Molecular Immunology

Division Photo

First Row: S. Divanovic, J. Aliberti, C. Chougnet
Back Row - K. Hoebe, C. Karp, E. Janssen

Division Data Summary

Research and Training Details	
Number of Faculty	7
Number of Joint Appointment Faculty	1
Number of Research Fellows	6
Number of Research Students	10
Number of Support Personnel	17
Direct Annual Grant Support	$3,379,480
Peer Reviewed Publications	22

Significant Publications

Moreno-Fernandez ME, Zapata W, Blackard JT, Franchini G, Chougnet CA. Human regulatory T cells are targets for human immunodeficiency Virus (HIV) infection, and their susceptibility differs depending on the HIV type 1 strain. J Virol. 2009 83:12925-33.

Regulatory T cells are a counter-regulatory subpopulation of CD4+ T cells that pioneering work by C. Chougnet has shown to play a pathophysiological role in the immunosuppression associated with HIV/AIDS. This important paper reports that, in turn, regulatory T cells are themselves susceptible to HIV infection. The relative susceptibility to HIV infection of regulatory T cells and effector T varies depending on both viral and host factors, variations that may well play an important, dynamic role in HIV pathogenesis.

Barnes MJ, Aksoylar H, Krebs P, Bourdeau T, Arnold CN, Xia Y, Khovananth K, Engel I, Sovath S, Lampe K, Laws E, Saunders A, Butcher GW, Kronenberg M, Steinbrecher K, Hildeman D, Grimes HL, Beutler B, Hoebe K. Loss of T cell and B cell quiescence precedes the onset of microbial flora-dependent wasting disease and intestinal inflammation in Gimap5-deficient mice. J Immunol. 2010, 184:3743-54.

Homeostatic control of the immune system involves mechanisms that ensure the self-tolerance, survival and

quiescence of hematopoietic-derived cells. Reporting on studies arising from K. Hoebe's programmatic use of forward genetic approaches to study fundamental immune mechanisms, via N-ethyl-N-nitrosourea mutagenesis in mice, this seminal paper establishes the GTPase of immunity associated protein 5 (Gimap5) as a key regulator of these processes—including hematopoietic integrity and lymphocyte homeostasis**.** Of note, Gimap5-deficiency provides an important new experimental model for human inflammatory bowel disease. As in human inflammatory bowel disease, aberrant immune responses triggered by the gastrointestinal microbiome appear critical to disease pathogenesis.

Madan R, Demircik F, Divanovic S, Trompette A, Allen J, Gu Y, Khoudon M, Hildeman D, Cardin R, Finkelman F, Mohrs M, Muller W, Roers A, Waisman A, Karp CL. Non-Redundant Counter-Regulatory Roles for B Cell-Derived IL-10. J Immunology. 2009. 183:2312-20.

While the immune system is essential for protection against pathogens, all immune responses themselves have potential for harming the responding host. Immune responses thus need to be tightly regulated in time, space and character. Despite this, dysregulated inflammation is central to the pathogenesis and expression of a broad range of diseases, both infectious and not. Although immunologists have traditionally focused on immune response activation, control of immune response amplitude and resolution is just as important. Several, often overlapping and redundant mechanisms of immune counter-regulation have been identified in recent years. Among these, the counter-regulatory cytokine interleukin 10 (IL-10) appears to play a uniquely important role. As numerous cell types are able to produce IL-10, however, the critical cellular sources have remained speculative in many diseases and disease models. This paper reports the generation of a novel IL-10 transcriptional reporter mouse in which green fluorescent protein expression is driven by the endogenous IL-10 locus, allowing for real time assessment of IL-10 expression in different organs and cell types. This publication reports an unexpected predominance of B cells among IL-10-expressing cells in peripheral lymphoid tissues at baseline and during diverse models of immunological challenge. More generally, the mouse has proved to be an extremely useful experimental tool, having been provided to more than 30 labs worldwide and playing an integral role in advancing our understanding of the immunobiology of IL-10 (*Nature Medicine* 2009. 15:277-84; *J Immunol* 2009. 183:797-801; *Nature Immunol* 2009. 10:1178-84; *Cell Host Microbe* 2009. 6: 503-512).

Division Highlights

Claire Chougnet, Ph.D.

