IN THE UNITED STATES DISTRICT COURT
FOR THE NORTHERN DISTRICT OF IOWA
WESTERN DIVISION

JENNIFER FROST, an individual; and
JANE DOE, an individual,

Plaintiffs,

v.

THE CITY OF SIOUX CITY, IOWA;
ROBERT PADMORE, in his official capacity; and
CINDY RARRAT, in her official capacity,

Case No. 5:16-cv-4107

DECLARATION OF
JESSICA HEKMAN, DVM, MS

I, Jessica Hekman, DVM, MS, swear, state, and testify that the following facts are true and correct:

1. I am over the age of majority and am otherwise competent to make this Declaration. I have personal knowledge of the facts set forth in this Declaration. If called as a witness, I could and would competently testify to the same.

2. I am a Ph.D. candidate, in the Department of Animal Sciences (Genetics, Genomics, and Bioinformatics), University of Illinois at Urbana-Champaign, studying the genomics of canine behavior. I have a Doctor of Veterinary Medicine and Master of Science in Comparative Biomedical Sciences from Cummings School of Veterinary Medicine at Tufts University. Attached as Exhibit 1 is a true and correct copy of my curriculum vitae.

3. I have conducted extensive literature review regarding the role of genetics and environment in canine aggression. Attached as Exhibit 2 is a true and correct copy of a report regarding the roles of genetics and environment in canine aggression.

4. The basis for the opinions offered in my report is my specialized education, training, knowledge and skill in the area of canine genetics and breed identification. All of the opinions expressed in the report are opinions I hold to a reasonable degree of scientific certainty.

Dated: October 27, 2016.

Jessica Hekman, DVM, MS

Exhibit 1

Curriculum Vitae: Jessica Hekman

707 E. Oregon St.
Urbana, IL 61801
(617) 548-0113
hekman2@illinois.edu

Education:

2012-present Ph.D. candidate, Department of Animal Sciences (Genetics, Genomics, and Bioinformatics), University of Illinois at Urbana-Champaign

2015 University of Illinois at Urbana-Champaign
Certificate in Foundations of Teaching

2007-2012 Cummings School of Veterinary Medicine at Tufts University
Doctor of Veterinary Medicine: *May, 2012*
Master of Science in Comparative Biomedical Sciences: *May, 2012*

1991-1995 Harvard University
Bachelor of Arts, Magna cum Laude: *May, 1995*
Major in History and Literature of the Middle Ages
Honors program with thesis

Academic Honors:

2014-2015 Graduate Fellowship Recognition, Gamma Sigma Delta, Illinois Chapter

2010 Henry L. Foster, DVM Scholars Program recipient
Tufts Cummings School of Veterinary Medicine

Funding:

2014 Office of International Programs (OIP) Graduate Student International Research Grant ($3000)

2013-2016 Jonathan Baldwin Turner (JBT) Scholarship

Employment:

2012-2013: Veterinary intern in Maddie's Shelter Medicine Program, University of Florida. Provided care for animals in shelters and on rotation in the University of Florida small animal hospital. Trained in high quality, high volume surgery techniques. Attended didactic courses in medical and behavioral care of shelter animals. Participated in consultation at a large Southern municipal shelter. Taught veterinary students during clinical rotations. Presented at shelter medicine and animal behavior journal clubs.

1995-2011: Online publishing programmer specializing in conversion of science, technology, and medicine publications from print to online media. Worked with XML documents and SQL databases using Java, C++, Perl, and PHP.

Professional Presentations:

Hekman, JP, Johnson, JL, Acland, GM, Trut, LN, Kukekova, AV. Transcriptome analysis of the hypothalamic-pituitary-adrenal system in tame and aggressive fox strains. July 10, 2015. Presented at the Annual Veterinary Behavior Symposium, Boston, MA.

Hekman, JP, Johnson, JL, Acland, GM, Trut, LN, Kukekova, AV. Transcriptome analysis of the hypothalamic-pituitary-adrenal system in tame and aggressive fox strains. June 23, 2015. Presented at the 8th International Conference on Advances in Canine and Feline Genomics and Inherited Disease, Cambridge, UK.

Spencer, TG, Magruder-McRae, EO, Crandall, MC, Levy, JK, Crawford, PC, Michaud, R, **Hekman, JP**, Kellenberger, A, & Alber, J. How can we effectively prepare more veterinarians to practice shelter medicine? August 25, 2012. Poster session presented at the Maddie's Shelter Medicine Conference, Orlando, FL.

Hekman, JP. Identification and reduction of stress in hospitalized dogs. August 4, 2010. Master's thesis defense, Tufts Cummings School of Veterinary Medicine, North Grafton, MA.

Publications:

Hekman JP, Johnson JL, Kukekova AV. "Transcriptome Analysis in Domesticated Species: Challenges and Strategies." *Bioinformatics and Biology Insights,* Vol 9, Suppl 4, pages 21-31, February 2016.

Hekman JP, Karas AZ, Sharp CR. Psychogenic stress in hospitalized dogs: cross species comparisons, implications for health care, and the challenges of evaluation." *Animals,* Vol. 4, Issue 2, pages 331-347, June 2014.

