CURRICULUM VITAE

NAME: Shaden Kamhawi, Ph.D.

***h* index 2014, 29**

ADDRESS

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PROFESSIONAL EXPERIENCE

2014-Present,	Associate Scientist, Core, Laboratory of Malaria and Vector Research (LMVR), NIAID, NIH
2006-2014,	Staff Scientist, Core, Laboratory of Malaria and Vector Research (LMVR), NIAID, NIH
2001- 2006,	Staff Scientist, Laboratory of Parasitic Diseases (LPD), NIAID, NIH.
1997- 2001,	Visiting associate, LPD, NIAID, NIH.
1996- 2000,	Associate professor, Department of Biological Sciences, Yarmouk University, Irbid, Jordan.
1990-1996,	Assistant professor, Department of Biological Sciences, Yarmouk University, Irbid, Jordan.

EDUCATION

1990, Ph.D. in Medical Entomology, Salford Univeristy, Salford, England.
1985, B.Sc. in Biological & Biochemical Sciences, Salford University, Salford, England.

AREA OF EXPERTISE

Vector Biology; Vector-Parasite-Host molecular interactions; Host immune response to transmission of *Leishmania* by sand fly bite; Development of vector-based vaccines; Field-oriented investigations of epidemiology of leishmaniases and transmission patterns.

CURRENT DUTIES:

Dr. Kamhawi plays an essential role in sand fly-related research at NIAID. She brings a unique set of skills including extensive field expertise in leishmaniasis epidemiology and

a proficiency in experimental techniques covering various fields including entomology, parasitology, immunology and molecular biology. Current duties of Dr. Kamhawi include:

***The sand fly Unit**:*
Dr. Kamhawi is a world expert on phlebotomine sand flies, vectors of the neglected tropical disease leishmaniasis. Upon arrival at LMVR, Dr. Kamhawi established state of the art sand fly insectaries for rearing important vectors of leishmaniasis. The insectaries consist of a breeding facility and BSL2 insectary where large-scale *Leishmania* infections of sand flies and subsequent transmission experiments are undertaken. The current sand fly colonies and the robust sand fly transmission protocols established by Dr. Kamhawi are critical to basic as well as *Leishmania* vaccine research studies at LMVR and has led to several national and international collaborations with Dr. Steve Reed at the Infectious Diseases Research Institute (IDRI), Dr. Laurent Fischer at Merial Limited, a world-leading animal health company, Dr. Rowton at the Walter Reed Army Institute of Research (WRAIR) and Dr. Naomi Aronson at the Uniformed Services University of the Health Sciences (USUHS), Drs Hira Nakhasi and Robert Ducan at the Center for Biologics Evaluation & Research (CBER)/FDA and others. The sand fly facility harbors one of the three most productive (if not the most productive) sand fly colonies in the world. These insectaries currently supply sand flies for several lines of research by investigators at NIAID including Drs. Jesus Valenzuela and Jose Ribiero at LMVR and David Sacks at LPD and outside including Dr. Luis Diaz at the University of North Carolina Chappel Hill, Dr. Marcelo Ortigao at Kansas State University and Dr. Mary Ann McDowell at Notre Dame University. Dr. Kamhawi currently monitors the progress and stability of the colonies. She supervises Mr. Claudio Menses, a technician directly in charge of the rearing activities and two students that assist in the day-to-day activities related to the colonies.

Supervision and project management at the Vector Molecular Biology Section (VMBS):
Laboratory-based: Dr. Kamhawi mentors and trains investigators in the VMBS and actively participates in designing experiments and discussing the interpretation of data and plays a significant part in writing manuscripts. She has supervised projects of several post-docs and IRTA students. Dr. Kamhawi is currently co-directing projects of Dr. Maha Abdeladhim, Dr. Iliano Vieira and Dr. Manoochehr Rasouli (post-doctoral students) and Sonia Metangmo and Shannon Townsend (IRTA) having recruited Ms. Townsend for a collaborative project with Dr. David Sacks. She is also supervising the projects of Lais Da Silva, a pre-doctoral student from Fiocruz, Bahia as part of her Science without borders awarded project with Dr. Claudia Brodskyn.
Field-based: Dr. Kamhawi has extensive field expertise in leishmaniasis epidemiology from her work prior to arriving at NIH. This played a critical part in setting up the leishmaniasis and sand fly laboratory at NIAID-International Centers for Excellence in Research (ICER)/Malaria Research and Training Center (MRTC) research station in Bamako, Mali. Dr. Kamhawi trained several Malian scientists on *Leishmania* epidemiology with emphasis on entomology. The leishmaniasis lab at the MRTC was highly productive leading to the acquisition of a TMRC from 2013-2017. Dr. Kamhawi was also critical to the success of a grant entitled “Development of Surveillance System and Control Strategy for Leishmaniasis in Georgia by means of Epidemiological Investigation and Strengthening of Laboratory Capacities” awarded by DHHS Biotechnology Engagement Program (BTEP). This grant was in collaboration with Dr. David Sacks at LPD and Dr. Eka Giorgobiani, National Institute for Disease Control and Medical Statistics (NIDCMS), Tiblisi, Georgia. Dr. Kamhawi wrote the entomological

section of the grant, trained the entomolgy team in Georgia and supervised all field and laboratory entomological activities of the grant. Currently, due to a successful execution of the activities of this grant, Dr. Kamhawi was approached by the Office of Global Research to consider a with-cost extension of the project for two years to carry out new objectives. Dr. Kamhawi, with the help of Drs. Valenzuela and Giorgobiani, wrote and was awarded $225.000 USD to investigate the immunogenicity of salivary proteins of incriminated vectors of visceral leishmaniasis (VL) in Tbilisi in humans and dogs.

Training:

Internal
Dr. Kamhawi trains members of LMVR and LPD as well as visiting scientists on sand fly- and *Leishmania*-related techniques. These include culturing of *Leishmania* parasites; sand fly rearing for colony establishment; sand fly infections with *Leishmania* parasites; undertaking vector-transmission studies; dissecting salivary glands and midguts; identification of various developmental stages of the parasite in the sand fly midgut including infectious metacyclics; handling of infected animals including aseptic organ and tissue processing and cell recovery and preparation for a variety of analyses. Dr. Kamhawi also trains VBMS investigators in immunological techniques including flow cytometry, an expertise acquired during 8 years working with Dr. David Sacks, RNA and DNA isolation, PCR and others. She also advises researchers interested in establishing facilities for sand fly-related research at their institutes. Recently trained visiting scientists include Drs. Ranadhir Dey, Sreenivas Gannavaram and Fernanda Arujo (FDA); Dr. Claudia Brodskyn, Fiocruz, Bahia, Brazil; Dr. Rita Mukhopadhyay, Florida International University, Miami, Florida; Dr. Patrick Kelly, University of Iowa, Iowa; Dr. Eka Giorgobiani, NIDCMS, Tbilisi, Georgia.

External
Dr. Kamhawi has also trains students through her participation in several renowned national and international training courses. These include invitations to participate in “Molecular Aspects of the Host-parasite Interaction Course”, Fiocruz, Belo Horizonte, MG, Brazil; Biology of Parasitism at Woods Hole and the Bi-annual United Nations sponsored “A Theoretical and Practical Course on *Leishmania*” organized by the International Centre for Genetic Engineering and Biotechnology, Trieste, Italy. She was also invited to teach at the II International Symposium on Leishmaniasis vaccines pre-symposium courses, the Biology of Disease Vectors, the Genética e Biologia Molecular de Insetos de Importância Médica e Veterinária, and others.

NIH/NIAID CITIZENSHIP:

- Member of NIAID Animal Care and Use Committee (ACUC) since 2009.
- Participates in writing clinical and animal protocols and amendments as well as USDA and CDC permits and preparation of IND applications in support of the mission of VMBS, LMVR, NIAID, NIH.
- Supports and conducts AAALAC tours for VMBS.
- A mentor for Iliano Vieira, a senior post-doc at the VMBS, LMVR, NIAID for the workshop "Arthropod Vectors and Disease Transmission: Translational Aspects” workshop organized by the Divisions of Allergy, Immunology and Transplantation and Microbiology and Infectious Diseases, NIAID, May 2014.

