Iain Drummond, PhD
Mount Desert Island Biological Laboratory

Date Prepared:	June 10, 2019
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Place of Birth:	Detroit, MI

Education

7/74 – 6/78	B.S	Biology	Union College, NY
9/81 – 12/86	Ph.D.	Cell and Developmental Biology	University of California, Berkeley

Postdoctoral Training

1/87-6/90	Postdoctoral Fellow	Cell signaling in Dictyostelium (Rex Chisholm PI)	Northwestern University Medical School
7/90-12/92	Research Associate	Molecular genetics (Vikas Sukhatme PI)	HHMI Univ. of Chicago

Faculty Academic Appointments

1/93-6/97	Instructor	Medicine	HMS
7/97-6/06	Assistant Professor	Medicine	HMS
7/06-9/19	Associate Professor	Medicine	HMS
6/07-9/19	Adjunct Appointment	Genetics	HMS
5/08-9/19	Adjunct Appointment	Developmental and Regenerative Biology	HMS
9/19 -	Professor	MDIBL	

Appointments at Hospitals/Affiliated Institutions

1/93-6/95	Research Associate	Division of Nephrology	Beth Israel Hospital
7/95-4/14	Assistant Biologist	Department of Medicine, Nephrology Division	Massachusetts General Hospital
5/14-9/19	Biologist	Department of Medicine, Nephrology Division	Massachusetts General Hospital

Other Professional Positions

5/86-9/86	Mentor, MARC program	University of California, Berkeley
6/99-6/09	Webmaster	Nephrology Division, MGH
5/07-	Scientific Advisory Committee	Polycystic Kidney Disease Foundation
5/08-1/12	Scientific Advisory Committee	The zebrafish TILLING consortium

Major Administrative Leadership Positions

Local

1/01-9/19	Fellowship Committee	Nephrology Division, MGH
1/05-9/19	Research Council Representative	Nephrology Division, MGH
8/08-9/19	Course Co-director, CB226; Concepts in Development, Self-renewal and Repair	BBS Program, Harvard Medical School
6/12-6/15	CROI Grants and IT committee Chair	MGH Research Administration
1/12-8/15	MGH PhD Steering Committee; Chair	MGH Research Administration
1/12-8/15	MGH PhD Steering Committee; Exec Committee	MGH Research Administration
6/12-9/19	MGH Research IT Advisory Board	MGH Research Administration
6/13-6/19	MGH SRRP Co-Chair	MGH Research Administration
8/17-9/19	Director of Fellowship Training	Nephrology Division, MGH

Regional

5/95-5/06	Organizer and Chair	Boston area zebrafish meeting (held yearly at Whitehead Institute, MIT or Novartis)

National and International

7/00	Chair, Organogenesis Symposium	Cold Spring Harbor meeting on Zebrafish Development and Genetics
11/05	Co-Chair, ASN Symposium	New Insights into the Molecular Pathogenesis of Human Renal Malformation
11/07	Co-Chair, ASN Symposium	Ciliary Signaling in PKD
4/10-8/10	Organizing Committee member	International Workshop in Developmental Nephrology
2/11-5/16	Scientific Advisory Committee	Johns Hopkins PKD Center (P30)
2/11-5/16	Scientific Advisory Committee	Mayo Clinic PKD Center (P30)
2/13-5/14	Scientific Advisory Committee	University of Alabama Kidney Center (P30)
2/13-5/16	Scientific Advisory Committee	NIH GUDMAP Consortium
2013	PhD Committee	American Society for Nephrology

2014-2015	ASN 2015 Program Committee	American Society for Nephrology
2016	GSA Program Committee	Genetics Society of America
2013-2017	Co-organizer	FASEB meeting on The Biology of Cilia and Flagella
2016	Prize Selection Committee	2017 Kaplan Prize for PKD
2017	ASN Kidney Health Initiative	Cellular devices committee
2018-	Scientific Advisory Committee	Imagine Institute, Paris France

Committee Service

Local

2003-2004	Thesis Advisory Committee, BBS (Rick James)	HMS, BBS Committee member
2003	Thesis Advisory Committee, MIT/WHOI (Heather Handley)	MIT Committee member
2007	Thesis Examination Committee BBS (Jamil Scott)	HMS / BBS Committee member
2007	PQE Committee (Tyler Gibson)	HMS / Biophysics Committee member
2007	PQE Committee (Jun Kawasaki)	HMS / BBS
2007-	Office of Research and Career Development Steering Committee 2007-	MGH Committee member
2008	PQE Committee (April Cook)	HMS / BBS
2008	PQE Committee (Jon Rosen)	HMS / BBS
2008	Thesis Advisory Committee (David Rhee)	HMS / BBS Chair
2008	Thesis Advisory Committee (Peter Yang)	HMS / BBS Chair
2009	Candidacy Examination Committee (Bob Kao)	Harvard University / MCB Committee member

2009	Thesis Advisory Committee (Ramon Bonegio)	BUSM / Nephrology Committee member
2009	Thesis Examination Committee (Corinne Nielsen).	HMS / BBS Committee member
2009	Thesis Examination Committee (Linyu Li)	HMS / BBS Committee member
2009	Thesis Examination Committee (Kristen Alexa)	UMass Medical School / Cell Biology Committee member
2011	Thesis Examination Committee (Nathan Billings).	HMS / BBS
2012-	Thesis Advisory Committee (Jake Daane)	HMS / BBS Committee member
2012-2015	Thesis Advisory Committee (Yuya Sugano)	Institute of Anatomy and Molecular Life Sciences, University of Zurich, Switzerland Committee member
2012	Executive Committee on Research Executive Director Search Committee	MGH Search Committee Member
2012	Office for Research Career Development Graduate Student Division Director Search Committee	MGH Search Committee Member
2013-	Post-doc Salary Task Force	MGH Committee Member
2013	Thesis Examination Committee (Shoshoni Caine)	Tufts University Committee member
2013	Thesis Examination Committee (Johanna Kowalko)	HMS/BBS Committee member

2013	Thesis Examination Committee (Peter Yang)	HMS/BBS Committee member
2014	Thesis Advisory Committee (Alena Yermalovich)	HMS / BBS Committee member
2017	Thesis Advisory Committee (Kate Harding)	HMS / BBS Committee member
2016	Office for Research Career Development Postdoctoral Division Director Search Committee	MGH
2016-	MGH Research Institute "Navigating the translational pipeline" course development	Committee member
2018	PQE Committee (Michael Florea)	HMS/BBS Committee member
2018	Thesis Advisory Committee (Rebecca Soto)	HMS/BBS Committee Chair
2018	Thesis Advisory Committee (Michael Florea)	HMS/BBS Committee Chair

Professional Societies

1/98-	American Society for Nephrology	Member, Abstract selection committee
1/98-	American Society for Cell Biology	Member
8/13-	American Society of Human Genetics	Member

Grant Review Activities

2002	NCRR Study Section	Ad Hoc Reviewer
2002-2003	NIDDK PPG Study Section	Ad Hoc Reviewer
2003	NIDDK GMB Study Section	Ad Hoc Reviewer
2003-2005	NIH Multi-Institute Zebrafish Initiative Study Section (RFA)	Ad Hoc Reviewer
2005	American Heart Foundation Fellowship Review	Ad Hoc Reviewer
2006-	Wellcome Trust Grants Review	Ad Hoc Reviewer
2008	National Kidney Foundation Review Committee	Ad Hoc Reviewer

2003-	PKD Foundation	
	2003-2006	Ad Hoc Reviewer
	2007-	Scientific Advisory Board
2006	March of Dimes Foundation Review Committee	Ad Hoc Reviewer
2007	The Dutch Cancer Society Grant Review	Ad Hoc Reviewer
2006-2008	The Alberta Heritage Medical Research Foundation (Canada)	Ad Hoc Reviewer
2009-2010	NIH Challenge Grant study section	Ad Hoc Reviewer
2011	Health Research Council of New Zealand	Ad Hoc Reviewer
2013	NIH Dev1 Study Section	Ad Hoc Reviewer
2013	NIH KMBD Study Section	Ad Hoc Reviewer
2014-2018	NIH KMBD Study Section	Study section member
2019-	NIDDK Council	Advisory councelor

Editorial Activities

Development
Developmental Cell
Developmental Biology
Cell
Current Biology
EMBO Journal
PNAS
Genes and Development
Nature
PLOS Genetics
Nature Genetics
Journal of Cell Science
Journal of Clinical Investigation
American Journal of Physiology
Developmental Genetics
Mechanisms of Development
Developmental Dynamics
Kidney International
Journal of the American Society for Nephrology
Human Molecular Genetics
Physiological Genomics

Other Editorial Roles

1/02-1/12	Editorial Board	American Journal of Physiology
1/07-1/18	Editorial Board	Journal of the American Society for Nephrology
1/13-1/16	Editorial Board	Physiological Genomics
6/12-	Editorial Board	Cilia

Honors and Prizes

1978	Sigma Xi	Sigma Xi Scientific Research Society	Scholarship in undergraduate research
1984	Mountain Scholarship	Mountain Memorial Scholarship, Woods Hole, MA	Research at Woods Hole

Report of Funded and Unfunded Projects

Funding Information

Past

1989-1990 Cloning by complementation in Dictyostelium discoideum.
NIH/NRSA
PI (Post-doctoral Fellow)
The goals of this proposal were to establish methods for cloning my complementation in Dictyostelium

1996-1997 Genetic analysis of Kidney Cystic Disease Using Zebrafish as a Model Organism.
National Kidney Foundation Young Investigator Award
Principal Investigator
The goals of this proposal were to characterize zebrafish pronephric development and cyst mutants

1998-2000 Zebrafish kidney development (Arindam Majumdar)
NIH NRSA
Mentor
To clone and characterize genes mutated in zebrafish kidney mutants

1999-2004 Kidney development and cystogenesis.
NIDDK PO1
Co-PI
The goals were to model Autosomal Dominant Polycystic Kidney Disease in zebrafish.

