout K (Co-PI), Morey A (Co-PI)**. NSF Convergence Accelerator Track J Phase 1 2236622; Rapid Detection Technologies and Decision-Support Systems for Safe, Equitable Food Systems; 12-15-2022 to 12-30-2023; Total: \$75,000; SZ: \$10,000.
12. **Zhang S (Key Personnel), Almasri M (PI), Li H (Co-PI), Safranski T (Co-PI), Trout K (Co-PI), Morey A (Co-PI)**. NSF Convergence Accelerator Track J Phase 2; Rapid Detection Technologies and Decision-Support Systems for Safe, Equitable Food Systems; 12-15-2023 to 11-30-2026; Total: \$5,000,000; SZ Direct: \$191,555 (Y1: \$54,090, Y2: \$89,874, Y3: \$47,591).
13. **Zhang S (PD)**. USDA NIFA 2023-37624-40716; NAHLN Level 1 Lab - Maintaining and Further Improving Capacity and Capabilities; 09-01-2023 to 08-31-2024; Total: \$250,000 (Direct: \$234,000)
14. **Zhang S (PD)**. USDA-APHIS-AP23VSD&B000C066; NAHLN Level 1 Lab - Maintaining and Further Improving Capacity and Capabilities II; 06-01-2023 to 05-31-2024; Total: \$137,870 (Direct: \$125,336)
15. **Zhang S (PI), Shen Z (Co-PI), Odemuyiwa S (Co-I), Gull T (Co-I)**. FDA 5U18FD006670-05; FDA Vet-LIRN Site - Tier I Lab Renewal; 06-01-2022 to 05-31-2023; Total: \$39,900 (Direct: \$30,000)
16. **Zhang S (PI), Tamara Gull (Co-PI), Tanya Muller (Key Personnel)**. USDA APHIS AP23VSSP0000C110; Development of an Antimicrobial Resistance Dashboard to Integrate Antimicrobial Susceptibility Testing Data Generated by Missouri Veterinary Medical Diagnostic Laboratory; 09-01-2023 to 08-31-2024; Total: \$214,528 (Direct: \$193,077)
17. **Zhang S (PI), Zhang M (Co-PI), Almasri M (Co-PI)**. Missouri Department of Conservation #450; Development and Application of MEMS-Based Biosensor and RT-QulC Assay for the Detection of Chronic Wasting Disease Prion in Anti- and Post-Mortem Cervid Samples; 03-01-2020 to 12-01-2024; Total: \$979,825 (Direct: \$881,842.5)
18. **Zhang S (PI)**. USDA/CSU ARP NAHLN Program; 10-01-2023 to 09-30-2025; Total: \$1,000,000 (Direct: \$909,090.46)

19. **Zhang S. (PD)**. USDA APHIS/Oklahoma State University; Increasing Capacity to Handle Surge Samples through Online Submissions and Elimination of the Sample Data Entry Step in the Laboratory; 01-02-2022 to 08-31-2023; Total: \$41,968 (Direct: \$38,125)

Peer Reviewed Publications

Published (N = 26)