- A mentor for Dr. Nichole A. Broderick, junior faculty at the University of Wisconsin, for the workshop entitled “Effect of Vector Innate Immunity and Human-Derived Immune Molecules on the Transmission of Vector-Borne Pathogens” organized by the Divisions of Allergy, Immunology and Transplantation and Microbiology and Infectious Diseases, NIAID, May 2013.
- A mentor for Dr. Constance Finney, junior faculty at the University of Calgary, Canada for the workshop entitled “Immunological Consequences of Vector – Derived Factors” for the Divisions of Allergy, Immunology and Transplantation and Microbiology and Infectious Diseases, NIAID, May 2012.
- Participates in nomination of prominent outside speakers for the Twinbrook and LMVR seminar series. Guests of Dr. Kamhawi include Dr. Phillip Scott, University of Pensylvania, Sept 2015; Drs. Rod Dillon from Lancaster University and Dr. Stefan Magez, Ir. Vrije Universiteit Brussel, April, 2013; Pr. Deborah Smith, University of York on April 11, 2012.
- Supervised presentations by Post-baccalaureates Dana Gilmore and Philip Castrovinci at the NIH Postbac Poster Day, 2011 & 2012.
- Participated in the NIH research festival as Co-organizer, Co-chair and presenter of a symposium on immune targeted therapies, 2011.
- Assisted the Office of Global Research planning and organizing a meeting on leishmaniasis in North Africa and the Middle East, NIH, 2009.
- Presented at the NIH Clinical Center Round, February, 2007.
- Set up the leishmaniasis and sand fly research lab at the NIAID-ICER-MALI at the University of Bamako with Dr. Valenzuela

COLLABORATION

INTRAMURAL

In coordination with Dr. Valenzuela

Dr. Kamhawi works primarily with Dr. Valenzuela at VMBS on the immune response to sand fly salivary proteins and their potential as *Leishmania* vaccines and the development of animal models of Leishmania transmission by infected vector sand flies. In addition to overseeing sand fly insectaries, Dr. Kamhawi’s responsibilities include directing research projects that involve supervision of post-docs, IRTA students and visiting scientists in coordination with Dr. Valenzuela. She is currently supervising the projects of the following post-docs in Dr. Valenzuela’s group:

Active

Dr. Maha Abdeladhim

1. This project was started by Dr. Teixiera and will be completed by Dr. Maha Abdeladhim. It addresses the immunogenicity and *Leishmania* vaccine potential of sand fly saliva in humans. This project was funded by Bench to Bedside Intramural Program.

Dr. Manoochehr Rasouli:

2. The hamster model of vector-transmitted VL led to the initiation of a CRADA with Dr. Steve Reed at IDRI. We are using the model to assess the efficacy of several

promising GMP-grade vaccine candidates against *L. donovani* for downstream testing prioritization in human clinical trials.

3. Preclinical assessment of the protective capacity of LJM143 and LJM19 salivary proteins from *Lu. longipalpis* against *L. mexicana* for a combination Leishmania-salivary antigen vaccine for meso America. This project is in collaboration with Drs. Peter Hotez, Maria Bottazzi, Baylor School of Medicine, Houston,TX and Dr. Eric Dumonteil, Autonomus University of Yucatan, Mexico.

Dr. Iliano Vieira:

4. Identify the midgut receptor of *Lutzomyia longipalpis* and other midgut and salivary molecules that act as transmission blocking vaccine thorugh interruption of the developmental cycle of the parasites in the fly.

Pre-doctoral student Lais da Silva:

5. Assess whether a transient infection with extracellular trypanosomes shown to non-specifically abrogate vaccine-induced immune memory cells will abolish the protection induced by vaccination with LJM11, a protective salivary molecule from the sand fly *Lutzomyia longipalpis*

Dr. Kamhawi also partially supervises IRTA post-baccalaureate students coming to the VMBS. Current students include Sonia Metangmo and Shannon Townsend.

Post-baccalaureate Sonia Metangmo:

6. Use the experimental model of natural transmission by vector bites to assess canine leishmaniasis vaccine candidates in dogs. This project was started by Dr. Aslan and was supported by CRADA with Merial limited. Ms Metangmo is finalizing data analysis for publication. Dr. Kamhawi wrote and was the PI on the animal protocol for this project.

7. Investigating the midgut development of *Leishmania* mutants lacking genes involved in metacyclogenesis and assess whether they are transmitted to the host during probing and/or feeding. This project is in collaboration with Dr. Deborah Smith, York University, England.

Post-baccalaureate Shannon Townsend:

8. Assessing the protective capacity of anti-LPG antibodies specific to metacyclics in against vector-transmitted progressive VL in hamsters. This project is in collaboration with Dr. David Sacks, LPD, NIAID, NIH.

Dr. Kamhawi is also supervising Dr. Ranadhir Dey (FDA) in collaboration with Dr. Hira Nakhasi, FDA, on two projects:

9. The hamster model of vector-transmitted VL led to the initiation of a strong collaboariton with FDA. We are using the model to assess the efficacy of live attenuated vaccines against *L. donovani* in collaboration with Dr. Nakhasi's group at the FDA.

10. A comparative assessment of the immune response and disease progression following vector-transmitted versus needle inoculated *L. donovani* in Balb/c mice looking at the kinetics of parasite tropism form the bite site to the viscera.

Completed

2010-2013: Dr. Hamide Aslan**;** Development of the first reproducible model of visceral leishmaniasis via infected sand fly bites in hamsters. The hamster model of VL was recently accepted for publication in the *Journal of Infectious Diseases* (2013).

Dr. Hamide Aslan; Investigation of the natural history of canine leishmaniasis in dogs following transmission with *L. infantum*-infected *Lu. longipalpis* sand flies. This project represents the first successful vector transmission of VL to dogs in a reproducible manner. The study is finished and has yielded interesting data revealing important aspects of the disease. This project is complete and the manuscript is currently submitted for publication to PNAS.

2010-2012: Dr. Clarissa Teixeira; Analysis of the early immune responses of saliva-exposed mice to *L. major* infected-*Phlebotomus duboscqi* sand flies to address the interaction of the innate and adaptive arms of the immune system in relation to protection from disease. This work was recently published in *PLoS Neglected Tropical Diseases*, 2014.

2010-2012: Dr. Regis Gomes: Test whether the antigens KSAC and L110f protective against needle challenge are protective against vector-challenge. Data resulting from this project demonstrated that KSAC but not L110f was protective against the virulence of vector-challenge, demonstrating the value of the natural transmission model in the selection of vaccine candidates. This work was published in *PLoS Neglected Tropical Diseases,* 2012.

2006-2011: Program on the epidemiology of cutaneous leshmaniasis in Mali, West Africa. Working with Dr. Valenzuela in collaboration with Dr. Seydou Doumbia, Malaria Research and Training Center, Bamako, Mali. This project generated three publications, two in the journal *PLoS Neglected Tropical Diseases* (2009 & 2011) and one in the *Journal of Investigative Dermatology* (2012).

In Collaboration with Dr. David Sacks (LPD), NIAID, NIH.

Active

2014-2015 A project entitled “Antibody mediated, ‘unnatural’ immunity based vaccines against Leishmaniasis” funded by the Bill & Melinda Gates Foundation. Dr. David Sacks invited Dr. Kamhawi to participate in the project to test the efficacy of antibodies to LPG in protection for visceral leishmaniasis. ($100,000 USD).

Completed

2006 - 2008: Studies on the role of lipophosphoglycans of Leishmania promastigotes in Vector competence resulting in a publication in the journal *PLoS Pathogens* (2010); Studies of vaccine efficacy against vector-challenge resulting in a publication in the journal *PLoS Pathogens* (2009); Studies on the role of neutrophils in the virulence of vector challenge resulting in a publication in the journal *Science* (2008); Analysis of the dose of an infectious sand fly and the virulence of vector-transmitted leishmaniasis resulting in a publication in the journal *PNAS* (2008).

EXTRAMURAL

Pending

1. A proposal entitled "A phase I dose- ranging human trial of a novel vector saliva derived recombinant antigen as a potential leishmaniasis vaccine" submitted to GHIT Fund Proposal Reference Number: GHIT-RFP-2014-002. Drs. Valenzuela and Kamhawi were invited by Dr. Naomi Aronson as Co-investigators.

Active

2014-Present Sand fy midgut proteins as transmission blocking vaccines for *Leishmania infantum*. Co-Investigators Jesus Valenzuela and Shaden Kamhawi, NIAID, NIH. Collaborators: Dr. Alex Reis, Universidade Federal de Ouro Preto, Brazil.

2013-2015 A proposal entitled "Clinical Studies on a Multivalent Vaccine for Human Visceral Leishmaniasis" submitted to the European Commission under the identifier call FP7-HEALTH-2013-INNOVATION-1. Dr. Valenzuela invited Dr. Kamhawi to assist in designing and writing the part of the proposal involving NIH where we will test the inclusion of a salivary protein from *Lu. longipalpis,* in a *Leishmania*-based vaccine in pre-clinical and phase I/II clinical trials. Proposal duration = 48 months; Total budget requested = $7,603,788.29 USD; NIH part = $608,010.47 USD.

2013-2015 Investigate the effect of non-specific immunosuppression of vaccine-induced immune memory following a transient infection with extracellular trypanosomes on the protective capacity of a salivary vaccine candidate against CL. Co-investigators: Shaden Kamhawi and Jesus Valenzuela, NIAID, NIH. Collaborators: Dr. Stefan Magez, Vrije Universiteit Brussel, Brussels, Belgium; Dr. Samuel Black, University of Massachusetts, Amherst.

