Jordan R. Willis

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Vanderbilt University 9022 NW 86th Ter

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PROFILE

Computational and molecular biologist working in the area of human antibodies and vaccines

* 8 years experience with molecular biology
* 5 years experience with molecular modeling
* 5 years experience with cell culture and transfection
* 4 years experience with high throughput sequencing and analysis

EDUCATION

**Vanderbilt University Medical Center, Nashville, TN** 2008-present

Ph.D. Chemical and Physical Biology

Defense anticipated March 27th, 2014

Dissertation: “Rational Antibody Design: From Mechanisms of Antibody Binding to Novel Vaccine Strategies”

Advisors: James E. Crowe, Jr., M.D., Jens Meiler Ph.D.

**Northwest Missouri State University** 2008

Bachelor of Science in A.C.S Accredited Chemistry

Magna Cum Laude, In Honors

*GPA* 3.81/ 4.0

**Northwest Missouri State University** 2008

Bachelor of Arts in Biology, with a focus in Molecular Biology

Magna Cum Laude, In Honors

*GPA* 3.81/ 4.0

RESEARCH EXPERIENCE

Vanderbilt Vaccine Center, Center for Structural Biology,

Vanderbilt University

Graduate Student 2008-present

Principal Investigators: James E. Crowe, Jr., M.D, Jens Meiler PhD

My thesis involves using computational design to answer specific questions in viral HIV immunology, with a focus on antibody design. The computational work was accomplished in the Meiler laboratory while the experimental laboratory work was conducted in the Crowe laboratory. My thesis work can be divided into four parts:

1. Multi-state antibody design to interrogate mechanisms for antibody polyspecificity. How do antibodies use a limited sequence repertoire to bind many antigens?
2. Molecular mechanisms of CD4-binding site escape for HIV-1 gp120. How does gp120 escape neutralization by two CD4-binding site-specific, broadly neutralizing antibodies, VRC01 and b12? We used computational characterization, homology modeling, and biophysical characterization to test our hypothesis.
3. Determine how closely antibody sequences from HIV-naïve individuals are to broadly neutralizing antibodies against HIV. Using computational modeling, high-throughput sequencing, and bioinformatics tools, we designed antibodies from HIV-naïve donor sequence pools that mimic broadly neutralizing antibodies with exceptionally long HCDR3s.
4. Using multi-state design to broaden reactivity of binding of influenza the HA stem binding antibody CR6261 to the stem of HA in virus subtypes that CR6261 did not naturally bind.

Department of Chemistry, University of Missouri 2007-2008

Principal Investigator: Kent Gates, PhD

Lead optimization drug discovery of hypoxic-cell targeting molecules that treat tumors. Using the pharmacaphore Tirapazamine as a scaffold, I used combinatorial synthesis techniques to add organic groups and evaluate structural activity relationships.

**SPECIALIZED TECHNICAL EXPERTISE**

* Molecular Modeling
  + Development and application of the software suite Rosetta
  + Molecular mechanics applications with software suite MOE and AMBER
  + Molecular viewing and scripting, PyMOL, Chimera, and RasMoL
  + Bioinformatics resources and tools
* Proteomics
  + Protein structure prediction
  + Post-translational modifications
  + Similarity search and alignments
  + Phylogeny and evolution
* Dynamic computer languages
  + Java
  + C++
  + Scripting with Python and BioPython
  + BioPython Development
* Computer databases
  + MySQL
  + MongoDB
* Influenza and human immunodeficiency virus (HIV) applications
  + HIV neutralization assays
  + Virus-like particles and pseudovirions
  + Production and purification
* Protein expression and purification
  + Novel cloning strategies
  + Novel purification strategies
* Cell culture and maintenance
* Biophysical characterization
  + Biolayer interferometry
  + ELISA
  + Isothermal titration calorimetry

**RESEARCH PUBLICATIONS**

Joyner AS, **Willis JR**, Crowe JE Jr, Aiken C (2011) Maturation-Induced Cloaking of Neutralization Epitopes on HIV-1 Particles. PLoS Pathog 7(9): e1002234.