2002-2004 Functional Analysis of cystic disease genes in zebrafish (Angela Zhao)
PKD Foundation Fellowship
Mentor
To study the function of Polycystins in zebrafish

2002 A Bioinformatics Web server for zebrafish genomics.
Sun Microsystems Academic Equipment Grant
PI
This award provided a Sun Fire V440 server to host a zebrafish and mouse bioinformatics server (for Blasting unassembled genomic sequence and generation of SSR markers for genetic mapping)

2006-2008 Polycystin- 2 in Renal Cyst Formation and Ca^{2+} Flux (Steve Mangos)

PKD Foundation fellowship
Mentor
To generate dominant negative, screenable models of ADPKD and study calcium transients using genetically encoded biosensors.

2006-2008 *osr1* function in nephrogenesis (Sudha Mudumana)
American Heart Association Fellowship
Mentor
To study *osr1* in kidney and vascular patterning and development

2009-2010 Cloning and analysis of the zebrafish *schmalhans* mutant (Jennifer Panizzi)
NIH NRSA
Mentor
To positionally clone and analyze the zebrafish primary ciliary dyskinesia mutant *schmalhans*.

2009-2010 Polycystin regulation of ER/Golgi calcium and its role in matrix assembly and secretion.
PKD Foundation
PI
The goals were to determine the role of ER calcium and the unfolded protein response in the pathophysiology of Autosomal Dominant Polycystic Kidney Disease.

2009-2010 ARRA Competitive Supplement to "Genetic analysis of zebrafish kidney development"
NIDDK
PI
To explore the function of nephronophthisis genes in zebrafish kidney development.

2010 Regulation of Motile Cilia in The Zebrafish Pronephros (Nathan Hellman; deceased)
NIDDK K08
Mentor

2008-2013 Analysis of the zebrafish *fleer* mutant (Narendra Pathak)
NIH KO1 ($805,750)
Mentor
To characterize mechanisms of tubulin post-translational modification regulated by the *fleer* gene.

2009-2014 Collective cell migration in nephron morphogenesis (Aleksandr Vasilyev)
NIH KO8 ($805,750)
Mentor
To explore cellular mechanisms underlying a novel cell migration in kidney tubule formation.

2012-2014 Zebrafish adult kidney stem cells
Harvard Stem Cell Institute ($80,000)
PI
The goals of this project are to generate new transgenics using the *fzd9b* gene promoter in order to test the developmental potential and origins of kidney stem cells.

2004-2015 Function of polycystins in zebrafish
NIDDK DK070263
PI ($1,455,795.00)
The aims of this grant are to determine signal transduction pathways and molecular regulation of morphogenesis by polycystins

2005-2015 Comparative analysis of *odd-skipped related1* function in nephrogenesis
NIDDK DK071041
PI ($955,840.00)
The goals of this project are to determine the function of *osr1* in kidney cell type differentiation.

Current

1997-2019 Ciliogenesis in epithelial injury
NIDDK DK053093
PI ($1,409,959.00)
The aims of this grant are to study genetic defects and ciliopathy in zebrafish

2013-2015 A small molecule screen for ciliopathies (Judith Bergboer)
Netherlands Organization for Scientific Research
Mentor
The goal of this project is to develop a zebrafish functional assay for sensory cilia using neuronal responses to odorants and calcium biosensors to create a platform for screening chemical libraries.

2015-2020 Mechanisms of tubule interconnection
NIDDK UH2/UH3 DK107372
PI ($426,000)
The goal of this project is to 1) establish quantitative assays for tubule interconnection in the context of new nephron addition after kidney injury in adult zebrafish, 2) assay signaling pathways that impact cell rearrangements and morphological processes required for lumenal interconnection.

2015-2017 Non-canonical wnt signaling and regulation of nephric duct insertion

NIH/NIDDK U54DK104309
PI ($75,000) pilot project

The goals of this pilot project are to assay a conserved role for Wnt5 in nephric duct / cloaca insertion and formation of the lower urinary tract. The source and target cells for Wnt5 signaling will be determined using tissue specific rescue experiments in zebrafish *wnt5b* mutants and dominant negative signaling constructs.

2016-2019 Genetics of Human Renal Hypodysplasia

NIDDK DK107372
Subcontract ($118,000)
The aims of this subcontract are to conduct functional assays of candidate human CAKUT disease alleles in zebrafish. Disease gene ortholog expression patterns will be determined by in situ hybridization and candidate human disease genes will be targeted for mutation using CRISPR/Cas9 genome editing to determine their roles in CAKUT pathology.

Current Unfunded Projects

2010 PI / "An FEI G2 F20 TWIN Electron Microscope"
I am continuing to try and raise funds to upgrade our electron microscopy core to enable structural EM studies and 3D tomography of thick tissue sections.

2013 PI / "A Lightsheet Microscope"
In this multiuser SIG I aim to establish a lightsheet confocal microscope for live time lapse confocal imaging.

Report of Local Teaching and Training

Teaching of Students in Courses

2000-2006	Renal Pathophysiology HST110 20-30 Medical and engineering students	HMS 1 1 hour lecture
2006	Vertebrate Developmental Biology CB207 BBS 1-3rd yr Graduate students	HMS 1 1hour lecture
2006-	Concepts in Development, Self Renewal and Repair, CB226 (Course Director) BBS graduate students, HMS medical students, HSD dental students and Harvard University SEAS students. https://canvas.harvard.edu/courses/42283	Simches (MGH) Organize 12 1 hour lectures, 12 2 hour literature reviews, grade 12 research proposals. Ongoing course offering.
2009	Cilia and Disease, DRB Nanocourse 80 students, post docs and interested faculty	HMS 2 3hour sessions
2012, 2013	MGH Molecular Biology Course, "*Current Techniques in Molecular Genetics"* 30-40 research fellows	Simches (MGH) 1 1 hour lecture
2014	Cilia and Disease, DRB Nanocourse 40 students, post docs and interested faculty	HMS 1 4 hour session

Regional, National and International Presentations

2004	Renal Development and Organogenesis. 20 graduate students	National University of Singapore 2 2 hour lectures

2011	Renal Development and Organogenesis. 20 graduate students	National University of Singapore 2 2 hour lectures
2010, 2011, 2012, 2014, 2016	Host lab for the University of Paris 7 Master's Student Internship program	6 months mentored training
2013	Frontiers of Genetics and Development 60 Fudan University graduate students	Fudan University, Shanghai China 4 x 1 hour lectures on organogenesis and tissue regeneration

Laboratory and Other Research Supervisory and Training Responsibilities

2005-2013	Confocal microscopy Postdoctoral fellows and graduate students	Nephrology Division, MGH 5 2 hour sessions/yr. Over 120 fellows trained
2014-2019	Site Director, Harvard summer research program in Kidney Medicine (NIDDK R25)	3 month mentoring of undergraduate students in research projects.

Formally Supervised Trainees

1997-2000	Arindam Majumdar / Research Assistant Professor, Uppsala University, Sweden Postdoctoral Mentor; Published 7 papers together; NRSA fellowship
2001-2004	Angela Zhao / Private Practice, Case Western Reserve, Cleveland OH. Postdoctoral Mentor; Published 7 papers together; PKD fellowship
2000-2004	Tomoko Obara / Assistant Professor, University of Oklahoma Postdoctoral Mentor; Published 5 papers together; left with NIH R21 grant
2002-2004	Albrecht Kramer-Zucker / Project leader, University of Freiburg, Germany Postdoctoral Mentor; Published 4 papers together
2002-2004	Dirk Hentschel / Instructor in Medicine, HMS Postdoctoral Mentor; Published 2 papers together
2004-2008	Narendra Pathak / Instructor in Medicine, HMS Postdoctoral Mentor; Published 3 papers and a book chapter together; KO1 award.
2005-2008	Steven Mangos / Research Assistant Professor, Rush University Medical Center, Chicago IL Postdoctoral Mentor; Published 6 papers together; PKD fellowship