2013-2015 BTEP extention of the grant "Development of Surveillance System and Control Strategy for Leishmaniasis in Georgia by means of Epidemiological Investigation and Strengthening of Laboratory Capacities" to investigate the salivary protein repertoire of *Phlebotomus kandelakii* and *P. balcanicus*, vectors of visceral leishmaniasis in the Republic of Georgia and assess their immunogenicity for humans and dogs. Co-investigators: Shaden Kamhawi and Jesus Valenzuela, NIAID, NIH. Collaborators: Eka Giorgobiani, National Institute for Disease Control and Medical Statistics, Tiblisi, Georgia.

2012-2016 Cutaneous Leishmaniasis in West Africa: Understanding the parasite, vector and disease. Program Director: Dr. Seydou Doumbia, Faculty of Medicine, University of Bamako, Mali; Prinicpal Investigators include Dr. Ousmane Faye, National Center of Disease Control; Dr. Yaya I. Coulibaly, University of Bamako, Bamako Mali, and Dr. Daniel A. Boakye, Noguchi Memorial Institute for Medical Research, University of Ghana, Ghana and Dr. Shaden Kamawi and Dr. Roshanak T. Semnani, NIAID, NIH, Bethesda, MD. Tropical Medicine Research Centers (P50); RFA-AI-11-001. TMRC was awarded Aug 2012.

2012-2015 Awarded the Science without borders fellowship with collaborator Dr. Claudia Brodskyn, CNPq Bahia, Salvador. Project objectives include the the establishment of working colonies of important vector sand flies and natural transmission models of New World species of *Leishmania* by vector bites.

2012-present Developing GMP grade vaccines against leishmaniasis and Chagas disease focusing on Mesoamerica. Collaborators: Drs. Peter Hotez and Maria Elena Bottazzi, Texas Childern's Hospital and the Baylor College of Medicine, Texas and Eric Dumonteil at the Universidad Autónoma de Yucatán, Mexico. Co-Investigators: Drs. Jesus Valenzuela and Shaden Kamhawi, LMVR, NIAID.

2012-present Test the relative efficacy of promising *Leishmania* vaccine candidates in hamsters following vector transmission. Drs. Steve Reed and Randy Howard, IDRI, Seattle

2011-present. Develop a vector-transmitted model of VL in mice to address the immunology and kinetics of parasite tropism form the bite site to the viscera. Co-investsigators: Shaden kamhawi and Jesus Valenzuela, NIAID, NIH; Collaborators: Drs. Hira Nakhasi and Ranadhir Dey, CBER/FDA, Bethesda.

2010-present. Test live attentuated Leishmania parasites using a model of progressive visceral leishmaniasis initiated via natural transmission for *Leishmania donovani* parasites by sand fly bites. Co-investsigators: Shaden kamhawi and Jesus Valenzuela, NIAID, NIH; Collaborators: Drs. Hira Nakhasi and Ranadhir Dey, CBER/FDA, Bethesda.

2012-present The vaccine potential and virulence for sand flies of *Leishmania majo*r parasites overexpressing a pro-apoptotic nuclease endonuclease G (endoG). Co-investigator: Shaden Kamhawi; Collaborators: Drs. Alain Debranbant and Sreenivas Gannavaram, CBER/FDA, Bethesda.

2012-present Investigate the presence and effects of exosomes within the sand fly midgut. Co-investigator: Shaden Kamhawi; Collaborator: Dr. Martin Olivier, Department of Microbiology and Immunology, McGill University, Montréal, Québec, Canada.

2012-present Investigate the vector microbiome of *Lutzomyia longiplapis* in colony-bred and field collected specimes and they impact the outcome of disease following vector-transmission of *Leishmania infantum*. Co-PI Shaden

Kamhawi and Jesus Valenzuela; Collaborator: Mary Wlison, University of Iowa, Iowa, USA.

2012-present Investigate the role of *Leishmania* aquaporins in the developmental cycle within the sand fly midgut. Co-investigators: Shaden kamhawi and Jesus Valenzuela, NIAID, NIH; Collaborator: Dr. Rita Mukhopadhyay, Department of Molecular Microbiology and Infectious Diseases; Herbert Wertheim College of Medicine; Florida International University; Florida.

2010-present: Bench to Bedside Intramural Program to study the Immunogenicity and *Leishmania* vaccine potential of sand fly saliva in humans. Co-PI: Drs. Jesus Valenzuela and Shaden Kamhawi; Collaborator: Dr. Naomi Aronson, the Uniformed Services University of the Health Sciences. *Practical part is completed but data analysis is still ongoing.*

2008 – present. Investigate the anti-saliva antibody response in Iraqi soldiers following deployment in Iraq. Co-investigators: Shaden Kamhawi and Jesus Valenzuela, NIAID, NIH. Collaborator: Naomi Aronson, the Uniformed Services University of the Health Sciences.

Completed

2008-2014. Dr. Edgar Rowton, Walter Reed Army Institute of Research. This collaboration investigates the efficacy of saliva-mediated immunity is protecting the non-human primates rhesus macaques from cutaneous leishmaniasis. Dr. Kamhawi wrote and was awarded a Gates Exploration grant that funds this current collaboration. Manuscript in preparation.

2012-2014 Investigate attenuated *Listeria monocytogenes* expressing LJM11 as a live vaccine against cutaneous leishmaniasis transmitted by vector bite. Co-Investigators: Drs. Valenzuela, Kamhawi and Oliveira. Collaborator: Dr. Hélène Marquis, Cornell University, Ithaca, NY. This work was published in *Infection and Immunity*, 2014.

2010-2014. A novel strategy using DNA prime-live non-pathogenic *Leishmania* boost expressing selected parasite antigens and sand fly salivary gland components as a candidate vaccine for cutaneous leishmaniasis; Co-investigators: Shaden Kamhawi and Jesus Valenzuela, NIAID, NIH. Collaborators: Dr. Sima Rafati, Pasteur Institute of Iran and Dr. Barbara Papadopoulou, Laval University, Canada. This study was published in *PLoS Neglected Tropical Diseases*, 2014.

2008 - 2011. Test the efficacy of promising *Leishmania* vaccine candidates against challenge by sand fly bites. Co-investigators: Shaden Kamhawi and Jesus Valenzuela, NIAID, NIH. Collaborators: Steve Reed, IDRI, Seattle. This study was published in *PLoS Neglected Tropical Diseases*, 2012.

2009-2010. Investigate the expression of cytochrome c oxidase in *Leishmania* parasites during their development in the sand fly vector. Co-investsigator: Shaden kamhawi, NIAID, NIH. Collaborator: Robert Duncan, CBER/FDA, Bethesda. This study was published in *Molecular Microbiology*, 2010.

2004-2010. Development of a control strategy for visceral leishmaniasis in Tiblisi, Georgia. Co-investigators: David Sacks, Shaden Kamhawi and Phil Lawyer, NIAID, USA. Collaborators: Eka Giorgobiani, National Institute for Disease Control and Medical Statistics, Tiblisi, Georgia. This study was published in *PLoS Neglected Tropical Diseases*, 2012.

2006-2008. Investigating the variability of sand fly saliva in natural populations collected from Egypt and Jordan as well as human cellular and antibody immune responses induced by repeated sand fly bites. Project entitled "Anti-Sand Fly Saliva Vaccine Development". Co-investigator: Shaden Kamhawi, NIAID, NIH. Collaborator: Dr. Mary Ann McDowell, University of Notre Dame. This study was published in *BMC Ecology*, 2011.

RESEARCH SUPPORT:

Dr. Kamhawi is experienced in writing grant applications, animal protocols and IRBs. She was successful in garnering outside support for research at VMBS and has initiated and/or played a critical role in the formation of the following grants awarded to VMBS:

EXTERNAL AWARDS

Pending

- A proposal entitled "A phase I dose- ranging human trial of a novel vector saliva derived recombinant antigen as a potential leishmaniasis vaccine" submitted to GHIT Fund Proposal Reference Number: GHIT-RFP-2014-002. Drs. Valenzuela and Kamhawi were invited by Dr. Naomi Aronson as Co-investigators.

Awarded

1. A proposal entitled "Clinical Studies on a Multivalent Vaccine for Human Visceral Leishmaniasis" submitted to the European Commission under the identifier call FP7-HEALTH-2013-INNOVATION-1. Proposal duration = 48 months. Total budget requested = $7,603,788.29 USD; NIH part = $608,010.47 USD.

2. Due to the interest in the VL model of Leishmania transmission by sand flies established by Dr. Kamhawi, Drs. Steve Reed and Randy Howard at the Infectious Disease Research Institute has established a CRADA to test *Leishmania* vaccine candidates in hamsters following vector transmission. This CRADA will also include the financial support of two post-bacs (2012-2014, $790,000 USD).

