Curriculum Vitae—Jeff Hardin

Date of birth: October 2, 1959 Birthplace: Milwaukee, Wisconsin Citizenship: U.S.

Education and Professional Experience

Undergraduate

1981—B.A. in German; B.S. in Zoology, Michigan State University (Phi Beta Kappa, magna cum laude)

Masters

1983 – M.Div., International School of Theology, San Bernardino, CA (specialization in Theology and Philosophy)

Doctoral

1987 - Ph.D. in Biophysics, University of California-Berkeley

Ph.D. under Drs. Ray Keller and Fred Wilt; project involved analysis of morphogenetic movements during gastrulation in amphibian and echinoderm embryos, using time-lapse Nomarski microscopy, scanning electron microscopy, immunostaining, and mechanical modeling

Postdoctoral

1987-1991: Postdoctoral fellow, Department of Zoology, Duke University

Postdoctoral fellow under Dr. David McClay; project involved the cellular and molecular basis of pattern formation by mesenchymal cells in the sea urchin gastrula, using microsurgery, micromanipulation, cell transplantation, time-lapse Nomarski microscopy, scanning electron microscopy, antibody production, in situ hybridization, standard molecular biology.

Faculty

1991-1997: Assistant Professor of Zoology, University of Wisconsin-Madison
1997-2002: Associate Professor of Zoology, University of Wisconsin-Madison
2003-2016: Professor of Zoology, University of Wisconsin-Madison
2016-present: Raymond E. Keller Professor, Department of Zoology (now Integrative Biology)
2024-2026: Wayland Noland Distinguished Professor, Department of Integrative Biology
2008-2021: Chair, Department of Zoology (now Integrative Biology), University of Wisconsin-Madison

Principal Investigator of laboratory studying cellular and molecular mechanisms of morphogenesis. Techniques used by the laboratory include four dimensional Nomarski microscopy, laser ablation, low-intensity fluorescence imaging, two-photon excitation and laser scanning confocal microscopy, digital image analysis, micromanipulation, ultrastructural analysis using low-voltage scanning and transmission electron microscopy, production and use of mono- and polyclonal antibodies, standard molecular biology, in situ hybridization, microinjection, antisense RNA injections, DNA construct injections, and developmental genetics. We study the molecular mechanisms of morphogenesis, predominantly using the embryonic hypodermis (epidermis) of *C. elegans* as a model system.

2002–2020 — Faculty Director, Biology Core Curriculum (Biocore)
Biocore was founded in 1967. It is a four-semester undergraduate honors sequence in intermediate/advanced biology, featuring intensive investigation-based laboratory experiences, active learning in lecture courses, and extensive team-based interactions among instructional faculty. Faculty are encouraged to pilot and publish original research on teaching and learning, and students regularly engage in outside service through Biocore Outreach Ambassadors, the Biocore Prairie, and through innovative peer mentoring groups.

Honors
Undergraduate
Phi Beta Kappa, National Merit Scholar, Alumni Distinguished Scholar, Ryder Scholar
Predoctoral
National Science Foundation Fellow, Regents Fellow, Dean's Training Fund awards, 1985-1987
Postdoctoral
Lucille P. Markey Scholar in the Biomedical Sciences, National Institutes of Health Postdoctoral Fellow, Duke University Hargitt Fellow

Awards
1986—Young Investigator Award, First Place, Society for Developmental Biology
1987—Western Regional Meeting of Electron Microscopists and Microbeam Analysts, First Place Award, Biological Sciences
Presidential Student Award, Electron Microscopy Society of America
1991—University of Wisconsin/American Cancer Society research award
1992-99 — NSF Young Investigator Award
1999-2001 --- University of Wisconsin Vilas Associate Award
2009 – University of Wisconsin Kellett Mid-Career Award
2011 — Chancellor's Distinguished Teaching Award
2016 – Wisconsin Alumni Research Foundation Named Professorship

Graduate Training Programs
Cellular and Molecular Biology, Medical Scientist Training Program (M.D./Ph.D. program), Genetics, Cellular and Molecular Pathology, Molecular and Cellular Pharmacology, Biophysics, Zoology

Professional Societies
American Society for Cell Biology, Society for Developmental Biology, American Association for the Advancement of Science, Genetics Society of America

Symposia/Invited Science Lectures
1996 — Invited Speaker, 1st South African International Symposium on Cell & Developmental Biology; Invited speaker, Developmental Biology of the Sea Urchin, Woods Hole; Invited speaker, 2nd Symposium on Integrated Microscopy, Madison, WI

1997 - Invited speaker, Department of Biology, University of California, Santa Cruz
Invited speaker, Department of Genetics, University of Wisconsin-Madison
Invited speaker, Developmental Biology of the Sea Urchin, Woods Hole

1998 - Invited speaker, Hörstadius Symposium, Stockholm

Invited speaker, Sunflower Developmental Genetics Symposium, Overland Park, KS
Invited speaker, Department of Cell Biology, University of Basel, Switzerland
Invited speaker. Fribourg, Switzerland