2005-2009	Sudha Mudumana, Biotechnology Consultant, Detroit MI Postdoctoral Mentor; Published 3 papers together; AHA fellowship
2007-2010	Jennifer Panizzi / Assistant Professor, Auburn University, AL Postdoctoral Mentor; Published 1 paper together; NRSA fellowship
2007-2013	Aleksandr Vasilyev / Assistant Professor, New York Institute of Technology Postdoctoral Mentor; Published 3 papers and 2 reviews together; KO8 and RO3 Awards.
2007-2010	Alexandra Terashima / Research Administration, RIKEN Institute for Brain Research PhD Graduate Advisor; 2 publications in process of submission
2008-2010	Nathan Hellman / deceased. Postdoctoral Mentor; Published 1 paper; KO8 Award
2008-2013	Christina Austin-Tse / Editor at the Journal of Visualized Experiments, Cambridge MA PhD Graduate Advisor; Published 4 papers
2010-	Caramei Kamei / Postdoctoral Fellow, Nephrology MGH Postdoctoral Mentor / NRSA Postdoctoral Fellowship
2010	Evelyne Huynh Cong / Masters Student, University of Paris 7 Masters Thesis Mentor
2010-2014	Stephanie Le Corre / Postdoctoral Fellow, Nephrology MGH Postdoctoral Mentor
2010-2016	Ritu Tomar / Postdoctoral Fellow, Nephrology MGH Postdoctoral Mentor
2010-2016	Erin Merkel / Graduate Student Department of Genetics, HMS PhD Graduate Advisor
2011	Anne-Laure Duchemin / Masters Student, University of Paris 7 Masters Thesis Mentor
2012	Aurelien Palmyre / Masters Student, University of Paris 7 Masters Thesis Mentor
2013-2016	Judith Berboer / Postdoctoral Fellow, Nephrology MGH Postdoctoral Mentor; NWO Postdoctoral Fellowship
2013	Yu Liang / Masters Student, M.D. University of Heidelberg, Germany Mentored training
2014-	Tom Gallegos / Postdoctoral Fellow, Nephrology MGH Postdoctoral Mentor

2014	Marie Dupont / Masters Student, University of Paris 7 Masters Thesis Mentor
2014	Mike Baltussen / Technology Student, The Netherlands Undergraduate Internship advisor
2015-2018	Yuya Sugano / Postdoctoral Fellow, Nephrology MGH Postdoctoral Mentor
2015	Guillaume Dorval / Postdoctoral Fellow, Nephrology MGH Postdoctoral Mentor
2016-	Magdalena Cardenas Rodriguez / Postdoctoral Fellow, Nephrology MGH Postdoctoral Mentor
2016	Simone Kersten / Masters Student, Biomedical Sciences at Radboud UMC Masters Thesis Mentor
2017	Hugo Siegfried / Masters Student, University of Paris Masters Thesis Mentor
2017-	Lydia Djenoune / Postdoctoral Fellow, Nephrology MGH Postdoctoral Mentor
2018-	Monica Sircar / Nephrology Research Fellow, Nephrology MGH Fellowship Mentor

Local Invited Presentations

1994	The Renal Unit, Massachusetts General Hospital
2004	Cutaneous Biology Research Unit, MGH, Charlestown
2004	Program in Matrix Biology, BIDMC, Boston MA
2004	Cardiovascular Research Center, MGH, Charlestown
2004	Forsyth Institute, Boston
2007	Northeastern University, Department of Biology, Boston MA
2010	Beth Israel Deaconess Grand Rounds
2012	Boston University School of Medicine, Pulmonary Division
2014	MGH Nephrology Grand Rounds

Report of Regional, National and International Invited Teaching and Presentations

Invited Presentations and Courses

Regional

1992	The Worcester Foundation for Experimental Biology, Worcester MA
1993	University of Connecticut Health Center CT
2003	Univ. Mass. Medical School, Worcester, MA
2004	Department of Biology, Univ. of Mass, Amherst MA

2006 The Mount Desert Island Stem Cell Symposium, Bar Harbor ME
2007 Yale School of Medicine, Genetics Department, New Haven CT
2008 Yale University, Department of Biology New Haven CT
2009 Umass Medical School, Program in Molecular Medicine, Worcester, MA
2015 Brigham and Womens Hospital, Boston

National

1987 35th Annual Meeting of the Radiation Research Society, Atlanta GA
1991 DePaul University, Chicago IL
1992 Baylor College of Medicine, Houston TX
1992 Washington University School of Medicine, St. Louis, MI
1992 McArdle Cancer Center, University of Wisconsin, Madison, WI
1993 The Center for Advanced Biotechnology and Medicine, Rutgers, NJ
1993 Loyola University Cancer Center, Chicago, IL
1995 The Sixth International Workshop on Developmental Nephrology, Airlie Virginia
1995 American Society of Nephrology annual meeting, San Diego, CA
1996 Cold Spring Harbor meeting on Zebrafish Development and Genetics
1996 American Society of Nephrology meeting on Renal Developmental Biology
1997 National Institutes of Health; NIDDK Workshop on Polycystic Kidney Disease
1998 Mount Sinai School of Medicine, NY, NY.
1998 Albert Einstein School of Medicine, NY
1998 Cold Spring Harbor meeting on Zebrafish Development and Genetics
1998 Meeting of the American Society for Cell Biology
1999 American Society of Nephrology
2000 American Society of Nephrology
2001 University of Kansas Medical Center.
2001 Banbury conference on epithelial and endothelial tube formation. CSHL
2002 Vanderbilt University Medical Center, Nashville, TN
2002 University of Alabama, Birmingham AL
2002 FASEB meeting on polycystic kidney disease, Tuscon AZ
2002 University of Indiana Medical School, Indianapolis IN
2002 Nephron patterning, ASN, Philadelphia PA
2002 Angioblasts/nephrogenesis session, FASEB, San Diego CA
2002 Kidney disease session, FASEB, San Diego CA
2004 International conference on podocytes, Seattle WA
2004 Model systems for kidney development, ASN, St. Louis MI
2005 FASEB PKD Summer Research Conference, Saxtons River, VT
2005 Zebrafish Strategic Meeting, MDIBL Bar Harbor ME
2005 Medical College of Wisconsin, Milwaukee, WI
2005 IUPS/FASEB, San Diego CA
2006 UCSD Department of Biology, San Diego CA
2006 NYU Department of Nephrology, NY NY
2006 University of Cincinnati, OH
2006 Johns Hopkins University, Genetic Medicine Baltimore MD
2006 Santa Cruz Developmental Biology Meeting, CA
2008 Zebrafish Development and Genetics, Madison WI
2007 University of Alabama, Birmingham AL

2007 FASEB Cilia Symposium, Saxton River VT
2007 FASEB symposium, Washington DC.
2008 Univ. Michigan Center for Organogenesis, Ann Arbor MI
2008 Zebrafish Development and Genetics, Madison WI
2009 Columbia University, Department of Nephrology, NY NY
2009 Department of Biology, Texas A&M College Station, TX
2010 Columbia University, Department of Genetics
2010 International Workshop in Developmental Nephrology, New York
2010 American Society of Nephrology
2010 Zebrafish Development and Genetics, Madison WI
2010 FASEB Meeting on Ciliogenesis, Saxton River, VT
2011 Gordon Conference on Cilia and Mucociliary Clearance, Ventura CA
2011 FASEB PKD Summer Research Conference, Saxtons River, VT
2011 American Society of Nephrology
2011 American Society for Cell Biology
2012 Duke University Developmental Biology Colloquium
2012 University of Nevada, Las Vegas
2012 ARVO meeting on cilia and retinopathies, Fort Lauderdale, FL
2012 Zebrafish Development and Genetics, Madison WI
2012 Mayo Clinic Scientific Advisory Board Keynote lecture
2012 American Society of Nephrology
2012 American Society for Cell Biology
2013 University of Alabama HRFDCC Keynote lecture
2013 Amgen Corporation, San Francisco CA
2014 Joubert Syndrome Biennial Conference, ASHG mtg. Boston
2015 Experimental Biology Meeting, Boston
2015 Skirball Institute, New York
2015 Columbia University, New York
2015 Indiana University Imaging course
2015 Kansas University PKD center, Kansas City
2015 Solve Organ Shortage Foundation, Austin TX
2015 Urology Symposium, Columbia University, New York
2015 Genome Editing, American Society of Nephrology
2016 Eli Lilly, Indianapolis, IN
2016 Yale University Medical School Nephrology Division
2016 Sanford Research Laboratories, Sioux Falls, SD
2017 Cincinnati Childrens Hospital Urology workshop, Cincinnati, OH
2017 Zebrafish Principal Investigators meeting, Asilomar CA
2017 Columbia University, New York
2018 Childrens National Hospital, Washington DC
2018 Workshop on cilia and flagella, Zebrafish Development and Genetics, Madison WI
2018 MDIBL, Kidney Repair and Regeneration, Bar Harbor ME

International

1996 German Nephrological Society, Berlin, Germany
2000 Conference on Developmental Genetics, Munich, GSF, Germany
2001 International conference on podocytes; Heidelberg, Germany