3. TMRC award entitled "Cutaneous Leishmaniasis in West Africa: Understanding the parasite, vector and disease", 2012-2017, $1,760,526 USD.

4. Slim Initiative for Antipoverty Vaccine Development focusing on the development of a vaccine to Chagas disease and cutaneous leishmaniasis in Mesoamerica (2012-2014, $150,000).

5. BTEP extention of the grant “Development of Surveillance System and Control Strategy for Leishmaniasis in Georgia by means of Epidemiological Investigation and Strengthening of Laboratory Capacities” (2013-2015, $320,000).

6. Bench to Bedside Intramural Program to study the Immunogenicity and *Leishmania* vaccine potential of sand fly saliva in humans. Co-PI: Drs. Jesus Valenzuela and Shaden Kamhawi. A two-year grant (2010-2012; $270,000).

7. U.S. Civilian Research & Development Foundation (CRDF). A novel strategy using DNA prime-live non-pathogenic *Leishmania* boost expressing selected parasite antigens and sand fly salivary gland components as a candidate vaccine for cutaneous leishmaniasis. A one-year grant (2010-2012; $30,000).

8. Grand Challenges Explorations, the Bill & Melinda Gates Foundation. A novel vaccination strategy for cutaneous leishmaniasis: Using defined salivary molecules from the vector sand fly *Phlebotomus duboscqi* to protect rhesus macaques from a natural challenge with *Leishmania major* infected sand flies. A one-year grant (2009-2010; $100,000).

9. A CRADA with Merial Limited. $864,478.00 towards CRADA 2006-0324 (title: Evaluation of a salivary antigen Leishmania DNA vaccine in dogs). Furthermore, a total of $22,898.00 towards CRADA 2008-0747 (title: Identification of immunogenic salivary antigens from the sand fly *Phlebotomus perniciosus* in dogs. The total amount we have received from Merial for both CRADAs is $887,376.00.

PROTOCOLS

Dr. Kamhawi co-authored clinical protocols with Dr. Valenzuela (protocol #06-I-N121; DMID protocol #12-0075) and with collaborator Dr. Naomi Aronson (WRAIR protocol # 355023). Dr. Kamhawi was also involved in preparation for an IND application to the FDA. She also assists Dr. Valenzuela with updating and amending VMBS animal protocols and with writing biosafety manuals and applications for USDA permits to import *Leishmania* and other pathogens used in research at VMBS. She authored and was the principal investigator on animal protocol ASP LMVR 16.

PATENTS

1. Patent: Anti-Arthropod Vector Vaccines, Methods of Selecting and Uses Thereof. Inventors: Valenzuela, Jesus; Belkaid, Yasmine; Kamhawi, Shaden; Ribeiro, Jose; Sacks, David. Patent Number: 7,388,089. Issued (Patented): June 17, 2008.
2. Patent Application: P. Ariasi Polypeptides and P. Perniciosus Polypeptides Method of Use. Inventors: Valenzuela, Jesus; Audonnet, Jean-Christophe; Belkaid, Yasmine; Fischer, Laurent; Kamhawi, Shaden; Milward, Francis; Ribeiro, Jose. Patent Application Number (US): 10/527,500.

3. Patent Application: Identification of LJL143 and LJM17 Salivary Proteins from the Sand Fly Lutzomyia longipalpis, the Vector of Visceral Leishmaniasis in Latin America, that Elicit Cellular Immunity and Interferon-Gamma Production in Dogs Resulting in Efficient Killing of Leishmania. Inventors: Collin, Nicolas; Gomes, Regis; Kamhawi, Shaden; Riberio, Jose; Teixeira, Clarissa; Valenzuela, Jesus. Patent Application Number (US): 61/051,635.
4. Patent Application: Insect Salivary Proteins, Particularly Sand Fly Salivary Proteins work as Non-Classical Natural Adjuvants Driving a Specific Immune Response that Accelerate the Immune Response to Another Protein or Pathogen. Inventors: Valenzuela, Jesus; Kamhawi, Shaden; Oliveira, Luis Fabiano. Patent Application Number (US): 61/089,884.
5. Leishmania Challenge Model. Inventors: Kamhawi Shaden; Valenzuela, Jesus; Aslan, Hamide; Fischer, Laurent. US Patent Application No. 13/296,675

SPECIAL SCIENTIFIC RECOGNITION:

2013-2014

- Awarded the honorary title of Associate Scientist, LMVR, NIAID, NIH, 2014.
- Recipient of the 2013-2014 NIAID MERIT AWARD.
- Associate Editor for PLoS Neglected Tropical Diseases since 2011.
- Member of the “Slim Initiative for Antipoverty Vaccine Development” Advisory and Scientific Committee, established in Merida, Yucatan, Mexico, since 2011.
- External reviewer for the French National Research Agency, 2014.
- Advised Dr. Nadira Karunaweera on the establishment of a sand fly colony in Sri Lanka, 2014.
- Awarded the NIH Fellow Award for Research Excellence, NIH, Bethesda, MD, 2013/2014.
- External reviewer for the Swiss National Science Foundation, 2013.
- Chair and reviewer for USAID proposal for cooperative projects in the Middle East, 2013.

Up to 2012

- Expert consultant on sand fly transmission of *Leishmania* parasites for Merial, a world-leading animal health company.
- Invited to organize a meeting on drug treatment of cutaneous leishmaniasis for Drugs for Neglected Diseases *initiative* (DNDi), October 2011.
- Co-chair and presenter at a symposium on immune targeted therapies at the NIH research festival and was chosen for the NIH Catalyst Newsletter.
- Chair, Lead grant reviewer or Member of grant review panel for USAID proposals for cooperative projects in the Middle East, 2008-2012.
- Awarded the NIH Fellow Award for Research Excellence, NIH, Bethesda, MD, 2001-2012.
- Co-chair and organizer of a symposium entitled “Beyond mice: revisiting animal models of natural parasite infections” for the upcoming ICOPA XII in Melbourne Australia, August 2010.
- Chair, ACMCIP Cellular Parasitology II, ASTMH, Atlanta, Georgia, 2010.

- Member of the Sand Fly Genome Steering Committee for sequencing the genome of *Phlebotomus papatasi* and *Lutzomyia longipalpis,* OW and NW species respectively.
- Member of the Planning and Scientific Committee for the meeting Leishmaniasis: Collaborative Research Opportunities in North Africa and the Middle East, Office of Global Research, NIH, 2009.
- Invited speaker at the NIH Clinical Center Ground Round, February, 2007.
- Member of Scientific Committee, 5th International Symposium On Phlebotomine Sand flies, Tunis, Tunisia, April 2005.
- Member of the steering committee for vaccines on Leishmaniases, WHO, 1996.
- Organizer of the `Clinical Trials of killed *Leishmania major* vaccine' in Amman, Jordan for the UNDP/World Bank/WHO Special Program for Research in Tropical Diseases, 1996.
- Consultant on vectors and transmission patterns in foci of visceral and cutaneous leishmaniasis, 1994-1998.
- Member of the administrative committee of the Forth International and Pan-Arab Seminar on Leishmaniases and other Zoonoses held in Jordan, 1993.
- Member of the advisory committee for the prevention of Rift Valley fever in Jordan, 1993.

SELECTED INVITED LECTURES AND SCIENTIFIC PRESENTATIONS:

2015

- Invited seminar, Fiocruz, Slavador, January 2015.
- Invited seminar, Carver School of Medicine, Iowa University, Iowa, March 2015.

2013-2014

- Sponsored invitation to participate in the “Molecular Aspects of host-parasite Interaction” Course, Fiocruz, Belo Horizonte, MG, Brazil, 19-21 Nov, 2014.
- Giving two oral presentations at the International Symposium on Phlebotomine Sand flies, Sept, 2014.
- **Keynote speaker** at the "Arthropod Vectors and Disease Transmission: Translational Aspects” workshop organized by the Divisions of Allergy, Immunology and Transplantation and Microbiology and Infectious Diseases, NIAID, May 2014
- Sponsored invitation, **Keynote speaker**, XVI Arthromint; Ilha Grande, State of Rio de Janeiro, Brazil, 31th July - 03rd August, 2013.
- Invited to participate in the 5th World Congress on Leishmaniasis, Porto de Galinhas, Pernambuco, 13th-17th May, 2013.

Up to 2012

- **Presentations at over 50 international meetings**. Recent meetings include the XLVIII Congress of the Brazilian Society for Tropical Medicine, Brazil, 2012; DMID International Research in Infectious Diseases Meeting, USA, 2011; ASTMH, Atlanta; 2010; the 4th Congress on Leishmaniasis, Lucknow,

India, 2009; XXXIV Congress of the Brazilian Society of Immunology, Salvador, Bahia, Brazil, 2009.

