# Ian J. MacRae

CURRICULUM VITAE

**Professor**
**The Scripps Research Institute**
**Integrative Computational and Structural Biology**
10550 N. Torrey Pines Road, La Jolla, CA 92037
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http://www.scripps.edu/macrae/macrae_lab.html


## EDUCATION

| Dates | DEGREE | INSTITUTION | TRAINING MENTOR | SCIENTIFIC DISCIPLINE |
|---|---|---|---|---|
| 7/2002-7/2007 | Post-doc | Univ. California, Berkeley | Jennifer A. Doudna | Structural Biology |
| 9/1996-6/2002 | Ph.D. | Univ. California, Davis | Irwin H. Segel and Andrew J. Fisher | Structural Biology |
| 3/1996 | B.S. | Univ. California, Davis | Irwin H. Segel | Biochemistry |

## PROFESSIONAL POSITIONS

| Dates | POSITION | DEPARTMENT | INSTITUTION AND LOCATION |
|---|---|---|---|
| 2016-current | Professor | Integrative Computational and Structural Biology | The Scripps Research Institute, La Jolla, CA |
| 2012-2016 | Associate Professor | Integrative Computational and Structural Biology | The Scripps Research Institute La Jolla, CA |
| 2007-2012 | Assistant Professor | Molecular Biology | The Scripps Research Institute, La Jolla, CA |
| 2002 - 2007 | HHMI Fellow | The Life Sciences Research Foundation | University of California at Berkeley, Berkeley, CA |
| 1997 - 2002 | Graduate Research Assistant | Molecular and Cellular Biology | University of California at Davis, Davis, CA |
| 1996 - 1997 | Research Technician | Molecular and Cellular Biology | University of California at Davis, Davis, CA |

## PROFESSIONAL AWARDS

Baxter Foundation Young Faculty Award (2012)
Blasker Science & Technology Award (2009)
Pew Scholar in the Biomedical Sciences (2008)
Life Sciences Research Foundation Postdoctoral Fellowship (2002)

## PEER REVIEWED PUBLICATIONS

Xiao Y and **MacRae IJ***. (2020) Robust differential microRNA targeting driven by supplementary interactions in vitro. *RNA* 26(2):162-174.

Xiao Y and **MacRae IJ***. (2019) Toward a Comprehensive View of MicroRNA Biology. *Molecular Cell.* 75(4):666-668.

Sheu-Gruttadauria J, Pawlica P, Klum SM, Wang S, Yario TA, Steitz JA*, **MacRae IJ***. (2019) Structural Basis for Target-Directed MicroRNA Degradation. *Molecular Cell* 75, 1243–1255.

Sheu-Gruttadauria J , Xiao Y, Gebert LFR, **MacRae IJ***. (2019) Beyond the seed: structural basis for supplementary microRNA targeting by human Argonaute2. *The EMBO Journal*. 8(13):e101153.

Foss DV*, Schirle NT, **MacRae IJ***, Pezacki JP*. (2019) Structural insights into interactions between viral suppressor of RNA silencing protein p19 mutants and small RNAs. *FEBS Open Bio*. 96):1042-1051

Chahal J, Gebert LFR, Gan HH, Camacho E, Gunsalus KC, **MacRae IJ**, Sagan SM*. (2019) miR-122 and Ago interactions with the HCV genome alter the structure of the viral 5' terminus. *Nucleic Acids Res*. 47(10):5307-5324

Gebert LFR and **MacRae IJ***. (2019) Regulation of microRNA function in animals. *Nat Rev Mol Cell Biol.* 20(1):21-37

Ziv O, Gabryelska MM, Lun ATL, Gebert LFR, Sheu-Gruttadauria J, Meredith LW, Liu ZY, Kwok CK, Qin CF, **MacRae IJ**, Goodfellow I, Marioni JC, Kudla G, Miska EA*. (2018) COMRADES determines in vivo RNA structures and interactions. *Nat Methods*. 15(10):785-788.

Sheu-Gruttadauria J, **MacRae IJ***. (2018) Phase Transitions in the Assembly and Function of Human miRISC. *Cell* May 3;173(4):946-957.

