**Harvard Medical School**
**Curriculum Vitae**


**Date Prepared:** **February 24, 2016**

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**Work FAX:**


**Place of Birth:** USA

## Education

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|---|---|---|---|
| 2001 | B.S. (cum laude) | Molecular Biology | Westminster College, New Wilmington, PA |
| 2007 | Ph.D. | Molecular Virology & Microbiology (Joseph C. Glorioso) | University of Pittsburgh School of Medicine, Pittsburgh, PA |

## Postdoctoral Training

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| 01/08-05/08 | Post-doctoral Fellow | Molecular Virology (Joseph C. Glorioso) | University of Pittsburgh School of Medicine, Pittsburgh, PA |
| 05/08-11/14 | Post-doctoral Fellow | Developmental Biology, Pluripotent Stem Cell Biology (Gordon Keller) | McEwen Centre for Regenerative Medicine, University Health Network, Toronto, ON, Canada |

## Appointments at Hospitals/Affiliated Institutions

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| 11/14-08/15 | Associate Scientific Research | Orthopaedic Surgery | Boston Children's Hospital |
| 09/15-10/18 | Assistant Professor | Orthopaedic Surgery | Harvard Medical School, Boston Children's Hospital |

## Other Professional Positions

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| 2002 | Pre-doctoral trainee, Joseph C. Glorioso | University of Pittsburgh School of Medicine, Pittsburgh, PA |
| 2014 | Chair, Bones & Teeth Gordon Research Seminar | Gordon Research Conferences |

## Committee Service

**Local**

| | | |
|---|---|---|
| 2003-2007 | Committee Member 2005-2006 | University of Pittsburgh School of Medicine Molecular Virology and Microbiology Graduate Program Annual Symposium |
| 2009-2014 | Committee Chair 2009-2011 | University of Toronto Post-doctoral Association |

**National and International**

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|---|---|---|
| 2014 | Bones & Teeth Gordon Research Seminar Chair | Gordon Research Conference |

## Professional Societies

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|---|---|---|
| 2004- | International Society for Stem Cell Research | Member |
| 2005-2008 | Tissue Engineering & Regenerative Medicine International Society, Student and Young Investigator Section | Member |
| 2005-2008 | American Society for Gene and Cell Therapy | Member |
| 2008-2014 | Canadian Stem Cell Network | Member |
| 2010- | American Society for Bone and Mineral Research | Member |
| 2013- | Orthopaedic Research Society | Member |
| 2015- | Tissue Engineering & Regenerative Medicine International Society | Member |

## Editorial Activities

Ad hoc Reviewer:
Development
Stem Cells
Osteoarthritis and Cartilage
Tissue Engineering
eCells and Materials Journal
Journal of Cellular Physiology

## Honors and Prizes

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| 2010 | Young investigator travel award | ASMBR | Awarded to trainees selected to give oral abstract presentations at the plenary session |
| 1998-2001 | Trustee's Scholarship | Westminster College | Highest awarded academic scholarship |

## Report of Funded and Unfunded Projects

### Funding Information

**Past**

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| 2010-2014 | Articular Chondrocyte Differentiation and Osteoarthritis<br>Canadian Institute of Health Research (CIHR), MOP 219710 Operating Grant<br>Post-doctoral research role/Non-PI (PIs: B. Alman, G. Keller) ($240,000)<br>To determine whether the signaling pathways responsible for articular chondrocyte development also play a role attenuating cartilage degeneration in OA. |
| 2012-2015 | Pluripotent Stem Cell-Derived Chondrocytes and Cartilage for Joint Repair and Disease Modeling<br>McEwen Centre for Regenerative Medicine Accelerating Discovery Research Award<br>Key personnel/Non-PI (PI: Gordon Keller) ($577,000)<br>Optimize and scale up cartilage production for animal studies and disease modeling *in vitro*, optimize animal models for transplantation of human cartilage tissues, initiate *in vitro* studies of osteoarthritis |

## Report of Local Teaching and Training

### Teaching of Students in Courses

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| 2012-2014 | Regenerative Medicine (BME510)<br>Bioengineering undergraduate and graduate students | Institute of Biomaterials and Biomedical Engineering, University of Toronto, Toronto, ON, Canada<br>Two lectures, 2 hours each per year |
| 2015 | Tissue Engineering Summer Workshop<br>Undergraduate, graduate, and post-doctoral participants | Department of Biomedical Engineering, Tufts Science & Technology Center, Medford, MA<br>Introduction to Pluripotent Stem Cells & Differentiation – 2 hour lecture<br>on behalf of Harvard Stem Cell Institute |
| 2016 | Stem Cells and Regeneration in the Pathobiology and Treatment of Disease (SCRB167)<br>Undergraduate students | Harvard Stem Cell and Regenerative Biology Department, Boston, MA<br>Pathology of joint disease (osteoarthritis) and Novel treatments based on stem cells – 2 hour interactive lecture |