1999 - Invited speaker, University of Pennsylvania, Philadelphia
Invited speaker, British Society for Developmental Biology, Manchester, England
Invited speaker, University of Wisconsin, Developmental Toxicology
Invited speaker, Duke University, Durham, NC
Invited speaker, International *C.elegans* Meeting, Madison, WI

2000 -Invited speaker, Northwestern University, IL
Invited speaker, American Society for Cell Biology Annual Meeting, San Francisco, CA
Invited speaker, University of Virginia, Charlottesville, VA
Invited Speaker, Anatomy Dept., UW-Madison

2001- Invited speaker, Society for Developmental Biology Annual Meeting, University of Washington, Seattle, WA; Invited speaker, British Society for Cell/Developmental Biology Annual Meeting, Sussex University , UK; Invited speaker, Cell contact and adhesion Gordon Conference; Invited speaker, University of Minnesota, Dept. of Cell, Molecular, and Development Biology; Invited speaker, University of North Carolina, Dept. of Biology; Invited speaker, MAGUK special interest subgroup meeting, Amer. Soc. Cell Biology Annual Meeting, Washington, DC

2002 – Invited speaker, Department of Biology, University of Toronto; Invited speaker, Symposium on "Epithelia in Development and Disease" (University of Düsseldorf)

2003 - Invited Speaker, Developmental Biology Symposium, UCSF; Cell Contact and Cell Adhesion Gordon Conference; Department of Biology, Northwestern University, p120 Special Interest Subgroup meeting, Amer. Soc. Cell Biology, San Francisco

2004 - Invited speaker, Molecular and Cellular Pharmacology Program, UW-Madison; Biological Imaging Symposium, UW-Madison

2005 - Invited speaker, Department of Anatomy and Cell Biology, Univ. of Kansas Medical School
Invited speaker, Department of Biology, Kansas State Univ; Invited Speaker, Cell Contact & Adhesion Gordon Conference

2006 - Plenary speaker, Northwest Regional Developmental Biology Meetings, Friday Harbor, WA; Plenary speaker, 2006 C. elegans Topics Meeting, Madison, WI

2007 – Plenary Speaker, International Wound Healing Symposium, Madrid Spain;
Invited speaker, minisymposium on cell motility, American Society for Cell Biology, Washington, DC

2008 –Invited speaker, Department of Molecular Genetics, University of Toronto

2009 – Invited speaker, Department of Biology, Simon Fraser Univ.; invited speaker, Department of Biology, Trinity Western University; invited speaker, Education session speaker, Midwest Regional Developmental Biology Meetings, Iowa City, IA; invited speaker, Cell Contact and Cell Adhesion Gordon Conference; invited speaker, Department of Molecular Genetics and Cell Biology, University of Chicago

2010 –Invited speaker, Department of Anatomy and Cell Biology, Medical College of Wisconsin; Invited speaker, Education session speaker, Northwest Regional

Developmental Biology Meetings, Friday Harbor, WA; Invited Speaker, Brisbane Cell and Developmental Biology day, Brisbane, Australia

2011 – Invited speaker, Cell Contact and Cell Adhesion Gordon Conference; invited speaker, Annual Developmental Biology Symposium, University of Minnesota; invited speaker (Pew Scholar), Union University, Jackson, TN

2012 – Invited speaker, Developmental and Stem Cell Biology program, Duke University; invited speaker, Skirball Institute, NYU Medical School; invited speaker, Cell and Developmental Biology program, Vanderbilt Univ.

2013 - Invited speaker, Genetics Department, UW-Madison; Cell and Regenerative Biology department, UW-Madison

2014 – Invited speaker, Department of Pathology and Cell Biology, Emory University

2015 - Invited speaker, Cell Contact and Cell Adhesion Gordon Conference

2016 – Invited Speaker, Faraday Institute, St. Edmund's College, Cambridge University; Invited Speaker, Department of Biology, University of Iowa; Invited Speaker, Rice University

2017 – Invited Speaker, American Scientific Affiliation Naperville Chapter; Invited speaker, Wheaton College; Invited Speaker, Development, Regeneration, and Stem Cell Biology (DRSB) program, University of Chicago

2018 – Invited Speaker, Trinity International University; Invited Speaker, V. Elving Anderson Lecture, Anselm House (Univ. of Minnesota)

2019 – Special seminar, Univ. of North Carolina-Chapel Hill; Invited Speaker, Ross Bush Institute, Southeastern Baptist Theological Seminary; Invited speaker, Cell Contact and Cell Adhesion Gordon Conference; Invited speaker, BioLogos National Conference

2020 – Keynote speaker, Genome Editing and Ethics, Arizona State University; Keynote speaker, Andor Academy, Madison, WI; Keynote speaker, Andor Cell & Developmental International Symposium

2021 - Invited speaker, Worm Skin meeting, Marseille, France; Invited speaker, Faraday Institute, Cambridge Univ.

2022 – Invited speaker, Wheaton College Science Symposium; Biology Colloquium, Univ. of Wisconsin-Madison; Invited speaker, Univ. of Iowa Dept. of Biochemistry

2023 – Invited speaker, Faraday Institute, Cambridge University; Invited speaker, Baylor University

2024 – Invited speaker, Global Observatory for Genome Editing, Harvard Univ. (March, Sept.

