BIOGRAPHICAL SKETCH

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NAME: Kim, Brian Sangwoo

eRA COMMONS USER NAME (credential, e.g., agency login): kimbrian

POSITION TITLE: Assistant Professor of Medicine

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
Haverford College	B.S. (Hons)	05/2001	Chemistry
National Institutes of Health/HHMI	N/A	07/2006	Immunology
University of Washington	M.D.	06/2007	Medicine
University of Washington	Intern	06/2008	Internal Medicine
University of Pennsylvania	Resident	06/2011	Dermatology
University of Pennsylvania	Postdoc	06/2014	Dermatology
University of Pennsylvania	M.T.R.	06/2014	Translational Research

A. Personal Statement

My long-term goals are to understand the regulatory mechanisms that control immune cell homeostasis at the skin barrier surface. Employing diverse models of allergic inflammation, autoimmunity, and microbial colonization, I am examining how innate and adaptive immune responses are regulated in the skin. Over the last 14 years, I have developed both basic and translational expertise in examining how immune cell responses are regulated in the context of inflammatory skin diseases. I began my training in immunology in 2004 as a Howard Hughes Medical Institute (HHMI)-National Institutes of Health (NIH) Research Scholar at NIH. My primary project in the laboratory of Dr. Stephen Katz focused on the role of epidermal keratinocytes and dendritic cells in mediating graft-versus-host disease (GvHD) in the skin. Subsequently, I pursued clinical residency training in dermatology at the Perelman School of Medicine at the University of Pennsylvania (UPenn) on the clinician-scientist track. In 2010, I entered the laboratory of Dr. David Artis as a postdoctoral fellow where I continued my training in immunology studying the cellular mechanisms underlying atopic dermatitis (AD). At the same time, I started a weekly AD specialty clinic at the Children's Hospital of Philadelphia (CHOP) where I developed an expertise in managing severe pediatric AD associated with multiple other allergic diseases. In 2011, I became a Clinical Instructor of Dermatology at UPenn and received my first independent grant from the UPenn Skin Disease Research Center (SDRC). The focus of the SDRC grant was to study the role of epithelial cell-derived cytokines in regulating innate immune cell homeostasis in the skin. These studies led me to apply for a Clinical and Translational Science Award (CTSA) from the Institute for Translational Medicine and Therapeutics (ITMAT) at UPenn and I received my first career development award (CTSA KL2) in 2012. In 2014, I received my NIH K08 Award and was also the recipient of an American Skin Association Research Grant. I was awarded the Doris Duke Charitable Foundation Clinician Scientist Award to support studies on chronic pruritus related to AD in 2016. I was also a finalist for the Burroughs Wellcome Fund Career Awards for Medical Scientists. Most recently, I was awarded my first NIH R01 Award in August of 2016. I received a Masters in Translational Research (MTR) in May 2014 and have employed skill sets derived from the MTR curriculum to translate hypotheses generated from mechanistic animal models to human studies. To date, I have published 36 primary peer-reviewed research papers, six basic science reviews and three clinical reviews in high profile journals including *Cell*, *Nature*, *Nature Immunology, Nature Medicine, Nature Genetics, Nature Communications, Science Translational Medicine*,

Immunity, Journal of Experimental Medicine, *Microbiome, Journal of Immunology*, *FEBS Letters, Journal of Allergy and Clinical Immunology*, *Current Opinion in Immunology, Journal of Investigative Dermatology*, *JAMA Dermatology*, *Archives of Dermatology, Cold Spring Harbor Perspectives in Biology*, and *Seminars in Immunopathology*. I have directly trained two undergraduate students, one of whom is currently a medical student at Baylor College of Medicine and another who is a Medical Scientist Training Program (MSTP) student at the Ohio State University College of Medicine and a former Amgen Scholar. I also trained a medical student who was selected for the Howard Hughes Medical Institute (HHMI) Medical Fellows Program to join my laboratory and has matched at a research-based residency in dermatology. Currently in the laboratory, I have two graduate students, two MSTP students, and a physician-scientist research fellow. As a faculty member, I am also actively engaged in the Division of Biology and Biomedical Sciences (DBBS), MSTP and graduate immunology programs with regard to recruitment, interviewing, and teaching of course materials. I have also served as an ad hoc member on multiple NIH study sections for both basic science and clinical trial grants. Finally, I have also designed a phase 2 multicenter randomized controlled trial for AD that is currently underway. These achievements demonstrate my expertise, leadership, mentorship, training, motivation, and strong track record in the areas of immunology, neuroscience, itch biology, dermatology, and atopic dermatitis.