1. Abo-Samaha MI, Sharaf MM, El Nahas AF, **Odemuyiwa SO**. Innate immune response to double-stranded RNA in American heritage chicken breeds. *Poult Sci*. 2023, 103(2):103318.
2. Abo-Samaha MI, Sharaf MM, El-Nahas AF, **Odemuyiwa SO**. Length-dependent modulation of B cell activating factor transcripts in chicken macrophage by viral double-stranded RNA. *Vaccines (Basel)*. 2023, 11(10):1561.
3. **Bowman J, Gull T, Ulmanis EG, Ogunbadewa AJ, Shen Z, Johnson GJ, Odemuyiwa SO**. Metagenomic identification of a novel oomycete cultured from a pyogranulomatous mass on the tail of a domestic cat. *J Vet Diagn Invest*. 2023, 35(5):507-513.
4. Cadmus S, Taiwo OJ, Akinseye V, Cadmus E, Famokun G, Fagbemi S, Ansumana R, Omoluabi A, Ayinmode A, **Oluwayelu D, Odemuyiwa S, Tomori O**. Ecological correlates and predictors of Lassa fever incidence in Ondo State, Nigeria 2017-2021: an emerging urban trend. *Sci Rep*. 2023, 3(1):20855.
5. Companjen A, **Moore SM**, Boulanger B, Kostense S, Marissen WE. Validation of adapted neutralization assays developed to discriminate anti-rabies virus activity of two different anti-rabies virus monoclonal antibodies administered as a combination. *Biologics*. 2023, 3:11–21.
6. **De New KM**, Coates JR, Millman Z, **Kim DY**, Hong HP, **Royal AB**. What is your diagnosis? Spinal mass in a young dog. *Vet Clin Pathol*. 2023, 52 Suppl 2:97-99.
7. **De New KM**, Coates JR, Wellehan J, **Gull T**, Childress A, Anderson MN, **Royal AB**. *Mycobacterium haemophilum* infection in canine cerebrospinal fluid. *Vet Clin Pathol*. 2023, 52(2):295-298.
8. Deng Z, Jang KB, Jalukar S, **Du X**, Kim SW. Efficacy of feed additive containing bentonite and enzymatically hydrolyzed yeast on intestinal health and growth of newly weaned pigs under chronic dietary challenges of fumonisin and aflatoxin. *Toxins*. 2023, 15: 433.
9. **Du X**, Schrunk DE, Imerman PM, Tahara J, Tkachenko A, Guag J, Reimschuessel R, Rumbleha WK. Extensive evaluation of a method for quantitative measurement of aflatoxins B1 and M1 in animal urine using high-performance liquid chromatography with fluorescence detection. *J AOAC Int*. 2023, 106:645-651.
10. Flatland B, Dehghanpir S, Freeman K, Grimes C, **Hancock T**, Hollinger C, Hooijberg E, Korchia J, Lawson C, Matlow J, **Sample S**, Viall A. Guidelines for resident training in veterinary clinical pathology. IV: Laboratory quality management – teaching domains, competencies, and suggested learning outcomes. *Vet Clin Path*. 2023, doi: 10.1111/vcp.13208.
11. **Gull T**. Fungal Diseases. in the Merck Veterinary Manual online, 2023.