Klum SM, Chandradoss SD, Schirle NT, Joo C, **MacRae IJ***. (2017) Helix-7 in Argonaute2 shapes the microRNA seed region for rapid target recognition. *EMBO J.* Sep 22. pii: e201796474.

Sheu-Gruttadauria J, **MacRae IJ***. (2017) Structural Foundations of RNA Silencing by Argonaute. *J Mol Biol.* Aug 18;429(17):2619-2639.

Suter SR, Sheu-Gruttadauria J, Schirle NT, Valenzuela R, Ball-Jones AA, Onizuka K, **MacRae IJ***, Beal PA*. (2016) Structure-Guided Control of siRNA Off-Target Effects. *J Am Chem Soc*. Jul 20;138(28):8667-9.

Schirle NT, Kinberger GA, Murray HF, Lima WF, Prakash TP*, **MacRae IJ***. (2016) Structural Analysis of Human Argonaute-2 Bound to a Modified siRNA Guide.
*J Am Chem Soc*. Jul 20;138(28):8694-7.

Wu MK, de Kock L, Conwell LS, Stewart CJ, King BR, Choong CS, Hussain K, Sabbaghian N, **MacRae IJ**, Fabian MR, Foulkes WD*. (2016) Functional characterization of multiple DICER1 mutations in an adolescent. *Endocr Relat Cancer*. Feb;23(2):L1-5

Schirle NT, Sheu-Gruttadauria J, Chandradoss SD, Joo C*, **MacRae IJ***. (2015) Water-mediated recognition of t1-adenosine anchors Argonaute2 to microRNA targets. *Elife*. Sep 11;4.

Chandradoss SD, Schirle NT, **MacRae IJ***, Joo C* (2015) Dynamic Search Process Underlies MicroRNA Targeting. *Cell* 162:96-107.

Schirle NT, Sheu-Gruttadauria J, and **MacRae IJ*** (2014) Structural Basis for microRNA Targeting. *Science* 346:608-13.

Xiong XP, Kurthkoti K, Chang KY, Lichinchi G, De N, Schneemann A, **MacRae IJ**, Rana TM, Perrimon N, Zhou R* (2013) Core small nuclear ribonucleoprotein particle splicing factor SmD1 modulates RNA interference in Drosophila. *Proc. Natl. Acad. Sci*. 110:16520-5.

De, N, Young, L, Lau, PW, Meisner, NC, Morrissey DV* and **MacRae IJ*** (2013) Highly Complementary Target RNAs promote release of guide RNAs from human Argonaute2. *Molecular Cell* 50:344-55.

Horman SR, Janas MM, Litterst C, Wang B, **MacRae IJ**, Sever MJ, Morrissey DV, Graves P, Luo B, Umesalma S, Qi HH, Miraglia LJ, Novina CD, Orth AP* (2013) Akt-Mediated Phosphorylation of Argonaute 2 Downregulates Cleavage and Upregulates Translational Repression of MicroRNA Targets. *Molecular Cell* 50:356-67.

Schirle NT and **MacRae IJ*** (2012) The crystal structure of human Argonaute-2. *Science* 336:1037-40.

Lau PW, Potter CS, Carragher B*, and **MacRae IJ*** (2012) DOLORS: Versatile Strategy for Internal Labeling and Domain Localization in Electron Microscopy. *Structure* 20:1995–2002.

Bale S, Julien JP, Bornholdt ZA, Kimberlin CR, Halfmann P, Zandonatti MA, Kawaoka Y, **MacRae IJ**, Wilson IA and Saphire EO* (2012) Marburgvirus VP35 can both fully coat the backbone and cap the ends of dsRNA for interferon antagonism. *PLOS Pathogens* 9:e1002916.

Pratt AJ, Rambo RP, Lau PW and **MacRae IJ*** (2012) Preparation and Characterization of the extracellular domain of human SID-1. *PLoS ONE* 7:e33607.

Lau PW, Guiley KZ, De N, Potter CS, Carragher B* and **MacRae IJ*** (2012) The molecular architecture of human Dicer. *Nature Structural and Molecular Biology* 19:436-40.

Guiley KZ, Pratt AJ and **MacRae IJ*** (2012) Single-pot enzymatic synthesis of Dicer-substrate siRNAs. *Nucleic Acids Research* 40:e40.

