Anne K. Kenworthy, Ph.D.
Professor
Department of Molecular Physiology and Biophysics
Department of Cell and Developmental Biology
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EDUCATION

1985-1989 B.A. in Biology, Kenyon College, Gambier, OH (with Honors in Biology; Summa Cum Laude)

1989-1994 Ph.D, in Cell Biology, Duke University Medical Center, Durham, NC
Certificate in Molecular Biophysics
Thesis advisor: Dr. Thomas McIntosh
Thesis title: Non-specific interactions between biomolecular surfaces: measurements for lens crystallins and polymer-grafted lipids

1994-1999 Postdoctoral fellow, Department of Biology, Johns Hopkins University, Baltimore, MD
Postdoctoral mentor: Dr. Michael Edidin

1999-2001 National Research Council Fellow, Cell Biology and Metabolism Branch, NICHD, NIH, Bethesda, MD
Postdoctoral mentor: Dr. Jennifer Lippincott-Schwartz

ACADEMIC APPOINTMENTS

Nov. 2001-March 2010 Assistant Professor, Vanderbilt School of Medicine
Primary appointment: Department of Molecular Physiology and Biophysics
Secondary appointment: Department of Cell and Developmental Biology

March 2010-June 2015 Associate Professor, Vanderbilt School of Medicine

July 2015-present Professor, Vanderbilt School of Medicine

PROFESSIONAL ORGANIZATIONS

American Society for Cell Biology; Biophysical Society; Sigma Xi; Phi Beta Kappa

PROFESSIONAL ACTIVITIES

Intramural Service

VISP steering committee, Sept 2010-May 2014
IGP Curriculum Committee, Jan 2010- present
Graduate Faculty Delegate Assembly, 2010-present
MPB GEC Dec 2010- 2013
MPB Faculty Seminar Series Coordinator, 2006-2011
Emphasis Committee, 2007-2008
Dissertation Enhancement Grants review committee, March 2008
MPB Biophysics Faculty Seminar Series Coordinator, 2015

Molecular Biophysics Training grant

Steering Committee member (2008-present)
Recruiting committee member (2003-2004, 2006-2008)
Education committee member (2002-2003)

Qualifying exam committees

Amanda Vanhoose, Winder lab (2002)
Susan Saban, Stewart lab (2003)
Mitsi Blount, Corbin lab (2003)
Jian Shi, Stewart lab (2005)
Mariena Silvestry, Stewart lab (2006)
Sak Sethaphong, Piston lab (2006)
Nidhi Jalan (2007)
Alessandro Ustione, Piston lab (2008)
Nicole Braun, Pathology, Major lab (2008)
David Melville, CDB, Knapik lab (2008)
Kavitha Surendhran, Biological Sciences, Graham lab (2008)
Fyza Shaikh, Micro and Immuno, Crowe Lab (2009)
Twila Mason, CDB, Goldenring lab (Summer 2010)
Paul Barrett, CPB, Sanders lab (Summer 2010)
Will Wan, CPB, Stubbs lab (Summer 2010)
Tara Archuleta, CPB, Spiller lab (Summer 2010)
Amy Elliot, MPB, Piston lab (Spring 2011)
Ashley Williams, MPB, Wasserman lab (Summer 2011)
Gage Matthews, CPB, Beth lab (Summer 2011)
Dia Beachboard, Micro and Immuno, Denison lab (Summer 2011)
Jeanne Jodoin, CDB, Laurie Lee lab (Summer 2011)
Naian Laio, Math, DiBenedetto (Fall 2011)
Andrea Hill, MPB, Hasty lab (Summer 2012)
Lukasz Wylezinski, MPB, Hawiger lab (Summer 2012)
Troy Hutchens, CPB, Piston lab (Summer 2012)

Allison Prewitt, CDB, deCaestecker lab (Fall 2012)
Nathan McDonald, CDB, Gould lab (August 2013)
Gokhan Unlu, CDB, Knapik lab (August 2013)
Hannah Hankins, Biological Sciences, Graham lab (October 2013)
Paula Zamora, Micro and Immuno, Dermody lab (Fall 2013)
Ramya Chandrasekaran, Micro and Immuno, Lacy lab (Fall 2013)
Megan Capozzi, MPB, Penn lab (March 2014)
Christi Therese Salisbury-Ruf, CDB, Zinkel lab (August 2014)
Bethany Carboneau, MPB, Gannon lab (August 2014)
Tim Moore, Chemical and Biomolecular Engineering, McCabe lab (September 2014)
Brittany Caldwell, Biomedical Engineering, Piston lab (November 2014)
Roxana Loperena, MPB, Harrison lab (March 2015)
MariaSanta Mangione, CDB, Gould lab (pending September 2015)

Current thesis committees
Hannah Hankins, Biological Sciences, Graham lab
Nathan McDonald, CDB, Gould lab
Gokhan Unlu, CDB, Knapik lab
Paula Zamora, PMI, Dermody lab
Ramya Chandrasekaran, PMI, Lacy lab
Lindsay Nyhoff, PMI, Kendall lab
Adrian Cadar, MPB, Lim lab
Christi Therese Salisbury-Ruf, CDB, Zinkel lab
Brittany Caldwell, Biomedical Engineering, Piston lab
Tim Moore, Chemical and Biomolecular Engineering, McCabe lab

