

University of Missouri Veterinary Medical Diagnostic Laboratory (VMDL) Annual Report – 2019

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Summary

The University of Missouri Veterinary Medical Diagnostic Laboratory (VMDL) is a full service veterinary diagnostic laboratory and it is Missouri's only laboratory accredited by the American Association of Veterinary Laboratory Diagnosticians (AAVLD). The VMDL is a Level I Lab of the National Animal Health Laboratory Network (NAHLN), Tier I Lab of the FDA Veterinary Laboratory Response Network (FDA Vet-LRN), and a National Poultry Improvement Plan (NPIP) authorized Lab. In 2019, the VMDL processed approximately 51,668 accessions and performed more than 167,000 diagnostic tests, which represents a 6.5% increase in accessions and an 18.5% increase in lab tests from 2018 to 2019. The VMDL provided diagnostic service to veterinarians and owners from 107 MO counties/independent cities and 44 US states and Canadian provinces. In 2019, the VMDL faculty taught (or co-taught) 39 courses and 18 clinical/diagnostic rounds. The VMDL faculty led and participated in 20 extramurally funded projects, including 10 new projects. The VMDL faculty published 32 peer-reviewed research and clinical papers, submitted an additional 12 articles for publication, contributed chapters to important textbooks, presented 12 conference posters and oral presentations, served on many prestigious national, state and university committees, attended important international, national and state conferences and trainings, and participated in various outreach and engagement activities.

Introduction

The MU VMDL is a full service veterinary diagnostic laboratory and it is Missouri's only laboratory accredited by the American Association of Veterinary Laboratory Diagnosticians (AAVLD). The faculty and staff of VMDL 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 2019 VMDL Annual Report summarizes diagnostic testing data, grants, publications, abstracts, and leadership activities from Jan 1, 2019 to Dec 30, 2019. To monitor caseload, data from 2015 to 2018 are also included in the report.

VMDL Mission Statement

To provide appropriate and timely diagnostic support to veterinary practitioners, livestock and poultry interests, companion animal interests, wildlife conservationists, and state-federal regulatory officials.

To monitor domestic animals, indigenous wildlife, and zoo animals for diseases that are a threat to livestock health and public health.

To support the teaching and service missions of the College of Veterinary Medicine.

To create new knowledge through fundamental and translational research.

The VMDL Advisory Board

Mission Statement

To advise VMDL management on policies, long-term developmental strategies, and collaborations with relevant university, private, state, national and international organizations.

VMDL Advisory Board Membership

The Advisory Board consists of 12 members representing the State Veterinarian's office, commodity groups, small animal practice, large animal practice, and the Veterinary Health Center.

VMDL Advisory Board Members

Steve Strubberg, DVM, Missouri State Veterinarian

Terry Gosch, DVM, USDA Area Veterinarian in Charge

Sherri Russell, DVM, Missouri Wildlife Veterinarian

Bruce Addison, President, Addison Biological Laboratory, Inc.

Philip Johnson, BVSc, MS, MRCVS, ACVIM, MU VHC Equine Service

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

Chuck Massengill, DVM, Missouri Cattlemen's Association

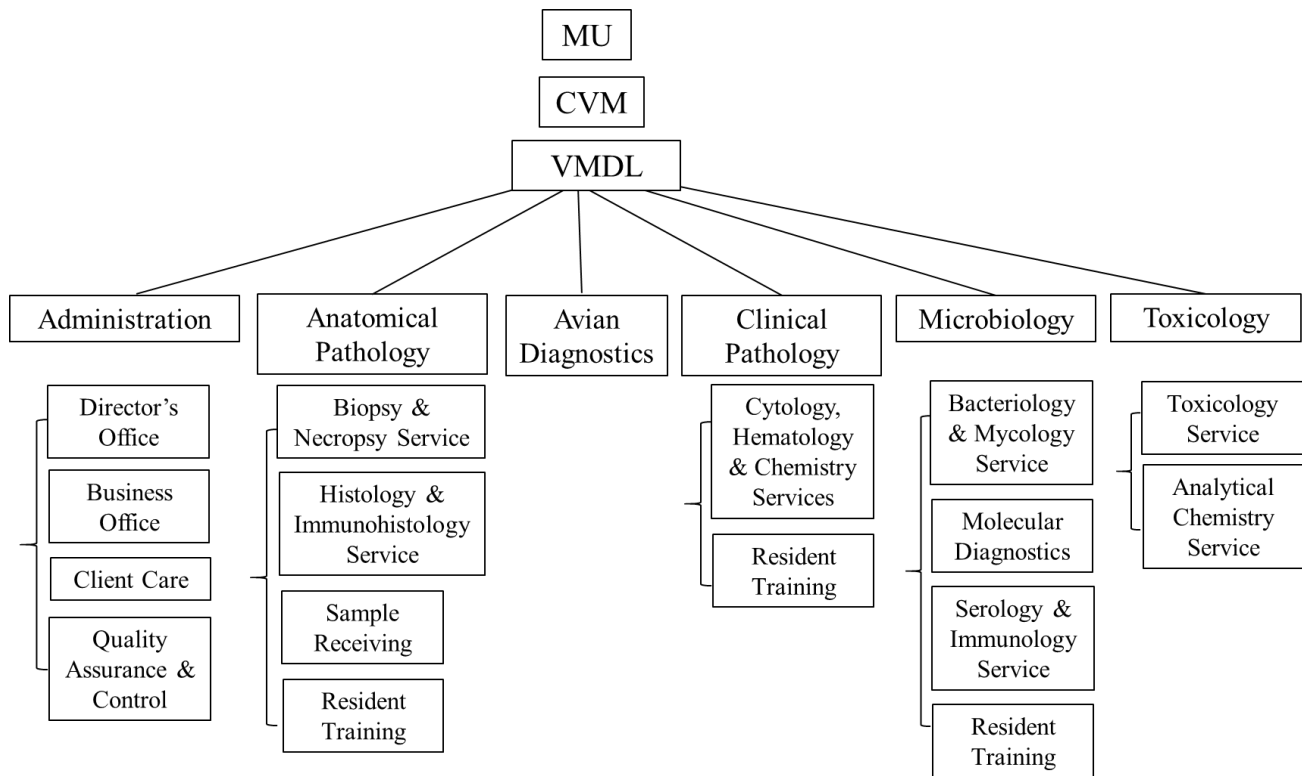
John Middleton, DVM, PhD, ACVIM MU VHC Food Animal Service