Hastie KM, Kimberlin CR, Zandonatti MA, **MacRae IJ**, Saphire EO* (2011) Structure of the Lassa virus nucleoprotein reveals a dsRNA-specific 3' to 5' exonuclease activity essential for immune suppression. *Proc. Natl. Acad. Sci*. 108:2396-401.

Kimberlin CR, Bornholdt ZA, Li S, Woods-Jr VL, **MacRae IJ** and Saphire EO* (2010) Ebolavirus VP35 uses a bimodal strategy to bind dsRNA for innate immune suppression. *Proc. Natl. Acad. Sci.* 107:314-9.

Lau PW, Potter CS, Carragher B. and **MacRae IJ*** (2009) Structure of the Human Dicer-TRBP Complex by Electron Microscopy. *Structure* 17:1326-1332.

Pratt AJ and **MacRae IJ*** (2009) The RNA-Induced Silencing Complex: a versatile gene-silencing machine. *Journal of Biological Chemistry* 284:17897-17901.

Lau PW and **MacRae IJ*** (2009) The Molecular Machines that Mediate MicroRNA Maturation. *Journal of Cellular and Molecular Medicine* 13:54-60.

Ma E, **MacRae IJ**, Kirsch JF and Doudna JD* (2008) Autoinhibition of human Dicer by its internal helicase domain. *Journal of Molecular Biology* 380:237-43.

**MacRae IJ***, Ma E, Zhou M, Robinson CV and Doudna JA* (2008) In vitro reconstitution of the human RISC-loading complex. *Proc. Natl. Acad. Sci.* 105:512-517.

**MacRae IJ** and Doudna JA* (2007) An unusual case of pseudo-merohedral twinning in orthorhombic crystals of Dicer. *Acta Crystallogr. D Biol. Crystallogr.* 63:993-999.

**MacRae IJ**, Zhou K, and Doudna JA* (2007) Structural determinants of RNA recognition and cleavage by Dicer. *Nature Structural and Molecular Biology* 14:934-40.

**MacRae IJ** and Doudna JA* (2007) Ribonuclease Revisited: Structural Insights into RNase III-family Enzymes. *Current Opinion in Structural Biology* 1:138-45.

**MacRae IJ**, Li F, Zhou K, Cande WZ and Doudna JA* (2006) “Structure of Dicer and Mechanistic Implications for RNAi” in Cold Spring Harbor Symposia on Quantitative Biology: *Regulatory RNAs*, 71:73-80.

**MacRae IJ**, Zhou K, Li F, Repic A, Brooks AN, Cande WZ, Adams PD and Doudna JA* (2006) Structural basis for double-stranded RNA processing by Dicer. *Science* 311:195-198.

**MacRae IJ** and Doudna JA* (2005) Ro's role in RNA reconnaissance. *Cell* 121:495-496.

Hanna E, Ng KF, **MacRae IJ**, Bley CJ, Fisher AJ and Segel IH* (2004) Kinetic and stability properties of *Penicillium chrysogenum* ATP sulfurylase missing the C-terminal regulatory domain. *Journal of Biological Chemistry* 279: 4415-4424.

**MacRae IJ**, Segel IH and Fisher AJ* (2002) Allosteric Inhibition via R-state Destabilization in ATP Sulfurylase from *Penicillium chrysogenum*. *Nature Structural Biology* 41:945-949.

Hanna E, **MacRae IJ**, Medina DC, Fisher AJ and Segel IH* (2002) ATP Sulfurylase from the Hyperthermophilic Chemolithotroph *Aquifex aeolicus*. *Archives of Biochemistry and Biophysics* 406, 275-288.

Beynon JD, **MacRae IJ**, Huston SL, Nelson DC, Segel IH and Fisher AJ* (2001) Crystal Structure of ATP Sulfurylase from the Bacterial Symbiont of the Hydrothermal Vent Tubeworm *Riftia pachyptila*. *Biochemistry* 40:14509-14517.

Medina DC, Hanna E, **MacRae IJ**, Fisher AJ and Segel IH* (2001) Temperature Effects on the Allosteric Transition of ATP Sulfurylase from *Penicillium chrysogenum. Archives of Biochemistry and Biophysics* 393:51-60.