Completed Thesis Committees
Troy Hutchens, CPB, Piston lab (PhD August 2015)
Allison Prewitt, CDB, deCaestecker lab (PhD July 2015)
Nan Hyung Hong, Cancer Biology, Weaver lab (PhD March 2015)
Dia Beachboard, PMI, Denison lab (PhD Jan 2015)
Jinlong Din, MPB, Delpire lab (PhD September 2014)
Tara Archuleta, CPB, Spiller lab (PhD May 2014)
Naian Laio, Math, DiBenedetto (PhD April 2014)
Will Wan, CPB, Stubbs lab (PhD March 2014)
Jeanne Jodoin, CDB, Laurie Lee lab (PhD November 2013)
Paul Barrett, CPB, Sanders lab (PhD September 2013)
Twila Mason, CDB, Goldenring lab (PhD August 2013)
Alessandro Ustione, MPB, Piston lab (PhD October 2012)
David Melville, CDB, Knapik lab (PhD April 2012)
Fyza Shaikh, Microbiology and Immunology, Crowe lab (PhD May 2012)
Robert Kim, CPB, Stewart lab (Masters April 2012)
Nicole Braun, Pathology, Major lab (PhD Feb 2011)
Sylvain Le Marchand, MPB, Piston lab (PhD Dec 2010)
Sabrina Doughty Robertson, Neurosci. Program, Galli Lab (PhD July 2010)
Russell McConnell, CDB, Tyska lab (PhD March 2010)

Jeanne Bristow, Biological Sciences, Webb lab (PhD Oct 2009)
Eric Shows, CDB, Wente Lab (Masters 2009)
Elizabeth Johnson, Microbiology and Immunology, Dermody lab (PhD August 2009)
A'Drian Pineda, Biological Sciences, Graham lab (Masters)
Karen Edelblum, CDB, Polk lab (PhD March 2008)
Nicole Garbarini, Neuroscience graduate program, Delpire lab (PhD Jan 2008)
Jian Shi, MPB, Stewart lab (PhD Dec 2007)
Brian Cox, Dept. Cancer Biology/Pathology, Jerome lab (PhD July 2007)
Nichole Ducharme, CDB, Goldenring lab (PhD Feb 2007)
Scott Myers, Pharmacology, Chung lab (PhD Dec 2006)
Kristina Wyatt, Biochemistry, Carpenter lab (PhD Aug 2007)
Ke Liu, Dept. Biological Sciences, Graham lab (PhD April 2007)
Gregg Wildenberg, Cancer Biology, Renyolds lab (PhD Nov 2006)
Abby Brown, MPB, Colbran lab (PhD Aug 2006)
Aaron Derdowski, Dept. Microbiology and Immunology, Spearman Lab (PhD Oct 2005)
Payal Ray, Dept. Biological Sciences, Broadie lab (transferred to Northwestern)
Amanda Vanhoose, MPB, Winder lab (PhD May 2005)

External thesis examiner
Heidi Weiner, Dept. of Basic Medical Sciences, NYU School of Medicine, Sept 2003

Fellow mentoring committees
Nick Ettinger, Pediatric Critical Care Fellow, Lamb lab (June 2013-July 2015)

Faculty Mentoring Committees
Tricia Thornton-Wells, Molecular Physiology and Biophysics (2013-2015)

National service

Editorial Board membership:
Biophysical Journal (July 2010-present)
Frontiers in Membrane Traffic (December 2013-present)
Traffic (March 2014-present)

Peer Reviewer for the following journals:
Analytical Biochemistry; BBA-Biomembranes; BBA- Molecular Cell Biology; Biochemistry; Bioinformatics; Biophysical Journal; Brain Research; Cell; Cell Reports; Cell Biochemistry and Biophysics; Cell Biology International; Chemistry and Physics of Lipids; Cytoskeleton; eLIFE; EMBO Journal; Epilepsia; Experimental Cell Research; Journal of the American Chemical Society; Journal of Biological Chemistry; Journal of Biomedical Optics; Journal of Cell Biology; Journal of Cell Science; Journal of Cellular and Molecular Medicine; Journal of Microscopy; Journal of Theoretical Biology; Langmuir; Molecular Biology of the Cell; Nature; Nature Biotechnology; Nature Communications; Nature Cell Biology; Nature Chemical Biology; Nature Methods;

Nature Nanotechnology; Nature Reviews Molecular Cell Biology; Physical Biology; PLoS ONE; PLoS Computational Biology; Proceedings of the National Academy of Sciences USA; Science; Traffic; Trends in Cell Biology

Mail grant reviewer for the following organizations:
Wellcome Trust
National Science Foundation
American Chemical Society Petroleum Research Fund
VA Merit Award
Science Foundation Ireland
United States - Israel Binational Science Foundation
EuroMEMBRANE Programme within the European Collaborative Research (EUROCORES) Scheme
Cancer Research UK
Netherlands Organisation for Scientific Research
Pennsylvania Department of Health
Atip-Avenir CNRS-Inserm programme

NIH Study section service:
Special Emphasis Review Panel, NIDDK, Nov 2006
Ad Hoc reviewer, NCI-F Manpower & Training Grants, Feb 25-27, 2007
NIA Membrane Associated Signaling Defects in Immune Cells with Aging RFA, March 28-29, 2007
Ad Hoc reviewer, NIH study section on Biochemistry and Biophysics of Membranes, October 2007, Oct 2009, May 2010
Ad Hoc reviewer, NCI-F Manpower & Training Grants, Feb 28-27, 2008
Ad Hoc reviewer, R13 Conference grants, March 2009
Phone reviewer, NICHD Developmental Biology Subcommittee, June 15-16, 2009
Mail reviewer, NIH RC1 ("Challenge") grants, Summer 2009
Ad Hoc reviewer, 2012/05 ZRG1 BCMB-P, April 3-4, 2012
Biochemistry and Biophysics of Membranes, full panel member, July 2011- June 2015 (committed to meet 2 times per year instead of 3); served as co-chair several times

NIH Study Section Chair
Chair, Biochemistry and Biophysics of Membranes, July 2015- June 2017.

Site visit reviews:
Laboratory of Receptor Biology and Gene Expression (LRBGE) of the NCI Intramural Research Program, May 14-16, 2012.