1. Oetjen, L.K., Mack, M.R., Feng, J., Whelan, T.M., Niu, H., Guo, C.J., Chen, S., Trier, A.M., Xu, A.Z., Tripathi, S.V., Luo, J., Gao, X., Yang, L., Hamilton, S.L., Wang, P.L., Brestoff, J.R., Council, M.L., Brasington, R., Schaffer, A., Brombacher, F., Hsieh,C.S., Gereau, R.W., Miller, M.J., Chen, Z.F., Hu, H., Davidson, S., Liu, Q., and **Kim, B.S.** (2017). Sensory Neurons Co-opt Classical Immune Signaling Pathways to Mediate Chronic Itch. Cell: 171(1):217-228. PMID: 28890086

2. **Kim, B.S.**, Siracusa, M.C., Saenz, S.A., Noti, M., Monticelli, L.A., Sonnenberg, G.F., Van Voorhees, A.S., Smith, D.E., Comeau, M.R., Artis, D. (2013). TSLP elicits IL-33-independent innate lymphoid cell responses to promote skin inflammation. Science Translational Medicine 5(170), 170ra16. PMID: 23363980 PMCID: PMC3637661

3. **Kim, B.S.**, Wang, K., Siracusa, M.C., Saenz, S.A., Brestoff, J.B., Monticelli, L.A., Noti, M., Tait Wojno, E.D., Fung, T.C., Kubo, M., Artis, D. (2014). Basophils promote innate lymphoid cell responses in inflamed skin. Journal of Immunology 193(7), 3717-3725. PMID: 25156365 PMCID: PMC4170007

4. Margolis, D.J., **Kim, B.**, Apter, A.J., Gupta, J., Hoffstad, O., Papadopoulos, M., Mitra, N. (2014). Thymic stromal lymphopoietin variation, filaggrin loss-of-function, and the persistence of atopic dermatitis, JAMA Dermatology 150(3), 254-259. PMID: 24401911 PMCID: PMC4414492

B. Positions and Honors

Positions and Employment

2011-2014	Instructor, Department of Dermatology, Perelman School of Medicine at the University of Pennsylvania, Philadelphia, PA
2014-	Assistant Professor, Division of Dermatology, Department of Internal Medicine, Washington University School of Medicine, St. Louis, MO
2014-	Co-Director, Center for the Study of Itch, Washington University School of Medicine, St. Louis, MO

Other Experience and Professional Memberships

1998	Howard Hughes Medical Institute Research Fellow
1999	Howard Hughes Medical Institute Interdisciplinary Scholar
2001	Colin F. MacKay Prize in Chemistry
2002	University of Washington Medical Student Research Training Program Fellow
2004	Howard Hughes Medical Institute-National Institutes of Health Research Scholar
2008-	Society for Investigative Dermatology Member
2009-2011	American Academy of Dermatology, Council on Science and Research
2010-2012	American Medical Association (Delegate)

2010-2012 Society for Investigative Dermatology, Delegate to the American Medical Association
2011- American Academy of Dermatology (Member, Fellow)
2011 American Academy of Dermatology Healthy Policy Retreat Attendee
2011 American Academy of Dermatology Legislative Conference Attendee
2012- Ad hoc reviewer for Journal of Investigative Dermatology
2014- Ad hoc reviewer for Nature Medicine
2015- Ad hoc reviewer for PLOS ONE
2015- Ad hoc reviewer for Genome Research
2015- Ad hoc reviewer for Journal of the American Academy of Dermatology
2017- Ad hoc reviewer for New England Journal of Medicine
2017- Chair, Cell Symposia: Neuro-Immune Axis
2018- Ad hoc reviewer for Cell
2018- Ad hoc reviewer for Nature Immunology
2018- Ad hoc reviewer for Immunity
2018- Ad hoc reviewer for Proceedings of the National Academy of the Sciences