Don Nikodim, Executive Vice President, Missouri Pork Association

Steve Patterson, DVM, Bethel, MO

David Wilson, DVM, MS, ACVS, MU VHC Director

VMDL Organizational Structure



VMDL Section Heads/Managers

Anatomical Pathology – Dr. Gayle Johnson

Avian Diagnostics – Dr. Dan Shaw/Dr. Mike Zinn

Business Office – Mr. Kirk Thompson

Client Care and Outreach – Dr. Lauren Delaney

Clinical Pathology – Dr. Angela Royal/ Ms. Cheryl Rojas

Director’s Office – Ms. Geri Hegstad

Histology – Dr. Dae-Young Kim/Ms. Candace Kassel

Microbiology – Dr. Tamara Gull/Mr. Jesse Bowman

Molecular Diagnostics – Dr. Solomon (Wole) Odemuyiwa/Ms. Debra Sharp

Quality Assurance – Ms. Susan Martin

Sample Receiving – Ms. Geri Hegstad

Serology/Immunology – Dr. Mike Zhang

Toxicology/Analytical Chemistry – Dr. Tim Evans/Dr. Xiangwei Du/Mr. Ben Landers

VMDL Diagnostic Program Coordinators

Anatomical Pathology Residency Program – Dr. Kei Kuroki

Clinical Pathology Residency Program – Dr. Angela Royal

Clinical and Diagnostic Microbiology – Dr. Tamara Gull

Equine Diagnostic Investigations – Dr. Fred Williams III

Food Animal Diagnostic Investigations – Dr. Tim Evans

Neuropathology and Oncopathology – Dr. Gayle Johnson

Small Animal Internal Medicine Pathology – Dr. Dae-Young Kim

VMDL Client Outreach Programs

Outreach Section has been established to address clients’ needs and concerns.

Online Portal is available for clients to check results and charges in real-time.

FedEx Express Prepaid Stamps enables inexpensive next day delivery.

Columbia Area Sample Courier service is available.

After-hours Sample Drop-off refrigerator is available at the VHC Small Animal Emergency Clinic.

Food Animal Field Investigations

VMDL Exhibitor presence at various veterinary and livestock meetings including booth at Missouri State Fair

VMDL Attendance at Regional VMA Meetings

Diagnostic Service Activities

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

Year	Total Accessions	Source (%) and Type				
		Main Lab	Clin Path	MO & Others/Total	VHC/Total	VHC/Main Lab
2015	48,848	32,195	16,653	28,266 (58%)	20,582 (42%)	3,929 (12%)
2016	48,617	30,032	18,585	26,293 (54%)	22,324 (46%)	3,879 (13%)
2017	45,680	25,598	20,082	22,631 (50%)	23,049 (50%)	3,873 (15%)
2018	48,538	27,719	20,819	24,339 (50%)	24,202 (50%)	4,156 (15%)
2019	51,668	26,933	24,675	23,417 (45%)	28,251 (55%)	4,309 (16%)

*A Main Lab accession may include multiple tests for multiple samples whereas each Clinical Pathology accession represents one test performed on one sample. More than 97% of clinical pathology accessions came from the VHC. Up to 16% of main lab accessions came from the VHC. From 2018 to 2019, total accessions increased 6.5%.

Table 2. Five Year VMDL (Main Lab and Clin Path) Tests by Animal Species*

Species	Avian	Bovine	Canine	Caprine	Equine	Feline	Wild/ Exotic	Non- Animal	Ovine	Porcine	Total
2015	8,306	18,579	42,595	1,609	11,217	7,067	7,005	4,196	579	5,280	106,433
2016	8,954	19,345	42,979	1,633	9,483	6,891	6,277	4,784	643	6,022	107,011
2017	10,298	17,693	44,570	2,270	9,156	7,517	15,657	4,590	568	3,557	115,876
2018	8,773	19,128	46,191	1,331	10,263	7,558	30,050	2,728	537	2,607	129,166
2019	4,118	15,878	64,204	1,778	10,140	9,975	44,882	1,790	1,414	3,715	157,894