Dr. Claire Chougnet, who directs a research program aimed at understanding the molecular mechanisms that underlie T cell dysfunction in aging (and in HIV/AIDS), has developed a new program of research aimed at understanding the development of T cell responses in early life. The ontogeny of immune responses in human neonates is not well understood, in part because T cell development in fetal life is divergent in humans and the experimental systems used most often by immunologists—inbred mice. Importantly, descriptive human studies and experimental studies in sheep have suggested that uncontrolled T cell responses are important in the development of bronchopulmonary dysplasia, which develops in about 25% of low birth weight preterm infants. In collaboration with Drs. Alan Jobe and Suhas Kallapur from the Perinatal Institute, Dr. Chougnet has set up novel, extramurally funded, complementary studies of T cell ontogeny in premature infants, sheep, and non-human primates.

Christopher Karp, Ph.D. and Senad Divanovic, Ph.D.

The prevalence of obesity, a major risk factor for type 2 diabetes, cardiovascular disease and steatohepatitis, continues to rise in Westernized countries. This ongoing epidemic of obesity does not spare children. In a research program that involves fruitful collaboration with Drs. Randy Seeley and Matthias Tschoep of the Diabetes and Obesity Center of Excellence at UCCOM/CCHMC, Drs. Christopher Karp and Senad Divanovic have discovered a novel link between the innate immune system and regulation of energy metabolism and, hence, the development of obesity under conditions of high fat diet stress. Understanding the molecular and cellular details of this unexpected link has promise for the development of novel approaches to obesity and its discontents.

Edith Janssen, Ph.D. and Jonathan Katz, Ph.D.

In a collaborative effort between Dr. Edith Janssen (Molecular Immunology) and Dr. Jonathan Katz (Endocrinology; adjunct faculty in Molecular Immunology) significant strides have been made in the identification and characterization of a specific dendritic cell population that orchestrates immune responses to self. Harnessing these dendritic cells for autologous cancer vaccine treatments significantly increases the efficacy of anti-tumor treatment in tumor-bearing mice. On the other hand, dysregulation of this dendritic cell population was found to be a major factor in breaking of peripheral tolerance and induction of the autoimmune disease type I diabetes in diabetes-prone NOD mice. Their two papers in press in *The Journal of Immunology* illustrate the broad implications and therapeutic potential of these observations and exemplify how melding two separate fields can unexpectedly accelerate the understanding of basic immunological principles and open new avenues for therapeutic approaches.

Division Collaboration

Collaboration with Immunobiology

Collaborating Faculty: David Hildeman, Ph.D.

- Homeostasis of regulatory T cells in aging (R01 funded in 2009; manuscript in review). (Chougnet)
- The role of NK and NKT cells in CD4 T cell activation after LCMV infection (Hoebe)
- Identification of genetic loci on the C57BL/6J and 129x1/SvJ background that determine NK cell function (Hoebe)
- Role of Gimap5 in lymphocyte survival (published in *J Immunol)*. (Hoebe)
- CD4 and CD8 T cell responses; priming, effector function and memory development (Hoebe)
- In vivo immunobiology of IL-10 (published in *J Immunol*). (Karp)
- Use of small-molecule BH3 inhibitors to control type 1 diabetes (R01 pending). (Katz)

Collaboration with Immunobiology

Collaborating Faculty: Marsha Wills-Karp, Ph.D.

- Role of PD-1 and its ligands in immune suppression associated with aging (manuscript in Press: *Aging Cell*). (Chougnet)
- Molecular underpinnings of allergy (published in *Nature*; R01 obtained). (Karp)
- Genetic modifiers of cystic fibrosis lung disease (published in *Nature*; R01 obtained). (Karp)
- The role of complement in allergic asthma (published in *J Immunol*). (Koehl)
- Role of IL-17R signaling in insulin sensitivity (Divanovic)

Collaboration with Immunobiology

Collaborating Faculty: Fred Finkelman, M.D.

- RP105 regulation of B cell function (ongoing R01, manuscript in review). (Karp)
- Biology of B cell IL-10 production (published in *J Immunol*). (Karp)

Collaboration with Immunobiology

Collaborating Faculty: Suzanne Morris, Ph.D. and Fred Finkelman, M.D.

- Genetic linkage analysis of existing differences in memory CD8 T cell populations observed in mice on a C57BL/6 and BALB/c background. (Hoebe)

Collaboration with Immunobiology

Collaborating Faculty: Marat Khodoun, Ph.D. and Fred Finkelman, M.D.