Publications

Complete List of Published Science Papers in MyBibliography:
http://www.ncbi.nlm.nih.gov/myncbi/browse/collection/40698693/?sort=date&direction=ascending

Peer-reviewed publications

1. Hardin, J.D. and Cheng, L.Y. (1986). The mechanisms and mechanics of archenteron elongation during sea urchin gastrulation. *Dev. Biol.* **115**, 490-501.
2. Stephens, L., Hardin, J., Keller, R., and Wilt, F. (1986). The effects of aphidicolin on differentiation and morphogenesis in the sea urchin embryo. *Dev. Biol.* **118**, 64-69.
3. Hardin, J.D. (1987). Archenteron elongation in the sea urchin embryo is a microtubule-independent process. *Dev. Biol.* **121**, 253-262.
4. Hardin, J.D. (1987). Disruption of collagen crosslinking during sea urchin morphogenesis. In *Proc. 45th Ann. Meet. Electr. Microsc. Soc. Amer.* (G.W. Bailey, ed.), pp. 786-787. San Francisco, San Francisco Press, Inc.
5. Butler, E., Hardin, J., and Benson, S. (1987). The role of lysyl oxidase and collagen crosslinking during sea urchin development. *Exp. Cell Res.* **173**, 174-182.
6. Hardin, J. and Keller, R. (1988). The behavior and function of bottle cells in gastrulation of *Xenopus laevis*. *Development* **103**, 211-230.
7. Hardin, J. (1988). The role of secondary mesenchyme cells during sea urchin gastrulation studied by laser ablation. *Development* **103**, 317-324.
8. Hardin, J. (1989). Local changes in position and polarized protrusive activity drive cell rearrangement during sea urchin gastrulation. *Dev. Biol.* **136**, 430-445.
9. Hardin, J., and McClay, D. (1990). Target recognition by the archenteron during sea urchin gastrulation. *Dev. Biol.* **142**, 86-102.
10. Hardin, J., Black, S., Coffman, J., and McClay, D. (1992). Commitment along the dorsoventral axis of the sea urchin embryo is altered in response to $NiCl_2$. *Development*.**116**, 671-685.
11. Armstrong, N., Hardin, J., and McClay, D. (1993). Cell-cell interactions regulate skeleton formation in the sea urchin embryo. *Development* **119**, 833-840.
12. Draper, B.W., Mello, C.C., Bowerman, B., Hardin, J., and Priess, J. (1996). MEX-3 is a KH domain protein that regulates blastomere identity in early *C. elegans* embryos. *Cell* **87**, 205-216.
13. Hardin, J. and Armstrong, N. (1997). Short range cell-cell signals control ectodermal patterning in the oral region of the sea urchin embryo. *Dev. Biol.* **182,** 132-149.
14. Williams-Masson, E., Malik, A., and Hardin, J. (1997). An actin-mediated, two-step mechanism is required for ventral enclosure of the *C. elegans* hypodermis. *Development* **124**, 2889-2901.
15. Benink, H., Wray, G., and Hardin, J. (1997). Archenteron precursors can organize secondary axial structures in the sea urchin embryo. *Development*. **124**, 3461-3470.
16. George, S.E., Simokat, K., Hardin, J., and Chisholm, A.D. (1998) The VAB-1 Eph Receptor Protein Tyrosine Kinase Functions in Epithelial Morphogenesis in *C.elegans. Cell* **92**, 633-643.
17. Costa, M., Raich,W., Agbunag, C., Hardin, J. and Priess, J. (1998). A putative catenin-cadherin system mediates morphogenesis of the *C. elegans* embryo. *J. Cell Biol.* **141,** 297-308.
18. Raich, W.B., Moran, A.N., Rothman, J.H., Hardin, J. (1998) Cytokinesis and midzone microtubule organization in *Caenarhabditis elegans* require the kinesis-like protein ZEN-4. *Molec.Biol.Cell* **9**, 2037-2049.