Figure 1. Distribution of Diagnostic Tests by Animal Species

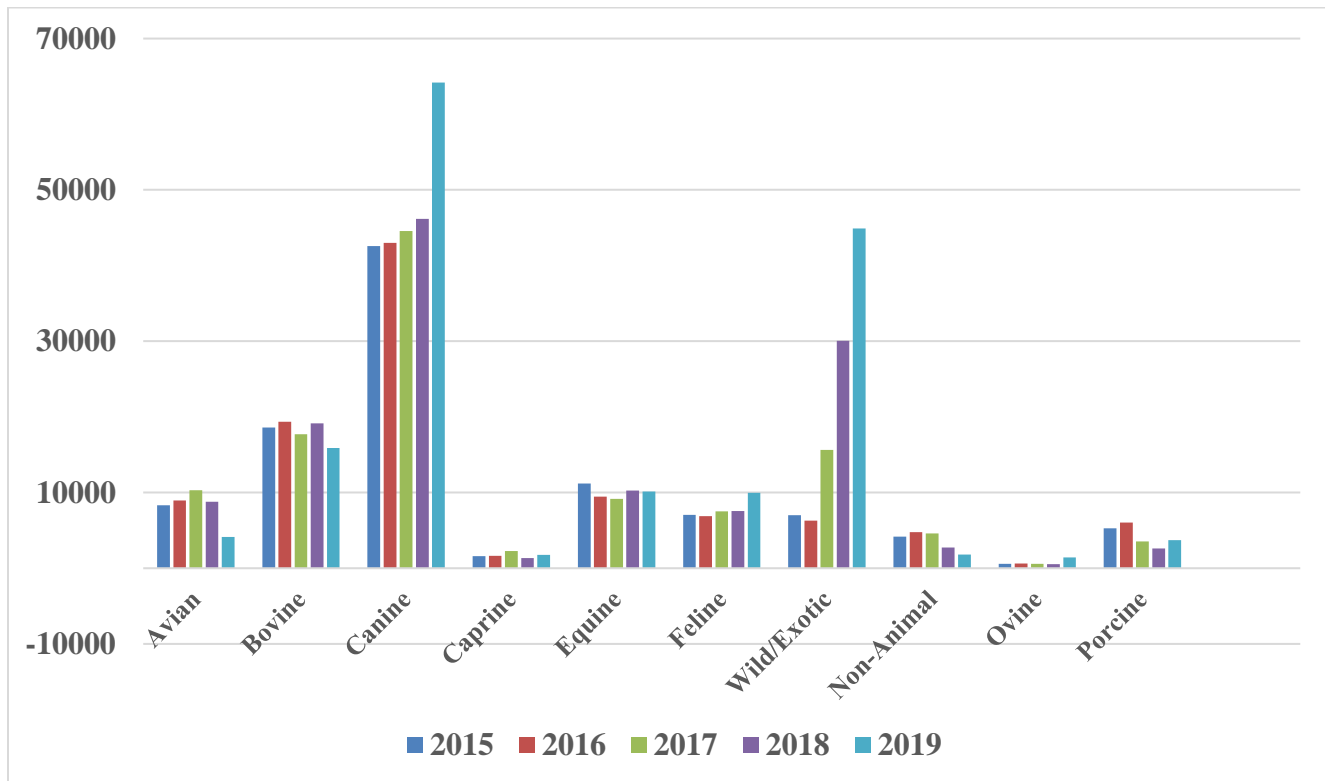


Table 3. Five Year VMDL (Main Lab and Clin Path) Tests by Section*

Year	Avian Dx.	Ana Path	Histo/IHC	Clin Path	Micro	Molecular Dx.	Serology /Immuno	Tox/Ana Chem	Research	Total
2015	4,374	10,620	22,526	23,242	16,373	10,372	14,520	4,406	N/A	106,433
2016	5,375	11,289	19,773	26,011	17,160	9,982	13,066	4,355	N/A	107,011
2017	5,415	11,352	29,850	28,249	16,727	10,911	21,634	4,610	N/A	128,748
2018	4,411	12,065	28,966	29,126	15,246	9,872	38,515	2,838	N/A	141,039
2019	1,587	12,154	41,117	31,992	13,589	8,449	46,646	2,360	9,193	167,087

*The number of diagnostic tests increased 18.5% from 2018 to 2019. 2017 and 2018 Histo/IHC numbers have been updated.

Table 4. Distribution of VMDL Accessions in 107 MO Counties/Independent City

County	#ACCN*	County	#ACCN	County	#ACCN	County	#ACCN
		Saint					
Boone	33,165	Francois	180	Linn	77	Saint Clair	22
Saint							
Louis	1,342	Moniteau	167	Oregon	71	Knox	21
Not							
Specified	878	Lafayette	161	Osage	64	Stoddard	20
Saint							
Charles	794	Howard	153	Laclede	62	Scotland	19
Greene	626	Monroe	153	Bates	60	Benton	18
Jackson	604	Randolph	150	Dunklin	59	Barton	17
Franklin	574	Pettis	137	Wright	59	DeKalb	17
Callaway	514	Marion	131	Warren	58	Maries	17
Cole	483	Putnam	124	Adair	55	Atchison	12
Camden	402	Cooper	121	Cedar	55	Clark	12
				Sainte			
Johnson	399	Polk	116	Genevieve	54	Mississippi	12
Jefferson	355	Livingston	115	Henry	53	Ozark	10
Christian	348	Stone	107	Morgan	45	Chariton	9
Cape							
Girardeau	288	Saline	106	Platte	45	Sullivan	9
Phelps	266	Audrain	103	Crawford	41	Shannon	8
Saint							
Louis City	264	Miller	102	Pulaski	37	Gentry	5
Jasper	240	Texas	98	Carroll	32	Schuyler	5
Lincoln	227	Shelby	96	Dallas	31	Washington	5

Ray	215	Scott	95	Vernon	31	Clinton	3
Howell	198	Nodaway	91	Madison	30	Harrison	3
Webster	197	Taney	91	Caldwell	29	St. Charles	3
Butler	192	Clay	88	Dent	27	Dade	2
Cass	190	Grundy	87	Andrew	26	Douglas	2
Gasconade	189	Lawrence	85	Bollinger	25	Daviess	1
Barry	188	McDonald	84	Montgomery	23	Mercer	1
Newton	185	Macon	83	Perry	23	Ralls	1
Buchanan	183	Pike	83	Lewis	22		

*ACCN: Accession

Table 5. Distribution of VMDL Accessions in 44 Non-MO States

State/Country	# Accession	State/Country	# Accession
Illinois	877	Wisconsin	14
Arkansas	662	Michigan	10
Florida	452	Kentucky	9
Kansas	363	New Mexico	7
Oklahoma	334	South Dakota	6
North Carolina	247	Washington	5
California	98	Wyoming	5
Iowa	66	Alabama	4
New Jersey	53	Ohio	4
Puerto Rico	32	Maryland	3
Arizona	30	Tennessee	3
Massachusetts	30	British Columbia	2
Montana	30	Maine	2
Virginia	28	Ontario	2
Manitoba	27	Oregon	2
Indiana	26	Rhode Island	2
Minnesota	26	Vermont	2
Utah	26	Connecticut	1
Pennsylvania	21	Delaware	1
Nebraska	19	Idaho	1
South Carolina	17	New York	1
Texas	16	Saskatchewan	1

External Proficiency Tests

Clinical IT-VetView

ASF Electronic Messaging Competency

CSF Electronic Messaging Competency
FMD Electronic Messaging Competency
IAV-A Electronic Messaging Competency
IAV-S Electronic Messaging Competency
Pseudorabies Electronic Messaging Competency

Clinical Pathology

Chemistry-Routine
Hematology
Microscopy
Urinalysis

Histology

Chronic Wasting Disease IHC

Microbiology

AAVLD Inter-laboratory Bacteriology Quality Assurance Survey
Contagious Equine Metritis (CEM) Culture
Listeria and *Salmonella* in Raw Dog Food
Salmonella Group D Culture and Serology - National Poultry Improvement Plan (NPIP)

Molecular Diagnostics

Avian Influenza Virus (IAV-A) qRT-PCR
Avian Paramyxovirus (APMV)-1/Exotic New Castle Virus qRT-PCR
African Swine Fever (ASF) qPCR
Classical Swine Fever Virus (CSFV) qRT-PCR
Foot-and-Mouth Disease Virus (FMDV) qRT-PCR
Swine Influenza Virus (SIV) qRT-PCR

Serology

Bluetongue Serology
Bovine Leukemia Virus (BLV) Serology
Brucellosis Serology
Chronic Wasting Disease (CWD) ELISA
Equine Infectious Anemia (EIA)
Johne's ELISA
Pseudorabies Virus (PRV) gB & gI ELISA

Toxicology

Aflatoxin in Feedstuffs HPLC
 Aflatoxin M1 in Tissues HPLC
 Deoxynivalenol (DON) in Feedstuffs HPLC
 Fumonisin in Feedstuffs HPLC

VMDL Participation in National Diagnostic Programs

Figure 3. Level I Lab of National Animal Health Laboratory Network (NAHLN)