2002 Temasek Life Science Laboratory, Singapore
2003 ELSO European Cell Biology Meeting, Dresden, Germany
2003 Novo Nordlsk Foundation; Diabetes Complications, Bro, Sweden
2003 Temasek Life Science Laboratory, Singapore
2004 Int. Workshop in Developmental Nephrology, Adelaide, Australia
2005 XII Annual UK/European Nephrogenesis Workshop, London
2005 4th International Symposium on Aquaporins, Brussels, Belgium
2006 Conference on Epithelial Biology, MDC, Berlin
2007 Institut Pasteur, Paris France.
2007 ISN meeting, Rio de Janeiro, Brazil
2007 Japanese Biochemistry and Molecular Biology Meeting, Yokohama, Japan
2008 Nature Forefronts Symposium on Polycystic Kidney Disease, Montreal
2009 International Society for Developmental Biology meeting, Edinburgh, Scotland
2011 Temasek Life Science Laboratory, Singapore
2011 Englert Lab retreat, Obertauern Austria
2011 2nd international Curie/UPMC Developmental Biology course, Paris
2012 9th International meeting on Podocytes, Miami FL
2013 Tonji University, Shanghai China
2013 Gordon Research conference on Cilia and Mucociliary clearance, Barga Italy
2013 International Workshop in Developmental Nephrology, Edinburgh Scotland
2014 EURenOmics Joint Annual Meeting, Heidelberg Germany
2014 Imagine Institute / Hopital Necker Paris France
2014 Sheffield University, England
2014 Novartis, Basel Switzerland
2014 Fritz Lippmann Institute, Jena Germany
2014 9th International meeting on Podocytes, Frieberg Germany
2014 FASEB Research conference on Polycystic Kidney Disease, Barga Italy
2014 International Society for Nephrology, Boston
2015 EURenOmics Joint Annual Meeting, Heidelberg Germany
2015 University of Zurich, Switzerland
2015 International Workshop in Developmental Nephrology, Snowbird Utah
2016 International Pediatric Nephrology Association, Iguçu Brazil
2017 International Union of Physiological Sciences, Rio de Janiero, Brazil
2017 7th International Kidney.CH Symposium, Zurich, Switzerland
2018 International Workshop in Developmental Nephrology, Israel

Report of Scholarship

Publications

Peer reviewed publications in print or other media

Research investigations

1. Ryser H.J-P., **Drummond** I.A., and Shen W.C. Cellular uptake of horseradish peroxidase and its poly(lysine) conjugate by cultured fibroblasts is qualitatively similar despite a 900-fold difference in rate. J. Cell. Physiol. 1982;113:167-178.

2. **Drummond** I.A.S., McClure S.A., Poenie M., Tsien R.Y. and Steinhardt R.A.. Large Changes in Intracellular pH and Calcium Observed during Heat Shock Are Not Responsible for the Induction of Heat Shock Proteins in Drosophila Melanogaster. Mol. Cell. Biol. 1986;6:1767-1775.

3. **Drummond** I.A.S., and Steinhardt R.A.. The role of oxidative stress in the induction of heat shock proteins. Exp. Cell Res. 1987;173:439-449.

4. **Drummond** I.A.S., Resendez E. Jr., Nakaki T., Lee A.S., and Steinhardt R.A.. Depletion of intracellular calcium stores by calcium ionophore A23187 induces the genes for glucose-regulated proteins in hamster fibroblasts. J. Biol. Chem.1987;262:12801-12905.

5. **Drummond** I.A.S, Livingstone D., and Steinhardt R.A.. Heat shock protein synthesis and cytoskeletal rearrangements occur independently of intracellular free calcium increases in Drosophila cells and tissues. Rad. Res. 1987;113: 402-413.

6. **Drummond** I.A.S., and Chisholm R.L.. The effect of caffeine, adenosine and buffer ionic composition on the induction of cell-surface cAMP binding during starvation of Dictyostelium discoideum. Dev. Genetics 1988;9: 293-301.

7. Hopkinson S.B., Pollenz R.S., **Drummond** I.A.S., and Chisholm R.L.. Expression and organization of BP74, a cAMP regulated prestalk gene expressed during Dictyostelium development. Mol. Cell. Biol. 1988;9:4170-4178.

8. **Drummond** I.A.S., and Chisholm R.L.. A pleiotropic defect in cAMP regulated gene expression in the Dictyostelium discoideum *agg*$^{-}$ mutant *synag 7.* Dev. Biol. 1990;140:225-228.

9. **Drummond** I.A., Madden S.L., Rohwer-Nutter P., Bell G.I., Rauscher F. III, and Sukhatme,V.P.. Repression of the IGF-II gene by the Wilms' tumor suppressor WT1. Science 1992;257:674-678.

10. Baxter B.T., McGee G.S., Shively V.P., **Drummond** I. A., Dixit S.N, Yamauchi M., and Pierce W.H.. Elastin content, cross-links and mRNA in normal and aneurysmal human aorta. J. Vasc. Surgery 1992; 16:192-200.

11. Werner H., Re G.G., **Drummond** I.A., Sukhatme V.P., Rauscher F.J. III, Sens D.A., Garvin A.J., LeRoith D., and Roberts C.T.. Increased expression of the insulin-like growth factor I receptor, *IGF1R*, gene in Wilms tumor is correlated with modulation of *IGF1R* Promoter activity by the *WT1* Wilms' tumor gene product. Proc. Natl. Acad. Sci. 1993;90: 5828-5832.

12. **Drummond** I.A., P. Rohwer-Nutter and Sukhatme V.P.. DNA recognition by splicing variants of the Wilms' Tumor suppressor WT1. Mol. Cell Biol. 1994;14:3800-3809.

13. Rupprecht H., **Drummond** I.A., Zilberstein M., andSukhatme V.P.. The WT1 gene is negatively autoregulated. J. Biol. Chem. 1994;269:6198-6206.

14. Werner H. , Rauscher F. J. III, Sukhatme V.P., **Drummond** I. A., Roberts C. T. Jr., and LeRoith D.. Transcriptional repression of the insulin-like growth factor I receptor (IGF-I-R) gene by the tumor

suppressor WT1 involves binding to sequences upstream and downstream of the IGF-I-R transcription start site. J. Biol. Chem. 1994;269:12577-12582.

15. **Drummond** I.A., Rohwer-Nutter P. and Sukhatme V.P.. The Zebrafish egr1 gene encodes a highly conserved, zinc finger transcriptional regulator. DNA and Cell Biol. 1994;13:953-961.

16. Kjelsberg C., Sakurai H., Spokes,K., Birchmeier C., **Drummond** I., Nigam S., and Cantley L. Met-/- Kidneys Express Epithelial Cells which Chemotax and Form Tubules in Response to EGF Receptor Ligands. American Journal of Physiology. Am. J. Physiol. 1997; 272:F222-F228

17. **Drummond** I.A., Goodyer P., and Sukhatme V.P. .Immortal, developmentally arrested human fetal kidney cell lines created by retroviral expression of human papillaloma virus E6 and E7. Exp Nephrol. 1997; 5:390-398.

18. **Drummond** I.A., Mukhopadtayay D. and Sukhatme V.P.. Expression of fetal kidney growth factors in a kidney tumor line: role of FGF2 in kidney development. Exp Nephrol. 1998; 6:522-533.

19. **Drummond** I.A., Majumdar A. Hentschel H., Elgar M., Solnica Krezel L., Schier A., Neuhauss S., Stemple D., Zwartkruis F., Rangini Z., Driever W. and Fishman M.C.. Early development of the zebrafish pronephros and analysis of mutations affecting pronephric function. Development 1998; 125:4655-4667.

20. Majumdar A. and **Drummond** I. A. Podocyte differentiation in the absence of endothelial cells as revealed in the zebrafish avascular mutant, *cloche*. Developmental Genetics 1999 24:220-229.

21. Kim E, Arnould T, Fan MJ, Gruening W, Sokol SY, **Drummond** I, and Walz G. Polycystin modulates Wnt signaling. J. Biol. Chem. 1999 274:4947-53.

22. Liu, A., A. Majumdar, H. E. Schauerte, P. Haffter, and I. A. **Drummond**. 2000. Zebrafish wnt4b expression in the floor plate is altered in sonic hedgehog and gli-2 mutants. Mechanisms of Development 91:409-413.

23. Majumdar, A., and I.A. **Drummond**. 2000. The zebrafish *floating head* mutant demonstrates podocytes play an important role in directing glomerular differentiation. Developmental Biology 222:147-157.

24. Kim K. I. A. **Drummond**, O. Ibraghimov-Beskrovnaya, K. Klinger, and M. A. Arnaout. 2000. Polycystin 1 is requried for the structural integrity of blood vessels. Proc. Natl. Acad. Sci. 97:1731-36

25. Majumdar, A., K. Lun, M. Brand, and I. A. **Drummond**. 2000. Zebrafish *no isthmus* reveals a role for pax2.1 in tubule differentiation and patterning events in the pronephric primordia. Development 127:2089-2098.

26. Lin Y, Liu A, Zhang S, Ruusunen T, Kreidberg JA, Peltoketo H, **Drummond** I, Vainio S. 2001. Induction of ureter branching as a response to Wnt-2b signaling during early kidney organogenesis. Dev Dyn. 222:26-39.

27. Xu, G. M., T. Sikaneta, B. M. Sullivan, Q. Zhang, M. Andreucci, T. Stehle, I. **Drummond**, M. A. Arnaout. 2001. Polycystin-1 Interacts with Intermediate Filaments. J. Biol. Chem.276:46544-46552.

28.Serluca, F., I.A. **Drummond**, and M.C.Fishman. 2002 Endothelial signaling in kidney morphogenesis. A role for hemodynamic forces. Curr Biol. 12:492-7.

29. Liu S., W. Lu, T. Obara-Ishihara, S. Kuida, J. Lehoczky, K. Dewar, I.A. **Drummond**, D.R. Beier. 2002. A defect in a novel Nek-family kinase causes cystic kidney disease in the mouse and in zebrafish. Development. Development 129: 5839-5846.