19. Mohler, W.A., Simske, J.S., Williams-Masson, E.M., Hardin, J.D. and White, J.G. (1998). Dynamic and ultrastructure of developmental cell fusion in the Caenorhabditis elegans hypodermis. *Curr. Biol.* **8**, 1087-1090.
20. Williams-Masson, E., Heid, P., Lavin, C.A. and Hardin, J. (1998). The cellular mechanism of epithelial rearrangement during morphogenesis of the *C. elegans* dorsal hypodermis. *Dev. Biol.* **204**, 263-276.
21. Kimberly, E.L. and Hardin, J. (1998) Bottle cells are required for the initiation of primary invagination in the sea urchin embryo. *Dev. Biol*. **204**, 235-25*0*.
22. Raich, W.B., Agbunag, C. and Hardin, J.D. (1999) Rapid epithelial-sheet sealing in the *Caenorhabditis elegans* embryo requires cadherin-dependent filopodial priming . *Current Biol*. **9**, 1139-1146.
23. Heid, P.J. and Hardin, J. (1999) Cell Line Analysis: Videomicroscopy Techniques. In: *Methods in Molecular Biology*, Vol 135. pp.323-330. Totowa, NJ, Humana Press, Inc.
24. Heid, P.J., Raich, W.B., Smith, R., Mohler, W.A., Gendreau, S.B., Rothman, J.H., and Hardin, J. (2001). The zinc finger protein DIE-1 is required for late events during epithelial cell rearrangement in *C. elegans. Dev. Biol.* **236**,165-180
25. Koeppen, M., Simske, J.S., Sims, P.A., Firestein, B.L., Hall, D.H., Radice, A.D., Rongo, C. and Hardin, J.D. (2001) AJM-1 is required for the integrity of *C. elegans* adherens junctions and is cooperatively regulated by LET-413 and DLG-1. *Nature Cell Biol.* **3:**983-991.
26. Simske, J.S., Köppen, M., Sims, P.A., Hodgkin, J., and Hardin, J.D. (2003). The cell junction protein VAB-9 regulates adhesion and epidermal morphology in *C. elegans*. *Nature Cell Biol.* **5**:619-625.
27. Pettitt, J., Cox, E.A., Broadbent, I.D., Fleet, A. and Hardin, J. (2003) The *C. elegans* p120 catenin homologue, JAC-1, modulates cadherin-catenin function during epidermal morphogenesis. *J. Cell Biol.* **162**,15-22.
28. Walston, T., Tuskey, C., Edgar, L., Hawkins, N., Ellis, G., Bowerman, B., Wood, W., and Hardin, J. (2004). Multiple Wnt signaling pathways converge to orient the mitotic spindle in early *C. elegans* embryos. *Dev Cell* **7**, 831-841.
29. Thomas-Virnig, C.L., Sims, P.A., Simske, J.S., and Hardin, J. (2004). The inositol 1,4,5-trisphosphate receptor regulates epidermal cell migration in *Caenorhabditis elegans*. *Curr Biol.* **14**,1882-7.
30. Sims, P.A., Lockwood, C.A., and Hardin, J (2005). Integrating light and TEM information with F-TEM images. *Micr. Today* **13**, 16-18.
31. Walston, T., Guo, C., Proenca, R., Wu, M., Herman, M., Hardin, J., and Hedgecock, E. (2006). mig-5/Dsh controls cell fate determination and cell migration in C. elegans. *Dev Biol* **298**, 485-97.
32. Lee, J. Y., Marston, D. J., Walston, T., Hardin, J., Halberstadt, A., and Goldstein, B. (2006). Wnt/Frizzled signaling controls *C. elegans* gastrulation by activating actomyosin contractility. *Curr Biol* **16**, 1986-97.
33. Hardin, J., and Illingworth, C. A. (2006). A homologue of *snail* is expressed transiently in subsets of mesenchyme cells in the sea urchin embryo and is down-regulated in axis-deficient embryos. *Dev Dyn* **235**, 3121-31.
34. Phillips, B. T., Kidd, A. R., 3rd, King, R., Hardin, J. and Kimble, J. (2007). Reciprocal asymmetry of SYS-1/b-catenin and POP-1/TCF controls asymmetric divisions in *Caenorhabditis elegans*. *Proc Natl Acad Sci U S A.* **104**, 3231-3236.
35. Sims, P. A., and Hardin, J. D. (2007). Fluorescence-integrated transmission electron