Honors

2005 National Cancer Institute Cancer Research Training Award
2005 Howard Hughes Medical Institute Research Training Fellowship for Medical Students
2007 Alpha Omega Alpha
2010 Society for Investigative Dermatology Travel Grant Recipient
2013 1st Prize Johnson-Beerman Award, College of Physicians, Section on Dermatology
2014 American Academy of Dermatology Young Investigator Award
2014 American Society for Clinical Investigation Young Physician-Scientist Award
2014 Burroughs Wellcome Fund Career Award for Medical Scientists Finalist
2016 St. Louis Business Journal's 40 Under 40 Class of 2016
2016 Doris Duke Charitable Foundation Clinician Scientist Development Award

C. Contribution to Science

1. As a tenure-track assistant professor, my laboratory program has focused on understanding how immune cells and cytokines influence sensory perception. My publications in neuroimmunology have focused on three fundamental concepts: (1) identifying how the immune system triggers sensations of itch, (2) defining new itch-sensory pathways, and (3) uncovering new therapeutic strategies for chronic itch patients. As a corresponding author, I have published one clinical paper identifying previously unrecognized immune dysregulation in patients with chronic idiopathic pruritus (CIP). Subsequently, we published a paper in *Cell* in 2017 identifying novel functions of IL-4, IL-13, and JAK1 in neurons to promote itch. In support of our findings, multiple phase 2 clinical trials for JAK inhibitors in AD have identified unprecedented efficacy in suppressing atopic itch as early as 24 hours after treatment. Further, patients with JAK1 gain-of-function mutations were identified in 2017 and found to have intractable itch that was only responsive to JAK inhibitors and not immunosuppresants. **Taken together, these studies have identified novel pathways that represent unique and important targets for the treatment of chronic itch.** The fundamental discovery of type 2 cytokine-neural circuits opens up a new field of inquiry combining innate immunity, neuroscience, and biochemistry.

a. Oetjen, L.K., Mack, M.R., Feng, J., Whelan, T.M., Niu, H., Guo, C.J., Chen, S., Trier, A.M., Xu, A.Z., Tripathi, S.V., Luo, J., Gao, X., Yang, L., Hamilton, S.L., Wang, P.L., Brestoff, J.R., Council, M.L., Brasington, R., Schaffer, A., Brombacher, F., Hsieh,C.S., Gereau, R.W., Miller, M.J., Chen, Z.F., Hu, H., Davidson, S., Liu, Q., and **Kim, B.S.** (2017). Sensory Neurons Co-opt Classical Immune Signaling Pathways to Mediate Chronic Itch. Cell: 171(1):217-228. PMID: 28890086
b. Xu, A.Z., Kim, B.S., Tripathi, S.V., Kau, A.L., Schaffer, A., **Kim B.S.** (2016). Immune dysregulation underlies a subset of patients with chronic idiopathic pruritus. Journal of the American Academy Dermatology: 74(5):1017-20. PMID: 27085236 PMCID: PMC4834432
c. Feng, J., Luo, J., Mack, M.R., Yang, P., Zhang, F., Wang, G., Gong, X., Cai, T., Mei, Z., **Kim, B.S.**, Yin, S., Hu, H. (2017). The antimicrobial peptide human beta-defensin 2 promotes itch through Toll-like receptor 4 signaling in mice. Journal of Allergy and Clinical Immunology: pii: S0091-6749(17)30663-2. PMID: 28442325

2. My publications during my postdoctoral fellowship (laboratory of David Artis) studied the role of epithelial cell-derived cytokines in regulating skin inflammation. At the time, it was widely believed that adaptive immune cells were the main contributors to the pathogenesis of AD or eczema. As a lead author, I identified previously unrecognized group 2 innate lymphoid cells (ILC2s) for the first time in the skin of both mice and humans and implicated them in the pathogenesis of AD. To date, this paper has been cited 310 times since 2013, highlighting its potential impact on the field of innate immunity. In a follow-up publication in 2014 (cited 96 times), I identified that basophils influence the function of ILC2s and also contribute to the pathogenesis of AD. **Taken together, these studies have provoked a new paradigm in which, in addition to adaptive immune cells, the innate immune response contributes significantly to the development of skin inflammation and AD.** The fundamental discovery of skin ILC2s and the identification of the role of basophils skin inflammation forms the basis of my current work investigating the neuroimmunologic regulation of atopic itch as outlined in this proposal.