- **Invited speaker to international meetings** (including the ASTMH). ASTMH, Atlanta, 2012; Institute of Tropical Medicine meeting (**Invited speakers only**), Antwerp, Belgium, 2012; II International Symposium on Leishmaniasis Vaccines, Brazil, 2012; ASTMH, Philadelphia, 2011; International Congress of Parasitology, Melbourne, Australia, 2010; ASTMH, Atalnta, 2010; XXXIV Congress of the Brazilian Society of Immunology (**conference speaker**), Salvador, Bahia, Brazil, 2009; Leishmaniasis: Collaborative Research Opportunities in North Africa and the Middle East, Tunisia, 2009; 3rd Congress on Leishmaniasis, Sicily, Italy, 2005; ASTMH, DC, USA, 2005; International Symposium on Phlebotomine Sand flies (**plenary speaker**), Tunis, Tunisia, 2005; Annual the 21st Annual Swiss Trypanosomatid Meeting, Leysin, Switzerland, 2004; XVI Annual meeting of the Brazilian Society of Protozoology, Caxambu, Brazil, 2000 and others.
- **Invited speaker at universities and scientific institutions**. Lectures given at the Herbert Wertheim College of Medicine, Florida, Laval Univeristy in Quebec, University of Pennsylvania, University of Maryland, the Uniformed Services University of the Health Services (several) and the FDA (several).
- **Meeting organizer or chair.** Drugs for Neglected Diseases *initiative* (DND*i*), Switzerland, 2011; International Congress of Parasitology, Melbourne, Australia, 2010; Collaborative Research Opportunities in North Africa and the Middle East, Tunisia, 2009.

AD-HOC REVIEWER FOR:

PLoS pathogens; Journal of Experimental Medicine; PLoS Neglected Tropical Diseases; Infection and Immunity; J. Infectious Diseases; J. Immunology; Eur. J. Immunology; Trends in Parasitology; American Journal of Tropical Medicine and Hygiene; BMC infectious diseases; Microbes and Infection; Experimental Parasitology; International Journal of Parasitology; J. Med. Entomology; PLoS one; Parasite Immunology; Vaccine and others.

PEER REVIEW OF PROJECT PROPOSALS FOR:

National Research Agency, France; Swiss National Science Foundation, Switzerland; USAID; Bill and Melinda Gates Foundation; Medical Research Council, UK; Wellcome Trust, UK; Scottish Executive Rural Affairs, agricultural and biological research group, Scotland; DFG, Germany; Romania Innovation Council, Romania.

BIBLIOGRAPHY:

Articles

1. **Kamhawi S**, Aslan H and Valenzuela JG. Vector saliva in vaccines for visceral leishmaniasis: a brief encounter of high consequence? Front. Public Health 2:99. doi: 10.3389/fpubh.2014.00099, 2014.

2. **Shaden Kamhawi**, Fabiano Oliveira and Jesus G. Valenzuela. Using Humans to Make a Human Leishmaniasis Vaccine. *Sci Transl Med*, 6:(234): 234fs18, 2014.

3. Teixeira C, Gomes R, Oliveira F, Meneses C, Gilmore DC, Dia-Eldin A. Elnaiem, Jesus G. Valenzuela and **Shaden Kamhawi**. Characterization of the Early Inflammatory Infiltrate at the Feeding Site of Infected Sand Flies in Mice Protected from Vector-Transmitted Leishmania major by Exposure to Uninfected Bites. PLoS Negl Trop Dis 8(4): e2781. doi:10.1371/journal.pntd.0002781, 2014.

4. Maha Abdeladhim, **Shaden Kamhawi** and Jesus G. Valenzuela. What's behind a sand fly bite? The profound effect of sand fly saliva on host hemostasis, inflammation and immunity. *Infection, Genetics and Evolution*, available online, 2014.

5. Dayana Rodriguez-Contreras, Hamide Aslan, Xiuhong Feng, Khoa Tran, Phillip Yates, **Shaden Kamhawi** and Scott M. Landfear. Regulation and Biological Function of a Flagellar Glucose Transporter in *Leishmania mexicana*: a Potential Glucose Sensor. *FASEB J*, 2014.

6. Farnaz Zahedifard, Elham Gholami, Tahereh Taheri, Yasaman Taslimi, Fatemeh Doustdari, Negar Seyed, Fatemeh Torkashvand, Claudio Meneses, Barbara Papadopoulou, **Shaden Kamhawi**, Jesus G. Valenzuela and Sima Rafati. Enhanced Protective Efficacy of Nonpathogenic Recombinant Leishmania tarentolae Expressing Cysteine Proteinases Combined with a Sand Fly Salivary Antigen. *PLoS Negl Trop Dis* 8(3): e2751. doi:10.1371/journal.pntd.0002751, 2014.

7. Delbert S. Abi Abdallah, Alan Pavinski Bitar, Fabiano Oliveira, Claudio Meneses, Justin J. Park, Susana Mendez, **Shaden Kamhawi**, Jesus G. Valenzuela and Hélène Marquisa. A Listeria monocytogenes-Based Vaccine That Secretes Sand Fly Salivary Protein LJM11 Confers Long-Term Protection against Vector-Transmitted *Leishmania major*. Infect. Immun., 82(7):2736, 2014.

8. Jenica Abrudan, Marcelo Ramalho-Ortigão, Shawn O'Neil, Gwen Stayback, Mariha Wadsworth, Megan Bernard, Doug Shoue, Scott Emrich, Phillip Lawyer, **Shaden Kamhawi**, Edgar D. Rowton, Michael J. Lehane, Paul A. Bates, Jesus G. Valenzeula, Chad Tomlinson, Elizabeth Appelbaum, Deborah Moeller, Brenda Thiesing, Rod Dillon, Sandra Clifton, Neil F. Lobo, Richard K. Wilson, Frank H. Collins, Mary Ann McDowell. The characterization of the Phlebotomus papatasi transcriptome. *Insect Mol Biol.* 22(2): 211–232, 2014.

9. Hamide Aslan, Ranadhir Dey, Claudio Meneses, Philip Castrovinci, Selma Maria Bezerra Jeronimo, Gaetano Oliva, Laurent Fischer, Robert C. Duncan, Hira L. Nakhasi, Jesus G. Valenzuela and **Shaden Kamhawi**. A New Model of Progressive Visceral Leishmaniasis in Hamsters by Natural Transmission via Bites of Vector Sand Flies. *Journal of Infectious Diseases*, 207(8): 1328-38, 2013.

10. Fabiano Oliveira, Bourama Traoré, Regis Gomes, Ousmane Faye, Dana C. Gilmore, Somita Keita, Pierre Traoré, Clarissa Teixeira, Cheick A. Coulibaly, Sibiry Samake, Claudio Meneses, Ibrahim Sissoko, Rick M. Fairhurst, Michael P.

Fay, Jennifer M. Anderson, Seydou Doumbia, **Shaden Kamhawi** and Jesus G. Valenzuela. Delayed-Type Hypersensitivity to Sand Fly Saliva in Humans from a Leishmaniasis-Endemic Area of Mali is T_H1-Mediated and Persists to Midlife. *Journal of Investigative Dermatology*, 133: 452-9, 2013.

11. Kristina M. Bacon, Peter J. Hotez, Stephanie D. Kruchten, **Shaden Kamhawi**, Maria Elena Bottazzi, Jesus G. Valenzuela, Bruce Y. Lee. The potential economic value of a cutaneous leishmaniasis vaccine in seven endemic countries in the Americas, *Vaccine*, 31(3): 480-6, 2013.

12. Abrudan J, Ramalho-Ortigão M, O'Neil S, Stayback G, Wadsworth M, Bernard M, Shoue D, Emrich S, Lawyer P, **Kamhawi S**, Rowton ED, Lehane MJ, Bates PA, Valenzeula JG, Tomlinson C, Appelbaum E, Moeller D, Thiesing B, Dillon R, Clifton S, Lobo NF, Wilson RK, Collins FH, McDowell MA. The characterization of the Phlebotomus papatasi transcriptome. *Insect Mol Biol.*, 22(2): 211-32, 2013.

13. Eric Dumonteil, Maria Elena Bottazzi, Bin Zhan, Michael J. Heffernan, Kathryn Jones, Jesus G. Valenzuela, **Shaden Kamhawi**, Jaime Ortega, Samuel Ponce de Leon Rosales, Bruce Y. Lee, Kristina M. Bacon, Bernhard Fleischer, BT Slingsby, Miguel Betancourt Cravioto, Roberto Tapia-Conyer, Peter J. Hotez. Special Report. Accelerating the Development of a Therapeutic Vaccine for Human Chagas Disease: Rationale and Prospects. Expert Review of Vaccines. doi: 10.1586/erv.12.85, 2012.

14. Regis Gomes, Fabiano Oliveira, Clarissa Teixeira, Claudio Meneses, Dana C. Gilmore, Dia-Eldin Elnaiem, **Shaden Kamhawi** and Jesus G. Valenzuela. Immunity to Sand Fly Salivary Protein LJM11 Modulates Host Response to Vector-Transmitted *Leishmania* Conferring Pathology-Free Protection. *J invest Dermatol*, doi: 10.1038/jid.2012.205. [Epub ahead of print], 2012.