microscopy images: integrating fluorescence microscopy with transmission electron microscopy. *Methods Mol Biol* **369**, 291-308.
36. Batchelder EL, Thomas-Virnig CL, Hardin JD, White JG. (2007). Cytokinesis is not controlled by calmodulin or myosin light chain kinase in the *Caenorhabditis elegans* early embryo. *FEBS Letters* **581**, 4337-41.
37. Qadota H, Inoue M, Hikita T, Köppen M, Hardin JD, Amano M, Moerman DG, Kaibuchi K. (2007). Establishment of a tissue-specific RNAi system in *C. elegans*. *Gene* **400**,166-73.
38. Sheffield, M., Loveless, T., Hardin, J., and Pettitt, J. (2007). *C. elegans* Enabled exhibits novel interactions with N-WASP, Abl, and cell-cell junctions during morphogenesis. *Curr. Biol.* **17**, 1791–1796.
39. Stevenson, T.O., Mercer, K., Cox, E.A., Szewczyk, N.J., Conley, C.A., Hardin, J.D., and Benian, G.M. (2007). *unc-94* encodes a tropomodulin in *C. elegans*. *J. Mol. Biol.* **374**, 936-50.
40. Hardin, J., King, R., Thomas-Virnig, C., and Raich, W.B. (2008). Zygotic loss of ZEN-4/MKLP1 results in disruption of epidermal morphogenesis in the C. elegans embryo. *Dev. Dyn*. **237**, 830-6.
41. Lockwood, C., Lynch, A., and Hardin, J. (2008). Dynamic analysis identifies novel roles for DLG-1 subdomains in AJM-1 recruitment and LET-413 dependent apical focusing. *J. Cell Sci.* **121**,1477-1487.
42. Ding, M., King, R.S., Berry, E.C., Wang, Y., Hardin, J., and Chisholm, A.D. (2008). The cell signaling adaptor protein EPS-8 is essential for C. elegans epidermal elongation and interacts with the ankyrin repeat protein VAB-19. *PLoS ONE* **3**:e3346.
43. Lockwood, C., Zaidel-Bar, R., and Hardin, J. (2008). The C. elegans Zonula Occludens ortholog ZOO-1 cooperates with the cadherin-catenin complex to recruit actin during epidermal morphogenesis. *Curr. Biol.* **18**:1333-7.
44. Yamashiro, S., Cox, E.A., Ballie, D.L., Hardin, J. and Ono, S. (2008). Sarcomeric actin organization is synergistically promoted by tropomodulin, ADF/cofilin, AIP1, and profilin in C. elegans body wall muscle. *J. Cell Sci* **121**:3867-77
45. King, R.S., Maiden, S.L., Hawkins, N.C., Kidd, A.R., Kimble, J., Hardin, J., and Walston, T.D. (2009). POP-1 asymmetry and morphogenesis defects in *dsh-2* mutant embryos can be rescued by either the DIX or DEP domain of DSH-2. *Dev. Biol.* **328**, 234-44.
46. Hingwing, K., Lee, S., Nykilchuk, L., Walston, T., Hardin, J., and Hawkins, N. (2009). CWN-1 functions with DSH-2 to regulate *C. elegans* asymmetric neuroblast division in a □-catenin independent Wnt pathway. *Dev. Biol.* **328**, 245–25.
47. Giuliani, C., Troglio, F., T., Zucconi, A., Bai, Z., Patel, F.B., Zucconi, A., Malabarba, M.G., Disanza, A., Stradal, T., Cassata, G., Confalonieri, S., Hardin**, J.**, Soto, M., Grant, B., and Scita, G. (2009). Requirements for F-BAR proteins TOCA-1 and TOCA-2 in actin dynamics and membrane trafficking during C. elegans oocyte growth and embryonic epidermal morphogenesis. *PLoS Genetics*, **5(10):** e1000675.
48. Grana, T.M., Cox, E.A., Lynch, A.M., and Hardin, J. (2010). SAX-7/L1CAM and HMR-1/cadherin function redundantly in blastomere compaction and non-muscle myosin accumulation. *Dev. Biol.* **344**:731–744.
49. Kwiatkowski, A.V., Maiden, S.L., Pokutta, S., Choi, H.-J., Benjamin, J.M., Lynch, A.M., Nelson, W.J., Weis, W.I., and Hardin, J. (2010). In vitro and in vivo

reconstitution of the cadherin-catenin-actin complex from *Caenorhabditis elegans*. *PNAS* **107**:14591-14596.

50. Zaidel-Bar, R., Joyce, M.J., Lynch, A.M., Witte, K., Audhya, A., and Hardin, J. (2010). The F-BAR domain of SRGP-1 facilitates cell-cell adhesion during C. elegans morphogenesis. *J. Cell Biol.* **191**, 761-9.
51. Neukomm, L.J., Frei, A.P., Cabello, J., Kinchen, J.M., Zaidel-Bar, R., Ma, Z., Haney, L.B., Hardin, J., Ravichandran, K.S., Moreno, S., and Hengartner, M.O. (2011). Loss of the RhoGAP SRGP1 promotes the clearance of dead and injured cells in Caenorhabditis elegans. *Nature Cell Biol.* **13**,79-86.
52. Ikegami, R., Simokat, K., Zheng, H., Dixon, L., Garriga, G., Hardin, J. and Culotti, J. (2012). Semaphorin and Eph receptor signaling guide a series of cell movements for ventral enclosure in C. elegans. *Curr. Biol*. **22**:1–11.
53. Cox-Paulson, E., Walck-Shannon, E., Lynch, A., Yamashiro, S., Zaidel-Bar, R., Celeste C. Eno, C., Ono, S., and Hardin, J. (2012). Tropomodulin protects α-catenin-dependent junctional actin networks under stress during epithelial morphogenesis. *Curr. Biol* **22**:1500-1505.
54. Lynch, A.M., Grana, T., Cox-Paulson, E., Annabelle Couthier, A., Cameron, M., Chin-Sang, I., Pettitt, J., and Hardin, J. (2012). A genome-wide functional screen identifies MAGI-1 as an L1CAM-dependent stabilizer of apical junctions in *C. elegans. Curr. Biol.* **22***,* 1891–1899
55. Maiden, S.L., Harrison, N., Keegan, J., Cain, B., Lynch, A.M., Pettitt, J., and Hardin, J. (2013). Specific conserved C-terminal amino acids of Caenorhabditis elegans HMP-1/α-catenin modulate F-actin binding independently of vinculin. *J. Biol. Chem*. **288**:5694-706.
56. Choi, H.-J.*, Loveless, T.*, Lynch, A.M., Bang, I., Hardin, J[+], and Weis, W.I.[+]. A conserved phosphorylation switch controls the interaction between cadherin and β-catenin In vitro and In vivo. *Developmental Cell* **33**, 82–93. [*Co-first authors; [+]Co-senior authors]
57. Callaci, S., Morrison, K., Shao, X., Schuh, A.L., Wang, Y., Yates III, J.R., Hardin, J., and Audhya, A. (2015). Phosphoregulation of the *C. elegans* cadherin-catenin complex. *Biochemistry* **472**:339-52.
58. Choi, H.-J.*+, Loveless, T.*, Lynch, A.M., Bang, I., Hardin, J+, and Weis, W.I.+. A conserved phosphorylation switch controls the interaction between cadherin and β-catenin in vitro and in vivo. *Developmental Cell* **33**, 82–93. [*Co-first authors; +Corresponding authors]
59. Walck-Shannon, E., Reiner, D., and Hardin, J. (2015). Polarized Rac-dependent protrusions drive epithelial intercalation in the embryonic epidermis of C. elegans. *Development* **142**:3549-3560.
60. Walck-Shannon, E., Lucas, B., Chin-Sang, I., Reiner, D., Kumfer, K., Cochran, H., Bothfeld, W., and Hardin, J. (2016). CDC-42 orients cell migration during epithelial intercalation in the Caenorhabditis elegans epidermis. *PLOS Genetics* **12**: e1006415.
61. Kang, H., Bang, I., Jin, K.S., Lee, B., Lee, J., Shao, X., Heier, J.A., Kwiatkowski, A.V., Nelson, W.J., Hardin, J., Weis, W., and Choi, H.-J. (2017). Structural and functional characterization of Caenorhabditis elegans α-catenin reveals constitutive binding to β-catenin and actin. *J. Biol. Chem.* **29**, 7077-7086.
62. Shao, X. Kang, H., Loveless, T., Lee, G.R., , Seok, C., Weis, W.I., and Choi, H.-