- Genetic linkage analysis of strain-dependent susceptibility to anaphylactic shock. (Hoebe)
- Molecular mechanisms underlying the development of peanut allergy (published in *JACI*). (Koehl)

Collaboration with Immunobiology

Collaborating Faculty: Richard Strait, M.D. and Fred Finkelman, M.D.

- Molecular mechanisms underlying the development of transfusion-related acute lung injury (TRALI). (Manuscript in review)

Collaboration with Immunobiology

Collaborating Faculty: Lee Grimes, Ph.D.

- Regulation of neutrophil effector function by the genetic modifier of CF lung disease, IFRD1 (published in *Nature*; R01 obtained). (Karp)
- Role of Gimap5 function in hematopoietic stem cells. (Hoebe)

Collaboration with Immunobiology

Collaborating Faculty: Michael Jordan, M.D.

- The role of the myeloid cell-specific IFN-gamma signaling in mediating resistance to protozoal infection (published in *J Immunol)*. (Karp, Aliberti, Divanovic)
- Dissection of cytolytic effector mechanisms (Janssen)

Collaboration with Immunobiology

Collaborating Faculty: Jochen Mattner, M.D.

- The role of AhR in mediating resistance to Salmonella oral infection in mice (Aliberti)

Collaboration with Immunobiology

Collaborating Faculty: De'Broski Herbert, Ph.D.

- Role of IL-4R signaling in regulation of insulin sensitivity (Divanovic)

Collaboration with Experimental Hematology & Cancer Biology

Collaborating Faculty: James Mulloy, Ph.D.

- Development of a humanized mouse model for HIV infection. (Chougnet)
- Use of a humanized mouse model to study innate immune responses to infection (Aliberti)

Collaboration with Experimental Hematology & Cancer Biology

Collaborating Faculty: Jose Cancelas, M.D. and Yi Zheng, Ph.D.

- Flow Core- Cincinnati Center for Excellence in Molecular Hematology (P30 submitted). (Chougnet)

Collaboration with Experimental Hematology & Cancer Biology

Collaborating Faculty: Marie-Dominique Philippi, Ph.D.

- Regulation of neutrophil effector function by the genetic modifier of CF lung disease, IFRD1 (published in *Nature*; R01 obtained). (Karp)

Collaboration with Hematology/Oncology

Collaborating Faculty: Joe Palumbo, M.D.

- Generation of CD8 T cell responses to live tumor cells (Janssen)

Collaboration with Hematology/Oncology

Collaborating Faculty: Tim Cripe, M.D.

- Immune responses to oncolytic viruses. (Janssen)

Collaboration with Gastroenterology, Hepatology & Nutrition

Collaborating Faculty: The Biliary Atresia Group - (Jorge Bezerra, M.D., Alexander Miethke, M.D. & Greg Tiao, M.D.)

- Dysfunction in biliary atresia (ongoing R01 with J. Bezerra, submitted R01 with G. Tiao; published paper in *J. Hepatol*; second manuscript submitted). (Chougnet)

Collaboration with Gastroenterology, Hepatology & Nutrition

Collaborating Faculty: Kris Steinbrecher, Ph.D.

- Understanding colitis development in Gimap5-deficient mice. (Hoebe)

Collaboration with Gastroenterology, Hepatology & Nutrition

Collaborating Faculty: Lee Denson, M.D.

- Colitis development in Gimap5-deficient mice. (Hoebe)
- Regulation of inflammatory bowel disease by TLR signaling (published in *Inflammatory Bowel Dis*)

Collaboration with Gastroenterology, Hepatology & Nutrition

Collaborating Faculty: Jorge Bezerra, M.D.

- Collaboration involves the characterization of a novel ENU germline mutant, designated *Lampe1,* that develops spontaneous hepatic steatosis. (Hoebe)

Collaboration with Pulmonary Biology

Collaborating Faculty: Alan Jobe, M.D., Ph.D. and Suhas Kallapur, M.D.

- Late Preterm Birth, Ureaplasma Species and Childhood Lung Disease (R01 funded in 2009). (Chougnet)
- Biomarkers of immunologic function and preterm respiratory outcomes (U01 funded in 2010). (Chougnet)
- Pilot project from the California National Primate Research Center to study IL-1 induced chorioamniotis in Rhesus macaques, funded in 2010. (Chougnet)

Collaboration with Pulmonary Biology

Collaborating Faculty: Jeffrey Whitsett, M.D.