15. Tetsuya Yanagida, Tahereh Mohammadzadeh, **Shaden Kamhawi**, Minoru Nakao, Seyed M Sadjjadi, Nawal Hijjawi, Abdel-Hafez Sami K, Yasuhito Sako, Munehiro Okamoto and Akira Ito. Genetic polymorphisms of *Echinococcus granulosus sensu stricto* in the Middle East. *Parasitol Int.* 61: 599–603, 2012.

16. Regis Gomes, Clarissa Teixeira, Fabiano Oliveira, Phillip G. Lawyer, Dia-Eldin Elnaiem, Claudio Meneses, Yasuyuki Goto, Ajay Bhatia, Randall F. Howard, Steven G. Reed, Jesus G. Valenzuela and **Shaden Kamhawi**. KSAC, a defined Leishmania antigen, plus adjuvant protects against the virulence of *L. major* transmitted by its natural vector *Phlebotomus duboscqi*. *PLoS Negl Trop Dis* 6 (4): e1610, 2012.

17. Ekaterina Giorgobiani, Phillip G. Lawyer, Giorgi Babuadze, Nato Dolidze, Ryan C. Jochim, Lamzira Tskhvaradze1, Konstantin Kikaleishvili, **Shaden Kamhawi**. Incrimination of *Phlebotomus kandelakii* and *Phlebotomus balcanicus* as Vectors of *Leishmania infantum* in Tbilisi, Georgia. *PLoS Negl Trop Dis* 6(4): e1609, 2012.

18. Peter J Hotez, Maria Elena Bottazzi, Eric Dumonteil, Jesus G. Valenzuela, **Shaden Kamhawi**, Jaime Ortega, Samuel Ponce de Leon Rosales, Miguel Betancourt Cravioto, and Roberto Tapia-Conyer. Texas and Mexico Sharing a

Legacy of Poverty and Neglected Tropical Diseases. PLoS Neglected Tropical Diseases Editorial, 6(3): e1497, 2012.

19. Ekaterina Giorgobiani, Nazibrola Chitadze, Gvantsa Chanturya, Marina Grdzelidze, Ryan C. Jochim, Anna Machablishvili, Tsiuri Tushishvili, Yulia Zedginidze, Marina Manjgaladze, Nino Iashvili, Manana Makharadze, Tsiuri Zakaraya, Konstantin Kikaleishvili, Ivan Markhvashvili, Goderdzi Badashvili, Teymuraz Daraselya, Michael P. Fay, **Shaden Kamhawi**, David Sacks. Epidemiologic Aspects of an Emerging Focus of Visceral Leishmaniasis in Tbilisi, Georgia. *PLoS Negl Trop Dis*, 5(12): e1415, 2011.

20. Mary Ann McDowell and **Shaden Kamhawi**. Targeting components in vector saliva. The Immune Response to Infection. Eds. S. H. E. Kaufmann, B. T. Rouse, and D. L. Sacks, ASM Press, 2011.

21. Xu Xueqing, Oliveira Fabiano, Chang Bianca W., Collin Nicolas, Gomes Regis, Teixeira Clarissa, Reynoso David, my Pham Van, Elnaiem Dia-Eldin, **Kamhawi Shaden**, Ribeiro José M.C., Valenzuela Jesus G. and Andersen John F. Structure and Function of a "Yellow" Protein from Saliva of the Sand Fly Lutzomyia longipalpis That Confers Protective Immunity against Leishmania major Infection Journal of Biological Chemistry, 286 (37): 32383-32393, 2011.

22. Jeffrey M. Bethony, Rhea N. Cole, Xiaoti Guo, **Shaden Kamhawi**, Marshall W. Lightowlers, Alex Loukas, William Petri, Steven Reed, Jesus Valenzuela and Peter J. Hotez. Vaccines to combat the neglected tropical diseases. *Immunological Reviews*, 239: 237–270, 2011.

23. Anderson JM, Samake S, Jaramillo-Gutierrez G, Sissoko I, Coulibaly CA, Bourama Traoré, Constance Soucko, Boubacar Guindo, Dansine Diarra, Michael P. Fay, Phillip G. Lawyer, Seydou Doumbia, Jesus G. Valenzuela, **Shaden Kamhawi**. Seasonality and Prevalence of *Leishmania major* Infection in *Phlebotomus duboscqi* Neveu-Lemaire from Two Neighboring Villages in Central Mali. *PLoS Negl Trop Dis* 5(5): e1139, 2011.

24. Iliano V Coutinho-Abreu , Rami Mukbel , Hanafi A Hanafi , Emad Y Fawaz , Shabaan S El-Hossary , Mariha Wadsworth , Gwen Stayback , Dilkushi A Pitts , Mahmoud Abo-Shehada , David F Hoel , **Shaden Kamhawi** , Marcelo Ramalho-Ortigao and Mary Ann McDowell. Expression plasticity of *Phlebotomus papatasi* salivary gland genes in distinct ecotopes through the sand fly season. BMC Ecology, 11:24doi:10.1186/1472-6785-11-24, 2011.

25. Deborah E. Dobson, **Shaden Kamhawi**, Phillip Lawyer, Salvatore J. Turco, Stephen M. Beverley, David L. Sacks. *Leishmania major* Survival in Selective *Phlebotomus papatasi* Sand Fly Vector Requires a Specific *SCG*-Encoded Lipophosphoglycan Galactosylation Pattern. *PLoS Pathog* 6(11): e1001185, 2010.

26. Clarissa Teixeira, Regis Gomes, Nicolas Collin, David Reynoso, Ryan Jochim, Fabiano Oliveira, Amy Seitz, Dia-Eldin Elnaiem, Arlene Caldas, Ana Paula de Souza, Claudia Brodskyn, Camila Indiani de Oliveira, Ivete Mendonca,

Carlos H. N. Costa, Peter Volf, Aldina Barral, **Shaden Kamhawi** and Jesus G. Valenzuela. Evidence for Markers of Exposure for Humans and Dogs Specific to Saliva of *Lutzomyia longipalpis*, the Vector of *Leishmania infantum chagasi* in Latin America. *PLoS Negl Trop Dis*, 4(3): e638, 2010.

27. Ranadhir Dey, Claudio Meneses, Poonam Salotra, **Shaden Kamhawi**, Hira L. Nakhasi and Robert Duncan. Characterization of a Leishmania stage-specific mitochondrial membrane protein that enhances the activity of cytochrome c oxidase and its role in virulence. Molecular Microbiology, 77(2): 399-414, 2010.

28. Amir Ahmad Akhavan, Hossein Mirhendi, Ali Khamesipour, Mohammad Hossein Alimohammadian, Yavar Rassi, Paul Bates, **Shaden Kamhawi**, Jesus G. Valenzuela, Mohammad Hossein Arandian, Hamid Abdoli, Niloufar Jalali-zand, Reza Jafari, Niloufar Shareghi, Maryam Ghanei, Mohammad Reza Yaghoobi-Ershadi. *Leishmania* species: Detection and identification by nested PCR assay from skin samples of rodent reservoirs. Experimental Parasitology, 126:552-556, 2010.

29. Fabiano Oliveira, Seydou Doumbia, Jennifer M. Anderson, Ousmane Faye, Souleymane S. Diarra, Pierre Traoré, Moumine Cisse, Guimba Camara, Koureissi Tall, Cheick A. Coulibaly, Sibiry Samake, Ibrahim Sissoko, Bourama Traoré, Daouda Diallo, Somita Keita, Rick M. Fairhurst, Jesus G. Valenzuela and **Shaden Kamhawi**. Discrepant Prevalence and Incidence of *Leishmania* Infection between Two Neighboring Villages in Central Mali Based on Leishmanin Skin Test Surveys. *PLoS Negl Trop Dis* 3(12): e565, 2009.

30. Nicolas Collin, Regis Gomes, Clarissa Teixeira, Lily Cheng, Andre Laughinghouse, Jerrold M. Ward, Dia-Eldin Elnaiem, Laurent Fischer, Jesus G. Valenzuela and **Shaden Kamhawi**. Sand Fly Salivary Proteins Induce Strong Cellular Immunity in a Natural Reservoir of Visceral Leishmaniasis with Adverse Consequences for *Leishmania*. *PLos Pathogens*, 5(5): e1000441, 2009.

31. Nathan C. Peters, Nicola Kimblin, Nagila Secundino, **Shaden Kamhawi**, Phillip Lawyer, David L. Sacks. Vector Transmission of *Leishmania* Abrogates Vaccine-Induced Protective Immunity. *PLos Pathogens*, 5(6): e1000484, 2009.