Invitations to serve on study sections that were declined due to conflicts:
NCI-F Manpower & Training Grants, June 13-14, 2007
NSF Signal Transduction Panel, October 24-26, 2007
NIH study section on Biochemistry and Biophysics of Membranes as ad hoc reviewer, May 29-30, 2008
Special emphasis panel, July 15, 2008
American Heart Association R4 Basic Cell & Molecular Biology 3 committee, March 31,

2009
Membrane Biology and Protein Processing (MBPP) study section as Ad Hoc reviewer, June 2008, June 2009 and October 2009
AHA Region IV Basic Cell Committee, October 29, 2009
Joint DMS/NIGMS Initiative to Support Research in the Area of Mathematical Biology, December 2010 and December 2013

National meeting co-organizer:
Peer-elected co-chair of 2009 FASEB Summer Research Conference on "Protein Lipidation, Signaling and Membrane Domains," July 26-31, 2009, Saxtons River, VT

Appointed as Program Co-chair, 2018 Biophysical Society meeting

Subgroup chair:
Peer-elected chair, Membrane Structure and Assembly subgroup, 2016 meeting of the Biophysical Society

Other:
Judge, Olympus Bioscapes competition, October 2010
Judge, Image competition, Biophysical Society 2012-2015

TEACHING ACTIVITIES

Course director

Fall 2010	Facilitator, MPB Tutorials (1.5h/week)
2010-2011	IMPACT Mentor (1h/week)
2009-2010	IMPACT mentor (1h/week)
Fall 2009	Facilitator, MPB Tutorials (1.5h/week)
Fall 2009	FOCUS group leader (2h/week)
2008-2009	IMPACT mentor (1h/week)
Fall 2008	Facilitator, MPB Tutorials (1.5h/week)
Fall 2007	Facilitator, MPB Tutorials (1.5h/week)
2004-2005	Facilitator, MPB Tutorials (1.5h/week)
2003-2004	Facilitator, MPB Tutorials; coordinator for fall semester (1.5h/week)
Spring 1997	Course director and instructor, "Biomembrane Structure," Johns Hopkins Masters Program in Biotechnology (3h/week)

Medical Student courses

Summer 2014-present	Small Group facilitator, Case Based Learning (17.5% effort)
July 2012-June 2014	Small Group Facilitator, Case Based Learning (20% effort)
Fall 2009	Molecular Foundations of Medicine (3 h)
Fall 2008	Molecular Foundations of Medicine (5 h)
Fall 2007	Molecular Foundations of Medicine (3 h)

Graduate student courses

Fall 2015 QCB 206 (2 h)
Spring 2015 CDB Microscopy course (2h)
Spring 2015 Molecular Biophysics course (1h)
Fall 2014 QCB 206 (3 h)
Fall 2013 CPB 206 (3 h)
Fall 2012 Bioregulation, Cell biology section (4h)
Fall 2012 CPB 206 (3 h)
Fall 2011 Bioregulation, Cell biology section (4h)
Spring 2011 Molecular Biophysics course (1h)
Spring 2011 CDB Microscopy course (2h)
Fall 2010 CPB 206 (3 h)
Spring 2010 Molecular Biophysics course (1h)
Spring 2010 CDB Microscopy course (2h)
Spring 2010 Bioregulation, Cell Signaling (2h)
Fall 2009 Bioregulation, Cell biology section (2h)
Spring 2009 Molecular Biophysics course (1h)
Spring 2009 CDB Microscopy course (1h)
Spring 2009 Bioregulation, Cell Signaling (2h)
Fall 2008 CellBio310 (3 h)
Fall 2008 Bioregulation Flextime (2 h)
Spring 2008 Biochemistry 330 (~20 h in evaluating proposals written by students)
Spring 2008 Molecular Biophysics course (1h)
Spring 2008 Bioregulation, Cell signaling (2h)
Fall 2007 CellBio310 (3 h)
Fall 2007 Bioregulation I, Cell biology section (1 h)
Fall 2007 Flextime in Structural biology (4 h)
Spring 2007 Bioregulation, Cell signaling (2h)
Fall 2006 Bioregulation I, Cell biology section (2h)
Fall 2006 CellBio310 (3h)
Fall 2006 Flextime, Bioregulation, Structural biology section (1h)
Fall 2005 CellBio310 (3h)
Fall 2005 Bioregulation I, Cell biology section (2h)
Fall 2004 Lecturer, Bioregulation I, Cell biology section (2h)
Fall 2004 Flex time, Bioregulation I, Cell biology section (1h)
Fall 2003 Bioregulation I, Cell biology section (2h)
Fall 2003 Flex time, Bioregulation I, Cell biology section (1h)
Summer 2003 Lecture, Summer Science Program (1h)
Fall 2002 Lecture, Special Topics in Neuroscience (1h)
Fall 2002 Bioregulation I, Cell biology (2h)
Fall 2002 Flex time, Bioregulation I, Cell biology (1h)

Directed study
Fall 2013 Modeling diffusion in biology (1h/week), Individual study with Colin Klaus, Dept. of Mathematics

Teaching faculty in national and international microscopy courses
2008-2015 Faculty, Quantitative Fluorescence Microscopy, MDIBL
2002-2015 Faculty, FRET Microscopy Workshop, University of Virginia
October 2006 Microscopy workshop and symposium, "Dynamic Microscopy," Würzburg, Germany

RESEARCH SUPERVISION

Postdoctoral fellows:

Former
J. Shawn Goodwin, Ph.D. (7/02-04/05)
Current position: Director of Fluorescence Microscopy Core and Assistant Professor, Department of Cancer Biology and Department of Biomedical Sciences, Meharry Medical College, Nashville, TN
Maria Kiskowski, Ph.D. (also known as Audi Byrne) (7/04-11/07)
Current position: Associate Professor of Mathematics and Statistics, University of Southern Alabama, Mobile, AL
Minchul Kang, Ph.D. (12/04-8/12)
Current position: Faculty, School of Science, Technology and Engineering Management, St. Thomas University, Miami Gardens, FL
Caroline Hanson, Ph.D. (11/08-4/10) co-mentor with Dr. Habibeh Khoshbouei, Meharry Medical College; (5/10-8/11) mentor
Current position: Assistant Professor of Biology, Columbia State Community College, Franklin, TN
Nicholas Baetz, Ph.D. (8/13-6/14)
Current position: postdoctoral fellow, The Johns Hopkins University

Current
Bing Han, Ph.D. (6/12- present)
Ajit Tiwari, Ph.D. (12/13-present)
Pallavi Manral, Ph.D. (6/14-present)
Krishnan Raghunathan, Ph.D. (9/14-present)

Graduate students:

Former
Charles Day (5/08-4/13); currently postdoctoral fellow at Hormell Institute
Lewis Kraft (5/10-4/14); current postdoctoral fellow at Harvard University

Current
Courtney Copeland (5/12-present)

Rotation students:
Choya Yoon, Spring 2003; Bonnie Garcia, Fall 2003; Kenneth Martin, Fall 2003; Will Bush, Spring 2004; Jie Wang, Fall 2004; Laurel Hoffman, Summer 2005; Chris Brosey,

Summer 2005; Alessandro Ustione, Spring 2006; Don Becker, Summer 2006; Carol Bansbach, Spring 2007; Charlie Day, Fall 2007; Rachelle Johnson, Spring 2008; Peter Frick, Summer 2008; Ileana Alers, Fall 2008; Mitch LeFrance, Fall 2008; Paul Barrett, Spring 2009; Lewis Kraft, Fall 2010; Ashley Grimaldi, Summer 2010; Carol Landerman, Fall 2010; Dana Hardbower, Fall 2011; Nicole Sexton, Spring 2012; Courtney Copeland, Spring 2012; Myriam Diaz, Fall 2012; Bradley Clarke, Fall 2012; Casey Nielsen, Fall 2013; Ian Williams, Winter 2013; Jessica Tumolo, Winter 2013; Clayton Wandishin, Summer 2014.

Undergraduate students:
Alex Luo, volunteer, fall 2015
Tiffany Wong, volunteer, summer 2015
Young-Hun Kim, research intern, summer 2015
Keysha Gonzalez, Vanderbilt Summer Science Academy, 2012
Jonathan Greer, Vanderbilt Summer Science Academy, 2010 and 2011
Tara Archuleta, Summer Science Program 2007 and 2008
Current position: Graduate Student, Vanderbilt IGP Program
Joelle Rhayem, Summer Science Program 2006
Current position: Student, College of Osteopathic Medicine, Erie, PA
Carl Rogers
Summer Science program for Natural Science Majors 2003
Work-study student 2003-2004
Summer Science program for Natural Science Majors 2004
Independent study in Chemistry, 2004-2005
Current position: Graduate student in Biophysics, UC Berkeley

High School students:
Alan Chou, Research Internship Program, Summer 2009
Helen Shi, Research Internship Program, Summer 2010

RESEARCH PROGRAM

Current

0970008 **(Kenworthy)** 09/01/2010-05/31/2016 (NCE)
NSF/DMS 2 calendar months
In vivo calibration of kinetic rate constants
The goal of the proposed work is to develop new methods to calibrate, measure and quantify reaction-diffusion kinetics in living cells.

1R01HL111259-01 (Loyd/Kenworthy) 1/01/2012-12/31/2016
NIH 2.4 calendar months
Caveolar defects underlie the genetic origins of PAH

The goal is to test the hypothesis that defects in caveolae represent a common mechanism underlying the genetic basis of pulmonary arterial hypertension through a series of experiments in cells, mouse models, and human patients.
Role: Co-PI

Pilot and Feasibility Grant (Kenworthy) 04/01/2012-03/31/2016 (NCE)
VUMC DRTC 0.6 calendar months
Role of selective autophagy in pancreatic beta cell homeostasis
The goal of this proposal is to test the hypothesis that selective autophagy is responsible for clearance of both cytoplasmic and nuclear protein aggregates that form in response to beta cell stress, and that failure of this process is associated with beta cell dysfunction.
Role: PI

R01 GM106720-01 (Kenworthy) 07/15/2013-04/30/2017
NIH 3.0 calendar months
Function and assembly of toxin-stabilized domains
The goal of this proposal is to elucidate how stabilized rafts domains form and function in cell and model membranes using cholera toxin B-subunit as a model with the specific aims of 1) testing the hypothesis that CTxB must cluster raft-associated glycolipids to assemble stabilized raft domains, 2) determining how toxin-stabilized rafts interact with the actin cytoskeleton, and 3) determining if stabilized rafts play an active role in targeting CTxB for uptake by clathrin independent endocytosis by mechanically deforming membranes.
Role: PI

R01 GM106672-01 (Sanders) 05/01/2013-04/30/2017
NIH 1.2 calendar months
Cholesterol and the Amyloid Precursor Protein
The goals of this project are to elucidate the structural basis for molecular recognition between cholesterol and APP/C99 and to test the hypothesis that formation of a complex between cholesterol and APP or C99 results in enhanced partitioning of these proteins to lipid rafts, thereby promoting amyloidogenesis.
Role: Co-Investigator

1R01 GM103926-01 (Lee) 06/01/2013-03/31/2017
NIH
Role of ubiquitination in the Wnt pathway
The goal of this proposal is to perform biochemistry, cell culture experiments, and Xenopus embryo studies to dissect the mechanism by which XIAP (X-linked inhibitor of apoptosis) promotes Wnt pathway activation. The role of Dr. Kenworthy in this work is to assist with FRET microscopy experiments.
Role: Co-Investigator