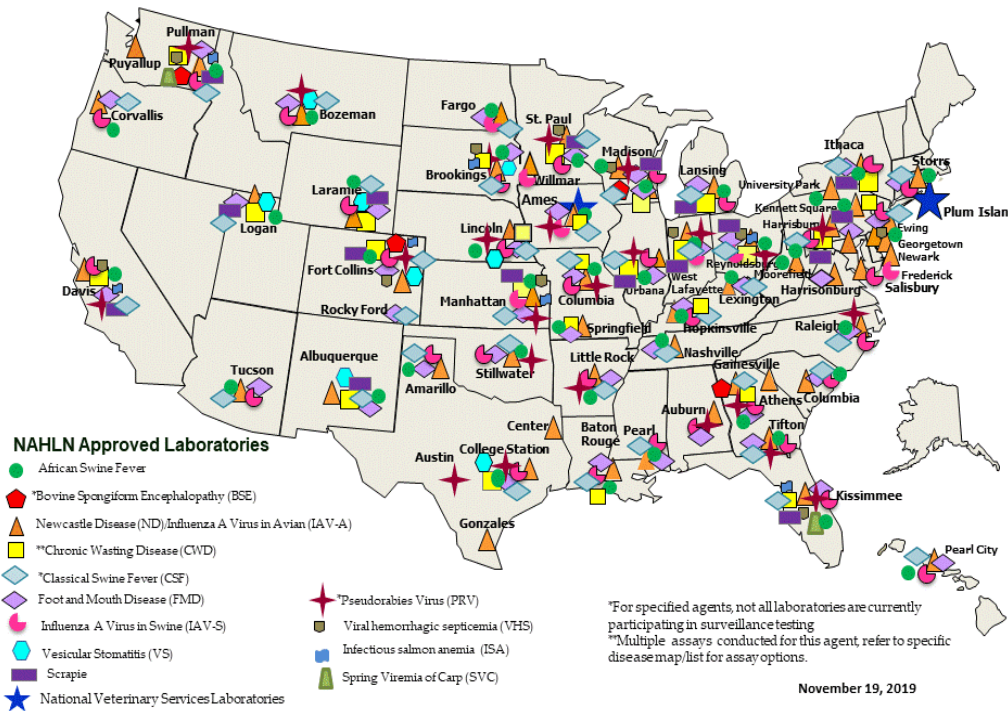


Figure 4. Tier I Member of FDA Veterinary Laboratory Investigation and Response Network (Vet-LIRN)



Faculty Teaching Activities

Didactic and Laboratory Courses (N = 39; Bold: Coordinated by VMDL Faculty)

AS 140/2140	Companion Animals
AS 325/4977	Horse Production
BioMed 3200	Comparative Hematology
BioMED 3310	Biomedical Pathophysiology Online
BioMed 4100	Veterinary Clinical Chemistry, Online
BioMed 4110/V_PBIO 7110	Veterinary Cytology
BioMED 4120	Principles of Toxicology Online (Undergraduate Level)
LAB_AN 9437	Lab Animal Pathology
MMI 8050	Mechanisms of Microbial Pathogenesis
P_Health 8150	Human Health and the Environment
V_BSCI 5506	Veterinary Cellular Biology
V_BSCI 5507	Veterinary Pharmacology
V_BSCI 5508	Veterinary Pharmacology
V_BSCI 5509	Veterinary Toxicology
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 5601/8601	Animals in Emergencies and Basic Emergency Response
V_PBIO 6647	Diagnostic Pathology and Special Species Medicine I
V_PBIO 6679	Diagnostic Pathology and Special Species Medicine II
V_PBIO 7120	Principles of Toxicology Online (Graduate Level)
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 = 18)

Chemistry Rounds
Comparative Orthopaedic Laboratory (COL) journal club
Cytology Rounds
Dermatology Rounds
Equine Journal Club
Food for Thought Rounds
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

International Programs

1. Department of Food Science and Engineering (USP) at the University of Sao Paulo (USP), Pirassununga, São Paulo, Brazil – Collaborative training and research
2. Agencia de Regulación y Control de la Bioseguridad y Cuarentena para Galápagos or Agency for Biosafety and Quarantine Regulation and Control for the Galápagos (ABG) – Building diagnostic capacity and collaborative research

Faculty National and State Leadership Activities

National and State Leadership

1. **Evans T.** Co-Chair AAVLD Toxicology Committee
2. **Evans T.** Member ABVT Student Award Committee
3. **Evans T.** Member ABVT Education Committee
4. **Evans T.** Veterinary Education Assessment Examination Question Reviewer
5. **Gull T.** ACVIM Credentials Committee.
6. **Gull T.** ACVM Board of Governors, ACVM Examination Committee, ACVIM Examination Committee.
7. **Gull T.** Chair, Drug & Medications Committee for the North American Trail Riding Conference
8. **Royal A.** Member of ACVP Certifying Exam Assembly and Administration Group (Clinical Pathology).
9. **Shaw D.** Chair of Training Program Review Committee of American College of Poultry Veterinarians, 2019.
10. **Shaw D.** Program Chair for 2019 North Central Avian Disease Conference, Minneapolis, MN, 12-13 March 2018.
11. **Zhang S.** AAVLD President Elect, Member of AAVLD Bacteriology/Mycology Subcommittee, Antimicrobial Susceptibility Subcommittee, Quality Assurance Committee, Government Relations Committee, Strategic Planning Committee, and Workforce Development Committee.
12. **Zhang S.** Missouri Biosecurity Working Group
13. **Zhang S.** Missouri Council on Captive Wild and Exotic Animals.
14. **Zhang S.** USDA NAHLN Antimicrobial Resistance Working Group, Technical Working Group.

Faculty/Staff Scholarly Activities

Grants and Contracts

New Grants and Contracts

1. 2019. John Middleton (PI), **Kim DY** (Co-PI, 30% effort). Fetal Lamb Tracheal Occlusion as a Model for Treatment of Congenital Diaphragmatic Hernia. Children's Mercy Hospital. \$137,502.00.
2. 2019. Middleton (PI), **Kim DY** (Co-I). Creation and Repair of a Myelomeningocele in Fetal Sheep – Myeloschsis. 2019. Children's Mercy Hospital. \$81,661.00.
3. 2019-2019. **Zhang MZ** (PI, 40% shared credit), **Zhang S** (Co-PI, 30% shared credit), **Shen Z** (Co-PI, 30% shared credit). Emerging Vector-Borne Diseases Assay Development. MDHSS. \$40,150 (Direct: \$30,188).
4. 2019-2020. **Evans T** (PI), **Zhang S** (Co-PI), **Rottinghaus G** (Co-PI). Updating GC/MS Analytical Capabilities to Enhance Human and Animal Health. NIH 1U18FD006710. \$110,378.
5. 2019-2020. Kevin Wells (PI), **Kim DY** (Co-PI, 5% effort). Swine somatic cell genome editing center. NIH office of the director. \$1,129,562.00
6. 2019-2020. Sebastian Cardona-Ramirez (PhD student), **Kuroki K** (Faculty Sponsor). Measurement of ECM metabolism in human and canine tendon fibroblasts subjected to clinically relevant mechanical stress. Phi Zeta Research. \$1,000.
7. 2019-2020. **Zhang MZ** (PD, 95% shared credit), **Kim DY** (CO-PD, 5% shared credit). Surveillance of chronic wasting disease (CWD) in Missouri wild deer and elk. MDC. \$650,100
8. 2019-2020. **Zhang S** (PD). NAHLN Level I Member Lab. USDA 16-9419-0159. \$300,000 (Direct: \$270,000)
9. 2019-2020. **Zhang S** (PI), **Evans T** (Co-PI), **Johnson GC** (Co-PI), **Gull T** (Co-PI), **Zhang MZ** (Co-PI), **Odemuyiwa S** (Co-PI). FDA Vet-LIRN Tier I Lab. NIH 1U18FD006670-01. \$39,900 (Direct: \$30,000).
10. 2019–2020. **Hancock TS**. AVMA Veterinary Educator Grant. \$959.

