

# 2014 Research Annual Report

## Center for Autoimmune Genomics & Etiology



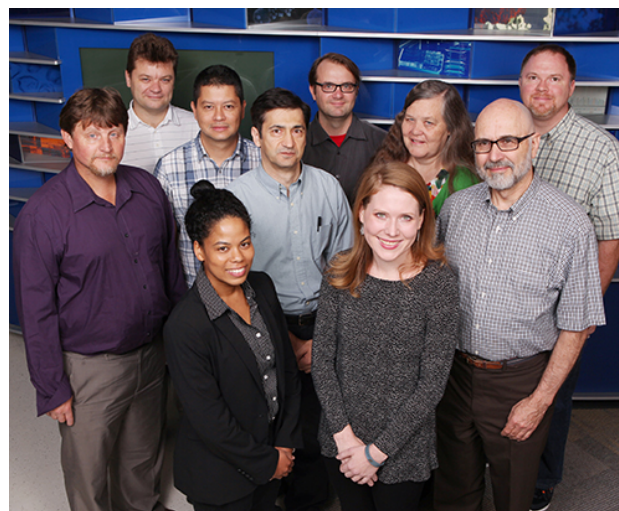
### Division Summary

#### RESEARCH AND TRAINING DETAILS

|                                |             |
|--------------------------------|-------------|
| Number of Faculty              | 10          |
| Number of Research Fellows     | 4           |
| Number of Research Students    | 20          |
| Number of Support Personnel    | 32          |
| Direct Annual Grant Support    | \$2,296,435 |
| Direct Annual Industry Support | \$220,000   |
| Peer Reviewed Publications     | 41          |

#### CLINICAL ACTIVITIES AND TRAINING

### Division Photo



Row 1: H Moncrieffe, L Kottyan  
Row 2: K Kaufman, B Namjou-Khales, J Harley  
Row 3: I Chepelev, S Thompson  
Row 4: A Porollo, M Weirauch, S Waggoner

## Significant Accomplishments

### Progress in understanding the roles of transcription factors

Transcription factors (TFs) play a key role in gene regulation by recognizing short genomic DNA sequences, called “motifs.” Discovering how TFs work is crucial to understand genome function, in both normal and disease states. However, DNA sequence binding specificities are currently known for less than 2 percent of eukaryotic TFs. A recent study led by [Matt Weirauch, PhD](#), describes a novel procedure that has identified 34 percent of TF binding motifs and is freely available. Weirauch and his colleagues also demonstrated how this tool can be used to identify TFs that might be affected by human disease-associated genetic variants.

### Controlling Natural Killer cells may be key to better vaccines

Natural Killer cells help eliminate dangerous cells, such as some cancer cells. [Stephen Waggoner, PhD](#), has learned that these cells also impair the immune response against some infections by neutralizing cells that fight the infection. The National Institute for Drug Abuse is funding his proposal in the fight against AIDS and HIV infection to develop more effective vaccines.

### Celebrating our PhD students

MD-PhD candidate, Sam Vaughn presented his findings on how PDK interacts with BCR, the immunoglobulin receptor on B lymphocytes, at the International Immunology Congress in Milan, Italy. Carolyn Rydyznski, who works on NK cell regulation of vaccine responses, won a travel award to visit the Scripps Institute in order to

bring technology associated with reverse engineering of arenaviral vaccine vectors to Cincinnati Children's. Laura Brungs is applying knowledge gained at an NIH-sponsored workshop on analyzing next generation sequencing data to her work examining rare de novo sequence mutations in juvenile idiopathic arthritis patients. Meanwhile, Carolyn Rydinski, Ke "Coco" Liu and Xiaoming Lu all won travel awards to the national meeting of American Association of Immunologists to present their research.