Briney BS, **Willis JR**, Crowe JE Jr (2012) Human Peripheral Blood Antibodies with Long HCDR3s Are Established Primarily at Original Recombination Using a Limited Subset of Germline Genes. PLoS ONE 7(5): e36750

Briney BS, **Willis JR**, McKinney BA, Crowe JE (2012) High-throughput antibody sequencing reveals genetic evidence of global regulation of the naïve and memory repertoires that extends across individuals plasticity Genes and Immunity 13(6), 469-473.

Briney BS, **Willis JR,** Crowe JE (2012) Location and length distribution of somatic hypermutation-associated DNA insertions and deletions reveals regions of antibody structural plasticity Genes and Immunity 13(7), 523-529

Briney BS, **Willis JR**, Hicar MD, Thomas JW, Crowe JE (2012) Frequency and genetic characterization of V(DD)J recombinants in the human peripheral blood antibody repertoire. Immunology 131(1) 56-64

**Willis JR**\*, Combs SA\*, DeLuca SL\*, DeLuca SH\*, Lemmon GH\*, Nguyen ED\*, Sheehan JH, Nannemann DP, Meiler J (2013) Comparative Modeling and Small-Molecule Ligand Docking in Rosetta. Nature Protocols 8(7) 1277-1298

**Willis, JR**, Briney, B. S., Deluca, S. L., Crowe, J. E. & Meiler, J. (2013) Human germline antibody gene segments encode polyspecific antibodies PLoS Computational Biology 9, e10030 AA45 L

**In submission or preparation**

Briney, BS, **Willis JR**, Finn, JA, McKinney, BA, Crowe JE. Tissue-specific expressed antibody variable gene repertoires. Submitted. PLoS One

**Willis JR**, Sapparapu G, Singh V, King HG, Finn JA, Briney BS, Lebranche CC, Montefiori DC, Cupo A, Moore JP, Meiler J, Crowe JE. Computationally redesigned PG9 variant monocolonal antibodies that exibit enhanced HIV neutralizing potency and breadth. Submitted Nat. Med. Lett.

**Willis JR,** Finn JA, Briney BS, Sapparapu, G, King HG, Singh V, Lebranche CC, Montefiori DC, Cupo A, Moore JP, Meiler J, Crowe JE. HIV neutralizing heavy chain complimentary determining region 3 loops from HIV-naïve donors. In preparation

**Willis JR**, Crowe JE. PyIg – PyIg – An open source graphical interface for analysis of high throughput sequencing of T cell receptors and immunoglobulins.  In preparation

**TEACHING EXPERIENCE**

Instructor - Rosetta teaching workshop 2012

Developed protocol, taught background and gave hands-on demonstration for design for Rosetta teaching workshop 2012

Instructor - Rosetta teaching workshop 2011

Developed protocol, taught background and gave hands-on demonstration for protein docking for Rosetta teaching workshop 2011

Laboratory teaching assistant to Professor Richard Toomey, 2007-2008

Northwest Missouri State University

Chemistry 1 and 2

Tutor - Talent Development Center, 2005-2006

Northwest Missouri State University

Tutored in the following subjects. General physics I and II.

General, organic, analytical and physical chemistry.

All mathematics including statistics, algebra, and calculus.