### Formal Teaching of Residents, Clinical Fellows and Research Fellows (post-docs)

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| 2003-2005 | Molecular Pathogenesis of Infectious Disease<br>First year medical students | University of Pittsburgh School of Medicine, Pittsburgh, PA<br>Teaching assistant, Lecture and lab components for 6 week course |

## Laboratory and Other Research Supervisory and Training Responsibilities

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| 2006 | Mentor, Summer Undergraduate Research Program, University of Pittsburgh School of Medicine, Pittsburgh, PA | Daily mentorship for 3 months |
| 2007-2008 | Mentor, Rotation student in Interdisciplinary Biomedical Graduate Program, University of Pittsburgh School of Medicine, Pittsburgh, PA | Daily mentorship for 4 months, continued after student joined lab permanently |
| 2012-2014 | Mentor, graduate students and incoming post-doctoral fellows in Prof. Gordon Keller's lab, McEwen Centre for Regenerative Medicine, University Health Network, Toronto, ON, Canada | Bi-weekly mentorship of several students and post-docs with respect to concepts in stem cell and developmental biology, and techniques related to cell culture, molecular biology, tissue engineering, and *in vivo* studies |
| 2015- | Mentor and advisor, Post-doctoral fellow, Boston Children's Hospital | Daily mentorship of Post-doctoral fellows in my lab |

## Local Invited Presentations

No presentations below were sponsored by outside entities.

2012 - 2013 *Articular Cartilage from Human Pluripotent Stem Cells*
Academic Advisory Board Meeting, Arthritis Program, Toronto General Hospital, Toronto, ON, Canada

2013 *Stem cells for the Future: Cartilage Tissues from Human Pluripotent Stem Cells*
Arthritis Industry Forum, Division of Orthopaedic Surgery, Toronto Western Hospital, Toronto, ON, Canada

2014 *Generating Articular Cartilage from Pluripotent Stem Cells: A Developmental Approach*
Stem Cell & Regenerative Biology Department, Harvard University, Cambridge, MA

2015 *Applications of Human Pluripotent Stem Cell-derived Cartilage Tissues*
The Bone Research Workshop Series, Harvard School of Dental Medicine, Harvard Medical School and Massachusetts General Hospital, Boston, MA

2015 *Generating Cartilage from Human Pluripotent Stem Cells: A Developmental Approach*
Division of Genetics and Genomics Seminar, Boston Children's Hospital
Department of Genetics, Harvard Medical School, Boston, MA

2015 *Modeling Embryonic Development of Cartilage* in vitro
The Musculoskeletal Research Consortium, Massachusetts General Hospital, Boston, MA.

2015 *Generating Cartilage from Pluripotent Stem Cells and Future Hopes for Repair*
Developmental and Regenerative Biology Graduate Program, Biological and Biomedical Sciences, Harvard Medical School, Boston, MA

## Report of Regional, National and International Invited Teaching and Presentations

No presentations below were sponsored by outside entities.

### Invited Presentations and Courses

**National**

2005 *Development of an HSV-based model system to Identify Events Critical in Embryonic Myogenesis* (chosen from submitted abstracts)
American Society for Gene Therapy, St Louis, MO

2013 *Generating Articular Cartilage from Pluripotent Stem Cells: A Developmental Approach*
Departments of Orthopaedic Surgery, Duke University Medical Center, and Cell Biology, Duke University, Durham, NC

2014 *Generating Cartilage from Pluripotent Stem Cells: A Developmental Approach* (chosen from submitted abstracts)
Bones & Teeth Gordon Research Conference, Galveston, TX

2015 *Human pluripotent stem cells for cartilage tissue engineering.*
Tissue Engineering-Developmental Biology paradigm: a tool for developing successful therapies workshop. Tissue Engineering and Regenerative Medicine International Society (TERMIS) World Congress, Boston, MA.