Completed

5R44 EB008589-04 (Kenworthy, sub from Protochips) 07/01/2012-06/30/2014
Flow cell for biological imaging with liquid STEM 0.6 calendar months
The goal of this project is to use liquid STEM to study the organization of lipid rafts in intact cell membranes using cholera toxin B-subunit as a model.
Role: PI of subcontract

Discovery Grant (Graham) 05/10/2010-12/31/2013 (NCE)
Vanderbilt University 0 calendar months
Influence of phospholipid asymmetry on cholesterol dynamics in membrane
The role of Dr. Kenworthy is to define the influence of Drs2 flippase activity on the formation of cholesterol-rich microdomains in Giant Unilamellar Vesicles by confocal microscopy.
Role: Co-PI

R01-GM073846-03 (Kenworthy) 05/01/06-04/30/12 (NCE)
NIH/GM 3 calendar months
Regulation of microdomain structure in living cells
The goals of this project are 1) to determine if the sub-micron distribution and diffusional mobility of three representative raft proteins are consistent with an actively maintained model for raft formation; 2) to determine if different types of raft proteins co-localize of compete for residence in the same rafts; and 3) to generate *in silico* simulations of lipid raft assembly mechanisms.

R01 GM075126-02 (Weaver) 08/01/2007-07/31/2012
NIH 0.6 calendar months
Cortactin Function in Lamellipodial Protrusion
The goals of this project are to 1) test the hypothesis that the primary role of cortactin in the lamellipodia is to stabilize nascent Arp2/3-nucleated filaments; 2) test the hypothesis that cortactin functions as a buffer system for actin turnover in the lamellipodia, and 3) determine the effects of interactions of cortactin with actin filaments, ADF/cofilins, and phospholipids in direct purified protein systems.

R01 GM081635-02 (Lee) 07/01/2007-06/30/2012
NIH 0.6 calendar months
Biochemical Reconstruction of Heterotrimeric G Proteins in the WRNT Pathway
The role of Dr. Kenworthy in this R01 is for Imaging. The goal of this project is to biochemically test whether heterotrimetic G proteins are core components of the Wnt pathway that couple Frizzled receptors to activate downstream Wnt effectors.

R01 DK048370-15 (Goldenring) 08/01/2008-05/31/2012
NIH/NIDDK 0.6 calendar months
Small GTP Binding Proteins in Gastrointestinal Mucosa

The role of Dr. Kenworthy in this project is for Imaging. The goals are (1) to determine the structural regulation of Rab11-FIP protein structures and the structural requirements for assembly of Rab11-FIP protein coordinated complexes; (2) to examine the roles of the microtubule cytoskeleton and the association of Rab11-FIP proteins with microtubules in regulating the plasma membrane recycling system and polarized trafficking; and (3) to determine the role of Rab11 family coordinated complexes in the regulating epithelial polarity and transformation.

Role of HIP14 in Ras trafficking to the plasma membrane
ACS Institutional Research Grant 01/01/06 – 12/31/06
Vanderbilt School of Medicine 1.2 calendar months
The goals of this application are to (1) test for endogenous HIP14 expression in mammalian cell lines where HRas and NRas are known to utilize the classical secretory pathway and reside in the Golgi complex under steady state conditions; (2) determine if knockdown of HIP14 expression inhibits delivery of HRas and NRas to the plasma membrane; and (3) determine if knockdown of HIP14 expression prevents establishment of a steady state population of HRas and NRas on the Golgi complex.

Identification of Novel Sites of KRas signaling: Insights into Colorectal Cancer Progression
P50 CA095103 01/01/06-12/31/06
NIH/GI SPO 0.6 calendar months
The goals of this proposal are (1) to identify novel intracellular sites of KRas localization in a mammalian tissue culture model, COS-7; (2) to investigate the timecourse and duration of KRas signaling on intracellular sites in response to proliferative and apoptotic signals; and (3) to determine the sites of KRas localization and signaling in human colorectal cell lines.

PUBLICATIONS AND PRESENTATIONS

Peer-reviewed publications

Kang, M. Andreani, M., and **A. K. Kenworthy**. 2015. Validation of normalizations, scaling, and photofading corrections for FRAP data analysis. *PLoS ONE* 10(5):e0127966

Day, C. A., Baetz, N. W., Copeland, C. A., Kraft, L. J., Han, B., Tiwari, A., Drake, K. R., De Luca, H., Chinnapen, D. J. -F., Davidson, M. W., Holmes, R. K., Jobling, M. G., Schroer, T. A., Lencer, W. I., and **A. K. Kenworthy**. 2015. Microtubule motors power plasma membrane tubulation in clathrin-independent endocytosis. *Traffic* 16(6):572-90. PMCID: PMC4440230

Han, B., Tiwari, A., and **A. K. Kenworthy**. 2015. Tagging strategies strongly impact the fate of overexpressed caveolin-1. *Traffic* 16(4): 417-38. PMCID: PMC4440517

Day, C. A. and **A. K. Kenworthy**. 2015. Functions of cholera toxin B-subunit as a raft cross-linker. *Essays in Biochemistry* 57:135-45. PMCID: PMC4346142 (invited, peer-reviewed).