**MacRae IJ**, Segel IH and Fisher AJ* (2001) Crystal Structure of ATP Sulfurylase from *Penicillium chrysogenum*: Insights into the Allosteric Regulation of Sulfate Assimilation. *Biochemistry* 40:6795-6804.

**MacRae IJ**, Hanna E, Ho JD, Fisher AJ and Segel IH* (2000). Induction of positive cooperativity by amino acid replacements within the C-terminal domain of *Penicillium chrysogenum* ATP sulfurylase. *Journal of Biological Chemistry*. 275:36303-36310.

**MacRae IJ**, Segel IH and Fisher AJ* (2000) Crystal Structure of Adenosine 5'-Phosphosulfate Kinase from *Penicillium chrysogenum*. *Biochemistry* 39:1613-1621.

**MacRae IJ** and Segel IH* (1999) Adenosine 5'-Phosphosulfate (APS) Kinase: Diagnosing the Mechanism of Substrate Inhibition. *Archives of Biochemistry and Biophysics* 361:277-282.

**MacRae IJ**, Rose AB and Segel IH* (1998) Adenosine 5'-Phosphosulfate Kinase from *Penicillium chrysogenum*: site-directed mutagenesis at putative phosphoryl-accepting and ATP P-loop residues. *Journal of Biological Chemistry* 273:28583-28589.

**MacRae I** and Segel IH* (1997) ATP Sulfurylase from Filamentous Fungi: Which Sulfonucleotide Is the True Allosteric Effector? *Archives of Biochemistry and Biophysics* 337:17-26.
*corresponding author(s)

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**TRAINEES**

**Pick-Wei Lau, Ph.D.**
Graduate Student (2007–2012)
Previous position: MS Student, University of Arizona
Current position: Scientist, US Food and Drug Administration

**Ashley J. Pratt, Ph.D.**
Graduate Student (2007–2010)
Previous position: Undergraduate Student, University of Colorado Boulder
Current position: Medical Writer, Health Interactions, San Francisco, CA

**Nabanita De, Ph.D.**
Postdoctoral Fellow (2010–2014)
Previous position: Graduate Student, H. Sonderman Lab, Cornell University
Current position: Senior Scientist, G. Ruvkun Lab, Massachusetts General Hospital

**Keelan Guiley, Ph.D.**
Undergraduate Researcher (2010–2012)
Previous position: Undergraduate Student, University of California, San Diego
Current position: Postdoctoral Fellow, K. Shokat Lab, University of California, San Francisco

**Nicole T. Schirle, Ph.D.**
Graduate Student (2011–2015)
Previous position: MS/BS Student, University of California, Davis
Current position: Postdoctoral Fellow, J. Weissman Lab, University of California, San Francisco

**Dana Danielson, Ph.D.**
Visiting Scholar (2014–2015)
Previous position: Graduate student, J. Pezacki Lab, University of Ottawa
Current position: Postdoctoral Fellow, R. Wilson Lab, University of California, Berkeley

**Jessica Sheu-Gruttadauria, Ph.D.**
Graduate Student (2012–2018)
Previous position: Technician, A. Hata Lab, University of California, San Francisco
Current position: Postdoctoral Fellow, R. Vale Lab, University of California, San Francisco

**Siobhan Hughes, Ph.D.**
Postdoctoral Fellow (2013–2016)
Previous position: Postdoctoral Fellow, P. Cherepanov Lab, Cancer Research UK
Current position: Postdoctoral Fellow, D. Burton Lab, TSRI

**Shannon Klum, Ph.D.**
Graduate Student (2013–2018)
Previous position: Undergraduate Student, University of Washington
Current position: Honolulu, Hawaii

**Luca Gebert, Ph.D.**
Postdoctoral Fellow (2014–current)
Previous position: Graduate Student, J. Hall Lab, ETH Zürich

**Helen Kim**
Graduate Student (2015–2016)
Previous position: Technician, A. Ward Lab, The Scripps Research Institute
Current position: Nursing Student, Stanford University