**HONORS AND AWARDS**

**Research and Scholarly Awards**

NIH 5 T23 AI060571 HIV/AIDS Research Training Program 2010-2011

Vanderbilt University

Steven’s Research Scholarship, $4,800 2007-2008

University of Missouri

Mary Marie Smith Chemistry Scholarship, $4,850/year 2007-2008

Northwest Missouri State University

J. Gordon Strong Chemistry Scholarship, $2,450/year 2006-2007

Northwest Missouri State University

Tower Scholar, $1,500/year 2004-2008

Northwest Missouri State University

**TRAVEL AWARDS**

Keystone HIV Vaccine Symposium Scholarship 2012

Chemical and Physical Biology Travel Award 2012

IBC Antibody Engineering Symposium Scholarship 2011

## RECENT ASSIGNED TRAINEES (Under the mentorship of laboratory PI)

Albert Cisneros 2013

Graduate student, Crowe laboratory

Martha Wall 2012

Graduate student, Young laboratory, Vanderbilt University

Katherine Bradley 2012

MPH student, University of California Berkeley

Jessica Finn 2011

Graduate student, Crowe laboratory

Mason Sanders 2011

Summer undergraduate research intern

Katherine Nichols 2010

Graduate student, Kalams laboratory, Vanderbilt University

## ABSTRACTS AND PRESENTATIONS (underline indicates presenter)

**Willis JR**, Crowe JE, Meiler J (2013) Broadly Neutralizing Antibodies to HIV in HIV-Naïve Donors Populations: The Broadly Neutralizing Antibody Problem. Chemical and Physical Biology Symposium, Vanderbilt University

Finn, JA, Nannemann, DP, **Willis JR**, Crowe, JE (2013) De Novo Modeling of Antibody CDRH3 Loops with Constraints. RosettaCon

**Willis JR**, Briney BS, Finn J, Meiler J, Crowe JE Jr (2012) Potential Paradigm Shifts in HIV Vaccine Design Using Ultra High-Throughput Sequencing and Antibody Modeling. Chemical and Physical Biology Retreat

Briney BS, **Willis JR,** Crowe JE Jr (2012) Somatic hypermutation-associated insertions and deletions reveal regions of antibody structural plasticity. Keystone Symposium on HIV Vaccines

Finn JA, **Willis JR**, Briney BS, Crowe JE Jr, Meiler J (2012) Structural Prediction of Long Complementarity Determining Region 3 Loops. RosettaCon

**Willis JR**, Briney BS, Meiler J, Crowe JE (2012) Structure Analysis of Healthy Donor Repertoire Confers Sequences that Match Long Complementary Determining Regions of Broadly Neutralizing Antibodies. Keystone Symposium on HIV Vaccines

Briney BS, **Willis JR**, Crowe JE Jr (2011) Genetic and Functional Analysis of the Human Anti-HIV Antibody Repertoire. Keystone Symposium on HIV Vaccines

**Willis JR**, Crowe JE, Meiler J (2011) Multi-State Design of Antibody-Antigen Interactions Confers Conformational Flexibility.

Briney BS, **Willis JR**, Crowe JE Jr (2011) Genetic origin of long HCDR3s in the circulating antibody repertoire. BC Life Sciences - Antibody Engineering & Therapeutics

**Willis JR**, Crowe JE Jr, Meiler J (2011) Structural Basis for Development of Broadly Neutralizing Antibodie3s to HIV Using Computational Predictions. . Chemical and Physical Biology Retreat.

**Willis JR**, Briney BS, Crowe JE Jr, Meiler J (2011) Antibody Design Infers Optimal Sequences for Binding Breadth and Affinity Maturation. IBC Life Sciences - Antibody Engineering & Therapeutics

**Willis JR**, Crowe JE, Meiler J (2010) Constrained Design of Broadly Neutralizing HIV Antibody-Antigen Interactions. RosettaCon

**Willis JR**, Meiler J, Crowe JE (2009) HIV gp160 Targeted Broadly Neutralizing Antibodies - Modeling and Design. RosettaCon

## MEMBERSHIPS

American Society of Collegiate Scholars 2004–2008

American Chemical Society 2006-2010

Tri-Beta biology honor society 2008

**REFERENCES**

James E. Crowe, Jr. MD

Ann Scott Carell Chair

Professor Pediatrics and Microbiology and Immunology

Director, Vanderbilt Vaccine Center

Vanderbilt University Medical Center

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Jens Meiler, Ph.D.

Associate Professor Chemistry, Pharmacology and Bioinformatics

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