Prewitt, A. R., Ghose, S., Frump, A. L., Datta, A., Austin, E. D., **Kenworthy, A. K.,** and M. P. de Caestecker. 2015. Heterozygous null bone morphogenetic protein receptor type 2 mutations promote SRC kinase-dependent caveolar trafficking defects and endothelial dysfunction in pulmonary arterial hypertension. *J Biol. Chem.* 290:960-71. PMCID: PMC4294523

Renard, H-F., Simunovic, M., Lemière, J., Boucrot, E., Garcia-Castillo, M-D., Arumugam, S., Chambon, V., Lamaze, C., Wunder, C., **Kenworthy**, **A. K.,** Schmidt, A. A., McMahon, H. T., Sykes, C., Bassereau, P., and L. Johannes. 2015. Endophilin-A2 functions in membrane scission in clathrin-independent endocytosis. *Nature* 517:493-6. PMCID: PMC4342003

Kraft, L. J., T. A. Nguyen, S. S. Vogel, and **A. K. Kenworthy**. 2014. Size, stoichiometry, and organization of soluble LC3-associated complexes. *Autophagy* 10(5):861-77. PMCID in progress

Mazerik, J. N., L. J. Kraft, **A. K. Kenworthy**, and M. J. Tyska. 2014. Single molecule imaging reveals that motor and tail homology 1 (TH1) domains antagonistically control myosin-1 dynamics. *Biophysical Journal* **106**(3):649-58. PMCID: PMC3944834.

Song, Y., **A. Kenworthy**, and C. Sanders. 2014. Cholesterol as a co-solvent and a ligand for membrane proteins. *Protein Science* **23**(1):1-22. PMCID: PMC3892294 (invited, peer reviewed)

Hanson, C.A., K.R. Drake, M.A. Baird, B. Han, L.J. Kraft, M.W. Davidson and **A. K. Kenworthy**. 2013. Overexpression of caveolin-1 is sufficient to phenocopy the behavior of a disease-associated mutant. *Traffic* **14**: 663-77. PMCID: PMC3674505

Day. C. A., L. J. Kraft, M. Kang, and **A. K. Kenworthy**. 2012. Analysis of protein and lipid dynamics using confocal fluorescence recovery after photobleaching. *Current Protocols in Cytometry,* Chapter 2: Unit 2.19. PMCID: PMC3538152

Kang, M., C. A. Day, **A. K. Kenworthy*** and E. DiBenedetto*. 2012. Simplified equation to extract diffusion coefficients from confocal FRAP data. *Traffic* 13(12):1589-1600. PMCID: PMC3731631. *Joint corresponding authors

Chinnapen, D., W. Hsieh, Y. t. Welscher, D. Saslowsky, L. Kaoutzani, E. Brandsma, L. D'Auria, H. Park, J. Wagner, K. Drake, M. Kang, T. Benjamin, M. Ullman, C. Costello, **A. K. Kenworthy**, B. T, R. Massol and W. I. Lencer. 2012. Lipid-sorting by ceramide structure from plasma membrane to ER for the cholera toxin receptor ganglioside GM1. *Dev. Cell* 23: 573-86. PMCID: PMC3443397

Day, C.A. and **A. K. Kenworthy**. 2012. Mechanisms underlying the confined diffusion of cholera toxin B-subunit in intact cell membranes. *PLoS ONE* 7:e34923. PMCID: PMC3325267

Kraft, L. J. and **A. K. Kenworthy**. 2012. Imaging protein complex formation in the autophagy pathway: analysis of the interaction of LC3 and Atg4B^{C74A} in live cells using Förster Resonance Energy Transfer and Fluorescence Recovery After Photobleaching. *J Biomed Optics*, 17:011008. PMCID: PMC3880812

Lapierre, L. A., N. A. Ducharme, K. R. Drake, J. R. Goldenring, and **A. K. Kenworthy**. 2012. Coordinated regulation of caveolin-1 and Rab11a in apical recycling compartments of polarized epithelial cells. *Exp. Cell Res.* 318:103-113. PMCID: PMC3230713

Kang, M., E. DiBenedetto, and **A. K. Kenworthy.** 2011. Proposed correction to Feder's anomalous diffusion FRAP equations. *Biophys J.* 100: 791-2. PMCID: PMC3030171

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Submitted manuscripts

Cui, Y., **A. K. Kenworthy**, M. Edidin, R. Divan, D. Rosenman, and P. Wang. Analyzing single giant unilamellar vesicles with a slotline-based radio-frequency nanometer sensor. Revision submitted to *Transactions on Microwave Theory and Techniques.*

Jonathan P. Schlebach, Paul Barrett, Charles A. Day, Ji Hun Kim, **Anne K. Kenworthy,** and Charles R. Sanders. Raftophilic Human Membrane Proteins Partition to Liquid-Disordered Domains in Phase-Separated Lipid Vesicles. Submitted to *Biochemistry*

Manuscripts in revision

Kraft, L. J., Dowler, J., Manral, P., and **A. K. Kenworthy**. Size, organization and dynamics of soluble SQSTM1 and LC3/SQSTM1 complexes in living cells. In revision for *Autophagy.*

Kristina E. Kitko, Tu Hong, Roman M. Lazarenko, J. Rafael Montenegro-Burke, Amy Shah, Da Ying, Krishnan Raghunathan, **Anne K. Kenworthy**, Melissa C. Skala, John A. McLean, Ya-Qiong Xu, and Qi Zhang. Graphene reshapes cell communication via its interaction with membrane cholesterol. In revision for *Nature Nanotechnology.*

Kraft, L. J., Dowler, J., Manral, P., and **A. K. Kenworthy**. Nuclear LC3 associates with slowly diffusing complexes that visit the nucleolus. In revision for *Traffic*.

Manuscripts in preparation

Lewis J. Kraft, Jacob Dowler, and **Anne K. Kenworthy**. FRAP Toolbox: Software for the analysis of Fluorescence Recovery After Photobleaching.

Yumeko Kawano, Bing Han, Courtney A. Copeland, Erika Berman Rosenzweig, Eric D. Austin, Layla Shahmirzadi, Sha Tang, **Anne K. Kenworthy**, Wendy K. Chung. Novel association of both pulmonary hypertension and congenital lipodystrophy with *Caveolin-1* mutation.