- Pro-resolution lipid mediators in CF lung disease and airway remodeling (ongoing R01). (Karp)
- Airway epithelial signaling in mucous metaplasia. (Karp)

Collaboration with Pulmonary Biology

Collaborating Faculty: Timothy Weaver, M.D., Ph.D.

- Analysis of B cell function in ERdj4-deficient mice (Karp)

Collaboration with Pulmonary Biology

Collaborating Faculty: Paul Kingma, M.D., Ph.D.

- Analysis of neutrophil function in cystic fibrosis. (Karp)

Collaboration with Molecular Immunology; Pulmonary Biology; Pulmonary Medicine; Developmental Biology; Gastroenterology, Hepatology & Nutrition

Collaborating Faculty: Christopher Karp, M.D.; Jeffrey Whitsett, M.D.; James Bridges, Ph.D.; Paul Kingma, M.D., Ph.D.; Yan Xu, Ph.D.; Carolyn Kercsmar, M.D.; James Wells, Ph.D.; Noah Shroyer, Ph.D.

- Cystic Fibrosis Foundation Research Development Program Center

Collaboration with Cardiovascular Molecular Biology

Collaborating Faculty: Jeffery Molkentin, Ph.D.

- The identification of ENU germline mutants with heart defects. (Hoebe)

Collaboration with Allergy and Immunology

Collaborating Faculty: Kimberly Risma, M.D., Ph.D.

- Dissection of cytolytic effector mechanisms. (Janssen)

Collaboration with Allergy and Immunology

Collaborating Faculty: Carine Blanchard, Ph.D.

- IL-10 production by eosinophils. (Karp)

Collaboration with Allergy and Immunology

Collaborating Faculty: Simon Hogan, Ph.D.

- Intestinal myeloid cell function under high fat diet stress. (Karp, Divanovic)

Collaboration with Biomedical Informatics

Collaborating Faculty: Bruce Aronow, Ph.D.

- Genetic identification of DC subsets. (Janssen)
- Genetic modifiers of CF lung disease allergy (published in *Nature*; R01 funded). (Karp)
- RP105 regulation of B cell function (ongoing R01). (Karp)
- Functional genomics of LCMV infection. (Karp)

Collaboration with Developmental Biology

Collaborating Faculty: Rashmi Hegde, Ph.D.

- Molecular underpinnings of allergy (published in *Nature*; Sandler Foundation Grant funded; R01 funded). (Karp)

Collaboration with Infectious Diseases

Collaborating Faculty: Nancy Sawtell, Ph.D.

- Role of indolamine 2,3 dioxygenase in HSV infection. (Karp)

Collaboration with Infectious Diseases

Collaborating Faculty: Rhonda Cardin, Ph.D.

- Role of B cell IL-10 production in MCMV infection (published in *J Immunol*). (Karp)

Collaboration with Pathology

Collaborating Faculty: Kenneth Setchell, Ph.D.

- Molecular underpinnings of allergy/regulation of obesity by the RP105/TLR axis. (Karp)

Collaboration with Nephrology & Hypertension

Collaborating Faculty: Prasad Devarajan, M.D.

- Establishment of a murine congenic kidney transplantation model (published in *Clinical & Experimental Immunology*). (Koehl)

Collaboration with Reproductive Sciences

Collaborating Faculty: S.K. Dey, Ph.D.

- Regulation of TLR signaling by cannabinoid receptors. (Divanovic, Karp)

Faculty Members

Christopher Karp, MD, Professor ; *Director, Division of Molecular Immunology; Gunnar Esiason/Cincinnati Bell Chair; Director, CF Research Center; Director, Trustee and Procter Scholar Programs*

Research Interests: Molecular mechanisms underlying regulation and dysregulation of inflammatory responses in infectious, allergic, autoimmune and genetic diseases

Julio Aliberti, PhD, Assistant Professor

Research Interests: Induction and regulation of immune responses to intracellular pathogens

Claire A. Chougnet, PhD, Associate Professor

Research Interests: Mechanisms of immune dysregulation in HIV and aging; ontgeny of immune responses in early life

Senad Divanovic, Ph.D., Instructor

Research Interests: Role of the innate immune system in obesity and its sequelae

Kasper Hoebe, PhD, Assistant Professor

Research Interests: Forward genetic analysis of pathways of innate immune activation, and NK and CD8+ T cell cytolytic effector function

Edith M. Janssen, PhD, Assistant Professor

Research Interests: Mechanistic analysis and translational exploitation of adaptive immune responses to antigens expressed by apoptotic cells