J., and Hardin, J. (2017). Cell–cell adhesion in metazoans relies on evolutionarily conserved features of the α-catenin•β-catenin–binding interface. *J. Biol. Chem.* **292**,16477–16490.

63. Loveless, T., Qadota, H., Benian, GM., and Hardin, J. (2017). C. elegans SORB-1 localizes to integrin adhesion sites and is required for organization of sarcomeres and mitochondria in myocytes. *Mol. Bio. Cell* **28**:3621-3633.
64. Hardin, J. and Weliky, M. (2019). Cell rearrangement induced by filopodial tension accounts for the late phase of convergent extension in the sea urchin archenteron. *Mol. Biol. Cell* **30**:1911-1919.
65. Shao, X., Lucas, B.G., Strauch, J. and Hardin, J. (2019). The adhesion modulation domain of *C. elegans* α-catenin regulates actin binding during morphogenesis. *Mol. Biol. Cell* **30**:2115-2123.
66. Serre, J.M. and Hardin, J (2022). The Lamellipodin homologue MIG-10 is not essential for dorsal intercalation in the embryonic epidermis of the *C. elegans* embryo. *microPublication Biology*. https://doi.org/10.17912/micropub.biology.000522
67. Lynch, A.M.*, Zhu, Y.*, Lucas, B.G., Winkelman, J.D., Bai, K., Martin, S.C.T. , Samuel Block, S., Slabodnick, M.S., Audhya, A., Goldstein, B., Pettitt, J., Gardel, M.L., and Hardin, J.(2022)**.** TES-1/Tes and ZYX-1/Zyxin protect junctional actin networks under tension during epidermal morphogenesis in the C. elegans embryo. *Curr. Biol*. **32**, 5189–5199 (*= co-first authors).
68. Serre, J., Lucas, B., Martin, S.C.T., Shao, X., and Hardin, J. (2022). Slit-Robo GTPase Activating Protein-1 is a novel α-catenin M domain-binding protein that strengthens cadherin-dependent adhesion in the *Caenorhabditis elegans* embryo. *Development* **149** (18): dev200775
69. Serre, J.M. Mark M. Slabodnick, M.S., Goldstein, B. and Hardin, J. (2023). SRGP-1/srGAP and AFD-1/Afadin stabilize HMP-1/α-catenin at rosettes to seal internalization sites following gastrulation in *C. elegans. PLoS Genet.* 2023 Mar 3;19(3):e1010507. doi: 10.1371/journal.pgen.1010507
70. Martin, S.C.T., Qadota, H., Oberhauser, A.F., Hardin, J., and Benian, G.M. (2023). FARL-11 (STRIP1/2) is required for sarcomere and sarcoplasmic reticulum organization in *C. elegans*. *Mol. Biol. Cell* 34:ar86, 1–13, August 1, 2023.
71. Zhu, Y. and Hardin, J. (2023). TIAM-1 regulates polarized protrusions during dorsal intercalation in the *C. elegans* embryo through both its GEF and N-terminal domains. *J. Cell Sci.* **137**(5):jcs261509.
72. Le*, S., Yu*, M., Fu*, C., Heier, J.A., Martin, S., Hardin, J., and Yan, J. (2024). Single-molecule force spectroscopy reveals intra- and intermolecular interactions of *C. elegans* HMP-1 during mechanotransduction. *Proc. Nat. Acad. Sci. USA*, in press. (*= co-first authors)

Reviews

1. Keller, R. and Hardin, J. (1987). Cell behaviour during active cell rearrangement: evidence and speculations. In *J. Cell Sci.* **Supp. 8**, *Cell Behaviour: Shape, Adhesion, and Motility* (J. Heaysman, A. Middleton, and F. Watt, eds.), pp. 369-393. London, Company of Biologists Limited.