Bing Han, Courtney A. Copeland, Ajit Tiwari, Eric Austin, James West, James Loyd, and **Anne K. Kenworthy**. Impact of a frameshift mutant of caveolin-1 associated with pulmonary arterial hypertension on caveolae assembly and function.

Colin Klaus, Krishnan Raghunathan, Emmanuele DiBenedetto, and **Anne K. Kenworthy**. Analysis of diffusion in membranes with complex geometries using finite element analysis.

Ajit Tiwari, Caroline A. Hanson, Courtney A. Copeland, Bing Han, Kimberly R. Drake, and **Anne K. Kenworthy**. Caveolin-1 is an aggresome inducing protein.

Daniel J. Klionsky… **Anne K. Kenworthy**… et al. Guidelines for the Use and Interpretation of Assays for Monitoring Autophagy (2nd edition)

Volumes edited

"Lipid domains," Volume 75, *Current Topics in Membranes*, Anne Kenworthy, editor. Academic Press, NY, 2015.

Invited papers and book chapters

Kang, M and **Kenworthy, A. K**. Complex Applications of Simple FRAP on Membranes. in Biomembrane Frontiers, ed. by Roland Faller et al. (Humana Press, New York, 2009)

Kenworthy, A.K. 2007. New and Notable: Breaking up isn't so hard to do. Biophys J. 2007 Jul 27

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Kenworthy, A. K. 2005. Photobleaching FRET Microscopy. *In* FRET Microscopy, American Physiological Society Book Series, A. Periasamy and R.Day, Eds., Oxford University Press.

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Kenworthy, A. K. 2001. Imaging protein-protein interactions using fluorescence resonance energy transfer microscopy. *Methods: A Companion to Methods in Enzymology* 24: 289-296

Kenworthy, A. K. and Edidin, M. 1999. Imaging fluorescence resonance energy transfer as a probe of the membrane organization and molecular associations of GPI-anchored proteins. *In* Methods in Molecular Biology Vol 116: Protein Lipidation Protocols. M. H. Gelb (Ed.) Humana Press Inc, Totowa, NJ. pp. 37-49

Kenworthy, A. K., McIntosh, T. J. and Hristova, K. 1997. Phase behavior and intersurface forces of self assembling polymer-lipid systems. *Current Topics in Colloid and Interface Science* 2: 83-93.

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Kenworthy, A. K. 2006. Mathematical modeling of cell membrane organization, dynamics and trafficking. Oberwolfach Reports, Proceedings on the Workshop on Biomath, in press.

Edidin, M., **Kenworthy, A. K.,** and Gheber, L. 1998. Light microscopy beyond the wavelength limit: methods for characterizing cell surface membranes. *Microsc. Microanal*. 4 (Suppl 2: Proceedings) pp. 1018-1019.

Expert source for feature articles

Katie Cottingham. 2004. "Do you believe in lipid rafts?" *Analytical Chemistry*, 403A-406A

Jill Adams. 2004. “The tiniest of life’s rafts.” *The Scientist*

Advisor for Nature Milestones, Light Microscopy (published October 2009)

INVITED PRESENTATIONS

09-15 (EMBO Endocytosis meeting, France (short talk selected from abstracts)

09-15 Curie Institute, France

09-15 Pasteur Institute, France

07-15 FASEB Summer Research Conference, “Protein Lipidation, Signaling and Membrane Domains” (short talk selected from abstracts)

04-15 Department of Chemistry, Lehigh University

02-15 Biophysical Society (short talk selected from abstracts)

11-14 Panelist, Intramural NIH workshop on “Reproducibility of Data Analysis and Collection: Modern Technologies in Cell Biology: Potentials and Pitfalls”

10-14 Midwest Trafficking and Signaling Symposium, University of Louisville (ASCB-sponsor local meeting)

09-14 University of New Mexico, Cellular and Molecular Basis of Disease Seminar Series

07-14 FASEB Summer Research Conference, “Molecular Biophysics of Membranes” (short talk selected from abstracts)

06-14 Gordon Research Conference, “Lysosomes and Endocytosis” (short talk selected from abstracts)

04-14 University of Akron, Department of Chemistry

04-14 Vanderbilt University, Department of Cell and Developmental Biology

02-14 Biophysical Society Meeting “New and Notable” symposium (unable to attend due to family emergency)

01-14 Gordon Research Conference, “Glycolipid and Sphingolipid Biology” (short talk selected from abstracts)

09-13 Purdue University, Life Science Program

07-13 Snowmass Membrane Conference on “Biological Membranes and Membrane Proteins: Challenges for Theory and Experiment”

07-13 FASEB Summer Research Conference, “Protein Lipidation, Signaling and Membrane Domains”

04-13 Clemson University

04-13 NSF-UWM Symposium 2013 - Open Forum for Innovation in Two-Photon Microspectroscopy

07-12 FASEB Summer Research Conference, “Molecular Biophysics of Cellular Membranes”

04-12 NHLBI, NIH

02-12 Membrane Structure and Assembly Subgroup, Biophysical Society Meeting

07-11 FASEB Summer Research Conference, “Protein Lipidation, Signaling and Membrane Domains”

04-11 Institute for Biophysical Dynamics, University of Chicago

02-11 University of Minnesota Duluth

03-10 FRET Microscopy Workshop, University of Virginia

11-09 University of Wisconsin-Madison, Department of Biochemistry

10-09 Drexel University, Department of Cell Biology

07-09 FASEB Summer Research Conference, “Protein Lipidation, Signaling and Membrane Domains”

03-09 FRET Microscopy Workshop, University of Virginia

09-08 Penn State University, Department of Chemistry

07-08 FASEB Summer Research Conference, “Molecular Biophysics of Cellular Membranes”