**Yao Xiao**
Graduate Student (2015–current)
Previous position: Technician, University of California, Riverside

**Todd Anzelon**
Graduate Student (2016–current)
Previous position: Undergraduate Student, Point Loma Nazarene University

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**AWARDS TO TRAINEES**
Pick-Wei Lau, American Heart Association pre-doctoral fellowship
Ashley Pratt, NSF pre-doctoral fellowship
Ashley Pratt, Fletcher Jones Foundation Fellow
Nicole Schirle Achievement Rewards for College Scientists (ARCS) Award
Nicole Schirle, American Heart Association pre-doctoral fellowship
Jessica Sheu-Gruttadauria, American Heart Association pre-doctoral fellowship
Jessica Sheu-Gruttadauria, Abrams Charitable Trust Award

## THESIS COMMITTEES

Thesis committee duties include rigorous annual meetings and assessments, informal mentoring, evaluation of qualifying examinations, dissertations, and thesis defenses.

Katie Petrie (Joyce Lab, TSRI)
Chris Kimberlin (Saphire Lab, TSRI)
Peter Watson (Fedor Lab, TSRI)
Peter Hawkins (Morris Lab, TSRI)
Melody Campbell (Carragher/Potter Lab, TSRI)
Nicholas Snead (Rossi Lab, City of Hope)
Joann Wu (Williamson Lab, TSRI)
Ana Kriebs (Lamia Lab, TSRI)
Julia Li (Lazzerini Denchi Lab, TSRI)
Gira Bhabha (Wright Lab, TSRI)
Willimam E. Solomon (Zamore Lab, UMass)
Anthony Milin (Deniz Lab, TSRI)
Katrina Tjhung (Joyce Lab, Salk)
Taylor Loe (Body Lab, TSRI)
Sydney Morris (Romsberg Lab, TSRI)
Melissa Parker (Karbstein Lab, TSRI)
Jennifer Kefauver (Ward and Patapoutian Labs, TSRI)
Sebastian Jojoa (Ward Lab, TSRI)
Colby Sandate (Lander Lab, TSRI)
Roberto Salatino (Karbstain Lab, TSRI)

## TEACHING (TSRI Graduate Program)

2007
Structural Biology, 1 lecture (1.5 hour), ~15 students enrolled
Molecular Biology, 1 lecture (1.5 hour), ~15 students enrolled

2008
Structural Biology, 2 lectures (1.5 hour each), ~15 students enrolled
Molecular Biology, 1 lecture (1.5 hour), ~15 students enrolled

2009
Structural Biology, 2 lectures (1.5 hour each), ~15 students enrolled

2010
Structural Biology, 2 lectures (1.5 hour each), ~15 students enrolled

2011
Structural Biology, 2 lectures (1.5 hour each), ~15 students enrolled

2012
Structural Biology, 2 lectures (1.5 hour each), ~15 students enrolled
Virology, 1 lecture (1.5 hour), ~15 students enrolled

2013
Structural Biology, 2 lectures (1.5 hour each), ~15 students enrolled
Virology, 1 lecture (1.5 hour), ~15 students enrolled

2014
Structural Biology, 2 lectures (1.5 hour each), ~15 students enrolled
Molecular Biology, 2 lectures (1.5 hour), ~15 students enrolled

2015
Structural Biology, 2 lectures (1.5 hour each), ~15 students enrolled
Molecular Biology, 2 lectures (1.5 hour), ~15 students enrolled
Virology, 1 lecture (1.5 hour), ~15 students enrolled

2016
Structural Biology, 2 lectures (1.5 hour each), ~15 students enrolled
Molecular Biology, course co-director, 2 lectures (1.5 hour), ~15 students enrolled

2017
Structural Biology, 2 lectures (1.5 hour each), ~15 students enrolled
Molecular Biology, course co-director, 2 lectures (1.5 hour), ~15 students enrolled
Virology, 1 lecture (1.5 hour), ~15 students enrolled

2018
Structural Biology, 2 lectures (1.5 hour each), ~15 students enrolled
Molecular Biology, course co-director, 2 lectures (1.5 hour), ~15 students enrolled

2019
Virology, 1 lecture (1.5 hour), ~25 students enrolled

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**OTHER ACTIVITIES**

TSRI Bicoastal Assistant Professor Faculty Search Committee (2016-2017)
ISCB Seminar Committee (2017-current)
TSRI Faculty Awards Committee (2018-current)
External Reviewer, Tenure Track Appointment Committee, University of Vienna (2018)
External Reviewer, Japan Society for the Promotion of Science (2017-2018)
TSRI Ad Hoc Promotion Committee (2019-current)

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**PATENTS**

United States Patent 8,440,430, "*Modified dicer polypeptide and methods of use thereof*" Doudna JA, Ma E, and **MacRae IJ**.