Hekman JP, Karas AZ, Dreschel NA. Salivary cortisol concentrations and behavior in a population of healthy dogs hospitalized for elective procedures. *Applied Animal Behaviour Science,* Vol. 141, Issue 3, pages 149-157,

November 2012.

Teaching Experience:

IAABC Online Courses. Taught a series of online classes, "Genetics for the Behavior Consultant," for the International Association of Applied Animal Behavior Consultants. January 2016 – present.

Behavior of Domestic Animals. Assisted Dr. Anna Kukekova with her class for upper-level undergraduates. Developed presentation topics for students, presented quizzes using student response system (iClicker), and lectured on shelter medicine and behavior problems in dogs and cats. Spring 2014; Spring 2015.

APDT Online Courses. Taught online classes for the Association of Professional Dog Trainers**.** Topics included introductory genetics, behavioral genetics, endocrinology, and neurobiology. June 2014 – March 2015.

Outreach Activities:

2014-present: Write for popular press publications on canine behavior, physiology, and genetics. Publications in *The Bark* and *The Whole Dog Journal.*

2010-2015: Chief Architect of ScienceSeeker.org, a web site for providing science news to general audiences

2009-present: Maintain blog at *The Dog Zombie* about canine behavior, veterinary medicine, and related topics

Genetics and environment in canine aggression

Jessica Hekman, DVM, MS
Ph.D. candidate in Genetics, Genomics, and Bioinformatics, University of Illinios
September 11,2016

Aggression, in canines as in humans, is affected by both genetics and environment. Studies of heritability of behavioral traits in dogs have suggested that behavioral tendencies are about 20-40% influenced by genetics. We believe that the rest of the variability that we see is due to differences in environment, meaning both early socialization and other early experiences, and how the animal is currently managed.

The genes influencing behavioral traits such as aggression in mammals are not yet known, despite large scale studies seeking them in human research. In the early 2000s, after the sequencing of the human genome, the use of genome-wide association studies (GWAS) to seek associations between markers in the human genome and behavioral traits became more and more common. At the time, the expectation was that a small number of genes would be found that controlled traits such as depression and aggression in humans. This GWAS approach compares phenotypes, such as a history of depression, with genotypes, a series of markers spread throughout the genome, for hundreds or thousands of individuals. Statistically significant associations between phenotypes and individual markers are sought, with the expectation that if a large number of individuals have both a particular marker and a particular phenotype, then that marker is likely to be close to the location in the genome of a gene that influences that phenotype.

Indeed, GWAS findings assisted in the successful identification of genes for some less complex traits, such as Crohn's, ulcerative colitis, and human height. However, more complex traits, such as the risk of developing a particular form of cancer or depression, did not prove as easy to understand using this approach. In some cases, genes affecting behavioral traits were identified, but were shown to explain less than one percent of the variation seen in the individuals studied. These studies also proved difficult to replicate; when performed on a new set of individuals, they often did not identify the same markers as associated with the behavioral trait in question.

Today, behavioral traits are believed to be highly polygenic, meaning they are influened by many, many genes, each with very small effect size. These genes are also believed to be epistatic, meaning that they interact with each other in highly unpredictable ways – a particular version of gene A may have one effect when present with a particular version of gene B, but may have the opposite effect when present with a different version of gene B (or a particular version of gene C). Epistasis is one of the reasons why reliably controlling behavioral characteristics by selective breeding is difficult: a version of a gene having one effect in a parent animal may have the opposite effect in offspring, when expressed against a different genetic background.

Additionally, environmental influences are extremely important in determining whether a genetic risk for a particular behavioral trait is realized. In humans, studies have shown that risk variants for particular deleterious behavioral traits, such as depression, are more likely to result in that behavior in

adults who have experienced childhood traumas. This effect is known as a gene-environment interaction. One of the best known cases of a gene-environment interaction is the effect of different versions of a gene for the serotonin transporter, which cycles the neurotransmitter serotonin in the brain. Low serotonin levels have been associated with both depression and aggressiveness. One version of the transporter gene has been associated with increased risk of depression in adults, but the effect is only seen in individuals who experienced childhood trauma. Therefore, even in the case of genes with known effects, these are not predictive of behavioral traits without an understanding of the environmental influences on the individual in question, and even then confer only risk, not behavioral absolutes.

Unfortunately, environmental effects are difficult to study in a controlled way in epidemiological studies. Studying them in highly controlled laboratory studies provides results which are difficult to extrapolate to real world situations. Differences in environment that affect adult behavior begin in utero, continue with early maternal care, and continue throughout life. Twin studies in human research have shown that even individuals with identical genetics raised in the same household experience different different environments, as evidenced by personality differences between identical twins.

For all of these reasons, genetics are not highly predictive of behavior in dogs. Individuals of a particular breed may share increased propensity for particular behavioral traits, but their genetics do not guarantee those traits. Environmental influences, such as appropriate early socialization and maintenance in the home as a family dog, are more predictive of a dog's behavioral traits than its genetics.