Joerg Koehl, MD, Adjunct Professor

Research Interests: Regulation of innate and adaptive immune responses by the complement system

Joint Appointment Faculty Members

Jonathan Katz, PhD, Associate Professor
Endocrinology
The immunology of Type 1 Diabetes Mellitus

Trainees

- **Jessica Allen, Ph.D.,** PGY-1, The Ohio State University
- **Jaclyn McAlees, Ph.D.,** PGY-1, The Ohio State University
- **Stephanie Walters, B.S.,** GSY-2, The Ohio State University
- **Isaac Harley, B.S.,** GSY-3, University of Oklahoma
- **Nicholas Boespflug, B.S.,** GSY-2, Seattle University
- **Halil Aksoylar, B.S.,** GSY-3, Middle East Technical University, Ankara, Turkey
- **Hao Fang, Ph.D.,** GSY-2, University of Texas Medical Branch
- **Maria Moreno Fernandez, B.S.,** GSY-1, Universidad de Antioquia
- **Pietro Presicce, Ph.D.,** PGY-4, University of Pavia, Italy
- **Cesar Rueda-Rios, B.S.,** GSY-3, Universidad de Antioquia
- **Celine Silva Lages, Ph.D.,** PGY-5, Institut Paris-Sud sur les Cytokines, France
- **Jonathan McNally, B.S.,** PGY-1, St. Mary's College, Maryland
- **Cortez McBerry, B.S.,** GSY-3, Southern Illinois University Carbondale
- **Rosa Maria Salazar-Gonzalez, Ph.D.,** PGY-1, Emory University, Atlanta, Georgia
- **Manoj Pandey, Ph.D.,** GSY-6, D.A.V. College, Civil Lines, Kanpur, India
- **Xun Zhang, B.S.,** GSY-5, Peking University

Significant Accomplishments

Delving into neonatal immune response

Claire Chougnet, PhD, who directs a research program aimed at understanding the molecular mechanisms that underlie T cell dysfunction in aging (and in HIV/AIDS) has developed a new program of research aimed at understanding the development of T cell responses in early life. The ontogeny of immune responses in human neonates is not well understood, in part because T cell development in fetal life is divergent in humans and the experimental systems used most often by immunologists—inbred mice. Importantly, descriptive human studies and experimental studies in sheep have suggested that uncontrolled T cell responses are important in the development of bronchopulmonary dysplasia, which develops in about 25% of low birth weight preterm infants. In collaboration with Alan Jobe, MD, and Suhas Kallapur, MD, of the Neonatal Institute, Chougnet has set up novel, extramurally funded, complementary studies of T cell ontogeny in premature infants, sheep, and non-human primates.

Linking obesity and the immune system

The prevalence of obesity, a major risk factor for type 2 diabetes, cardiovascular disease and steatohepatitis, continues to rise in Westernized countries. This ongoing epidemic of obesity does not spare children. In a research program that involves fruitful collaboration with Randy Seeley and Matthias Tschoep of the Diabetes and Obesity Center of Excellence at UCCOM/CCHMC, Christopher Karp, MD, and Senad Divanovic, PhD, have discovered a novel link between the innate immune system and regulation of energy metabolism and, hence, the development of obesity under conditions of high fat diet stress. Understanding the molecular and cellular details of this unexpected link has promise for the development of novel approaches to obesity and its discontents.

Dendritic cells and immune response

In a collaborative effort between Edith Janssen, PhD, and Jonathan Katz, PhD, significant strides have been made in the characterization of a specific dendritic cell population that orchestrates immune responses to self. Harnessing these dendritic cells for autologous cancer vaccine treatments significantly increased the efficacy of anti-tumor treatment in tumor bearing mice. On the other hand, dysregulation of this dendritic cell population was found to be a major factor in breaking of peripheral tolerance and induction of the autoimmune disease type I diabetes in diabetes prone NOD mice. Their two recently published papers in the Journal of Immunology illustrate the broad implications and therapeutic potential of their observations and exemplify how melding two separate fields can unexpectedly accelerate the understanding of basic immunological principles and open new avenues for therapeutic approaches.