12. KuKanich K, Burklund A, McGaughey R, Muturi N, Thomason S, Chengappa MM, Garrison I, Stacey B, **Zhang S, Gull T**. One health approach for reporting veterinary carbapenem-resistant Enterobacterales and other bacteria of public health concern. *Emerg Infect Dis*. 2023, 29(6):1-9.
13. Lee N, Kim DY, Kim YJ, **Kim DY**. Splenic epidermoid cyst in a dog. *J Vet Diagn Invest*. 2023, 35(2):209-211.
14. Maguey-González JA, Nava-Ramírez MJ, Gómez-Rosales S, Ángeles ML, Solís-Cruz B, Hernández-Patlán D, Merino-Guzmán R, Hernandez-Velasco X, Hernández-Ramírez JO, Loeza I, Senas-Cuesta R, Latorre JD, Vázquez-Durán A, **Du X**, Méndez-Albores A, Hargis BM, Téllez-Isaías G. Evaluation of the efficacy of humic acids to counteract the toxic effects of aflatoxin B1 in turkey poults. *Front Vet Sci*. 2023, 0:1276754.
15. Marquis CR, **Gull T**, Dodam J, Thombs L, Bukoski A. Comparison of four endotracheal tube cleaning protocols in anesthetized dogs. *J Am Vet Med Assoc*. 2023, 261(3):336-341.
16. Muhsin SA, Abdullah A, **Kobashigawa E**, Al-Amidie M, Russell S, **Zhang MZ, Zhang S**, Almasri M. A microfluidic biosensor for the diagnosis of chronic wasting disease. *Microsyst Nanoeng*. 2023, 9:104.
17. Oladeji LO, Stoker AM, **Kuroki K**, Stannard JP, Cook JL. Making the case for hyperosmolar saline arthroscopic irrigation fluids: A systematic review of basic science, translational, and clinical evidence. *J Knee Surg*. 2023. doi: 10.1055/a-2198-8131.
18. **Oluwayelu DO**, Desario C, Babalola ET, Pratelli A, Daodu OB, Elia G, **Odemuyiwa SO**, Buonavoglia C, Decaro N, Diakoudi G. Genetic characterization of parvoviruses identified in stray cats in Nigeria. *Acta Trop*. 2023, 250:107108.
19. **Oluwayelu DO**, Moutailler S, **Odemuyiwa SO**. Editorial: Tick-borne viruses of domestic livestock: Epidemiology, evolutionary trends, biology and climate change impact. *Front Vet Sci*. 2023,10:1147770.
20. Schaefer EAF, Chu S, Wylie KM, Wylie TN, Griffith OL, Pearce JW, **Johnson GC**, Bryan JN, Flesner BK. Metagenomic Analysis of DNA Viruses with Targeted Sequence Capture of Canine Lobular Orbital Adenomas and Normal Conjunctiva. *Microorganisms*. 11(5):1163, 2023.
21. Smiljanic D, Dakovic A, Obradovic M, **Rottinghaus GE**, de Gennaro B. Influence of the type of and the amount of surfactant in phillipsite on adsorption of diclofenac sodium. *Catalysts* 13(1):71, 2023.
22. Townsend KS, Johnson PJ, Donnelly LL, LaCarrubba AM, Lattimer JC, Havis B, Spinger NL, **Kim DY**. Concurrent chronic lymphocytic leukemia and primary hyperparathyroidism in a mule. 2023, *J Vet Intern Med*. 37(3):1250-1255.
23. Townsend KS, Johnson PJ, **Kuroki K**. Head and neck squamous cell carcinoma with heterotopic ossification, lymphovascular invasion, and nodal and pulmonary metastases in a 23-year-old Morgan gelding. *Can Vet J*. 2023, 64(7):627-632.
24. Walker KE, Middleton JR, **Gull T**, Payne CA, Adkins PRF. Bacterial culture and susceptibility of samples taken from septic foot lesions of adult beef cattle. *J Vet Intern Med*. 2023, 37(2):757-765.
25. Wang L, Zheng B, **Shen Z**, Nath ND, Li Y, Walsh T, Li Y, Mitchell WJ, He D, Lee J, Moore S, Tong S, **Zhang S**, Ma W. Isolation and characterization of mammalian orthoreovirus from bats in the United States. *J Med Virol*. 2023, 95(2):e28492.

26. Zajac MD, Ortega MT, **Moore SM**. Development and evaluation of an enzyme-linked immunosorbent assay targeting rabies-specific IgM and IgG in human sera. *Viruses*. 2023, 15:874.

In-Press and Accepted

1. Adams M, Zeltwanger J, Meng K, Bailey E, Brake D, Petzel E, Nelson B, **Du X**. Interaction of metsulfuron and nitrogen fertilizer in tall fescue pastures grazed by stocker cattle. *App Anim Sci* 2023, Accepted.
2. Adriana F, **DeCoursey M**, Miller M, Chen A, Martin L, Guess S, Wardrop J, Souza C, Owen T. Cytologic features of canine melanotroph and corticotroph pituitary adenomas. *Vet Clin Pathol* 2023, Accepted.
3. Cleveson S, **DeCoursey M**, Davis WC. Use of RNA-seq to identify genes encoding cytokines and chemokines activated following uptake and processing of a candidate peptide vaccine developed against *Mycobacterium avium* subsp. *Paratuberculosis*. *Braz J Vet Med* 2023. Accepted.
4. **Shen Z**, Zhang CY, **Gull T**, **Zhang S**. Comparison of genotypic and phenotypic antimicrobial resistance profiles of *Salmonella enterica* isolates from poultry diagnostic specimens. *JVDI*, 2024.