30. Otto EA, Schermer B, Obara T, O'Toole JF, Hiller KS, Mueller AM, Ruf RG, Hoefele J, Beekmann F, Landau D, Foreman JW, Goodship JA, Strachan T, Kispert A, Wolf MT, Gagnadoux MF, Nivet H, Antignac C, Walz G, **Drummond** IA, Benzing T, Hildebrandt F. 2003. Mutations in INVS encoding inversin cause nephronophthisis type 2, linking renal cystic disease to the function of primary cilia and left-right axis determination. Nat Genet. 34:413-20. PMC3732175

31. Kramer-Zucker, A. G., Olale, F., Haycraft, C. J., Yoder, B. K., Schier, A. F., and **Drummond**, I. A. 2005. Cilia-driven fluid flow in the zebrafish pronephros, brain and Kupffer's vesicle is required for normal organogenesis. Development 132:1907-1921.

32. Hentschel, D. M., Park, K. M., Cilenti, L., Zervos, A. S., **Drummond**, I., and Bonventre, J. V. 2005. Acute Renal Failure in Zebrafish - A Novel System to Study a Complex Disease. Am J Physiol Renal Physiol. 288:F923-9.

33 Bedell V.M., Yeo S.Y., Park K.W., Chung J., Seth P., Shivalingappa V., Zhao J., Obara T., Sukhatme V.P., **Drummond** I.A., Li D.Y., Ramchandran R. 2005. *roundabout4* is essential for angiogenesis in vivo. Proc Natl Acad Sci U S A. 102:6373-8. PMC1088354

34 Kramer-Zucker, A.G., Wiessner, S., Jensen, A.M. and **Drummond**, I. 2005. Organization of the pronephric filtration apparatus in zebrafish requires Nephrin, Podocin and the FERM domain protein Mosaic eyes. Developmental Biology, 285:316-29. PMC2836015

35. Shmukler, B.E., Kurschat, C.E., Ackernann, G.E., Jiang, L., Zhou, Y., Barut, B., Stuart-Tilley, A.K., Zhao, J., Zon, L.I., **Drummond**, I.A., Vandorpe, D.H., Paw, B.H., and Alper, S.L. 2005. Zebrafish slc4a2/ae2 Anion Exchanger: cDNA Cloning, Mapping, Functional Characterization, and Localization. Am. J. Physiol. Renal Physiol. 289(4): F835-849

36. Sayer, J.A., E. A. Otto, J. F. O'Toole, G. Nurnberg, M. A. Kennedy, C. Becker, H. C. Hennies, J. Helou, M. Attanasio, B. V. Fausett, B. Utsch, H. Khanna, Y. Liu, I.**Drummond**, I. Kawakami, T. Kusakabe, M. Tsuda, L. Ma, H. Lee, R. G. Larson, S. J. Allen, C. J. Wilkinson, E. A. Nigg, C. Shou, C. Lillo, D. Williams, B. Hoppe, M. Kemper, T. Neuhaus, M. A. Parisi, I. A. Glass, M. Petry, A. Kispert, J. Gloy, A. Ganner, G. Walz, X. Zhu, D. Goldman, P. Nurnberg, A.Swaroop, M. R. Leroux, and F. Hildebrandt. 2006. A novel centrosomal protein, nephrocystin-6, is mutated in Joubert syndrome and activates transcription factor ATF4/CREB2. Nature Genetics, 2006. 38(6): p. 674-81.

37 Obara, T., S. Mangos, Y. Liu, J. Zhao, S. Wiessner, A. Kramer-Zucker, F. Olale, A.F. Schier, and I. **Drummond**. 2006. Polycystin2 immunolocalization and function in zebrafish. J Am Soc Nephrol., 17:2706-18 PMC3698611

38. Hinkes, B., Wiggins, R. C., Gbadegesin, R., Vlangos, C. N., Seelow, D., Nurnberg, G., Garg, P., Verma, R., Chaib, H., Hoskins, B. E., Ashraf, S., Becker, C., Hennies, H. C., Goyal, M., Wharram, B. L., Schachter, A. D., Mudumana, S., **Drummond**, I., Kerjaschki, D., Waldherr, R., Dietrich, A., Ozaltin, F., Bakkaloglu, A., Cleper, R., Basel-Vanagaite, L., Pohl, M., Griebel, M., Tsygin, A. N., Soylu, A., Muller, D., Sorli, C. S., Bunney, T. D., Katan, M., Liu, J., Attanasio, M., O'Toole J, F., Hasselbacher, K., Mucha, B., Otto, E. A., Airik, R., Kispert, A., Kelley, G. G., Smrcka, A. V., Gudermann, T., Holzman, L. B., Nurnberg, P. and Hildebrandt, F. 2006. Positional cloning uncovers mutations in PLCE1 responsible for a nephrotic syndrome variant that may be reversible. Nat Genet 38, 1397-405. PMID- 17086182

39. Mangos,S., Y. Liu, and Iain A. **Drummond**. 2007. Dynamic expression of the osmosensory channel *trpv4* in multiple developing organs in zebrafish. Mech. Dev. 7:480-484 PMC2692568

40. Liu, Y., Pathak, N., Kramer-Zucker, A. and **Drummond**, I.A. 2007. Notch signaling controls the differentiation of transporting epithelia and multiciliated cells in the zebrafish pronephros. Development, 134:1111-22.

41. Panizzi, J., Jessen, J.R., **Drummond**, I.A. and Solnica-Krezel, L. 2007. New Functions for a Vertebrate Rho Guanine Nucleotide Exchange Factor in Ciliated Epithelia. Development 134:921-31.

42. Pathak, N., Obara, T., Mangos, S., Liu, Y., and **Drummond**, I.A. 2007. The Zebrafish *fleer* Gene Encodes an Essential Regulator of Cilia Tubulin Polyglutamylation. Mol Biol Cell 18:4353-4364. PMC2043541

43. Insinna, C., Pathak, N., Perkins, B., **Drummond**, I., and Besharse, J.C. 2008. The homodimeric kinesin, Kif17, is essential for vertebrate photoreceptor sensory outer segment development. Dev. Biol. 316:160-70. PMC2362383

44 Möller,' C.C, Mangos' S., **Drummond**,I.A., and Reiser, J. 2008. Expression of *trpC1* and *trpC6* orthologs in zebrafish. Mech. Dev. 8:291-6. PMC2431112

45. Mudumana S.P., Hentschel D., Liu Y., Vasilyev A., **Drummond** I.A. 2008. *odd skipped related1* reveals a novel role for endoderm in regulating kidney versus vascular cell fate. Development. 2008 Oct;135(20):3355-67 PMC2742377

46. Vasilyev, A., Liu, Y., Mudumana' S.P., Steve Mangos' S., Lam, P., Majumdar, A., Jinhua Zhao, J., Poon, K-L, Kondrychyn, I., Korzh, V., and Iain A. **Drummond**, I.A. 2009. Collective Cell Migration Drives Morphogenesis of the Kidney Nephron. PLoS Biology Jan 6;7(1):e9 PMC2613420

47. Sussman, C.R., Zhao, J., Plata, C., Lu, J., Daly, C., Angle, N., Dipiero, J., **Drummond**, I.A., Liang, J.O., and Boron, W.F. 2009. Cloning, localization and functional expression of the electrogenic Na+ bicarbonate cotransporter (NBCe1) from zebrafish. Am J Physiol Cell Physiol. 297:C865-C875. PMC2770747

48. Mangos, S., Lam, P.Y., Zhao, A., Liu, Y., Mudumana, S., Vasilyev, A., Liu, A., and **Drummond**, I.A. 2010. The ADPKD genes *pkd1a/b* and *pkd2* regulate extracellular matrix formation. Disease Models and Mechanisms 3, 354-365. PMC2860853

49. Chen, L. M., Zhao, J., Musa-Aziz, R., Pelletier, M. F., **Drummond**, I. A. and Boron, W. F. 2010. Cloning and characterization of a zebrafish homologue of human AQP1: A bifunctional water and gas channel. Am J Physiol Regul Integr Comp Physiol. PMC2980453

50. Cianciolo Cosentino, C., Roman, B. L., **Drummond**, I. A. and Hukriede, N. A. (2010). Intravenous microinjections of zebrafish larvae to study acute kidney injury. J Vis Exp. 2010 Aug 4;(42) PMC3156013

51. Hellman, N. E., Liu, Y., Merkel, E., Austin, C., Le Corre, S., Beier, D. R., Sun, Z., Sharma, N., Yoder, B. K., **Drummond**, I. A., 2010. The zebrafish *foxj1a* transcription factor regulates cilia function in response to injury and epithelial stretch. Proc Natl Acad Sci U S A. 107:18499–18504. PMC2972951

52. Pathak N, Austin CA, **Drummond IA**. 2011 Tubulin tyrosine ligase like genes TTLL3 and TTLL6 maintain zebrafish cilia structure and motility. J Biol Chem. 286(13):11685-95. PMC3064220

53. Rothschild, S.C., Francescatto, L., **Drummond, I.A**. & Tombes, R.M. CaMK-II is a PKD2 target that promotes pronephric kidney development and stabilizes cilia. Development 138, 3387-97 (2011).