a. **Kim, B.S.**, Siracusa, M.C., Saenz, S.A., Noti, M., Monticelli, L.A., Sonnenberg, G.F., Van Voorhees, A.S., Smith, D.E., Comeau, M.R., Artis, D. (2013). TSLP elicits IL-33-independent innate lymphoid cell responses to promote skin inflammation. Science Translational Medicine 5(170), 170ra16. PMID: 23363980 PMCID: PMC3637661
b. **Kim, B.S.**, Wang, K., Siracusa, M.C., Saenz, S.A., Brestoff, J.B., Monticelli, L.A., Noti, M., Tait Wojno, E.D., Fung, T.C., Kubo, M., Artis, D. (2014). Basophils promote innate lymphoid cell responses in inflamed skin. Journal of Immunology 193(7), 3717-3725. PMID: 25156365 PMCID: PMC4170007
c. Roediger, G., Kyle, R., Yip, K.H., Sumaria, N., Guy, T.V., **Kim, B.S.**, Mitchell, M.J., Tay, S.S., Jain, R., Forbes-Blom, E., Chen, X., Tong, P.L., Bolton, H.A., Artis, D., Paul, W.E., Fazekas de St. Groth, B., Grimbaldeston, M.A., Le Gros, G., Weninger, W. (2013). Cutaneous immunosurveillance and regulation of inflammation by group 2 innate lymphoid cells. Nature Immunology 14(6), 564-573. PMID: 23603794 PMCID: PMC4282745
d. **Kim, B.S.** (2014). Innate lymphoid cells in the skin. Journal of Investigative Dermatology 135(3), 673-678. PMID: 25339380 PMCID: PMC4556524

3. I have also published extensively through direct collaborations with both basic science and clinical research colleagues. Through this work, we established the importance of thymic stromal lymphopoietin (TSLP), IL-33, ILC2s and/or basophils in contributing to AD disease persistence, type 2 inflammation, protective immunity and metabolic homeostasis in multiple other organ systems including the skin, gut, lung and adipose tissue. **These studies have demonstrated that the cellular and molecular mechanisms uncovered in my work are important in human disease and conserved across multiple systems and disease states.**

a. Noti M., Tait Wojno E.D., **Kim B.S.**, Siracusa M.C., Giacomin P.R., Nair M.G., Benitez A.J., Ruymann K.R., Muir A.B., Hill D.A., Kudakwashe R.C., Moghaddam A.E., Sattentau Q.J., Menard-Katcher P., Kubo M., Comeau M.R., Brown-Whitehorn T., Sleiman P.M., Hakonarson H., Cianferoni A., Falk G.W., Wang M.L., Spergel J.M., Artis D. (2013). TSLP-elicited basophil responses mediate the pathogenesis of eosinophilic esophagitis. Nature Medicine 19(8):1005-13. PMCID: PMC3951204
b. Margolis D.J., **Kim B.**, Apter A.J., Gupta J., Hoffstad O., Papadopoulos M., Mitra N. (2014). Thymic stromal lymphopoietin variation, filaggrin loss-of-function, and the persistence of atopic dermatitis. JAMA Dermatology 150(3):254-9. PMID: 24401911 PMCID: PMC4414492
c. Noti, M., **Kim, B.S.**, Siracusa, M.C., Rak, G.D., Kubo, M., Moghaddam, A.E., Sattentau, Q.A., Comeau, M.R., Spergel, J.M., Artis, D. (2014). Exposure to food allergens through inflamed skin promotes intestinal food allergy through the thymic stromal lymphopoietin-basophil axis. Journal of Allergy and Clinical Immunology, 133(5), 1390-1399. PMID: 24560412 PMCID: PMC4007098
d. Brestoff J.R., **Kim B.S.**, Saenz S.A., Stine R.R., Monticelli L.A., Sonnenberg G.F., Thome J.J., Farber D.L., Lutfy K., Seale P., Artis D. (2015). Group 2 innate lymphoid cells promote beiging of white adipose tissue and limit obesity. Nature, 519(7542), 242-246. PMID: 25533952 PMCID: PMC4447235