2. Hardin, J. (1990). Context-sensitive cell behaviors during gastrulation. *Sem. Dev. Biol.* **1**, 335-345.
3. McClay, D.R., Armstrong, N.A., and Hardin, J. (1992). Cell interactions regulating pattern formation in the sea urchin embryo. *Development* **1992 Suppl.**, 33-41.
4. Hardin, J. (1994). Local cell-cell interactions and the regulation of gastrulation. *Sem. Dev. Biol.* **5**, 77-84.
5. Hardin, J. (1995). Target recognition by mesenchyme cells in the sea urchin embryo. *Amer. Zool.* **35**, 358-371.
6. Hardin, J. (1996). The cellular basis of sea urchin gastrulation. *Curr. Top. Dev. Biol.* **33**, 159-262.
7. Thomas, C., DeVries, P., Hardin, J., and White, J. (1996). Four-dimensional imaging: computer visualization of 3D movements in living specimens. *Science* **273**, 603-607.
8. Hardin, J. (2000) A degrading way to make an organ. *Science* **288**, 2142-2143.
9. Simske, J.S., and Hardin, J. (2001). Getting into shape: epidermal morphogenesis in *Caenorhabditis elegans* embryos. *Bioessays*, **23**: 12-23.
10. Cox, E.A. and Hardin, J. (2004) Sticky worms: adhesion complexes in *C. elegans*. *J. Cell Sci.* **117**,1885-97.
11. Cox, E.A., Tuskey, C. and Hardin, J. (2004) Cell adhesion receptors in *C. elegans*. *J. Cell Sci.* **117**,1867-70.
12. Hardin, J. and Walston, T. (2004). Models of morphogenesis: the mechanisms and mechanics of cell rearrangement. *Curr. Opin. Genetics & Dev*. **14***,* 399-406.
13. Hardin, J. and Lockwood, C. (2004) Skin tight: cell adhesion in the epidermis of *Caenorhabditis elegans*. *Curr. Opin. Cell Biol*. **16**, 486-492.
14. Chisholm, A. and Hardin, J. (2005). Epidermal morphogenesis. In *WormBook*, ed. The *C. elegans* Research Community, http://www.wormbook.org
15. Walston, T. D., and Hardin, J. (2006). Wnt-dependent spindle polarization in the early C. elegans embryo. *Semin Cell Dev Biol* **17**, 204-13.
16. Yap, A., Crampton, M.S., and Hardin, J. (2007). Making and breaking contacts: the cellular biology of cadherin regulation. *Curr. Opin. Cell Biol.* **19**,1-7.
17. Hardin, J. (2008). To thine own self be true: self-fusion in single-celled tubes. *Dev Cell.* **14**, 465-6.
18. Hardin J, King RS. (2008). The long and the short of Wnt signaling in C. elegans. *Curr Opin Genet Dev.* **18**:362-7.
19. Lynch, A. and Hardin, J. (2009). The assembly of epithelial junctions in *C. elegans*. *Frontiers Biosci.***14**, 1414-1432.
20. Hardin, J. (2011). Mechanotransduction: Getting morphogenesis down Pat. *Curr. Biol.* **21**:R309-11.
21. Schramp, M. and Hardin, J (2011). Basement remodeling: making way for cellular invaders. *Curr. Biol.* **21**:R585-587.
22. Maiden, S.L. and Hardin, J. (2011). The secret life of α-catenin: moonlighting in morphogenesis. *J. Cell Biol.* **195**:543–552.
23. Loveless, T. and Hardin, J. (2012). Dynamic regulation of the cadherin-catenin complex in C. elegans. *Curr Opinion Cell Biol*. **24**:695-701.

24. Hardin, J. (2012). An MBoC Favorite: "Cytokinesis and midzone microtubule organization in Caenorhabditis elegans require the kinesin-like protein ZEN-4". Mol. Biol. Cell **23**:3025.
25. Walck-Shannon, E. and Hardin, J. (2014). Cell intercalation from top to bottom. *Nature Rev. Mol. Cell. Bio* **15**:34-48.
26. Hardin, J. (2015). Getting to the core of the cadherin complex in *C. elegans*. F1000Research 2015, 4(F1000 Faculty Rev):1473 (doi: 10.12688/f1000research.6866.1)
27. Hardin, J. (2016). Regulating cell-cell junctions from A to Z. *J. Cell Biol.* **213**, 151–153.
28. Walck-Shannon, E. and Hardin, J. (2016). Another morphogenetic movement on the map: Charting dorsal intercalation in C. elegans.. *Worm* **5**:2, e1176664.
29. Lucas, B. and Hardin, J. (2017). Mind the (sr)GAP – roles of Slit/Robo GAPs in neurons, brains, and beyond. *J. Cell Sci.* **130**: 3965-3974.
30. Hardin, J. (2024). Recovering FRAP for the masses: simple, free options for routine FRAP analysis. Invited review for *Mol. Biol. Cell*, in preparation.