54. Panizzi, J.R., Becker-Heck, A., Castleman, V.H., Al-Mutairi, D.A., Liu, Y., Loges, N.T., Pathak, N., Austin-Tse, C., Sheridan, E., Schmidts, M., Olbrich, H., Werner, C., Haffner, K., Hellman, N., Chodhari, R., Gupta, A., Kramer-Zucker, A., Olale, F., Burdine, R.D., Schier, A.F., O'Callaghan, C., Chung, E.M., Reinhardt, R., Mitchison, H.M., King, S.M., Omran, H., **Drummond, I.A.**, 2012. CCDC103 mutations cause primary ciliary dyskinesia by disrupting assembly of ciliary dynein arms. Nature genetics 44, 714-719. PMC3371652

55. Vasilyev, A., Liu, Y., Hellman, N., Pathak, N. and **Drummond, I.A.** 2012. Mechanical stretch and PI3K signaling link cell migration and proliferation to coordinate epithelial tubule morphogenesis in the zebrafish pronephros. PLOS One 7(7):e39992. PMC3399848

56. Zhang, Q., Liu, Q., Austin, C., **Drummond, I.A,** Pierce, E.A., 2012. Knockdown of ttc26 disrupts ciliogenesis of the photoreceptor cells and the pronephros in zebrafish. Molecular Biology of the Cell 23, 3069-78. PMC3418303

57. Leshchiner, I., Alexa, K., Kelsey, P., Adzhubei, I., Austin, C., Cooney, J., Anderson, H., King, M., Stottmann, R.W., Ha, S., **Drummond, I.A**, Paw, B.H., North, T., Beier, D., Goessling, W., Sunyaev, S., 2012. Mutation mapping and identification by whole genome sequencing. Genome Research. 22, 1541-8. PMC3409267

58. Fan, Xueping, Qinggang Li, Anna Pisarek-Horowitz, Hila Milo Rasouly, Xiangling Wang, Ramon G. Bonegio, Hang Wang, Margaret McLaughlin, Steve Mangos, Raghu Kalluri, Lawrence B. Holzman, **Iain A. Drummond,** Dennis Brown, David J. Salant, Weining Lu. 2012 Inhibitory Effects of Robo2 on Nephrin: A Crosstalk between Positive and Negative Signals Regulating Podocyte Structure. Cell Rep. 26, 52-61 PMC3627357

59. Chaki, M., R. Airik, A.K. Ghosh, R.H. Giles, R. Chen, G.G. Slaats, H. Wang, T.W. Hurd, W. Zhou, A. Cluckey, H.Y. Gee, G. Ramaswami, C.J. Hong, B.A. Hamilton, I. Cervenka, R.S. Ganji, V. Bryja, H.H. Arts, J. van Reeuwijk, M.M. Oud, S.J. Letteboer, R. Roepman, H. Husson, O. Ibraghimov-Beskrovnaya, T. Yasunaga, G. Walz, L. Eley, J.A. Sayer, B. Schermer, M.C. Liebau, T. Benzing, S. Le

Corre, **I.A. Drummond**, S. Janssen, S.J. Allen, S. Natarajan, J.F. O'Toole, M. Attanasio, S. Saunier, C. Antignac, R.K. Koenekoop, H. Ren, I. Lopez, A. Nayir, C. Stoetzel, H. Dollfus, R. Massoudi, J.G. Gleeson, S.P. Andreoli, D.G. Doherty, A. Lindstrad, C. Golzio, N. Katsanis, L. Pape, E.B. Abboud, A.A. Al-Rajhi, R.A. Lewis, H. Omran, E.Y. Lee, S. Wang, J.M. Sekiguchi, R. Saunders, C.A. Johnson, E. Garner, K. Vanselow, J.S. Andersen, J. Shlomai, G. Nurnberg, P. Nurnberg, S. Levy, A. Smogorzewska, E.A. Otto, and F. Hildebrandt. 2012. Exome Capture Reveals ZNF423 and CEP164 Mutations, Linking Renal Ciliopathies to DNA Damage Response Signaling. Cell 150(3):533-48. PMC3433835

60. Kao RM, Vasilyev A, Miyawaki A, **Drummond IA**, McMahon AP. 2012. Invasion of distal nephron precursors associates with tubular interconnection during nephrogenesis. J Am Soc Nephrol. 23:1682-90. PMC3458467

61. Manning, D.K., M. Sergeev, R.G. van Heesbeen, M.D. Wong, J.H. Oh, Y. Liu, R.M. Henkelman, **I. A. Drummond**, J.V. Shah, and D.R. Beier. 2013. Loss of the ciliary kinase nek8 causes left-right asymmetry defects. J Am Soc Nephrol,. 24, 100-12. PMC3537214

62. Sanna-Cherchi, S., R.V. Sampogna, N. Papeta, K.E. Burgess, S.N. Nees, B.J. Perry, M. Choi, M. Bodria, Y. Liu, P.L. Weng, V.J. Lozanovski, M. Verbitsky, F. Lugani, R. Sterken, N. Paragas, G. Caridi, A. Carrea, M. Dagnino, A. Materna-Kiryluk, G. Santamaria, C. Murtas, N. Ristoska-Bojkovska, C. Izzi, N. Kacak, B. Bianco, S. Giberti, M. Gigante, G. Piaggio, L. Gesualdo, D. Kosuljandic Vukic, K. Vukojevic, M. Saraga-Babic, M. Saraga, Z. Gucev, L. Allegri, A. Latos-Bielenska, D. Casu, M. State, F. Scolari, R. Ravazzolo, K. Kiryluk, Q. Al-Awqati, V.D. D'Agati, **I.A. Drummond,** V. Tasic, R.P. Lifton, G.M. Ghiggeri, and A.G. Gharavi. 2013. Mutations in DSTYK and dominant urinary tract malformations. N Engl J Med,. 369, 621-9. PMC3846391

63. Austin-Tse, C., J. Halbritter, M.A. Zariwala, R.M. Gilberti, H.Y. Gee, N. Hellman, N. Pathak, Y. Liu, J.R. Panizzi, R.S. Patel-King, D. Tritschler, R. Bower, E. O'Toole, J.D. Porath, T.W. Hurd, M. Chaki, K.A. Diaz, S. Kohl, S. Lovric, D.Y. Hwang, D.A. Braun, M. Schueler, R. Airik, E.A. Otto, M.W. Leigh, P.G. Noone, J.L. Carson, S.D. Davis, J.E. Pittman, T.W. Ferkol, J.J. Atkinson, K.N. Olivier, S.D. Sagel, S.D. Dell, M. Rosenfeld, C.E. Milla, N.T. Loges, H. Omran, M.E. Porter, S.M. King, M.R. Knowles, **I.A. Drummond***, and F. Hildebrandt. 2013. Zebrafish Ciliopathy Screen Plus Human Mutational Analysis Identifies C21orf59 and CCDC65 Defects as Causing Primary Ciliary Dyskinesia. Am J Hum Genet, 93(4): p. 672-86. *Co-Corresponding Author. PMC3791264

64. Zariwala, M.A., H.Y. Gee, M. Kurkowiak, D.A. Al-Mutairi, M.W. Leigh, T.W. Hurd, R. Hjeij, S.D. Dell, M. Chaki, G.W. Dougherty, M. Adan, P.C. Spear, J. Esteve-Rudd, N.T. Loges, M. Rosenfeld, K.A. Diaz, H. Olbrich, W.E. Wolf, E. Sheridan, T.F. Batten, J. Halbritter, J.D. Porath, S. Kohl, S. Lovric, D.Y. Hwang, J.E. Pittman, K.A. Burns, T.W. Ferkol, S.D. Sagel, K.N. Olivier, L.C. Morgan, C. Werner, J. Raidt, P. Pennekamp, Z. Sun, W. Zhou, R. Airik, S. Natarajan, S.J. Allen, I. Amirav, D. Wieczorek, K. Landwehr, K. Nielsen, N. Schwerk, J. Sertic, G. Kohler, J. Washburn, S. Levy, S. Fan, C. Koerner-Rettberg, S. Amselem, D.S. Williams, B.J. Mitchell, **I.A. Drummond,** E.A. Otto, H. Omran, M.R. Knowles, and F. Hildebrandt. 2013. ZMYND10 Is Mutated in Primary Ciliary Dyskinesia and Interacts with LRRC6. Am J Hum Genet, 93(2): p. 336-45. PMC3738827

65. Lam, P.Y., C.N. Kamei, S. Mangos, S. Mudumana, Y. Liu, and **I.A. Drummond**. 2013. *odd-skipped related 2* is required for fin chondrogenesis in zebrafish. Dev Dyn, 242(11): p. 1284-92. PMC4041527

66. Thomas, S., K.J. Wright, S. Le Corre, A. Micalizzi, M. Romani, A. Abhyankar, J. Saada, I. Perrault, J. Amiel, J. Litzler, E. Filhol, N. Elkhartoufi, M. Kwong, J.L. Casanova, N. Boddaert, W. Baehr, S. Lyonnet, A. Munnich, L. Burglen, N. Chassaing, F. Encha-Ravazi, M. Vekemans, J.G. Gleeson, E.M. Valente, P.K. Jackson, **I.A. Drummond,** S. Saunier, and T. Attie-Bitach. 2014. A homozygous PDE6D mutation in Joubert syndrome impairs targeting of farnesylated INPP5E protein to the primary cilium. Hum Mutat. 35:137-46. PMC3946372

67. Burger A, Vasilyev A, Tomar R, Selig MK, Nielsen GP, Peterson RT, **Drummond IA**, Haber DA. 2014. A zebrafish model of chordoma initiated by notochord-driven expression of HRASV12. Dis Model Mech 7:907-913. PMC4073279

68. Jin D, Ni TT, Sun J, Wan H, Amack JD, Yu G, Fleming J, Chiang C, Li W, Papierniak A, Cheepala S, Conseil G, Cole SP, Zhou B, **Drummond IA**, Schuetz JD, Malicki J, Zhong TP. 2014. Prostaglandin signalling regulates ciliogenesis by modulating intraflagellar transport. Nat Cell Biol 16:841-851. PMC4154319

69. Le Corre S, Eyre D, **Drummond IA.** 2014. Modulation of the secretory pathway rescues zebrafish polycystic kidney disease pathology. J Am Soc Nephrol 25:1749-1759.