Submitted

1. Branstad-Spates EH, McCarthy CS, Hamilton BC, King LE, Bowers EL, Tesouro A, Borrell J, Diez D, **Rottinghaus GE**, and Baumgard LH. Supplementing silicoglycidol for the reduction of aflatoxin M1 in milk and biomarkers of liver dysfunction in dairy cows. *J of Dairy Science*, 2024.
2. Chan A, Coates J, **Johnson GC**. Diagnosis of degenerative myelopathy in a Boston Terrier-French Bulldog mixed breed. submitted to the *J Small Animal Practice*. December 2023.
3. Danielson JA, Burzette RG, Bailey MR, Berent LM, Case H, Casey-Reed A, Dascanio J, Feinberg RA, **Hancock TS**, Kirk CA. Basic science knowledge underlies clinical science knowledge and clinical problem solving: evidence from veterinary medicine. *Adv Health Sci Educ*, resubmitted Dec 2023
4. **Ierardi RA**, Burnum AL, Delaney LE, **Gull T**, Havis BM, Hinds CA, **Johnson GC**, **Kim DY**, **Kuroki K**, **Mammone RM**, **Mitchell WJ**, Navarro MA, Rivero LA, **Smith AC**, Uzal FA, Valerio CM, **Williams III F**, **Zinn MM**. Bacillary hemoglobinuria in beef cattle with *Fascioloides magna* infestation. *J Vet Diagn Invest*, submitted 2023.
5. Karaffa K, **Hancock TS**, Sanford-Martens T Perfectionistic cognitions, self-compassion, and psychological distress among veterinary medical students. *J Coll Stud Psychother*, submitted Oct 2023.
6. **Kobashigawa E**, Russell S, **Zhang MZ**, Sinnott EA, Connolly M, **Zhang S**, RT-QuIC Detection of Chronic Wasting Disease Prion in Platelet Samples of White-Tailed Deer. *BMC Vet Res*. 2023
7. McCurdy K, **Gull T**, **Du X**, Moeller BC, Flores L and McCracken ME. Effect of intra-articular morphine on the antimicrobial activity of amikacin in equine synovial fluid. *Vet Surg*. In revision Dec 2023.
8. Silva JCC, Caldeira MO, Moraes JGN, Sellmer Ramos I, **Gull T**, Ericsson AC, Pooch SE, Spencer TE and Lucy MC. Metritis is associated with long-term changes in endometrial transcriptome of dairy cows. *Biol Reprod*, submitted Dec 2023.

Scientific Presentations & Invited Talks (N = 25)

1. Burgess B, McClure J, Stull J, Gull T, Feyes E, Taylor S, Jasper N and Perkins G. Joint ACVIM/ACVPM Consensus Statement Panel on the Prevention of Zoonotic Disease in Veterinary Teaching Hospitals. American College of Veterinary Internal Medicine 50th Annual Forum, 2023; Philadelphia, PA
2. **Carpenter A**, Saavedra A, Wiggen K, **Gull T** and **Ierardi R**. *Candida tropicalis* embedded in a pulmonary artery mural thrombus in a puppy with PDA. ACVP /ASVCP Annual Meeting; Oct. 28 – 31, 2023; Chicago, IL
3. **Dashek MK, Muthuraj PG, Bowman J, Gull T, Shaw DK**. *Salmonella* spp. isolated from commercial game bird clinical cases in Missouri and Kansas: retrospective study. 2023 AAAP Annual Meeting; Jun. 11-14, 2023; Jacksonville, FL
4. **Dashek MK, Shaw DP**. Histopathological evaluation of pulmonary lesions in chickens exposed to Teflon-coated heat lamps. 2023 AAAP Histopathology Interest Group Annual Meeting; Jun. 1, 2023; Virtual
5. **Hancock, T. S.** & Topka, J. Veterinary student deliberations around professional roles and identity in interprofessional learning. 2023 Meeting of AAVMC Iverson Bell Symposium, Mar. 9-11, 2023, Washington, DC
6. **Hancock, T. S.** *Teaching and Training Digital Clinical Pathology*. ACVP/ASVCP Annual Pre-meeting workshop. Oct. 28, 2023, in Chicago, IL (Invited)
7. **Johnson GC**, Levine C. Canine encephalocele. 2023 ACVP /ASVCP Annual Meeting; Oct. 28 – 31, 2023; Chicago, IL
8. **Johnson GC**, O'Brien D, **Mammone R**. Pathology and quantitation of neurons in autonomic ganglia of dogs with canine dysautonomia (Poster). 2023 ACVP /ASVCP Annual Meeting; Oct. 28 – 31, 2023; Chicago, IL
9. Josh K, Natesh NS, Shanmugam MP, Poonooru RR, Subramanyam P, Garrett C, Schlink S, Gerb S, Porter J, Telugu B, Prather RS, Whitworth K, Wells K, **Kim DY**, Bryan JN, Kunin J, Hoffman T, Kaifi J, Rachagani S. Lung tumor induction and characterization in a transgenic oncopig model. MU Health Sciences Research Day; November 10, 2023; Columbia, MO
10. **Kim DY, Ogunbadewa AJ, Odemuyiwa SO**. Coinfection of bovine adenovirus-6 and-10 in a heifer in Missouri. AAVDL Annual Meeting; October 12-18; National Harbor, MD.
11. **Knight M, Bogue S, Townsend K, Carpenter A, Royal A**. Foal peritoneal fluid analysis with milk and bio-sponge interferences (student poster). 2023 ACVP /ASVCP Annual Meeting; Oct. 28 – 31, 2023; Chicago, IL
12. Kujiraoka A, **Ierardi R, Zhang S**, Raghavan R. Field surveillance of host-seeking ticks on beef cattle pastures in Missouri. Veterinary Scholars Symposium; August 3-5, 2023; San Juan, Puerto Rico
13. **Kuroki K**, Ma R, Stoker AM, Cook JL. A comparative histological analysis of human versus canine synovium associated with anterior cruciate ligament injuries. ACVP/ASVCP 2023 Annual Meeting. Oct. 28-31, 2023. Chicago, IL.
14. **Kuroki K**. Histology in Veterinary Medicine. National Society for Histotechnology. 2023 NSH Webinar Series. Sep. 27, 2023. (Invited)