Existing Active

11. 2018-2023. Lucy M (PI), **Evans TJ** (Co-I, 5% shared credit), **Gull T** (Co-I, 5% shared credit). Uterine microbiome: Functional significance in establishing the uterine program postpartum. NIH (1R01HD092254-01A1), \$1.6 million (Direct: \$720,000, Indirect: \$880,000).
12. 2016-2021. Hung C (PI) (Cook JL Consortium PI), **Kuroki K** (Co-I, 20% shared credit, 5% FTE). Prime sponsor NIH/NIAMS (R01AR068133). \$406,820 (Direct \$265,029).
13. 2017-2021. Lee CH (PI) (Cook JL Consortium PI), **Kuroki K** (Co-I, 5% shared credit, 2% FTE). Seamless healing of avascular meniscus tears by stem cell recruitment. NIH/NIAMS (R01AR071316). \$239,281 (Direct \$155,883).
14. 2018-2021. Stannard JP (PI), **Kuroki K** (Co-I, 2% shared credit, 5% FTE). A biologic joint replacement strategy to treat patients with post-traumatic osteoarthritis – Expansion. DEPT. OF DEFENSE (W81XWH1810430). \$1,989,044 (Direct \$1,302,402).

15. 2017-2019. Cook JL (PI), **Kuroki K** (Co-I, (20% shared credit, 0% FTE). Pivotal Anchor Study: Supplement. ARTHREX, INC. \$72,626 (Direct \$50,505)
16. 2018-2019. Cook JL (PI), **Kuroki K** (Co-I, 10% shared credit, 5% FTE). ARTHREX, INC. \$110,517 (Direct \$76,855)
17. 2018-2019. Cook JL (PI), **Kuroki K** (Co-I, 15% shared credit, 1% FTE). Comparison of scaffolds for augmentation of partial rotator cuff tears in a canine model. ARTHREX, INC. \$259,665 (Direct \$170,458).
18. 2018-2019. **Zhang S** (PI) FDA CVM Vet-LRN Tier I Vet Diagnostic Lab Supplement. \$16,500
19. 2018-2019. **Zhang S** (PI). AMR Surveillance and Test Development. FDA1U18FD005179- Total:\$119,350 (Direct:\$104,470)
20. 2018-2019. **Zhang S** (PD). NAHLN Level I Member Lab. USDA 16-9419-0159. \$328,000. 07/01/2018 – 06/30/2023.

Peer Reviewed Publications

Published

1. Ahner CE, Stoker AM, Bozynski CC, Cook CR, Leary E, **Kuroki K**, Cruz CN, Cook JL. Protein biomarkers in serum and urine for determining presence or absence of hip dysplasia in a canine model. *J Orthop Res* 37:916-920, 2019.
2. Asokan VR, Kerl ME, **Evans T**, Harmon M. Organophosphate intoxication in 2 dogs from ingestion of cattle ear tags. *Vet Emerg Crit Care* 29(4):424-430, 2019.
3. Birt JA, Khajeloo M, Rega-Brodsky CC, Siegel MA, **Hancock, TS**, Cummings K, Nguyen PG. Fostering agency to overcome barriers in college science teaching: Going against the grain to enact reform-based ideas. *Science Education*, 103(4), 770-798, 2019. doi: 10.1002/sce.21519
4. Dastider SG, Jasim I, **Shen Z**, Yuksek N, **Zhang S**, Dweik M, Almasri M. Microfluidic based impedance biosensor for pathogens detection in food products. *Electrophoresis* 40:508-520, 2019. doi: 10.1002/elps.201800405.
5. Franco LT, Petta T, **Rottinghaus GE**, Bordin K, Gomes G, Alvito P, Assuncao R, Oliveira CAF. Assessment of mycotoxin exposure and risk characterization using occurrence data in foods and urinary biomarkers in Brazil. *Food and Chemical Toxicology* 128:21-34, 21019.
6. Franco LT, Petta T, **Rottinghaus GE**, Bordin K, Gomes GA, Oliveira C. Co-occurrence of mycotoxins in maize food and maize-based feed from small-scale farms in Brazil: a pilot study. *Mycotoxin Research* 35(1):65-73, 2019.
7. Franklin SP, Stoker AM, Lin ASP, Pownder SL, Burke EE, Bozynski CC, **Kuroki K**, Guldberg RE, Cook JL. T1p, T2 mapping, EPIC- μ CT imaging in a canine model of knee osteochondral injury. *J Orthop Res* Aug 20, 2019. doi: 10.1002/jor.24450.
8. Gersoff WK, Bozynski CC, Cook CR, Pfeiffer FM, **Kuroki K**, Cook JL. Evaluation of a novel degradable synthetic biomaterial patch for augmentation of tendon healing in a large animal model. *J Knee Surg* 32:434-440, 2019.