32. Oliveira, F., Jochim, R.C., Valenzuela, J.G. and **Kamhawi, S**. Sand flies, Leishmania, and transcriptome-borne solutions. *Parasitol Int*. 58(1):1-5, 2009.

33. **Shaden Kamhawi** and Jesus G. Valenzuela. Lectins in sand fly-*Leishmania* interactions. Animal lectins: A Functional View. Eds Gerardo Vasta AND Hafiz Ahmed. CRC Press, 2009.

34. Nicola Kimblin, Nathan Peters, Alain Debrabant, Nagila Secundino, Phillip Lawyer, Jackson Egan, **Shaden Kamhawi** and David Sacks. Determination of the infectious dose of *Leishmania major* transmitted by vector sand flies and its influence on disease severity. . *Proc Natl Acad Sci USA.,* 105:10125-30, 2008.

35. Peters NC, Egen JG, Secundino N, Debrabant A, Kimblin N, **Kamhawi S**, Lawyer P, Fay MP, Germain RN, Sacks D. In vivo imaging reveals an essential

role for neutrophils in leishmaniasis transmitted by sand flies. *Science*, 321(5891):970-4, 2008.

36. Fabiano Oliveira, Phil Lawyer, **Shaden Kamhawi** and Jesus Valenzuela. Immunity to distinct sand fly salivary proteins primes the anti-Leishmania immune response towards protection or exacerbation of disease. *PLoS Negl Trop Dis,* 2(4):e226, 2008.

37. Gomes Regis, Clarissa Teixeira, Maria Teixeira, Fabiano Oliveira, Maria Menezes, Claire Silva, Camila de Oliveira, Jose Miranda, Dia-Eldin Elnaiem, **Shaden Kamhawi**, Jesus Valenzuela, Claudia Brodskyn. Immunity to a salivary protein of a sand fly vector of visceral leishmaniasis protects against the fatal outcome of disease. *Proc Natl Acad Sci USA.* 105:7845-50, 2008.

38. Anderson CF, Lira R, **Kamhawi S**, Belkaid Y, Wynn TA, Sacks D. IL-10 and TGF-beta control the establishment of persistent and transmissible infections produced by Leishmania tropica in C57BL/6 mice. *J Immunol,* 180(6):4090-7, 2008.

39. Sacks, S., Lawyer, P. and **Kamhawi S**. The Biology of *Leishmania*- Sand fly Interactions. *Leishmania* after the genome. Eds Peter J. Myler and Nicolas Fasel, Caister Academic Press, 2008.

40. Hide, M., Bucheton, B., **Kamhawi S.**, Bras-Gonçalves R., Sundar S., Lemesre J.L., Bañuls A.L. Understanding human leishmaniasis: the need for an integrated approach. Encyclopedic guide to infectious disease reseach: modern methodologies. Ed. Michel Tibayrenc. Wiley Inc. 2007.

41. **Kamhawi S**. Phlebotomine sand flies and Leishmania parasites: friends or foes? Trends Parasitol. (9): 439-45, 2006.

42. Ramalho-Ortigão M, Jochim RC, Anderson JM, Lawyer PG, Pham VM, **Kamhawi S**, Valenzuela JG. Exploring the midgut transcriptome of *Phlebotomus papatasi*: comparative analysis of expression profiles of sugar-fed, blood-fed and *Leishmania-major*-infected sandflies. *BMC Genomics* 8:300, 2007.

43. Michael J. Donovan, Andrew S. Messmore, Deborah A. Scrafford, David L. Sacks, **Shaden Kamhawi**, and Mary Ann McDowell. Uninfected Mosquito Bites Confer Protection Against Malaria Infection. *Infec. Immun*. 75(5):2523-30, 2007.

44. Fabiano Oliveira, **Shaden Kamhawi**, Amy E. Seitz, Van My Pham, Pierre M. Guigal, Laurent Fischer, Jerrold Ward, and Jesus G. Valenzuela. From transcriptome to immunome: Identification of DTH inducing proteins from a *Phlebotomus ariasi* salivary gland cDNA library. *Vaccine* 24(3): 374-390*,* 2006.

45. Kato H, Anderson JM, **Kamhawi S**, Oliveira F, Lawyer PG, Pham VM, Sangare CS, Samake S, Sissoko I, Garfield M, Sigutova L, Volf P, Doumbia S, Valenzuela JG. High degree of conservancy among secreted salivary gland proteins from two geographically distant Phlebotomus duboscqi sandflies populations (Mali and Kenya). *BMC Genomics* 7:226, 2006.

46. van Zandbergen G, Bollinger A, Wenzel A, **Kamhawi S**, Voll R, Klinger M, Muller A, Holscher C, Herrmann M, Sacks D, Solbach W, Laskay T. *Leishmania* disease development depends on the presence of apoptotic promastigotes in the virulent inoculum. Proc Natl Acad Sci U S A., 103(37):13837-42, 2006. Epub 2006. Erratum in: *Proc Natl Acad Sci U S A.* 103(44):16615, 2006

47. Anderson JM, Oliveira F, **Kamhawi S**, Mans BJ, Reynoso D, Seitz AE, Lawyer P, Garfield M, Pham M, Valenzuela JG. Comparative salivary gland transcriptomics of sandfly vectors of visceral leishmaniasis. *BMC Genomics* 7:52, 2006.

48. J. Marcelo Ramalho-Ortigão, **Shaden Kamhawi**, Manju B. Joshi, David Reynoso, Philip G. Lawyer, Dennis M. Dwyer, Jesus G. Valenzuela and David L. Sacks. Characterization of a blood activated chitinolytic system in the midgut of the sand fly vectors *L. longipalpis* and *P. papatasi*. Insect Molecular Biology, 14 (6): 703-712, 2005.

49. **Kamhawi, S.**, Ramalho-Ortigao, M., Pham, V.M., Kumar, S., Lawyer, P.G., Turco, S.J., Barillas-Mury, C., Sacks, D.L. and Valenzuela, JG. A role of insect galectins in parasite survival. *Cell* 119: 329–41, 2004.

50. M. A. Nasrieh, S. K. Abdel-Hafez, **S. A. Kamhawi,** P. S. Craig, and P. M. Schantz. Cystic echinococcosis in Jordan: socioeconomic evaluation and risk factors. *Parasitology Research* 90: 456–466, 2003.

51. Ramalho-Ortigão JM, **Kamhawi S**, Rowton ED, Ribeiro JMC & Jesus G.Valenzuela. Cloning and characterization of trypsin- and chymotrypsin-like proteases from the midgut of the sand fly vector *Phlebotomus papatasi*. *Insect Biochemistry & Molecular Biology*, 33, 163-171, 2003.

52. **Kamhawi, S.:** The journey of *Leishmania* parasites within the digestive tract of phlebotomine sand flies. In Farrell, J. P. (Ed.): World Class Parasites: *Leishmania*, Volume IV. Kluwer Academic Publishers, U.S.A., 2002, pp. 59-73, 2002.

53. Joshi PB, Kelly BL, **Kamhawi S**, Sacks DL and McMaster WR. Targeted gene deletion in *Leishmania major* identifies leishmanolysin (GP63) as a virulence factor. *Molecular and Biochemical Parasitology ,* 120 (1): 33-40, 2002.

54. Sacks, D. and **Kamhawi, S.**. Molecular aspects of parasite-vector and vector-host interactions in leishmaniasis. Annual Reviews in Microbiol. 55:453-483, 2001.

55. Jesus G. Valenzuela, Yasmine Belkaid, Mark Garfield, Susana Mendez, **Shaden Kamhawi**, Edgar D. Rowton, David L. Sacks and Jose M.C. Ribeiro. Toward a Defined Anti-*Leishmania* Vaccine Targeting Vector Antigens: Characterization of a Protective Salivary Protein, *Journal of Experimental Medicine*, 194 (3), 331-342, 2001.

56. Belkaid Y., Hoffmann K.F., Mendez S., **Kamhawi S.**, Udey M.C., Wynn T.A. and Sacks D.L. The role of interleukin (IL)-10 in the persistence of *Leishmania major* in the skin after healing and the therapeutic potential of anti-IL-10 receptor

antibody for sterile cure, *Journal of Experimental Medicine*, 194 (10), 1497-1506, 2001.

57. Mendez S., Gurunathan S., **Kamhawi S.**, Belkaid Y., Moga M.A., Skeiky Y.A.W., Campos-Neto A., Reed S., Seder R. and Sacks D. The potency and durability of DNA- and protein–based vaccines against *Leishmania major* evaluated using low-dose, intra-dermal challenge, *Journal of Immunology* , 166, 5122-5128, 2001.

58. **Kamhawi S.**, Belkaid Y., Modi G., Rowton E. and Sacks D. Bites of uninfected sandflies vaccinate mice against cutaneous leishmaniasis, *Science*, 290 (5495), 1351-1354, 2000.