## Division Publications

1. Adrianto I, Lin CP, Hale JJ, Levin AM, Datta I, Parker R, Adler A, Kelly JA, Kaufman KM, Lessard CJ, Moser KL, Kimberly RP, Harley JB, Iannuzzi MC, Rybicki BA, Montgomery CG. **Correction: Genome-Wide Association Study of African and European Americans Implicates Multiple Shared and Ethnic Specific Loci in Sarcoidosis Susceptibility.** *PLoS One*. 2013; 8.
2. Angeles-Han ST, McCracken C, Pichavant M, Jenkins K, Ponder L, Myoung E, Stevens KR, Vogler LB, Kennedy C, Yeh S, Cope S, Bohnsack JF, Hersh AO, Thompson SD, Prahalad S. **A123: HLA Associations in a Matched Cohort of Juvenile Idiopathic Arthritis Children With and Without Uveitis.** *Arthritis Rheumatol*. 2014; 66 Suppl 11:S160-1.
3. Ardoin SP, Schanberg LE, Sandborg CI, Barnhart HX, Evans GW, Yow E, Mieszkalski KL, Ilowite NT, Eberhard A, Imundo LF, Kimura Y, Levy D, von Scheven E, Silverman E, Bowyer SL, Punaro L, Singer NG, Sherry DD, McCurdy DK, Klein-Gitelman M, Wallace C, Silver RM, Wagner-Weiner L, Higgins GC, Brunner HI, Jung L, Soep JB, Reed AM, Thompson SD, investigators A. **Secondary analysis of APPLE study suggests atorvastatin may reduce atherosclerosis progression in pubertal lupus patients with higher C reactive protein.** *Ann Rheum Dis*. 2014; 73:557-66.
4. Barbar-Smiley F, Thompson SD, Higgins GC. **A37: children with small joint oligoarticular onset juvenile idiopathic arthritis are more likely to develop extended arthritis.** *Arthritis Rheumatol*. 2014; 66 Suppl 11:S57.
5. Caster DJ, Korte EA, Nanda SK, McLeish KR, Oliver RK, G'Sell R T, Sheehan RM, Freeman DW, Coventry SC, Kelly JA, Guthridge JM, James JA, Sivils KL, Alarcon-Riquelme ME, Scofield RH, Adrianto I, Gaffney PM, Stevens AM, Freedman BI, Langefeld CD, Tsao BP, Pons-Estel BA, Jacob CO, Kamen DL, Gilkeson GS, Brown EE, Alarcon GS, Edberg JC, Kimberly RP, Martin J, Merrill JT, Harley JB, Kaufman KM, Reveille JD, Anaya JM, Criswell LA, Vila LM, Petri M, Ramsey-Goldman R, Bae SC, Boackle SA, Vyse TJ, Niewold TB, Cohen P, Powell DW. **ABIN1 dysfunction as a genetic basis for lupus nephritis.** *J Am Soc Nephrol*. 2013; 24:1743-54.
6. Dozmorov I, Dominguez N, Sestak AL, Robertson JM, Harley JB, James JA, Guthridge JM. **Evidence of dynamically dysregulated gene expression pathways in hyperresponsive B cells from African American lupus patients.** *PLoS One*. 2013; 8:e71397.
7. Freedman BI, Langefeld CD, Andringa KK, Croker JA, Williams AH, Garner NE, Birmingham DJ, Hebert LA, Hicks PJ, Segal MS, Edberg JC, Brown EE, Alarcon GS, Costenbader KH, Comeau ME, Criswell LA, Harley JB, James JA, Kamen DL, Lim SS, Merrill JT, Sivils KL, Niewold TB, Patel NM, Petri M, Ramsey-Goldman R, Reveille JD, Salmon JE, Tsao BP, Gibson KL, Byers JR, Vinnikova AK, Lea JP, Julian BA, Kimberly RP, Lupus Nephritis-End-Stage Renal Disease C. **End-stage renal disease in African Americans with lupus nephritis is associated with APOL1.** *Arthritis Rheumatol*. 2014; 66:390-6.
8. Fuxman Bass JI, Tamburino AM, Mori A, Beittel N, Weirauch MT, Reece-Hoyes JS, Walhout AJ. **Transcription factor binding to *Caenorhabditis elegans* first introns reveals lack of redundancy with gene promoters.** *Nucleic Acids Res*. 2014; 42:153-62.
9. Gorelik M, Fall N, Altaye M, Barnes MG, Thompson SD, Grom AA, Hirsch R. **Follistatin-like protein 1 and the ferritin/erythrocyte sedimentation rate ratio are potential biomarkers for dysregulated gene**