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**Reviewer 2007-2018**

Aquaculture Research
Biochimica et Biophysica Acta
BMC Molecular Biology
Cell
Cell Reports
Cell Research
EMBO Journal

Genes and Development
Journal of Biological Chemistry
Journal of Molecular Biology
JACS
Molecular Cell
Nature
Nature Communications
Nature Structural and Molecular Biology
Nucleic Acid Research
PNAS
RNA
Science
Trends in Biochemical Sciences
Trends in Cell Biology

## INVITED SEMINARS

"Structural Basis for Double-Stranded RNA Processing by Dicer", New York Academy of Sciences, New York, NY 2006.

"Structural Insights into the Initiation of RNAi", Pfizer Research Technology Center, Cambridge, MA, February 2008.

"Structural Insights into the Initiation of RNAi", NIBR Scientific Seminar Series, Cambridge, MA, March 2009.

"The 3D Architecture of Human Dicer", 5th Microsymposium on Small RNAs, Vienna, Austria, May 2010.

"Target RNAs promote release of guide RNAs from human Ago2", Small RNA workshop, Novartis Campus, Basel, Switzerland, September 2010.

"Target RNAs promote release of guide RNAs from human Ago2", Keystone symposia: Mechanism and Biology of Silencing, Monterey, CA, March 2011.

"Structures and Mechanisms of Dicer Enzymes", University of Utah: Biochemistry Seminar Series, Salt Lake City, Utah, April 25, 2011.

"Target RNAs promote release of guide RNAs from human Ago2", Regulus Therapeutics, San Diego, CA, May 26, 2011.

"Target RNAs promote release of guide RNAs from human Ago2", NIBR Scientific Seminar Series, Cambridge, MA, June 23, 2011.

"The Crystal Structure of Human Argonaute-2", 7th Microsymposium on Small RNAs, Basel, Switzerland, May 2012.

"Structure and Mechanism of Human Argonaute-2", 8th Annual Meeting of the Oligonucleotide Therapeutics Society, Boston, MA, October 2012.

“Structure of Human Arognaute-2: the heart of human RNAi”, City of Hope, Durante, CA, May 23, 2013.

“Structure and Mechanism of Human Argonaute-2”, Nucleic Acids Gordon Research Conference, Biddeford, ME, June 2013.

“Mechanisms of Gene Silencing by Human Argonaute-2”, University of Toronto, Ontario, Canada, September, 2013.

“Structural Insights into the Initiation of RNA Silencing”, 36th Annual meeting of The Molecular Biology Society of Japan, Kobe, Japan, December 2013.

“Human Argonaute-2 is a sensor of small RNA asymmetry”, RIKEN Symposium: RNA Sciences in Cell and Developmental Biology III, Kobe, Japan, December 2013.

“Structure of Dicer and Argonaute”, RNA Silencing Keystone Symposium, Seattle, WA, January 2014.

“Structure of Argonaute-2 and mechanisms of gene-silencing”, 9th Microsymposium on Small RNAs, Vienna, Austria, May 2014.

“Structural basis for gene-silencing by human Argonaute-2”, Global Technology Community: Non-Coding RNAs and RNAi Research & Therapeutics Conference, San Diego, CA, June 2014.

“The Mechanics of Dicer”, 16th International Congress of Endocrinology & The Endocrine Society’s 96th Annual Meeting & Expo, Chicago, IL, June 2014.

“Structural basis for post-transcriptional gene silencing by human Argonaute-2”, 23rd Congress and General Assembly of the International Union of Crystallography, Montreal, Canada, August 2014.

“Structural basis for target RNA recognition by human Argonaute-2”, to be given at the 248th American Chemical Society National Meeting & Exposition, San Francisco, CA August 2014.