59. **Kamhawi, S.**. The biological and immunomodulatory properties of sand fly saliva and its role in the establishment of *Leishmania* infections. Microbes and Infection 2(14):1765-1773, 2000.

60. Belkaid Y.,Valenzuela J.G., **Kamhawi S.**, Rowton E., Sacks D.L. and Ribeiro, J.M.C. Delayed-type hypersensitivity to *Phlebotomus papatasi* sand fly bite: An adaptive response induced by the fly ?, *Proccedings of the National Academy of Sciences, USA*, 97(12):6704-6709, 2000*.*

61. **Kamhawi S.**, Modi G.B., Pimenta P.F.P., Rowton E. and Sacks D.L. The vectorial competence of *Phlebotomus sergenti* is restricted to *Leishmania tropica* and is controlled by species-specific, lipophosphoglycan mediated midgut attachment, *Parasitology*, 121:25-33, 2000.

62. El-Shehabi F.S., **Kamhawi S**., Schantz P.M., Craig P.S. and Abdel-Hafez S.K. Diagnosis of canine echinococcosis: comparison of coproantigen detection with necropsy in stray dogs and red foxes from northern Jordan. *PARASITE*, 7(2):83-90, 2000.

63. El-Shehabi F.S., Abdel-Hafez S.K. and **Kamhawi S.** Prevalence of intestinal helminths of dogs and foxes from Jordan. *Parasitology Research*, 85(11), 928-34, 1999.

64. Qadoumi, MZ; Abdel-Hafez SK; **Kamhawi S**. Chaetotaxy of fourth instar larvae of four Phlebotomus (Diptera: Psychocidae) sandflies from Jordan. *Arab Gulf Journal of Scientific Research*, 17, 111-126, 1999.

65. Ito A., Plancarte A., Ma L., Kong Y., Flisser A., Cho S.Y., Liu Y., **Kamhawi S.A.**, Lightowlers M.W., Schantz P. Novel antigens for neurocysticercosis: Simple method for preparation and evaluation for serodiagnosis, *American Journal of Tropical Medicine and Hygiene*, 59(2):291-4, 1998.

66. Jumaian N., **Kamhawi S.A.**, Halalsheh M. and Abdel-Hafez S.K. Short report: outbreak of cutaneous leishmaniasis in a nonimmune population of soldiers in Wadi Araba, Jordan. *American Journal of Tropical Medicine and Hygiene*, 58(2), 160-162, 1998.

67. Qadoumi M.Z., Abdel-Hafez S.K. and **Kamhawi S.A.**. Egg surface sculpturing of some Phlebotomus sandflies from Jordan (Diptera: Psychodidae). *Arab Gulf Journal of Scientific Research*, 16, 569-579, 1988.

68. Belkaid Y., **Kamhawi S.**, Modi G., Valenzuela J., Noben-Trauth N., Rowton E., Ribeiro J. and Sacks D.L. Development of a natural model of cutaneous leishmaniasis: powerful effects of vector saliva and saliva preexposure on the long-term outcome of Leishmania major infection in the mouse ear dermis. *Journal of Experimental Medicine*, 188(10), 1941-53, 1998.

69. Abdel-Hafez, S. K. and **Kamhawi, S. A.:** Cystic echinococcosis in Levant countries (Jordan, Palestinian Autonomy, Israel, Syria and Lebanon). In Anderson, F. L., Ouhelli, H. and M. Kachani (Eds.) Compendium on cystic echinococcosis in Africa and in Middle Eastern countries with special reference to Morocco. Brigham Young University, UT, U.S.A., 292-316, 1997.

70. Jumaian N.F., **Kamhawi S.**, Nimri F.A. and Abdel-Hafez, S.K. A case of intestinal myiasis caused by *Lucilia cuprina* (Wiedemann) from Jordan. *Japanese Journal of Parasitology*, 44, 361-364, 1995.

71. **Kamhawi S.**, Hijjawi N., Abu-Ghazaleh A. and Abbass M. Prevalence of hydatid cysts in livestock from five regions in Jordan. *Annals of Tropical Medicine and Hygiene*, 89, 621-629, 1995.

72. Janini R., Saliba E. and **Kamhawi S.** Species composition and population dynamics of *Phlebotomus papatasi* in the Jordan Valley, Jordan. *Journal of Medical Entomology*, 32, 822-826, 1995.

73. Janini R., Saliba E., Khouri S., Oumeish O., Adwan S. and **Kamhawi S.** Incrimination of *Phlebotomus papatasi* as vector of *Leishmania major* in the southern Jordan Valley, Jordan. *Medical and Veterinary Entomology*, 9, 420-422, 1995.

74. **Kamhawi S.** A retrospective study of human cystic echinococcosis in Jordan. *Annals of tropical Medicine and Parasitology*, 89, 409-414, 1995.

75. **Kamhawi S.**, Abdel-Hafez S. K. and Molyneux D.H. A comprehensive account of species composition, distribution and ecology of phlebotomine sandflies in Jordan. *PARASITE*, 2, 163-172, 1995.

76. **Kamhawi S.**, Abdel-Hafez S.K. and Arbagi A. A new focus of *Leishmania tropica* in Northern Jordan. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 89, 255-257, 1995.

77. **Kamhawi S.**, Hijjawi N., Shatnawi N. and Abdel-Hafez S. Multiple cystic echinococcosis in a Jordanian patient: case report and *in vitro* culturing. *Japanese Journal of Parasitology*, 43, 489-492, 1994.

78. Nasrieh M.A, Abdel-Hafez S.K., **Kamhawi S.,** Craig, P.S. and Schantz P.M. Cystic echinococcosis in Jordan: socioeconomic evaluation and risk factors. Parasitology Research 90: 456–466, 1993.

79. Abdel-Hafez S.K. and **Kamhawi S.** Cystic echinococcosis in Jordan. *Echinomed*, 9, 5, 1993.

80. **Kamhawi S.**, Arbagi A., Adwan S. and Rida M. Environmental manipulation in the control of a zoonotic cutaneous Leishmaniasis focus*. Archives de L'Institut Pasteur de Tunis*, 70, 383-390, 1993.

81. Hijjawi N.S., Abdel-Hafez S.K. and **Kamhawi S.A.** *Echinococcus granulosus*: Formation of a Shelled Egg *In Vitro*. *International Journal of Parasitology*, 22, 117-118, 1992.

82. **Kamhawi S.**, Lane R.P., Cameron M., Phillips A., Milligan P. and Molyneux D.H.The Cuticular Hydrocarbons of *Phlebotomus argentipes* from Field Populations (N. India and Sri Lanka) and their Change with Laboratory Colonization. *Bulletin of Entomological Research*, 82, 209-212, 1992.

83. **Kamhawi S.**, Abdel-Hafez S.K. and Molyneux D.H. 1991. The Dispersal and Behaviour of sandflies in Ras El Naqb, South Jordan, with particular emphasis on *Phlebotomus kazeruni*. *Parasitologia*, 33 (Suppl. 1), 307-314, 1991.

84. **Kamhawi S.**, Abdel-Hafez S.K. and Molyneux D.H. Urbanization - Does it affect the abundance and behaviour of sandflies? *Parasitologia*, 33 (Suppl. 1), 299-306, 1991.

85. Phillips A., Milligan P.J.M., Maroli M., Lane R., **Kamhawi S.** and Molyneux D.H. Intraspecific Variation in the Cuticular Hydrocarbons of *Phlebotomus perfiliewi* in Italy. *Medical and Veterinary Entomology*, 4, 451-457, 1990.

86. **Kamhawi S.**, Abdel-Hafez S. and Molyneux D.H. 1990. Sandfly Control: Use of a Simple Method to Reduce Biting Rates in Jordan. *Parasitology Today*, 5, 1990.

87. Phillips A., **Kamhawi S.**, Milligan P.J.M. and Molyneux D.H. Cuticular Hydrocarbons Analysis as a Tool in sandfly Identification. Leishmaniases (Ed. D.T. Hart) NATO/ASI Publication, Plenum Press, N.Y., 1989.

88. Lane R.P., Abdel-Hafez S. and **Kamhawi S.** The Distribution of Phlebotomine sandflies in the Principal Ecological Zones of Jordan. *Medical and Veterinary Entomology*, 2, 237-246, 1988.

89. **Kamhawi S.A.**, Abdel-Hafez S. and Molyneux D.H. 1988. Ecology and Distribution of Sandflies (Diptera:Psychodidae) in Aqaba District, South Jordan. *Fauna of Saudi Arabia*, 9, 83-89, 1988.

90. **Kamhawi S.**, Molyneux D.H., Killick-Kendrick R., Milligan P.J.M., Phillips A., Wilkes T.J. and Killick-Kendrick M. 1987. Two populations of *Phlebotomus ariasi* in the Cevennes focus of Leishmaniasis in the south of France revealed by

analysis of cuticular hydrocarbons. *Medical and Veterinary Entomology*, 1, 97-102.