- expression and macrophage activation syndrome in systemic juvenile idiopathic arthritis.** *J Rheumatol.* 2013; 40:1191-9.
10. Green JV, Orsborn KI, Zhang M, Tan QK, Greis KD, Porollo A, Andes DR, Long Lu J, Hostetter MK. **Heparin-binding motifs and biofilm formation by *Candida albicans*.** *J Infect Dis.* 2013; 208:1695-704.
11. Guthridge JM, Lu R, Sun H, Sun C, Wiley GB, Dominguez N, Macwana SR, Lessard CJ, Kim-Howard X, Cobb BL, Kaufman KM, Kelly JA, Langefeld CD, Adler AJ, Harley IT, Merrill JT, Gilkeson GS, Kamen DL, Niewold TB, Brown EE, Edberg JC, Petri MA, Ramsey-Goldman R, Reveille JD, Vila LM, Kimberly RP, Freedman BI, Stevens AM, Boackle SA, Criswell LA, Vyse TJ, Behrens TW, Jacob CO, Alarcon-Riquelme ME, Sivils KL, Choi J, Joo YB, Bang SY, Lee HS, Bae SC, Shen N, Qian X, Tsao BP, Scofield RH, Harley JB, Webb CF, Wakeland EK, James JA, Nath SK, Graham RR, Gaffney PM. **Two functional lupus-associated BLK promoter variants control cell-type- and developmental-stage-specific transcription.** *Am J Hum Genet.* 2014; 94:586-98.
12. Kim-Howard X, Sun C, Molineres JE, Maiti AK, Chandru H, Adler A, Wiley GB, Kaufman KM, Kottyan L, Guthridge JM, Rasmussen A, Kelly J, Sanchez E, Raj P, Li QZ, Bang SY, Lee HS, Kim TH, Kang YM, Suh CH, Chung WT, Park YB, Choe JY, Shim SC, Lee SS, Han BG, Olsen NJ, Karp DR, Moser K, Pons-Estel BA, Wakeland EK, James JA, Harley JB, Bae SC, Gaffney PM, Alarcon-Riquelme M, Genles, Looger LL, Nath SK. **Allelic heterogeneity in NCF2 associated with systemic lupus erythematosus (SLE) susceptibility across four ethnic populations.** *Hum Mol Genet.* 2014; 23:1656-68.
13. Lessard CJ, Li H, Adrianto I, Ice JA, Rasmussen A, Grundahl KM, Kelly JA, Dozmorov MG, Miceli-Richard C, Bowman S, Lester S, Eriksson P, Eloranta ML, Brun JG, Goransson LG, Harboe E, Guthridge JM, Kaufman KM, Kvarnstrom M, Jazebi H, Cunnigham Graham DS, Grandits ME, Nazmul-Hossain AN, Patel K, Adler AJ, Maier-Moore JS, Farris AD, Brennan MT, Lessard JA, Chodosh J, Gopalakrishnan R, Hefner KS, Houston GD, Huang AJ, Hughes PJ, Lewis DM, Radfar L, Rohrer MD, Stone DU, Wren JD, Vyse TJ, Gaffney PM, James JA, Omdal R, Wahren-Herlenius M, Illei GG, Witte T, Jonsson R, Rischmueller M, Ronnblom L, Nordmark G, Ng WF, Registry UKPSsS, Mariette X, Anaya JM, Rhodus NL, Segal BM, Scofield RH, Montgomery CG, Harley JB, Sivils KL. **Variants at multiple loci implicated in both innate and adaptive immune responses are associated with Sjogren's syndrome.** *Nat Genet.* 2013; 45:1284-92.
14. Lin YW, Ren LL, Xiong H, Du W, Yu YN, Sun TT, Weng YR, Wang ZH, Wang JL, Wang YC, Cui Y, Sun DF, Han ZG, Shen N, Zou W, Xu J, Chen HY, Cao W, Hong J, Fang JY. **Role of STAT3 and vitamin D receptor in EZH2-mediated invasion of human colorectal cancer.** *J Pathol.* 2013; 230:277-90.
15. Mangale D, Kariuki SN, Chrabot BS, Kumabe M, Kelly JA, Harley JB, James JA, Sivils KL, Niewold TB. **Familial aggregation of high tumor necrosis factor alpha levels in systemic lupus erythematosus.** *Clin Dev Immunol.* 2013; 2013:267430.
16. Manku H, Langefeld CD, Guerra SG, Malik TH, Alarcon-Riquelme M, Anaya JM, Bae SC, Boackle SA, Brown EE, Criswell LA, Freedman BI, Gaffney PM, Gregersen PA, Guthridge JM, Han SH, Harley JB, Jacob CO, James JA, Kamen DL, Kaufman KM, Kelly JA, Martin J, Merrill JT, Moser KL, Niewold TB, Park SY, Pons-Estel BA, Sawalha AH, Scofield RH, Shen N, Stevens AM, Sun C, Gilkeson GS, Edberg JC, Kimberly RP, Nath SK, Tsao BP, Vyse TJ. **Trans-ancestral studies fine map the SLE-susceptibility locus TNFSF4.** *PLoS Genet.* 2013; 9:e1003554.
17. Maunakea AK, Chepelev I, Cui K, Zhao K. **Intragenic DNA methylation modulates alternative splicing by recruiting MeCP2 to promote exon recognition.** *Cell Res.* 2013; 23:1256-69.
18. Meir YJ, Lin A, Huang MF, Lin JR, Weirauch MT, Chou HC, Lin SJ, Wu SC. **A versatile, highly efficient, and potentially safer piggyBac transposon system for mammalian genome manipulations.** *FASEB J.* 2013; 27:4429-43.