4. My early publications as an HHMI-NIH Scholar (laboratory of Stephen I. Katz) addressed the role of the adaptive immune response in initiating inflammation in the skin. At the time, it was widely appreciated that $CD8^+$ T cells contribute greatly to the pathogenesis of graft-versus-host disease (GvHD). However, the cytokines that regulate this process and the dendritic cell subsets that prime T cells in this context were unclear. In one co-authored study, I helped to identify that the cytokine IL-15 is a critical stimulator of $CD8^+$ T cells in GvHD-like disease. Subsequently, it has been shown by multiple other groups that IL-15 is an essential component for the

development of GvHD-like disease. In a related but separate study, as a lead author, I identified that keratinocytes can directly stimulate the initiation of antigen-dependent T cell responses to mediate GvHD-like disease. **These studies have highlighted that epithelial cells can directly engage the adaptive immune system to promote skin inflammation.** The conceptual advances from this early work led me to pursue my later work in epithelial cell-derived cytokine biology (see above).

a. **Kim, B.S.**, Miyagawa, F., Cho, Y.H., Bennett, C.L., Clausen, B.E., Katz, S.I. (2009). Keratinocytes function as accessory cells for presentation of endogenous antigen expressed in the epidermis. Journal of Investigative Dermatology, 129(12), 2805-2817. PMID: 19554018 PMCID: PMC2784095
b. Miyagawa, F., Tagaya, Y., **Kim, B.S.**, Patel, H.J., Ishida, K., Ohteki, T., Waldmann, T.A., Katz, S.I. (2008). IL-15 serves as a costimulator in determining the activity of autoreactive CD8 T cells in an experimental mouse model of graft-versus-host-like disease. Journal of Immunology, 181(2), 1109-1119. PMID: 18606663 PMCID: PMC2435206

Complete List of Published Work in MyBibliography
http://www.ncbi.nlm.nih.gov/sites/myncbi/brian.kim.1/bibliography/47517480/public/?sort=date&direction=ascending

D. Research Support

Ongoing Research Support

K08-AR065577 Kim (PI) 04/01/2014–03/31/2019 3.0 calendar
Innate Immune Regulation of Skin Inflammation
The goal of this study is to test the role of group 2 innate lymphoid cells (ILC2s) and commensal microbiota in regulating skin inflammation in the context of atopic dermatitis.
Role: PI

R01-AR079062 Margolis (PI) 02/18/16 – 01/31/21 0.6 calendar
African-Americans with Atopic Dermatitis: Skin Barrier & Immune Dysregulation
The purpose of this project is to investigate novel mutations in genes that encode skin barrier proteins as they relate to immune dysfunction in African-American patients with atopic dermatitis.
Role: Key Personnel

Doris Duke CSDA Kim (PI) 07/01/16 – 07/01/16 1.2 calendar
Immune Regulation of Atopic Dermatitis and Itch
The aims of this proposal are to employ novel mass cytometric approaches to define complex cellular immune signatures that underlie atopic dermatitis and uncover previously unrecognized neuroimmunologic itch-sensory pathways.
Role: PI

R01-AR070116 Kim (PI) 08/05/16 – 07/01/21 3.6 calendar
Immune Regulation of Atopic Itch
The goal of this proposal is to identify whether type 2 inflammatory cells interact with sensory neurons to mediate chronic itch and whether the sensation of itch is dependent on Janus kinase (JAK) signaling.
Role: PI

Completed Research Support

KL2-RR024132 Fitzgerald (PI) 07/01/2012–06/30/2014 9.6 calendar
The Role of Thymic Stromal Lymphopoietin (TSLP) and Basophils in the Atopic March
The major goals of this project were to investigate the mechanisms by which TSLP and basophils promote type 2 inflammation in the skin and subsequently lead to allergic diseases at other barrier surfaces such as the gut.
Role: Postdoctoral fellow

American Skin Association Kim (PI) 01/01/2015—12/31/2015
Cytokine Regulation of Atopic itch
The major goal of this study is to examine how IL-4 receptor alpha regulates neurophysiologic itch in the context of atopic dermatitis.
Role: PI