**International**

2010 *Directed Differentiation of ES cells to the Chondrocyte Lineage* (Plenary session oral presentation, chosen from submitted abstracts)
American Society for Bone and Mineral Research, Toronto, ON

2011 *Regulation of Articular and Growth plate Chondrocyte Development from Pluripotent Stem Cells* (chosen from submitted abstracts)
Bones & Teeth Gordon Research Conference, Les Diablerets, Switzerland

2012 *Pluripotent Stem Cells: A Developmental Approach for Cartilage and Bone Tissue Engineering* (Invited Keynote Lecture)
Belgium Tissue Engineering Symposium, Katholieke Universiteit Leuven, Belgium

2013 *Specification of Paraxial Mesoderm and Chondrocytes from Pluripotent Stem Cells Results in Articular and Growth Plate-like Cartilage* (chosen from submitted abstracts)
Cartilage Biology and Pathobiology Gordon Research Conference, Les Diablerets, Switzerland

### Report of Technological and Other Scientific Innovations

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| New markers for cardiomyocyte purification and enrichment (March 2012) | Patent, WO 2012/024782 A1<br>*Methods for Enriching Pluripotent Stem Cell-Derived Cardiomyocyte Progenitor Cells Based on SIRPA Expression*<br>I co-discovered a novel cell-surface marker that can be used to screen for, isolate, and purify hPSC-derived cardiomyocytes from human pluripotent stem cell cultures. This technology is now used to generate pure populations of cells for drug toxicology studies and for transplantation. All other methods used to purify cardiomyocytes rely on genetic modification or fixation of cells, which cannot be translated into the clinic. |

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| Methods for production of chondrocytes from human pluripotent stem cells (October 2014) | Patent, WO 2014161075 A1<br>*Methods for production of chondrogenic mesoderm, chondrocytes, and hypertrophic and non-hypertrophic articular-like cartilage from human pluripotent stem cells, A Novel Cell Surface Molecule marks Primary and hPSC-derived Articular Chondrocytes*<br>I delineated the signaling pathways required to generate chondrocytes and cartilage tissues that can be used to develop new cell- and tissue-based therapeutics, to model musculoskeletal diseases *in vitro*, and to screen for drugs that can attenuate them. Currently, this protocol is the only available method to generate *bona fide* articular cartilage tissue from any human stem cell population. |

## Report of Education of Patients and Service to the Community

### Activities

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| 2008-2014 | McEwen Center for Regenerative Medicine, University Health Network, Toronto, ON, Canada<br>Participated in McEwen Centre for Regenerative Medicine events to educate the public about stem cell research and its impact on arthritis, diabetes as well as heart and liver disease. |

## Report of Scholarship

### Peer reviewed publications in print or other media

1. **Craft AM**, Krisky DM, Wechuck JB, Lobenhofer EK, Jiang Y, Wolfe DP, Glorioso JC. *HSV-mediated expression of Pax3 and MyoD in embryoid bodies results in lineage-related alterations in gene expression profiles.* Stem Cells. 2008 Dec;26(12):3119-29. PMID: 18787207

2. Wolfe DP*, **Craft AM***, Cohen JB, Glorioso JC. *An HSV vector system for expression and selection of complex cellular cDNA libraries.* J Virol. 2010 Jul;84(14):7360-8. PMID: 20463073
*Authors contributed equally to this work

3. Dubois NC, **Craft AM**, Sharma P, Elliott DA, Stanley EG, Elefanty AG, Gramolini A, Keller G. *SIRPA is a specific cell-surface marker for isolating cardiomyocytes derived from human pluripotent stem cells.* Nature Biotechnology. 2011 Oct 23;29(11):1011-8. PMID: 22020386

4. **Craft AM**, Ahmed N, Rockel JS, Baht GS, Alman BA, Kandel RA, Grigoriadis AE, Keller GM. *Specification of chondrocytes and cartilage tissues from embryonic stem cells.* Development. 2013 Jun;140(12):2597-610. doi: 10.1242/dev.087890. PMID: 23715552

5. **Craft AM**, Rockel JS, Nartiss Y, Alman BA, Kandel RA, Keller GM. *Generation of articular chondrocytes from human pluripotent stem cells.* Nature Biotechnology. 2015 Jun;33(6):638-45. PMID: 25961409

6. Rockel JS, Yu C, Whetstone H, **Craft AM**, Reilly K, Ma H, Tsushima H, Puviindran V, Al-Jazrawe M, Keller GM, Alman BA. Hedgehog inhibits beta-catenin activity in synovial joint development and osteoarthritis. J Clin Invest. 2016 Mar 28; pii. 80205. doi: 10.1172/JCI80205. PMID: 27018594.

## Thesis

Craft, AM. Development of an HSV-based model system to identify events critical for embryonic myogenesis. ProQuest, UMI Dissertations Publishing, 2007. University of Pittsburgh School of Medicine. ISBN 9780549454809. http://search.proquest.com/docview/304838126

## Abstracts, Poster Presentations and Exhibits Presented at Professional Meetings

1. Rockel JS, Yu C, **Craft AM**, Whetstone H, Reilly K, Keller G, Alman BA. *Regulation of hedgehog signaling is necessary for interzone cell patterning during synovial joint development.* Poster Presentation, Bone & Teeth Gordon Research Conference, Les Diablerets, Switzerland, June 2011.