19. Mok CC, Yap DY, Navarra SV, Liu ZH, Zhao MH, Lu L, Takeuchi T, Avihingsanon Y, Yu XQ, Lapid EA, Lague-Lizardo LR, Sumethkul V, Shen N, Chen SL, Chan TM, Asian Lupus Nephritis N. **Overview of lupus nephritis management guidelines and perspective from Asia.** *Int J Rheum Dis.* 2013; 16:625-36.
20. Moncrieffe H, Ursu S, Holzinger D, Patrick F, Kassoumeri L, Wade A, Roth J, Wedderburn LR. **A subgroup of juvenile idiopathic arthritis patients who respond well to methotrexate are identified by the serum biomarker MRP8/14 protein.** *Rheumatology (Oxford).* 2013; 52:1467-76.
21. Morris DL, Fernando MM, Taylor KE, Chung SA, Nititham J, Alarcon-Riquelme ME, Barcellos LF, Behrens TW, Cotsapas C, Gaffney PM, Graham RR, Pons-Estel BA, Gregersen PK, Harley JB, Hauser SL, Hom G, Langefeld CD, Noble JA, Rioux JD, Seldin MF, Systemic Lupus Erythematosus Genetics C, Vyse TJ, Criswell LA. **MHC associations with clinical and autoantibody manifestations in European SLE.** *Genes Immun.* 2014; 15:210-7.
22. Namjou B, Keddache M, Marsolo K, Wagner M, Lingren T, Cobb B, Perry C, Kennebeck S, Holm IA, Li R, Crimmins NA, Martin L, Solti I, Kohane IS, Harley JB. **EMR-linked GWAS study: investigation of variation landscape of loci for body mass index in children.** *Front Genet.* 2013; 4:268.
23. Namjou B, Kim-Howard X, Sun C, Adler A, Chung SA, Kaufman KM, Kelly JA, Glenn SB, Guthridge JM, Scofield RH, Kimberly RP, Brown EE, Alarcon GS, Edberg JC, Kim JH, Choi J, Ramsey-Goldman R, Petri MA, Reveille JD, Vila LM, Boackle SA, Freedman BI, Tsao BP, Langefeld CD, Vyse TJ, Jacob CO, Pons-Estel B, Argentine Collaborative G, Niewold TB, Moser Sivils KL, Merrill JT, Anaya JM, Gilkeson GS, Gaffney PM, Bae SC, Alarcon-Riquelme ME, Biolupus, Networks G, Harley JB, Criswell LA, James JA, Nath SK. **PTPN22 association in systemic lupus erythematosus (SLE) with respect to individual ancestry and clinical sub-phenotypes.** *PLoS One.* 2013; 8:e69404.
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25. Prahalad S, Marion MC, Cobb J, Sudman M, Hinks A, Pichavant M, Ponder L, Reed AM, Wallace C, Becker ML, Yeung RS, Rosenberg AM, Punaro MG, Mellins ED, Nelson JL, Vider V, Rygg M, Nardal E, Brown MA, Cutler D, Bohnsack JF, Thomson W, Thompson SD, Langefeld CD. **A159: the autoimmune genetic architecture of childhood onset rheumatoid arthritis.** *Arthritis Rheumatol.* 2014; 66 Suppl 11:S205-6.
26. Prahalad S, McCracken C, Ponder L, Angeles-Han ST, Stevens KR, Vogler LB, Langefeld CD, Thompson SD, Investigators CR. **A120: Familial Autoimmunity in the CARRA Registry.** *Arthritis Rheumatol.* 2014; 66 Suppl 11:S157.
27. Qian Y, Johnson JA, Connor JA, Valencia CA, Barasa N, Schubert J, Husami A, Kissell D, Zhang G, Weirauch MT, Filipovich AH, Zhang K. **The 253-kb inversion and deep intronic mutations in UNC13D are present in North American patients with familial hemophagocytic lymphohistiocytosis 3.** *Pediatr Blood Cancer.* 2014; 61:1034-40.
28. Rasmussen A, Ice JA, Li H, Grundahl K, Kelly JA, Radfar L, Stone DU, Hefner KS, Anaya JM, Rohrer M, Gopalakrishnan R, Houston GD, Lewis DM, Chodosh J, Harley JB, Hughes P, Maier-Moore JS, Montgomery CG, Rhodus NL, Farris AD, Segal BM, Jonsson R, Lessard CJ, Scofield RH, Sivils KL. **Comparison of the American-European Consensus Group Sjogren's syndrome classification criteria to newly proposed American College of Rheumatology criteria in a large, carefully characterised sicca cohort.** *Ann Rheum Dis.* 2014; 73:31-8.
29. Ray D, Kazan H, Cook KB, Weirauch MT, Najafabadi HS, Li X, Gueroussov S, Albu M, Zheng H, Yang A, Na H, Irimia M, Matzat LH, Dale RK, Smith SA, Yarosh CA, Kelly SM, Nabet B, Mecnas D, Li W, Laishram RS, Qiao M, Lipshitz HD, Piano F, Corbett AH, Carstens RP, Frey BJ, Anderson RA, Lynch KW,