15. Ma R, Stoker AM, Cook JL, **Kuroki K**. A Comparative Analysis of the Human and Canine Synovial Response to Anterior Cruciate Ligament Ruptures. Paper No. 951. Orthopaedic Research Society 2023 Annual Meeting. Feb. 10-14, 2023. Dallas, TX.
16. Ma R, Stoker AM, Cook JL, **Kuroki K**. Characterization of the Human Synovial Response in Anterior Cruciate Ligament Injuries. Paper No. 950. Orthopaedic Research Society 2023 Annual Meeting. Feb. 10-14, 2023. Dallas, TX.
17. **Mammone RM, Ierardi RA, Johnson GC**. Focal dysautonomia of the anterior cranial mesenteric ganglion in a Missouri donkey. (Poster). 2023 ACVP /ASVCP Annual Meeting; Oct. 28 – 31, 2023; Chicago, IL
18. **Moore SM, Keating C, Pralle S**. Comparison of International Rabies Antibody Reference Standards. XXXIV Rabies in the Americas Meeting; Oct. 17, 2023; Bogota, Colombia
19. **Shen Z, Gull T, Zhang S**. Comparison of genotypic and phenotypic antimicrobial resistance profiles of *Salmonella enterica* isolated from poultry diagnostic specimens. The 66th AAVLD Meeting; Oct. 12-15, 2023; National Harbor, MD
20. **Shen Z, Zhang CY, Zhang S**. Prediction of antimicrobial resistance in nontyphoidal *Salmonella* from poultry with whole-genome sequencing (Poster). National Institute of Antimicrobial Resistance Research and Education (NIAMRRE) Annual Conference; May 16-18, 2023; Gainesville, FL
21. **Smith AC, Burnum A**. Bilateral T Cell Lymphoma in a Domestic Shorthair. Society of Comparative Ocular Pathology Annual Conference; Mar. 31- Apr. 1, 2023; Virtual.
22. Szmactinski Z, **Ogunbadewa A, Muthuraj P, Odemuyiwa SO, Kim DY**. *Prescottella (Rhodococcus) equi* infection in a dog with severe pyogranulomatous dermatitis, panniculitis, and lymphadenitis. ACVP Annual Meeting. October 28-31, 2023; Chicago, IL.
23. Warwick JR, Simenson AP, **Kim DY**, Childs TE, Johnson PJ. Expression of Mu opioid receptor in the equine hoof lamellar interface in health and laminitis. National Veterinary Scholars Symposium; August 3-5, 2023; Puerto Rico.
24. **Williams III F**. Pathology of Exotic Animals (CE Credit). MVMA Convention; January 2023; Columbia, MO (Invited)
25. **Williams III F**. Pathology of Exotic Animals. Tuskegee University Symposium; March 2023; Tuskegee, AL (Invited)