“Structural basis for microRNA targeting”, Biology Colloquium Series, MIT, Cambridge, MA, September 2014.

“Structural basis for microRNA targeting”, 4th Zing Nucleic Acids Conference, Cancún, Mexico, December 2014.

“Mechanisms underlying gene silencing by microRNAs”, RNA mini-symposium, University of California at Irvine, Irvine, CA, April 2015.

“Structural basis for gene-silencing by human Argonaute proteins”, American Society for Biochemistry and Molecular Biology 2015 Annual Meeting, Boston, MA, March 2015.

“Mechanisms of gene-regulation by microRNAs”, Distinguished Faculty Lecture Series, The Scripps Research Institute, La Jolla, CA, April 2015.

"Mechanisms of gene-regulation by microRNAs", Department of Chemistry and Biochemistry Seminar Series, UCSD, San Diego, CA, October 2015.

"Mechanisms of gene-regulation by microRNAs", University of Colorado School of Medicine, Denver, CO, October 2015.

"Mechanisms of gene-regulation by microRNAs", Johns Hopkins School of Medicine, Baltimore, MD, October 2015.

"Mechanisms of gene-regulation by microRNAs", University of Massachusetts Medical School, Worcester, MA, December 2015.

"Structure and Mechanism of Argonaute Proteins", Small RNA Silencing Keystone Symposium, Keystone, CO, January 2016.

"Structural basis for of microRNA-mediated repression", EMBO | EMBL Symposium: Complex Life of mRNA, Advanced Training Centre, Heidelberg, Germany, October 2016.

"Beyond the seed: structural basis for extended miRNA-target interactions", EMBO | EMBL Symposium: The Non-Coding Genome, Advanced Training Centre, Heidelberg, Germany, September 2017.

"Structural basis for gene-silencing by microRNAs", Yale University, New Haven, CT, November 2017.

"Mechanisms of gene regulation by small RNAs", University of California, San Diego, RNA Revolution Symposium, San Diego, January 2019.

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**RESEARCH SUPPORT***

**Current Support**

R35 GM127090 — 07/01/2019–07/31/2023
National Institute of General Medicine — $350,000 x 5 years (direct)
*Structural and Mechanistic basis for RNA Silencing*
Role: Principle Investigator

**Completed Support**

R01 GM104475 — 08/01/2013-06/30/2019
National Institute of General Medicine — $201,400 x 6 years (direct)
*Structural Basis for RNA Silencing by Human Argonaute2*
Role: Principle Investigator

R01 GM115649 — 09/01/2015-06/30/2019
National Institute of General Medicine — $197,500 x 4 years (direct)
*Structure and Mechanism of the RISC-loading Complex*
Role: Principle Investigator

R21 CA201861 12/11/2015-11/30/2017
National Cancer Institute $130,500 x 2 years (direct)
*Methods for controlling small RNA stability*
Role: Principle Investigator

PAR-10-225 (Carragher/Potter) 5/1/2010
NIH/NCRR $21,955 (direct)
*Structural Studies of the RNA Interference Machinery*
Subproject of program grant submitted to NIH/NCRR.
Role: co-PI

R01GM086701-01S1 (MacRae) 09/30/09-08/31/10
NIH/NIGMS $50,325 (direct)
*Structure and Mechanism of the RISC-loading Complex*
Recovery Act Administrative Supplement to R01GM086701.
Role: Principle Investigator

R01 GM086701 12/01/2008-11/30/2013
National Institute of General Medicine $184,500 x 5 years (direct)
*Structure and Mechanism of the RISC-loading Complex*
Role: Principle Investigator

1008-000745-009 7/1/2008-6/30/2013
Pew Charitable Trusts $60,000 x 4 years (direct)
*Structure and mechanism of the RISC-loading complex*
Role: Principle Investigator
Portion allocated to salary: 0%

C-2008-00297 7/1/2008-6/30/2009
$55,000 (direct)
The San Diego Foundation Blasker Science & Technology
*Delivery of Double Stranded RNA to Human Cells: Probing the Mechanism of SID-1*
Role: Principle Investigator
Portion allocated to salary: 0%