70. Palmyre A, Lee J, Ryklin G, Camarata T, Selig MK, Duchemin AL, Nowak P, Arnaout MA, **Drummond IA**, Vasilyev A. 2014. Collective epithelial migration drives kidney repair after acute injury. PLoS One 9:e101304. PMC4092191

71. Pathak N, Austin-Tse CA, Liu Y, Vasilyev A, **Drummond IA**. 2014. Cytoplasmic carboxypeptidase 5 regulates tubulin glutamylation and zebrafish cilia formation and function. Mol Biol Cell 25:1836-1844. PMC4055263

72. Terashima AV, Mudumana SP, **Drummond IA**. 2014. Odd skipped related 1 is a negative feedback regulator of Nodal-induced endoderm development. Dev Dyn. 243:1571-80.

73. Tomar R, Mudumana SP, Pathak N, Hukriede NA, **Drummond IA**. 2014. *osr1* Is Required for Podocyte Development Downstream of *wt1a*. J Am Soc Nephrol. 11:2539-45

74. Kamei, C.N., Y. Liu, and **I.A.Drummond.** 2014. Kidney regeneration in adult zebrafish by gentamicin induced injury. JoVE 3:e51912.

75. Fogelgren, B., X. Zuo, J.M. Buonato, A. Vasilyev, J.I. Baek, S.Y. Choi, M.F. Chacon-Heszele, A. Palmyre, N. Polgar, **I.A. Drummond**, K.M. Park, M.J. Lazzara, and J.H. Lipschutz. 2014. Exocyst Sec10 Protects Renal Tubule Cells from Injury by EGFR/MAPK Activation and Effects on Endocytosis. Am J Physiol Renal Physiol. 307:F1334-41.

76. Yeo, N.C., C.C. O'Meara, J.A. Bonomo, K.N. Veth, R. Tomar, M.J. Flister, **I.A. Drummond**, D.W. Bowden, B.I. Freedman, J. Lazar, B.A. Link, and H.J. Jacob. 2015. Shroom3 contributes to the maintenance of the glomerular filtration barrier integrity. Genome Res. 25:57-65.

77. Slaats, G.G., A.K. Ghosh, L.L. Falke, S. Le Corre, I.A. Shaltiel, G. van de Hoek, T.D. Klasson, M.F. Stokman, I. Logister, M.C. Verhaar, R. Goldschmeding, T.Q. Nguyen, **I.A. Drummond,** F. Hildebrandt, and R.H. Giles. 2014. Nephronophthisis-Associated CEP164 Regulates Cell Cycle Progression, Apoptosis

and Epithelial-to-Mesenchymal Transition. PLoS Genet, 10(10): p. e1004594.

78. Oltrabella F, Pietka G, Ramirez IB, Mironov A, Starborg T, **Drummond IA**, Hinchliffe KA, Lowe M. 2015 The Lowe syndrome protein OCRL1 is required for endocytosis in the zebrafish pronephric tubule. PLoS Genet. 11:e1005058. PMCID: PMC4383555.

79. Bizet AA, Becker-Heck A, Ryan R, Weber K, Filhol E, Krug P, Halbritter J, Delous M, Lasbennes MC, Linghu B, Oakeley EJ, Zarhrate M, Nitschk√© P, Garfa-Traore M, Serluca F, Yang F, Bouwmeester T, Pinson L, Cassuto E, Dubot P, Elshakhs NA, Sahel JA, Salomon R, **Drummond IA**, Gubler MC, Antignac C, Chibout S, Szustakowski JD, Hildebrandt F, Lorentzen E, Sailer AW, Benmerah A, Saint-Mezard P, Saunier S. 2015. Mutations in TRAF3IP1/IFT54 reveal a new role for IFT proteins in microtubule stabilization. Nat Commun. 6:8666. PMCID: PMC4617596.

80. Lewis, WR, Malarkey, EB, Tritschler, D, Bower, R, Pasek, RC, Porath, JD, Birket, SE, Saunier, S, Antignac, C, Knowles, MR, Leigh, MW, Zariwala, MA, Challa, AK, Kesterson, RA, Rowe, SM, **Drummond, IA,** Parant, JM, Hildebrandt, F, Porter, ME, Yoder, BK, Berbari, NF. 2016. Mutation of Growth Arrest Specific 8 Reveals a Role in Motile Cilia Function and Human Disease. PLoS Genet, 12: e1006220.

81. Noonan, HR, Metelo, AM, Kamei, CN, Peterson, RT, **Drummond, IA**, Iliopoulos, O. 2016. Loss of vhl in the zebrafish pronephros recapitulates early stages of human clear cell renal cell carcinoma. Dis Model Mech, 9: 873-884.

82. Lopez-Rivera, E, Liu, YP, Verbitsky, M, Anderson, BR, Capone, VP, Otto, EA, Yan, Z, Mitrotti, A, Martino, J, Steers, NJ, Fasel, DA, Vukojevic, K, Deng, R, Racedo, SE, Liu, Q, Werth, M, Westland, R, Vivante, A, Makar, GS, Bodria, M, Sampson, MG, Gillies, CE, Vega-Warner, V, Maiorana, M, Petrey, DS, Honig, B, Lozanovski, VJ, Salomon, R, Heidet, L, Carpentier, W, Gaillard, D, Carrea, A, Gesualdo, L, Cusi, D, Izzi, C, Scolari, F, van Wijk, JA, Arapovic, A, Saraga-Babic, M, Saraga, M, Kunac, N, Samii, A, McDonald-McGinn, DM, Crowley, TB, Zackai, EH, Drozdz, D, Miklaszewska, M, Tkaczyk, M, Sikora, P, Szczepanska, M, Mizerska-Wasiak, M, Krzemien, G, Szmigielska, A, Zaniew, M, Darlow, JM, Puri, P, Barton, D, Casolari, E, Furth, SL, Warady, BA, Gucev, Z, Hakonarson, H, Flogelova, H, Tasic, V, Latos-Bielenska, A, Materna-Kiryluk, A, Allegri, L, Wong, CS, **Drummond, IA**, D'Agati, V, Imamoto, A, Barasch, JM, Hildebrandt, F, Kiryluk, K, Lifton, RP, Morrow, BE, Jeanpierre, C, Papaioannou, VE, Ghiggeri, GM, Gharavi, AG, Katsanis, N, Sanna-Cherchi, S. 2017 Genetic Drivers of Kidney Defects in the DiGeorge Syndrome. The New England journal of medicine, 376: 742-754.

83. Oxburgh, L, Carroll, TJ, Cleaver, O, Gossett, DR, Hoshizaki, DK, Hubbell, JA, Humphreys, BD, Jain, S, Jensen, J, Kaplan, DL, Kesselman, C, Ketchum, CJ, Little, MH, McMahon, AP, Shankland, SJ, Spence, JR, Valerius, MT, Wertheim, JA, Wessely, O, Zheng, Y, **Drummond, IA** 2017 (Re)Building a Kidney. J Am Soc Nephrol, 28: 1370-1378.

84. Olabisi, O., K. Al-Romaih, J. Henderson, R. Tomar, **I. Drummond,** C. MacRae, and M. Pollak, From man to fish: What can Zebrafish tell us about ApoL1 nephropathy? Clin Nephrol, 2016. 86 (13): p. 114-118.

85. Tang, Q., S. Iyer, R. Lobbardi, J.C. Moore, H. Chen, C. Lareau, C. Hebert, M.L. Shaw, C. Neftel, M.L. Suva, C.J. Ceol, A. Bernards, M. Aryee, L. Pinello, **I.A. Drummond**, and D.M. Langenau. 2017.

Dissecting hematopoietic and renal cell heterogeneity in adult zebrafish at single-cell resolution using RNA sequencing. J Exp Med, 214(10): p. 2875-2887.

86. Bergboer, J.G.M., Wyatt, C., Austin-Tse, C., Yaksi, E., and **Drummond, I.A.** 2018. Assaying sensory ciliopathies using calcium biosensor expression in zebrafish ciliated olfactory neurons. Cilia 7, 2.

87. Grainger, S., N. Nguyen, J. Richter, J. Setayesh, B. Lonquich, C.H. Oon, J.M. Wozniak, R. Barahona, C.N. Kamei, J. Houston, M. Carrillo-Terrazas, **I.A. Drummond**, D. Gonzalez, K. Willert, and D. Traver. 2019. EGFR is required for Wnt9a-Fzd9b signalling specificity in haematopoietic stem cells. Nat Cell Biol, 21(6): p. 721-730.

88. Kamei, C.N., Gallegos, T.F., Liu, Y., Hukriede, N., and **Drummond, I.A.** 2019. Wnt signaling mediates new nephron formation during zebrafish kidney regeneration. Development 146.