9. **Hancock TS**, Friedrichsen P, Kinslow AK, Sadler TD. Selecting socio-scientific issues (SSI): A grounded theory study of how science teachers collaboratively design SSI-based curricula. *Science and Education*, 28(6-7), 639-667, 2019. doi: 10.1007/s11191-019-00065-x
10. Jasim I, **Shen Z**, Mlaji Z, Abdullah A, Liu J, Ghosch S, El-Dweik M, **Zhang S**, Almasri M. An impedance biosensor for simultaneous detection of low concentration of Salmonella serogroups in poultry and fresh produce samples. *Biosensors and Bioelectronic* 126:292-300, 2019. <https://doi.org/10.1016/j.bios.2018.10.065>
11. **Johnson GC, Fales WH**, Shoemake BM, Adkins PR, Middleton JR, **Williams F 3rd, Zinn M, Mitchell WJ**, Calcutt MJ. An outbreak of *Mycoplasma mycoides* subspecies capri arthritis in young goats: a case study. *J Vet Diagn Invest* 31(3):453-457, 2019.
12. Karaffa K, **Hancock TS**. Mental health stigma and veterinary medical students' attitudes toward seeking professional psychological help. *J Vet Med Educ* 46(4): 459-469, 2019. doi: 10.3138/jvme.1217-185r.
13. Karaffa K, **Hancock TS**. Mental health experiences and service use among veterinary medical students. *J Vet Med Educ* 46(4):449-458, 2019. doi: 10.3138/jvme.1017-145r1.
14. Kenyon SL, Roberts CA, Lory JA, Bailey EA, Kallenbach RL, **Rottinghaus GE**, C.A. Young, Davis DK. Comparison and diet preference of novel endophyte-infected tall fescue cultivars. *Crop Science* 59:1317-1329, 2019.
15. **Kuroki K**, Williams N, Ikeda H, Bozynski CC, Leary E, Cook JL. Histologic assessment of ligament vascularity and synovitis in dogs with cranial cruciate ligament disease. *Am J Vet Res* 80:152-158, 2019.
16. Lacey CA, Chambers CA, **Mitchell WJ**, Skyberg JA. IFN- γ -dependent nitric oxide suppresses Brucella-induced arthritis by inhibition of inflammasome activation. *J Leukoc Biol* 106(1):27-34, 2019.
17. Ledbetter L, Cherla R, Chambers C, Zhang Y, **Mitchell WJ**, Zhang G. MHC-II-restricted, CD4₊ T cell-dependent and -independent mechanisms are required for vaccine-induced protective immunity against *Coxiella burnetii*. *Infect Immun* pii: IAI.00824-19, 2019.
18. Liu J, Jasim, I, **Shen Z**, Zhao L, El-Dweik M, **Zhang S**, Almasri M. A microfluidic based biosensor for rapid detection of *Salmonella* in food products. *PLOS One* 14(5):e0216873, 2019.
19. Moore SG, Ericsson AC, Behura SK, Lamberson WR, **Evans TJ**, McCabe MS, Pooch SE, Lucy MC. Concurrent and long-term associations between the endometrial microbiota and endometrial transcriptome in postpartum dairy cows. *BMC Genomics* 20(1):405-424, 2019.
20. Muhsin SA, Al-Amidie M, Mlaji Z, **Shen Z**, Abdullah A, Liu J, Dweik F, Jasim I, El-Dweik M, **Zhang S**, Almasri M. Smart biosensor for rapid and simultaneous detection of waterborne pathogens in tap water. *IEEE Transducer* pp. 701-704, 2019.
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In Press and Submitted:

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2. Gomez Y, Merrill K, **Gull T**, **Royal AB**. What's Your Diagnosis? Candida and Cyniclomyces in the bronchoalveolar lavage of a dog. *Vet Clin Path* Submitted in 2019.
3. **Hancock TS**. Embroidery as method: Stitching together narrative becomings and data. *Journal of Education*. In Press.

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5. Karaffa K, Bradtke J, **Hancock TS**. Embedded student counseling services: Insights from veterinary mental health practitioners. *Journal of College Counseling* In Press.
6. Katz M, Buckley R, Biegen V, O'Brien D, **Johnson GC**, Warren W, Lyons L. Neuronal Ceroid Lipofuscinosis in a Domestic Medium-haired Cat Associated with a DNA Sequence Variant that Creates a Premature Stop Codon in CLN6. *Molecular Genetics and Metabolism* Submitted in December 2019.
7. **Kuroki K**, Morishima Y, Neil J, Beerntsen BT, Matsumoto J, Stich RW. Intestinal echinococcosis in a pet dog from Missouri. *J Am Vet Med Assoc* In Press.
8. Martin LM, **Ierardi RA**, Patterson DF, LaCarrubba AM, **Johnson GC**. An incidental finding: Pineocytoma in an aged female mule. *J Vet Diagn Invest* Submitted in November 2019.
9. **Rothacker T**, Pohlman L, Lin D, Andrews G. Pathology in practice: mediastinal mass in a dog. *J Am Vet Med Assoc* In Press.
10. **Rothacker T**. Novel Penicillium species causing disseminated disease in a Labrador Retriever dog. *Medical Mycology* In Press.
11. Volokhov DV, Blom J, Amselle M, Delmonte P, Gao Y, **Shen Z, Zhang S**, Gulland FM, Chizhikov VE, Eisenberg T. *Oceanivirga miroungioralis* sp. nov. isolated from oral cavity of northern elephant seal (*Mirounga angustirostris*). *IJSEM* Submitted in December 2019.
12. Weissman M, Donnelly LL, Branson K, Glahn A, Nagy D, **Havis B, Johnson GC**, Flesner BK. Electrochemotherapy for a cutaneous squamous cell carcinoma in a Vietnamese Pot-bellied pig (*Sus scrofa*). *J Exot Pet Med* Submitted in November 2019.

Book Chapters

1. **Evans TJ, Rottinghaus GE, Landers BR**: Mycotoxins. In Smith BP (ed): *Large Animal Internal Medicine, 6th edition*, p 1785. St. Louis, Mosby 2019
2. **Evans TJ**: Abortion, spontaneous, infectious. In Lavoie J-P (ed): *Blackwell's Five-Minute Veterinary Consult Equine, 3rd edition*, p 13. Philadelphia, Wiley-Blackwell, 2019.
3. **Evans TJ**: Abortion, spontaneous, noninfectious. In Lavoie J-P (ed): *Blackwell's Five-Minute Veterinary Consult Equine, 3rd edition*, p 16. Philadelphia, Wiley-Blackwell, 2019.
4. **Evans TJ**: Conception failure. In Lavoie J-P (ed): *Blackwell's Five-Minute Veterinary Consult Equine, 3rd edition*, p 175. Philadelphia, Wiley-Blackwell, 2019.
5. **Evans TJ**: Early embryonic death. In Lavoie J-P (ed): *Blackwell's Five-Minute Veterinary Consult Equine, 3rd edition*, p 241. Philadelphia, Wiley-Blackwell, 2019.
6. **Evans TJ**: Embryo transfer. In Lavoie J-P (ed): *Blackwell's Five-Minute Veterinary Consult Equine, 3rd edition*, p 248. Philadelphia, Wiley-Blackwell, 2019.
7. **Evans TJ**: Fetal stress, distress, and viability. In Lavoie J-P (ed): *Blackwell's Five-Minute Veterinary Consult Equine, 3rd edition*, p 308. Philadelphia, Wiley-Blackwell, 2019.

8. **Evans TJ**: High risk pregnancy. In Lavoie J-P (ed): *Blackwell's Five-Minute Veterinary Consult Equine, 3rd edition*, p 375. Philadelphia, Wiley-Blackwell, 2019.
9. **Evans TJ**: Spermatogenesis and factors affecting sperm production. In Lavoie J-P (ed): *Blackwell's Five-Minute Veterinary Consult Equine, 3rd edition*, p 711. Philadelphia, Wiley-Blackwell, 2019.
10. **Evans TJ**: Reproductive toxicity and endocrine disruption. In Gupta, RC (ed): *Handbook of Toxicology of Chemical Warfare Agents, 3rd edition*. New York, Academic Press/Elsevier, Inc., In Press 2019.