- Penalva LO, Lei EP, Fraser AG, Blencowe BJ, Morris QD, Hughes TR. **A compendium of RNA-binding motifs for decoding gene regulation.** *Nature*. 2013; 499:172-7.
30. Sakurai D, Zhao J, Deng Y, Kelly JA, Brown EE, Harley JB, Bae SC, Alarcomicronn-Riquelme ME, Biolupus, networks G, Edberg JC, Kimberly RP, Ramsey-Goldman R, Petri MA, Reveille JD, Vila LM, Alarcon GS, Kaufman KM, Vyse TJ, Jacob CO, Gaffney PM, Sivils KM, James JA, Kamen DL, Gilkeson GS, Niewold TB, Merrill JT, Scofield RH, Criswell LA, Stevens AM, Boackle SA, Kim JH, Choi J, Pons-Estel BA, Argentine Collaborative G, Freedman BI, Anaya JM, Martin J, Yu CY, Chang DM, Song YW, Langefeld CD, Chen W, Grossman JM, Cantor RM, Hahn BH, Tsao BP. **Preferential binding to Elk-1 by SLE-associated IL10 risk allele upregulates IL10 expression.** *PLoS Genet*. 2013; 9:e1003870.
  31. Schoberle TJ, Nguyen-Coleman CK, Herold J, Yang A, Weirauch M, Hughes TR, McMurray JS, May GS. **A novel C2H2 transcription factor that regulates gliA expression interdependently with GliZ in Aspergillus fumigatus.** *PLoS Genet*. 2014; 10:e1004336.
  32. Sebe-Pedros A, Ariza-Cosano A, Weirauch MT, Leininger S, Yang A, Torruella G, Adamski M, Adamska M, Hughes TR, Gomez-Skarmeta JL, Ruiz-Trillo I. **Early evolution of the T-box transcription factor family.** *Proc Natl Acad Sci U S A*. 2013; 110:16050-5.
  33. Smith K, James JA, Harley JB. **Editorial for Lindop et al. "long-term Ro60 humoral autoimmunity in primary Sjogren's syndrome is maintained by rapid clonal turnover".** *Clin Immunol*. 2013; 148:110-2.
  34. Song X, Gao H, Lin Y, Yao Y, Zhu S, Wang J, Liu Y, Yao X, Meng G, Shen N, Shi Y, Iwakura Y, Qian Y. **Alterations in the microbiota drive interleukin-17C production from intestinal epithelial cells to promote tumorigenesis.** *Immunity*. 2014; 40:140-52.
  35. Subramanian Vignesh K, Landero Figueroa JA, Porollo A, Caruso JA, Deepe GS, Jr.. **Zinc sequestration: arming phagocyte defense against fungal attack.** *PLoS Pathog*. 2013; 9:e1003815.
  36. Subramanian Vignesh K, Landero Figueroa JA, Porollo A, Caruso JA, Deepe GS, Jr.. **Granulocyte macrophage-colony stimulating factor induced Zn sequestration enhances macrophage superoxide and limits intracellular pathogen survival.** *Immunity*. 2013; 39:697-710.
  37. Syed K, Porollo A, Miller D, Yadav JS. **Rational engineering of the fungal P450 monooxygenase CYP5136A3 to improve its oxidizing activity toward polycyclic aromatic hydrocarbons.** *Protein Eng Des Sel*. 2013; 26:553-7.
  38. Waggoner SN, Daniels KA, Welsh RM. **Therapeutic depletion of natural killer cells controls persistent infection.** *J Virol*. 2014; 88:1953-60.
  39. Yao X, Huang J, Zhong H, Shen N, Faggioni R, Fung M, Yao Y. **Targeting interleukin-6 in inflammatory autoimmune diseases and cancers.** *Pharmacol Ther*. 2014; 141:125-39.
  40. Young KA, Terrell DR, Guthridge JM, Kamen DL, Gilkeson GS, Karp DR, Ishimori ML, Weisman MH, Holers VM, Harley JB, Norris JM, James JA. **Smoking is not associated with autoantibody production in systemic lupus erythematosus patients, unaffected first-degree relatives, nor healthy controls.** *Lupus*. 2014; 23:360-9.
  41. Zhang Y, Macaubas C, Gupta S, Klein C, Pascual V, Hay A, Thompson SD, Sandborg CI, Ilowite NT, Mellins ED. **A160: role of interleukin-1 in abnormal monocyte phenotype in systemic onset juvenile idiopathic arthritis.** *Arthritis Rheumatol*. 2014; 66 Suppl 11:S207-8.