2. Rockel JS, Yu C, Whetstone H, **Craft AM**, Katherine Reilly K, Alman B. *Inhibition of hedgehog signaling is necessary for b-catenin-regulated interzone differentiation and joint morphogenesis*. Poster Presentation, Society for Developmental Biology, Cancun, Mexico, June 2013.

3. Rockel JS, Yu C, Whetstone H, **Craft AM**, Keller GM, Alman BA. *Hedgehog signaling in interzone progeny alters cell differentiation and synovial joint morphogenesis by inhibiting beta-catenin-mediated Fgf18 expression*. Oral Abstract & Poster Presentation, Bones & Teeth Gordon Research Conference, Galveston, TX, January 2014.

4. **Craft AM**, Rockel JS, Nartiss Y, Alman BA, Kandel RA, Keller G. *Human Pluripotent Stem Cell-derived Articular Chondrocytes Generate and Maintain Stable Articular Cartilage* in vitro *and* in vivo. Poster Presentation, Orthopaedic Research Society Annual Meeting, New Orleans, LA, March 2014.

5. Juneja S, Whetstone H, Keller G, **Craft AM**. *Engraftment of Human Pluripotent Stem Cell-derived Articular Cartilage tissues in the Athymic Nude Rat Knee.* Poster Presentation, Cartilage Biology & Pathobiology Gordon Research Conference, Galveston, TX, March 2015.

6. Juneja S, **Craft AM**, Viswanathan S, Anhlek D, Weston A, Gomez-Aristizabal, Veillette C. *A Simplified Method for the Aspiration of Bone Marrow from Volunteer Patients Undergoing TKR or THR for Isolating Mesenchymal Stem Cells*. Canadian Orthopaedic Association/Canadian Orthopaedic Research Society Annual Meeting. High Scoring CORS Poster. Vancouver, BC, Canada, June 2015.

7. **Craft AM**. *Applications of Human Pluripotent Stem Cell-Derived Articular Cartilage.* Poster Presentation, Center for Skeletal Research Symposium, Boston, MA, June 2015.

## Narrative Report **(limit to 500 words)**

During my post-doctoral studies, I successfully initiated, designed, and led two independent projects focused on the specification of mesoderm subsets during the early stages of differentiation and the subsequent generation of chondrocytes and cartilage tissues from both mouse and human PSCs.

In my studies using mouse PSCs, I demonstrated that through the appropriate manipulation of the BMP signaling pathway, it is possible to inhibit the formation of blood and cardiac mesoderm, while promoting the development of paraxial/chondrogenic mesoderm (Craft et al., Development, 2013). My work highlighted the importance of understanding the differential signaling requirements of mesoderm derivatives in order to specify an appropriate progenitor population in the absence of contaminating cell lineages. Building on these findings, I was able to show that distinct members of the TGFβ family of pathway agonists were able to specify the paraxial mesoderm to either an articular or growth plate-like (hypertrophic) chondrocyte fate. The results of my studies revealed, for the first time, the ability to generate subtypes of chondrocytes and highly organized proteoglycan-rich cartilage tissues that are characteristic of articular cartilage and growth plate cartilage. In my efforts to translate these findings to the human system, I have confirmed that the signaling pathways responsible for specifying chondrogenic mesoderm from the pluripotent stem cell stage are conserved between mouse and human. Furthermore, I have generated both articular and growth plate-like (hypertrophic) chondrocytes, as well as cartilage tissues comprised of these cells from hPSC-derived mesoderm (Craft et. al., Nature Biotechnology, 2015). Histological and gene expression analyses indicate that these chondrocytes and tissues share many of the same characteristics of primary human articular cartilage and growth plate cartilage, which was confirmed upon transplantation into mice. Importantly, I was the first to demonstrate that articular cartilage generated in this manner resists vascularization and ossification for extended periods of time *in vivo*. In contrast, grafts generated by hypertrophic chondrocytes initiate the process of endochondral ossification akin to growth plate chondrocyte fate. hPSC-derived articular cartilage also responds appropriately to environmental stresses, such as pro-inflammatory cytokines, suggesting that these cartilage tissues will be a useful model to study cartilage degeneration and disease.

Overall, my work provided the first detailed insights into the regulation of the earliest stages of mesoderm and chondrocyte commitment, and was the first to demonstrate that it is possible to generate distinct populations of chondrocytes from human PSCs. This work serves as a foundation for novel studies of human cartilage development and disease as well as patient specific therapeutic strategies. My future research will continue to focus on identifying the molecular determinants that control lineage commitment, with the ultimate goals of generating articular chondrocyte and cartilage tissues, modeling cartilage and bone disease, and translating my findings into the clinic.