Scientific Presentations

1. Cook JL, Stoker AM, Bozynski CC, **Kuroki K**, Cook CR, Pfeiffer FM, Stannard JP. Unicompartiment bipolar osteochondral and meniscal allograft transplantation is effective for treatment of medial compartment gonarthrosis in a canine model. Orthopaedic Research Society, Paper #1734. Austin, TX. Feb. 2-5, 2019.
2. **Gull T**. Development of Antimicrobial Resistance in Equine Medicine. Missouri Veterinary Medical Association annual meeting, Columbia MO, 2019.
3. **Gull T**. Molecular Diagnostics in Equine Medicine. Missouri Veterinary Medical Association annual meeting, Columbia MO, 2019.
4. **Hancock TS**, Karaffa K. *Barriers to seeking mental health services among veterinary medical students*. Poster presentation at annual American Educational Research Association Conference, Toronto, Ontario. 2019
5. **Havis B**, Walker K, **Shen Z**, Gull T, Adkins P, Nagy DW, Kim DY. Systemic coccidioidomycosis in a llama cria born in Missouri. American College of Veterinary Pathologists annual meeting, San Antonio, TX, Nov 9-13, 2019.
6. Howard J, Reinero C, Cohn L, Vientos-Plotts A, **Gull T**. Documenting secondary bacterial infection in canine aspiration pneumonia. University of Missouri CVM Research Day, Columbia MO 2019.
7. Karaffa K, **Hancock TS**. *Mental health experiences and service use among veterinary professionals*. Invited presentation at the annual Missouri Veterinary Medical Association meeting, Columbia, Missouri. 2019
8. Karaffa KM, **Hancock TS**. *Challenging stigma as cultural competence*. Workshop presentation at AVMA Wellbeing Summit, Chicago, Illinois. 2019.
9. **Kuroki K**, Williams N, Cook JL. Histopathologic characterization of synovial biopsies from clinical canine patients with cranial cruciate ligament disease. 75th ACVP/ASVCP Concurrent Annual Meeting, San Antonio, TX, Nov. 9-13, 2019.
10. Moraes JGN, Ciernia LA, Kumro FG, **Gull T**, Poock SE, Lucy MC. Insights on the Establishment of the Uterine Microbiome in Virgin Holstein Heifers. Submitted to the Society for the Study of Reproduction meeting, San Jose CA, 2019.
11. **Shen Z**, **Zhang, MZ**, **Zhang S**. New real-time PCR assays for detection of equine Herpesvirus 1 and equine Herpesvirus 4 and genotyping of equine Herpesvirus 1. AAVLD, Providence, RI, Oct 24-30, 2019.

12. Studstill CJ, Pritzl C, **Kim DY**, Seo YJ, Xia C, Vijayan M, Hahm B. Sphingosine Kinase 2 mediates LCMV-induced CD4+ T cell suppression and instigates viral persistence while preventing immunopathology, American Association of Immunologists annual meeting, San Diego, CA, May 9-13, 2019.

Extension/Outreach/Engagement Presentations

1. Spring 2019 **Delaney L**. Editor. Under the Scope – MU VMDL Newsletter.
2. Spring 2019 **Delaney L**. Bovine Abortion/Neonatal Death Summary – MU VMDL Website.
3. Summer 2019 **Delaney L**. Editor. Under the Scope – MU VMDL Newsletter.
4. Summer 2019 **Delaney L**. Bovine Necropsy Summary – MU VMDL Website.
5. Fall 2019 **Delaney L**. Editor. Under the Scope – MU VMDL Newsletter.
6. Fall 2019 **Delaney L**. Bovine Necropsy Summary – MU VMDL Website.
7. Winter 2019 **Delaney L**. Editor. Under the Scope – MU VMDL Newsletter.
8. 3/6/2019 **Delaney L**. MU Extension Biosecurity Workshop (Versailles, MO): “What can the Diagnostic Lab do for you?”
9. 3/8/2019 **Delaney L**. MU Extension Biosecurity Workshop (Springfield, MO):” What can the Diagnostic Lab do for you?”
10. 3/13/2019 **Delaney L**. MU Extension Biosecurity Workshop (Cape Girardeau, MO): “What can the Diagnostic Lab do for you?”
11. 3/15/2019 **Delaney L**. MU Extension Biosecurity Workshop (Kirksville, MO): “What can the Diagnostic Lab do for you?”
12. 3/18/2019 **Delaney L**. MU Extension Biosecurity Workshop (St. Joseph, MO): “What can the Diagnostic Lab do for you?”
13. 7/23/2019 **Delaney L**. 2019 Missouri Swine Health Symposium (Sedalia, MO): “The place to test your pigs!”
14. 12/23/2019 **Evans TJ and Delaney L**. Field Investigation of Neonatal Caprine Deaths in Salem, MO.
15. 12/7/2019 **Evans TJ**. Annual Meeting of Academy of Veterinary Consultants (Kansas City, MO): “A Dynamic, but Practical Approach to Ergot Alkaloids”
16. 12/7/2019 **Evans TJ**. Missouri Livestock Symposium (Kirksville, MO): “Perilous Pastures and Fatal Feedstuffs for Cattle”
17. 12/7/2019 **Evans TJ**. Missouri Livestock Symposium (Kirksville, MO): “Perilous Pastures and Fatal Feedstuffs for Goats”
18. 12/7/2019 **Evans TJ**. Missouri Livestock Symposium (Kirksville, MO): “Perilous Pastures and Fatal Feedstuffs for Sheep”
19. 11/21/2019 **Evans TJ**. Derby Ridge Elementary School (Columbia, MO): Junior Achievement Day with Dr. Abiyou’s Kindergarten Class: “Becoming a Superhero”
20. 11/15/2019 **Evans TJ**. School’s Out COMO at MU Family Action Center (Columbia, MO): “Balloon Animal Medicine,” “Listening to a Dog’s Heart,” and supervision of service learning opportunity for Veterinary Professional Students