## Faculty, Staff, and Trainees

### Faculty Members

**John B. Harley, MD, PhD**, Professor  
**Leadership** Division Director

**Iouri Chepelev, PhD**, Assistant Professor

**Kenneth Kaufman, PhD**, Professor

**Halima Moncrieffe, PhD**, Instructor

**Alexey Porollo, PhD**, Assistant Professor

**Nan Shen, MD**, Associate Professor

**Susan Thompson, PhD**, Professor

**Stephen Waggoner, PhD**, Assistant Professor

**Matthew Weirauch, PhD**, Assistant Professor

**Bahram Namjou, MD**, Assistant Professor

Trainees

- **Ke Liu, BS**, 2003, Nanchang University
- **Samuel Vaughn, BS**, 2004, Brigham Young University
- **Jiadi Xu, BS**, 2010, China Agricultural University
- **Leah Kottyan, PhD**, 2010, University of Cincinnati
- **Erin Zoller, PhD**, 2011, University of Cincinnati
- **Dong Liang, PhD**, 2010, Université Paris Descartes
- **Mariana Saint Just Ribeiro, PhD**, 2009, Karolinska Institute, Sweden
- **Carolyn Rydyznski, BS**, 2012, University of Cincinnati
- **Xiaoming Lu, BS**, 2011, Sun Yat-sen University
- **Laura Brungs, BS**, 2012, Thomas Moore College
- **Xiaoting Chen, MA**, 2009, Central Michigan University
- **Siddarth Dixit, BS**, 2009, Jaypee University of Information Technology