89. Gallegos, T.F, Kamei, C.N., Rohly, M., and **Drummond, I.A.** 2019. Fibroblast growth factor signaling mediates progenitor cell aggregation and nephron regeneration in the adult zebrafish kidney. Developmental Biology (*in press*).

Non-peer reviewed scientific or medical publications/materials in print or other media

Reviews, chapters, monographs and editorials

Drummond, I.A. 2000. The zebrafish pronephros: a genetic system for studies of kidney development. Pediatric Nephrology 14:428-35.

Drummond, I.A. 2002. The Pronephros. Pattern Formation in Zebrafish. L. Solnica-Krezel. Heidelberg, Springer. 40: 322-344.

Drummond, I.A. and A. Majumdar 2002. The pronephric glomus and vasculature. The Kidney. P. Vise, J.B.L. Bard. and A. Woolf (eds). San Diego, Academic Press.

Drummond, I.A. 2003. Making a zebrafish Kidney: a tale of two tubes. Trends in Cell Biology 13:357-65

Drummond I.A. 2003. The skate weighs in on kidney regeneration. 2003. J Am Soc Nephrol. 14:1704-5

Drummond, I.A. 2004. Zebrafish Kidney Development Methods in Cell Biology, L. Zon, W. Dietrich and M. Westerfield (eds). San Diego, Academic Press.

Drummond, I.A. 2005. Kidney development and disease in the zebrafish. J Am Soc Nephrol,. 16:299-304.

Drummond IA. 2008. Some assembly required: renal hypodysplasia and the problem with faulty parts. J Am Soc Nephrol. 2008 May;19(5):834-6.

Drummond, I.A. 2009. Zebrafish Kidney Development Essential Zebrafish Methods, M. Westerfield

(ed). Elsevier.

Pathak, N.H. and **Drummond**, I.A.. Polyglutamylation and the fleer Gene. Methods in Cell Biology (Volume 94), Primary Cilia. Sloboda (ed.) Academic Press, 2009, p. 316.

Drummond, I.A. 2009. Studying Cilia in Zebrafish. Cilia: Model Organisms and Intraflagellar Transport. King and Pazour, (eds),. Academic Press, 2009, p. 197.

Vasilyev A, **Drummond IA**. Fluid flow and guidance of collective cell migration. Cell Adh Migr. 2010 Jul-Sep; 4 (3):353-7. PMC2958608

Drummond, I.A. and Davidson, A.J. 2010. Zebrafish Kidney Development Methods in Cell Biology, L. Zon, W. Dietrich and M. Westerfield (eds). San Diego, Academic Press.

Drummond, I.A. 2011. Polycystins, focal adhesions and extracellular matrix interactions. Biochim. Biophyica Acta. Molecular Basis of Disease. 1812(10):1322-6. PMC3132319

Drummond I.A. 2012 Cilia functions in development. Curr Opin Cell Biol. Jan 4. [Epub ahead of print] PubMed PMC3464970

Vasilyev, A., **Drummond, I.A.**, 2012. Live imaging kidney development in zebrafish. Methods in molecular biology 886, 55-70.

Drummond, I.A. and Austin-Tse, C. 2013. Zebrafish Cilia. Methods in Enzymology Marshall W. (ed.) Elsevier. 525, 219-44

Drummond, I.A., 2013. The cilium in lights: new views of an ancient organelle. BMC Biol,. 11: p. 74. PMC3700750

Drummond, I.A. and Davidson, A.J. 2016. Zebrafish Kidney Development Methods in Cell Biology, L. Zon, W. Dietrich and M. Westerfield (eds). San Diego, Academic Press.

Professional educational materials or reports, in print or other media

Zebrafish Comparative Blast website (2004-2014; http://danio.mgh.harvard.edu/blast/blast.html). This site facilitated gene discovery in the zebrafish prior to the genome assembly by providing search capabilities (tblastn) on large datasets (the Sanger Center zebrafish whole genome shotgun sequence) that are not provided elsewhere due to the computational intensity of the task. Usage: 3000 hits/month from international users; 33 MB/month of data transferred.

Zebrafish genetic marker search page (2004-2018; http://danio.mgh.harvard.edu/bacmarkers/ssr.html and http://danio.mgh.harvard.edu/chrMarkers/zfssr.html). These sites facilitate positional cloning in the zebrafish by generating novel simple sequence repeat marker primer pairs for using in genetic mapping mutations. This web application automates the tasks of repeatmasking large genomic contigs, extracting potential simple sequence repeats, and designing PCR primer pairs that can be used as genetic markers.

This process has yielded many new and useful SSR markers and is still used by labs in the U.S. and abroad.

Mouse genetic marker search page (2008-2012). This site facilitated genetic mapping in the mouse by generating novel simple sequence repeat marker primer pairs from the public builds of the mouse genome sequence. Starting with any 3 MB segment of the mouse genome, users can derive a list of novel candidate SSR marker primer pairs. To date the success rate has been high with most all marker primer pairs amplifying single bands from genomic DNA and many of these being polymorphic.

Thesis

Drummond, I.A.. Cellular Ionic Responses to Stress [Dissertation]. Berkeley, California: University of California, 1986. 152 pp.

Abstracts, Poster Presentations and Exhibits Presented at Professional Meetings

Narrative Report

My contributions for the past 23 years at HMS have been in researching kidney development and organ regeneration and discovering new mechanisms of human genetic disease. I also teach developmental and regenerative biology in the Harvard/MIT Health Science and Technology program and the HMS BBS graduate program. My lab established the zebrafish as a genetic model system for studies of nephrogenesis by 1) characterizing renal development in zebrafish, 2) positionally cloning and analyzing the function of genes required for kidney cell differentiation, 3) analyzing mutants that affect pronephric development, and 4) collaborating with human geneticists to discover new human disease genes.

1) We characterized fifteen zebrafish cystic kidney mutants that exhibit retinal degeneration, hydrocephalus, and left right asymmetry defects, highlighting a syndromic phenotype equivalent to human ciliopathies. We positionally cloned the *double bubble* mutant and find the mutant gene encodes IFT172, a gene required cilia formation. We have positionally cloned the zebrafish renal-retinal mutant *fleer* and identified a mutation in a novel TPR repeat protein that regulates tubulin post-translational modifications and ciliogenesis. We discovered that kidney cilia in zebrafish are motile and play an important role in propelling fluid in kidney tubules; defects in cilia structure or motility cause cystic disease due to abnormal lumenal fluid accumulation. We cloned three additional novel zebrafish genes that are required for cilia motility and through collaboration identified human patient families carrying mutations in orthologous human genes. We are pursuing how Notch signaling directs single vs. multiciliated cell differentiation, how the ciliogenesis program is controlled at the transcriptional level by *foxj1* expression, and how physical force (cell stretch) signals ciliogenesis, stimulates cell proliferation and regulates kidney nephron morphogenesis.

2) Using a gene targeted approach, we have shown that genes causing human polycystic kidney disease (ADPKD; PKD1 and the TRP channel PKD2) are also essential for kidney development and axis formation in zebrafish. Our data point to a novel role for Polycystin2 and Polycystin1 in regulating secreted matrix protein translation and processing that has a primary effect in causing developmental and disease phenotypes. We have shown that small molecule inhibitors of ER-Golgi traffic rescue matrix overproduction phenotype and are now using Mass Spec proteomic approaches to determine the zebrafish "matrisome"; i.e. the complete spectrum of extracellular matrix proteins in zebrafish and how they might be altered in PKD-deficient embryos.

3) We are studying transcription factors that direct early kidney development and epithelial patterning. We find that mutation or knock down of the *odd-skipped related* zinc-finger transcription factor *osr1* impacts both nephron tubule and podocyte development. Mis-patterning of tubule and angioblast lineages occurs indirectly via an effect on endoderm development while podocyte defects appear to be cell-autonomous. In addition to pursuing mechanisms of these kidney defects, we have demonstrated a role for *osr1* as a transcriptional mediator of an incoherent feed-forward loop (negative feedback) regulating Nodal signaling during gastrulation.

4) We have shown that the human nephrotic syndrome genes nephrin and podocin are also essential in the zebrafish pronephros to maintain proper filtration discrimination in the kidney glomerulus. Using the assay we developed, we found that the *crumbs*-interacting, apical pathway protein *mosaic eyes* (*moe*) is a novel determinant of podocyte function. We have found that phospholipase C epsilon is required for glomerulus formation and function, implicating calcium and DAG signaling in this process. Using transgenic *in vivo* calcium biosensor expression in podocytes coupled with live *in vivo* imaging, we have shown that glomerular morphogenesis is regulated by calcium signaling that controls expression of human disease gene orthologs.

5) Unlike mammalian kidneys that regenerate after acute injury by proliferation of pre-existing tubule cells, zebrafish kidneys are capable of *de novo* nephron formation from adult organ stem cells. We find that adult kidney progenitor cells express the wnt receptor *frizzled9b* (*fzd9b*) and that new nephron formation after injury requires wnt signaling. The goals of our work are to 1) determine where and when in the process of stem cell based regeneration wnt signaling acts, 2) employ CreER / brainbow and cell ablation transgenics to discover the origins and fate of adult kidney stem cells, and 3) determine how new progenitor cell-derived nephron tubules connect to a pre-existing closed tubule network of the adult kidney.