21. 11/8/2019 **Evans TJ.** MU VHC KC Animal Emergency Center (Kansas City, MO): “Prescription, Over-the-counter, and Recreational Drug Intoxications in Small Animals”
22. 11/8/2019 **Evans TJ.** MU VHC KC Animal Emergency Center (Kansas City, MO): “The Neighbor Did It”
23. 10/27-29/2019 **Evans TJ.** Kemin Intestinal Health Symposium (Naples, FLA): “Mycotoxins and Animal Gut Health”
24. 10/23/2019 **Evans T.** MU Engagement and Health Fair (Jesse Hall at MU): “Balloon Animal Medicine” and “Introduction to MU’s CVM and VMDL”
25. 10/23/2019 **Evans TJ.** MU CVM SAVMA (Columbia, MO): “The Dope on Dope”
26. 10/2019 **Evans TJ.** MU CVM (Columbia, MO): NAVLE “Toxicology Review”
27. Fall Semester **Evans TJ.** St. Louis High School Group (Columbia, MO): “The Box of Tox Introduction to Veterinary Toxicology”
28. Fall Semester **Evans TJ.** Kansas City High School Group (Columbia, MO): “The Box of Tox Introduction to Veterinary Toxicology”
29. 9/30/2019 **Evans TJ.** School’s Out COMO at MU Family Action Center (Columbia, MO): “Balloon Animal Medicine”
30. 9/21/2019 **Evans TJ.** Visit of Home Schooling Families to MU CVM (MU CVM, Columbia, MO): “Listening to a Dog’s Heart” and VHC Tour
31. 9/14/2019 **Evans TJ.** West Central Veterinary Medical Association (Marshall, MO): “Toxic Potpourri”
32. 8/28/2019 **Evans TJ.** Greater St. Louis Veterinary Medical Association Meeting (Creve Coer, MO): “The Neighbor Did It”
33. 8/28/2019 **Evans TJ.** Greater St. Louis Veterinary Medical Association (Creve Coer, MO): “Prescription, Over-the-counter, and Recreational Drug Intoxications in Small Animals”
34. 8/24/2019 **Evans TJ.** MIZZOU-TO-YOU at Lucas Motor Speedway (Hickory, MO): “Balloon Animal Medicine” and “An Introduction to MU’s CVM”
35. 8/18/2019 **Evans TJ.** Missouri State Fair (Sedalia, MO): “Balloon Animal Medicine” and “An Introduction to MU’s CVM and VMDL”
36. 7/15/2019 -7/19/2019 **Evans TJ.** Christian Veterinary Missions Trip to Navajo Reservation (Hardrock, AZ): Various talks to veterinary professional students from Auburn University, Texas A&M, Tufts University, and University of Florida, veterinarians, and Navajo pet and livestock owners on topics pertaining to toxic plants and animal health.
37. 6/10/2019 **Evans TJ.** Advanced Veterinary Academy (MU CVM, Columbia, MO): “The Box of Tox Introduction to Veterinary Toxicology”
38. 6/7/2019 **Evans TJ.** 4-H Summer Camp in Montgomery County: “The Box of Tox Introduction to Veterinary Toxicology”
39. 6/6/2019 **Evans TJ.** Derby Ridge Elementary School (Columbia, MO) with Ms. Cross’ 2nd Grade Class: “How Do You Become a Superhero?”
40. 4/24/2019 **Evans TJ.** Laclede County Soil and Water Conservation District Meeting (Lebanon, MO): “Nitrates and Cattle”

41. 4/18/2019 **Evans TJ.** Derby Ridge Elementary School (Columbia, MO) Ms. Cross' 2nd Grade Class: "THE ANTIDOTE Says Don't Let Your Dog Eat Chocolate, PART II"
42. 4/13/2019 **Evans TJ.** Show Me MIZZOU Day (MU Campus, Columbia, MO): "Balloon Animal Medicine" and "An Introduction to MU's CVM"
43. 4/6/2019 **Evans TJ.** MU CVM Open House (MU CVM, Columbia, MO): "Veterinary Toxicology for Young Pet Owners"
44. 4/4/2019 **Evans TJ.** Missouri Environmental Health Association Meeting (Springfield, MO): "Nitrate/Nitrite Poisoning from the Human and Animal Perspectives."
45. 2/26/2019 **Evans TJ.** Southwest Missouri Spring Forage Conference (Springfield, MO): "How to Find Out What Killed the Cow, When It Wasn't the Feed or the Vaccines"
46. 2/14/2019 **Evans TJ.** Derby Ridge Elementary School (Columbia, MO) Ms. Cross' 2nd Grade Class: "THE ANTIDOTE Says Don't Let Your Dog Eat Chocolate"
47. 2/9/2019 **Evans TJ.** Columbia's Young Scientist Fair (Columbia, MO): "Balloon Animal Medicine" and "An Introduction to MU's CVM"
48. January/February 2019 **Evans TJ.** In-Service Meetings with Extension Livestock Specialists: "Nitrate Problems in Cattle/Weak Calf Syndrome"
49. 1/14/2019 **Evans TJ.** Derby Ridge Elementary School (Columbia, MO) Junior Achievement Day with Ms. Cross' 2nd Grade Class: "What Do You Want to Do When You Grow Up?"
50. August 2019 **Ierardi RA.** Contribution to Academy of Veterinary Consultants (AVC) Diagnostic Laboratory Report. "*Anaplasma marginale* cELISA Testing Summary"
51. October 2019 **Ierardi RA.** Bovine Pneumonia Summary – MU VMDL Website.
52. December 2019 **Ierardi RA.** Contribution to Academy of Veterinary Consultants (AVC) Diagnostic Laboratory Report. "Bovine Respiratory Disease and Bovine Viral Diarrhea"
53. 10/16/19 **Williams F 3rd.** Pre-Vet Club "Why Do Necropsies and How to Get into Vet School"
54. 10/10/19 **Williams F 3rd.** NAVLE Review Part 1
55. 10/14/19 **Williams F 3rd.** NAVLE Review Part 2
56. 9/11/19 **Williams F 3rd.** Zew Club Pathology Talk
57. 7/17/19 **Williams F 3rd.** Dog Days of Summer
58. 6/10-12/19 **Williams F 3rd.** Advanced Veterinary Academy
59. 5/7/19 **Williams F 3rd.** Exotics Animal Behavior Talk
60. 4/6/19 **Williams F 3rd.** Open House. Why Do Necropsies
61. 2/21/19 **Williams F 3rd.** Zoo/Wildlife Pathogen Talk
62. 1/22/19 **Williams F 3rd.** Pathology Club Necropsy Lab
63. 1/13/19 **Williams F 3rd.** Exotics Symposium Wet Lab

Faculty Awards

Hancock TS. 2019 Outstanding Young Alumni Award from the College of Veterinary Medicine at Iowa State University.

Williams F 3rd and Evans T. 2019 Finalists for Hooding Veterinary Professional Students at

Commencement.

Major Annual Professional Meetings and Trainings

1. American Association of Veterinary Laboratory Diagnosticians (AAVLD) Annual Meeting
 2. American College of Veterinary Internal Medicine (ACVIM) Annual Meeting
 3. American College of Veterinary Microbiologists (ACVM) Annual Meeting
 4. Combined Annual Meetings of the American College of Veterinary Pathologists (ACVP) and American Society for Veterinary Clinical Pathology (ASVCP)
 5. American Veterinary Medical Association (AVMA) Annual Meeting
 6. Midwest Association of Veterinary Pathologists Annual Meeting
 7. Missouri Veterinary Medical Association (MVMA) Annual Meeting and District Meetings
 8. Missouri Biosecurity Working Group Quarterly Meetings
 9. Missouri Captive Wild Animal Health Meetings
 10. US Animal Health and AAVLD Government Relations Meeting
 11. Vet-LIRN (Veterinary Laboratory Investigation and Response Network) Monthly Conference Calls
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