Engagement & Outreach Interviews, Publications and Presentations

1. Dashek M. Egg prices too high? VMDL Resources for Backyard Poultry Owners; MU CVM Open House; May 6, 2023; Columbia, MO
2. Dashek M. Invited Panelist; AAAP Student Webinar Poultry Veterinarian Career Path; May 17, 2023; Virtual
3. Dashek M. Invited Panelist; Poultry Science Association Think Tank: Layer Welfare; Sept. 7, 2023; Virtual
4. Dashek M. Basics of Backyard Poultry Diagnostics; VET ECHO; Sept. 12, 2023; Virtual
5. Delaney L. Editor. Under the Scope – 2023 Winter MU VMDL Newsletter
6. Delaney L. Editor. Under the Scope – 2023 Spring MU VMDL Newsletter

7. Delaney L. Editor. Under the Scope – 2023 Summer MU VMDL Newsletter
8. Delaney L. Editor. Under the Scope – 2023 Fall MU VMDL Newsletter
9. Delaney L. VMDL’s Role in Disease Diagnostics; MU Biosecurity Workshops; Apr. 26, 2023; Columbia, MO
10. Delaney L. VMDL’s Role in Disease Diagnostics; MU Biosecurity Workshops; Apr. 28, 2023; Macon, MO
11. Delaney L. VMDL’s Role in Disease Diagnostics; MU Biosecurity Workshops; May 2, 2023; Mt. Vernon, MO
12. Delaney L. VMDL’s Role in Disease Diagnostics; MU Biosecurity Workshops; May 4, 2023; Sedalia, MO
13. Delaney L. MU’s Diagnostic Lab – For All Your Testing Needs; 2023 Missouri Swine Institute; November 2, 2023; Sedalia, MO
14. Ierardi, R. Longhorned Ticks Discovered in Boone County for First Time, MU researchers find; Jul. 24, 2023; Show Me Mizzou (Interviewed by Brian Consiglio)
15. Ierardi, R. Longhorned Tick Spotted in Boone County for First Time: How It Can Impact You; Jul. 25, 2023; KOMU 8 TV segment (Interviewed by Tia Maggio)
16. Ierardi, R. Longhorned Tick, Dangerous for Cattle, Found in Three Areas of Missouri; Apr. 3, 2023; Drovers (Interviewed by Linda Geist)
17. Ierardi RA. Livestock Mortality: To Necropsy or Not to Necropsy? Jan. 2023; Joplin Regional Stockyards Cattlemen’s News, p. 30
18. Ierardi RA. Diagnostic Testing of Bovine Abortions. Feb. 2023; Joplin Regional Stockyards Cattlemen’s News, p. 30.
19. Ierardi RA. Neospora Caninum Abortions in Cattle. Mar. 2023; Joplin Regional Stockyards Cattlemen’s News, p. 30
20. Ierardi RA. Next-Generation Sequencing. May 2023; Joplin Regional Stockyards Cattlemen’s News, p. 28
21. Ierardi RA. BVD Diagnostics. Oct. 2023; Joplin Regional Stockyards Cattlemen’s News, p. 57.
22. Ierardi RA. Johne’s Disease—Not Just for Dairy Cows. Dec. 2023; Joplin Regional Stockyards Cattlemen’s News, p. 31
23. Ierardi RA. Multiple Death Losses on a Cow-calf Operation within a Few Weeks; Veterinary Education & Training (VET) ECHO; Mar. 14, 2023; online CE Event for Practitioners
24. Ierardi, R. Bovine Anaplasmosis in Missouri; North Central MVMA; Mar. 9, 2023; Bucklin, MO
25. Ierardi, R. Bovine Anaplasmosis in Missouri; Northwest MVMA; Mar. 25, 2023; St. Joseph, MO
26. Ierardi, R. Bovine Anaplasmosis in Missouri; Andrew/Buchanan County chapter of the Missouri Cattlemen’s Association; June 6, 2023; St. Joseph, MO
27. Ierardi RA. *Theileria orientalis* and the Invasive Longhorned Tick; VET ECHO; Jul. 11, 2023; online CE Event for Practitioners
28. Ierardi, R. Ticks on Missouri Cattle Pastures; Northern Missouri Research, Extension and Education Center Field Day; August 3, 2023; Novelty, MO