04-08 The University of Kansas Medical Center, Department of Biochemistry and Molecular Biology

03-08 Biomembrane Frontiers workshop, UC Davis

03-08 FRET Microscopy Workshop, University of Virginia

01-08 New York University School of Medicine

01-08 Sloan-Kettering Cancer Center, Program in Cell Biology

01-08 Dept. of Pathology, Vanderbilt School of Medicine

12-07 The Johns Hopkins University, Department of Biology

12-07 ASCB subgroup meeting on “Dynamics of rafts, stabilized rafts, and other non-raft domains of membrane”

08-07 Advanced Light Microscopy for Biological Questions symposium at Microscopy & Microanalysis 2007, Ft. Lauderdale, FL

06-07 Gordon Research Conference, “Phosphorylation and G protein mediated signaling networks”

03-07 FRET Microscopy Workshop, University of Virginia

11-06 Emory University, Department of Physics

10-06 University of Wisconsin-Milwaukee, Department of Physics

10-06 Microscopy workshop and symposium, “Dynamic Microscopy,” Würzburg, Germany

9-06 American Chemical Society, Colloid and Surface Chemistry Division, Session on “Chemistry at Biological Interfaces,” San Francisco, CA

9-06 American Chemical Society, Physical Chemistry Division, Session on “Physical chemistry foundations of biological membrane phenomena,” San Francisco, CA

07-06 FASEB Summer Research Conference, “Regulation and Function of Small GTPases”

07-06 FASEB Summer Research Conference, "Protein Lipidation, Signaling and Membrane Domains"

06-06 National Biotechnology Conference of the American Association of Pharmaceutical Scientists, Boston, MA

06-06 EMBO Workshop on Cell Membrane Dynamics, Bilbao, Spain

05-06 Oberwolfach Conference on “Mathematical Biology,” Oberwolfach, Germany

03-06 Keystone Symposium on Lipid Rafts and Cell Function, Steamboat Springs, CO.

03-06 FRET Microscopy workshop, University of Virginia

02-06 Association for Research in Otolaryngology Midwinter meeting, Symposium on Imaging Protein-Protein Interactions, Baltimore, MD

11-05 Liver Center, Albert Einstein College of Medicine

10-05 NIAA Workshop on Signaling Defects in Aging (invited as expert on lipid rafts), Potomoc, MD

09-05 2nd Omaha Imaging symposium *(unable to attend)*

04-05 Symposium on “Lipid rafts: from bench to bedside,” Experimental Biology

03-05 FRET Microscopy workshop, University of Virginia

01-05 University of Cincinnati, Department of Cell Biology

01-05 Medical College of Georgia, Department of Pharmacology and Toxicology

11-04 Advanced microscopy course on multi-color imaging, FRET, FRAP, FCS and FLIM, Leica Microsystems, Harvard University

10-04 Biophysical Discussion on Probing Membrane Microdomains, Asilomar, CA

09-04 International HDL meeting, Crete

05-04 Space and Time in Cells, University of Warwick, UK, (*unable to attend*)

03-04 Keystone Symposia, Molecular Cell Biology of Lipid Domains, Vancouver, BC

03-04 FRET Microscopy workshop, University of Virginia

02-04 Biophysical Society Membrane Structure and Assembly subgroup meeting

12-03 Advanced microscopy course on multi-color imaging, FRET, FRAP, FCS and FLIM, Leica Microsystems (*unable to attend*)

09-03 NYU Cancer Institute, New York University School of Medicine

07-03 Gordon Research Conference, Molecular Membrane Biology

05-03 Department of Molecular Physiology and Biophysics, VUMC

04-03 Department of Cell Biology, Johns Hopkins University School of Medicine

03-03 FRET Microscopy workshop, University of Virginia

10-02 Department of Biological Sciences, Vanderbilt University

09-02 Department of Cell and Developmental Biology, VUMC

05-02 FRET workshop, Proteomics meeting, VUMC

03-02 FRET workshop, University of Virginia

01-02 Department of Molecular Biophysics and Physiology, Rush Medical College

01-02 Department of Microbiology and Immunology, VUMC

09-01 Optical Technology Division, Department of Physics, National Institute of Standards and Technology.

03-01 Laboratory of Cell Biology, NHLBI, NIH

02-01 Department of Biochemistry and Molecular Biology, Oregon Health Sciences University

03-01 Department of Biology, University of Maryland, College Park

02-01 Division of Molecular Biology and Biochemistry, University of Missouri-Kansas City

02-01 Department of Biology, University of Virginia

02-01 Laboratory of Cellular and Molecular Biology, Division of Basic Sciences, National Cancer Institute, National Institutes of Health

02-01 Department of Molecular Physiology and Biophysics, Vanderbilt University Medical Center

02-01 Laboratory of Cell Biochemistry and Biology, NIDDK, National Institutes of Health

01-01 Department of Cell Biology, University of Texas Southwestern Medical Center

01-01 Department of Biological Sciences, Dartmouth College

01-01 School of Molecular and Cellular Biology, University of Illinois at Urbana-Champaign

01-01 School of Biology, Georgia Institute of Technology

01-01 Department of Biochemistry, Molecular Biology and Cell Biology, Northwestern University

11-00 Department of Pathology and Anatomy, Eastern Virginia Medical School

11-00 Department of Physiology and Cell Biology, Ohio State University

12-99 American Society for Cell Biology Subgroup Meeting, Raftology: lipid microdomains and membrane function

02-99 Third Annual Membrane Research Forum, Nagoya, Japan

07-98 FASEB Summer Conference, Lipid Modification of Proteins

02-98 Biophysical Society Meeting Workshop, Applications of Fluorescence Imaging in Cell Membrane Biophysics