Grants, Contracts, and Industry Agreements

| Grant and Contract Awards                                                             |                   | Annual Direct |
|---------------------------------------------------------------------------------------|-------------------|---------------|
| HARLEY, J                                                                             |                   |               |
| <b>Better Outcomes for Children: GWAS &amp; PheWAS in eMERGEII</b>                    |                   |               |
| National Institutes of Health                                                         |                   |               |
| U01 HG 006828                                                                         | 05/15/12-04/30/15 | \$586,394     |
| <b>Better Outcomes for Children: GWAS &amp; PheWAS in eMERGE II - CERC Supplement</b> |                   |               |
| National Institutes of Health                                                         |                   |               |
| U01 HG 006828                                                                         | 05/01/13-04/30/15 | \$330,718     |
| <b>Better Outcomes for Children: GWAS &amp; PheWAS in eMERGE II - PGx Supplement</b>  |                   |               |
| National Institutes of Health                                                         |                   |               |
| U01 HG 006828                                                                         | 05/15/12-04/30/15 | \$121,473     |
| <b>Genetic Linkage in Lupus</b>                                                       |                   |               |
| National Institutes of Health                                                         |                   |               |
| R37 AI 024717                                                                         | 09/07/10-02/28/15 | \$277,494     |
| <b>Genomics of Lupus</b>                                                              |                   |               |

|                                                                                           |                   |                    |
|-------------------------------------------------------------------------------------------|-------------------|--------------------|
| National Institutes of Health(Oklahoma Medical Research Foundation)                       |                   |                    |
| P01 AI 083194                                                                             | 08/01/11-07/31/14 | \$191,969          |
| <b>Neutrophin Regulation of Taste System Development</b>                                  |                   |                    |
| National Institutes of Health(University of Louisville)                                   |                   |                    |
| R21 AI 103980                                                                             | 01/18/13-12/31/14 | \$41,589           |
| <b>Gene Expression in Pediatric Arthritis</b>                                             |                   |                    |
| National Institutes of Health                                                             |                   |                    |
| P01 AR 048929                                                                             | 09/01/11-08/31/16 | \$50,199           |
| <b>KAUFMAN, K</b>                                                                         |                   |                    |
| <b>Genetic Susceptibility for Occupational Asthma</b>                                     |                   |                    |
| National Institutes of Health (University of Cincinnati)                                  |                   |                    |
| R01 OH 008795                                                                             | 09/01/13-08/31/15 | \$11,629           |
| <b>Reverse Genomics of Anti-Protective Antigen Response</b>                               |                   |                    |
| National Institutes of Health(Oklahoma Medical Research Foundation)                       |                   |                    |
| U19 AI 062629                                                                             | 09/01/11-08/31/14 | \$19,055           |
| <b>POROLLO, A</b>                                                                         |                   |                    |
| <b>Directed Culturing of Pneumocystis Using Metatranscriptomics</b>                       |                   |                    |
| National Institutes of Health (University of Cincinnati)                                  |                   |                    |
| R01 HL 119190                                                                             | 05/22/13-02/28/14 | \$51,338           |
| <b>GM-CSF-Induced Metal Sequestration and Histoplasma</b>                                 |                   |                    |
| National Institutes of Health (University of Cincinnati)                                  |                   |                    |
| R01 AI 106269                                                                             | 05/15/13-04/30/18 | \$18,930           |
| <b>WAGGONER, S</b>                                                                        |                   |                    |
| <b>A Revolutionary Approach to an Efficacious HIV Vaccine</b>                             |                   |                    |
| National Institutes of Health                                                             |                   |                    |
| DP1 DA 038017                                                                             | 06/01/14-05/31/19 | \$500,000          |
| <b>AAI Early Career Faculty Travel Grant</b>                                              |                   |                    |
| American Association of Immunologists                                                     |                   |                    |
|                                                                                           | 05/02/14-05/31/14 | \$1,250            |
| <b>Effect of Aging on Natural Killer Cell Regulation of T Cells in Viral Pathogenesis</b> |                   |                    |
| Ellison Medical Foundation                                                                |                   |                    |
| AG-NS-0958-12                                                                             | 07/01/13-06/30/16 | \$94,397           |
| <b>Current Year Direct</b>                                                                |                   | <b>\$2,296,435</b> |
| <b>Industry Contracts</b>                                                                 |                   |                    |
| <b>SHEN, N</b>                                                                            |                   |                    |
| MedImmune LLC                                                                             |                   |                    |
|                                                                                           |                   | \$220,000          |
| <b>Current Year Direct Receipts</b>                                                       |                   | <b>\$220,000</b>   |

Service Collaborations

WEIRAUCH, M

|                 |                     |             |
|-----------------|---------------------|-------------|
| Univ of Toronto |                     | \$10,000    |
|                 | Current Year Direct | \$10,000    |
|                 | Total               | \$2,526,435 |