29. Ierardi, R. Ticks of Missouri Cattle Pastures; Lee Greenley Jr. Memorial Research Farm FFA Day; Sept. 6, 2023; Novelty MO

Awards and Honors

1. Gull T. Orthopaedic Trauma Association Basic Science Chairman's Award, OTA 2023 for Treatment of Acute Fracture Related Infections Utilizing Bacteriophage Therapy by C. Bozynski, A. Stoker, T. Gull, D. Duren, J.L. Cook.
2. Hancock, T. Dadd Award for Teaching Excellence, CVM, MU

International, National, State, and Local Leadership Activities

1. **DeCoursey M:** Student chapter of the ACVP Faculty Advisor, ASVCP Media and Communications Committee Member, ACVP Late Breaking Abstracts Committee Member, Washington State University Diagnostic Challenge Facilitator.
2. **Gull T.** ACVPM representative to the NAVLE Item-writing Committee; ACVM Examination Committee (Immunology subcommittee chair); ACVIM Form Writing (Examination) Committee, chair; NATRC Judges' Committee Veterinary Co-chair; University of Missouri Faculty Advisory Council; University of Missouri Military and Veterans' Committee member; University of Missouri Status of Women Committee member; NATRC Drug Committee Chair; CLSI VET09 Working Group; ACVIM/ACVPM Joint Consensus Statement Working Group; USEF Drug Testing Veterinarian; FEI Permitted Treatment Veterinarian; Colonel, U.S. Army Reserve Veterinary Corps; Boone County Large Animal Rescue Team; Missouri Volunteer Veterinary Corps member
3. **Hancock T.** Academic Veterinary Assessment Committee Member, International Council on Veterinary Assessment; Co-chair, ACVP Competency Framework Task Force; Secretary, Faculty Policy Committee University of Missouri CVM
4. **Ierardi RA.** Academy of Veterinary Consultants (AVC), coordinator of the biannual Diagnostic Laboratory Report for the Beef Cattle Health & Well-Being Committee; October 2022-Present.
5. **Kuroki K.** AAVLD Pathology Committee Member; Japanese Group of ACVP (JaGA) Vice President; International Veterinary Pathology Coalition; ACVP Member
6. **Moore S.** WHO Rabies Experts Committee; ACIP Rabies Workgroup; National Institute for Biological Standards and Control (NIBSC) in the UK; USDA National Rabies Management Plan Blue Ribbon Committee for Rabies Serology, writing/editing the update of the US National Plan for Wildlife Rabies Management (USNP), APHL Laboratory Systems and Standards (LSS) Committee Member, American Association of Bioanalysts (ABB) Member
7. **Royal A.** ACVP Certifying Exam Board Member; Chair for Clinical Pathology Exam Assembly and Administration Group
8. **Zhang S.** AAVLD, AAVLD Award Committee, AAVLD Government Relations Committee Member, Strategic Planning Committee Member, Missouri Biosecurity Working Group, Missouri Council on Captive Wild and Exotic Animals.

Major Professional Meetings and Trainings

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1. American Association of Veterinary Laboratory Diagnosticians (AAVLD) Annual Meeting

2. AAVLD Accreditation Auditor Training
 3. American College of Veterinary Internal Medicine (ACVIM) Annual Meeting
 4. American College of Veterinary Microbiologists (ACVM) Annual Meeting
 5. Combined Annual Meetings of the American College of Veterinary Pathologists (ACVP) and American Society for Veterinary Clinical Pathology (ASVCP)
 6. American Veterinary Medical Association (AVMA) Annual Meeting
 7. Midwest Association of Veterinary Pathologists Annual Meeting
 8. Missouri Veterinary Medical Association (MVMA) Annual Meeting and District Meetings
 9. Missouri Biosecurity Working Group Quarterly Meetings
 10. Missouri Captive Wild Animal Health Meetings
 11. National Animal Health Laboratory Network (NAHLN) Preparedness Weekly Conference
 12. National Poultry Improvement Plan (NPIP) Salmonella Workshop
 13. North American Veterinary Dermatology Forum (NAVDF)
 14. USAHA/AAVLD Government Relations Meeting
 15. Veterinary Laboratory Investigation and Response Network Monthly Conference
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