Division Publications

Grants, Contracts, and Industry Agreements

Grant and Contract Awards — Annual Direct / Project Period Direct

Aliberti, J

Control of Immune Responses by Lipoxins during Tuberculosis
National Institutes of Health
R01 AI 075038 — 02/01/2008 - 01/31/2013 — $230,604 / $1,052,454

Long-Term Immunity Against Toxoplasmosis
George Washington University (National Institutes of Health)
R01 AI 033325 — 07/01/2008 - 06/30/2013 — $34,345 / $171,725

Innate Immune Responses During Toxoplasmosis
National Institutes of Health
R01 AI 078969 — 09/01/2009 - 08/31/2011 — $250,000 / $500,000

Chougnet, C

Role of Regulatory T Cells in HIV Infection
National Institutes of Health
R01 AI 068524 — 08/01/2006 - 07/31/2011 — $246,331 / $1,248,084

A New Role for C5aR in HIV Infection
University of Cincinnati
09/17/2009 - 09/16/2010 — $30,000 / $30,000

Homeostasis and Function of Regulatory T Cells in Aging
National Institutes of Health
R01 AG 033057 — 09/15/2009 - 08/31/2011 — $316,403 / $355,586

Biomarkers of Immunologic Function and Preterm Respiratory Outcomes
National Institutes of Health
U01 HL 101800 — 05/01/10 - 04/30/15 — $23,441 / $23,441

Hoebe, K

Functional Analysis of NK cells and Their Potential to Generate CTL Responses
National Institutes of Health
R01 AI 074743 — 07/10/2009 - 06/30/2013 — $251,667 / $997,500

A Novel NK Cell-Mediated Adjuvant Approach to Generate CD8 T Cell Responses
International AIDS Vaccine Initiative
05/01/2008 - 06/30/2010 — $114,783 / $537,222

Sphinx: A New Cause of Hepatic Neoplasia
National Institutes of Health
R21 CA 133649 — 07/01/2008 - 06/30/2011 — $108,750 / $239,250

Janssen, E

Activating Robust Immunity to Tumor-Associated Antigens: Mechanisms and Biology
National Institutes of Health
R01 CA 138617 — 04/01/2009 - 02/28/2014 — $207,500 / $1,165,000

T Cell Memory to Cell-Associated Antigens by a New DC
National Institutes of Health
R21 AI 079545 — 08/01/2008 - 07/31/2011 — $125,000 / $600,000

Karp, C

Regulation of TLR Signaling and Innate Immunity by RP105
National Institutes of Health
R01 AI 075159 — 07/01/2007 - 06/30/2012 — $245,250 / $1,228,548

Novel immune-based therapy for leishmaniasis and tuberculosis
NewLink Genetics Corporation (National Institutes of Health)
R41 AI 082812 — 07/20/09 - 06/30/11 — $259,631 / $259,631

Cystic Fibrosis Foundation Research Development Program
Cystic Fibrosis Foundation
R457-CR07 07/01/2007 - 06/30/2011 $333,000 / $1,036,000

Karp, C	Project 4/Core 2	113,000
Whitsett, J	Transgenic Core	50,000
Kercsmar, C	Core 3a	30,000
Kingma, P	Project 1	50,000
Wooldridge, J	Project 2	50,000
Akinbi, H	Project 3	40,000

Immunobiology of IFRD1, a Gene Modifying CF Lung Disease
National Institutes of Health
R01 HL 094576 08/01/2009 - 07/31/2013 $258,340 / $1,035,414

Allergenicity Resulting from Functional Mimicry of the TLR Complex
National Institutes of Health
R01 AI 088372 03/01/2010 - 02/28/2015 $289,585 / $289,585

Presicce, P

Role of Dendritic Cell in Induction or Expansion of Th17 Cells in HIV_Infected Patients
University of Cincinnati
01/01/2010 - 12/31/2010 $5,000 / $5,000

Silva-Lages, C

Role of Peripheral Conversion in Regulatory T Cell Accumulation in Aging
Ellison Medical Foundation
07/01/2009 - 06/30/2010 $49,850 / $49,850

Current Year Direct **$3,379,480**

Funded Collaborative Efforts

Cougnet, C

Biomarkers of Immunologic Function and Preterm Respiratory Outcomes
National Institutes of Health
Jobe, A 05/01/10 - 04/30/15 10 %

Immune Dysfunction in Biliary Atresia
National Institutes of Health
Bezerra, J 02/25/08 - 01/31/13 10 %

Late Preterm Birth Ureaplasma Species and Childhood Lung Disease
National Institutes of Health
Jobe, A 09/24/09 - 07/31/13 10 %

Total $3,379,480