Book chapters

1. McClay, D.R., Alliegro, M.C., and Hardin, J.D. (1989). Cell interactions as epigenetic signals in morphogenesis of the sea urchin embryo. *In* "The Cellular and Molecular Biology of Pattern Formation" (ed. D. Stocum). Oxford, Oxford University Press, pp70-87.
2. McClay, D.R., Coffman, J.C., and Hardin, J.D. (1989). Epigenetic signals at gastrulation in the sea urchin. *U.C.L.A. Symp. Mol. Cell. Biol*, **New Series, Vol. 25** (eds. E. Davidson, J. Ruderman, and J. Posakony). New York, Alan R. Liss, pp. 251-255.
3. McClay, D.R., Morrill, J., and Hardin, J. (1991). Archenteron morphogenesis in the sea urchin. In "Cell-Cell Interactions in Early Development" (J. Gerhart, ed.), New York, Alan R. Liss, pp. 15-29.
4. Hardin, J. (1994). The sea urchin embryo. In "Embryos: Color Atlas of Development" (J. Bard, ed.), pp. 37-53. London, Wolfe Publishing.
5. Weng, W., Cheetham , J., Hardin, J., and Venuti, J.M. (2000). A *twist* in sea urchin gastrulation and mesoderm specification. In: "Regulatory Processes in Development" (C.-O. Jacobson, L. Olson, eds) Wenner-Gren International Series, Vol. 76, pp. 153-158. Portland Press, London.
6. Hardin, J., Raich, W.B. and Simske, J.S. (2000). Morphogenesis at single-cell resolution: studying changes in the shape of the embryo in the tradition of Hörstadius. In: "Regulatory Processes in Development" (C.-O. Jacobson, L. Olson, eds) Wenner-Gren International Series, Vol. 76. Portland Press, London.
7. Hardin, J. (2006). Confocal and Multi-Photon Imaging of Living Embryos. In *Handbook of Biological Confocal Microscopy*, 3e (J. Pawley, ed.). New York: Plenum, pp. 746-768.
8. Sims, P., Albrecht, R., Pawley, J.B., Centonze, V., Deerink, T., and Hardin, J. (2006). When Light Microscope Resolution Is Not Enough: Correlational Light Microscope and Electron Microscope. In *Handbook of Biological Confocal Microscopy*, pp. 846-860.
9. Walston, T., and Hardin, J. (2011). Visualizing cell contacts and cell polarity in *Caenorhabditis elegans* embryos. In *Imaging in Developmental Biology: A Laboratory Manual* (J. Sharpe ad R.O. Wong, eds). Cold Spring Harbor, NY: Cold Spring Harbor Press, pp. 229-244.

10. Simske, J.S. and Hardin, J. (2011). Claudins in *C. elegans*. *Methods Mol. Biol*. **762**:147-69.
11. Hardin, J. (2011). Imaging embryonic morphogenesis in C. elegans. In: Joel H. Rothman and Andrew Singson, editors: *Methods In Cell Biology*, Vol 106, Oxford: Academic Press; 2011, p. 377-412.
12. Hardin, J., Lynch, A., Loveless, T., and Pettitt, J. (2013). Cadherins and their partners in the nematode worm Caenorhabditis elegans. In "The Molecular Biology of Cadherins" (ed. F. van Roy). *Prog Mol Biol Transl Sci.***116**:239-62.
13. Hardin, J., Serre, J., King, R., Walck-Shannon, E., and Reiner, D. (2021). Imaging epidermal cell rearrangement in the C. elegans embryo. *Methods Mol Biol* **2438**:345-376.

Protocols

1. Walston, T., Hardin, J., 2010. Laser killing of blastomeres in Caenorhabditis elegans. *Cold Spring Harb Protoc* 2010, pdb prot5543.
2. Walston, T., Hardin, J., 2010. Analysis of 4D DIC microscopic data to determine cell contacts in Caenorhabditis elegans embryos. *Cold Spring Harb Protoc* 2010, pdb prot5542.
3. Walston, T., Hardin, J., 2010. Acquisition of 4D DIC microscopic data to determine cell contacts in Caenorhabditis elegans embryos. *Cold Spring Harb Protoc* 2010, pdb prot5541.
4. Walston, T., Hardin, J., 2010. An agar mount for observation of Caenorhabditis elegans embryos. *Cold Spring Harb Protoc* 2010, pdb prot5540.

Books

1. Becker, W., Kleinsmith, L., and Hardin, J. (2000). *The World of the Cell*, 4th ed. San Francisco: Benjamin Cummings.
2. Becker, W., Kleinsmith, L., and Hardin, J. (2003). *The World of the Cell*, 5th ed. San Francisco: Benjamin Cummings.
3. Becker, W., Kleinsmith, L., and Hardin, J**.** (2005). *The World of the Cell*, 6th ed. San Francisco: Benjamin Cummings.
4. Becker, W., Kleinsmith, L., Hardin, J. **,** and Bertoni, G. (2008). *The World of the Cell,* 7th ed. San Francisco: Benjamin Cummings.
5. Hardin, J., Bertoni, G., and Kleinsmith, L. (2011). *The World of the Cell*, 8th ed. San Francisco: Pearson.
6. Hardin, J., Bertoni, G., and Kleinsmith, L. (2016). *The World of the Cell*, 9th ed. San Francisco: Pearson.
7. Hardin, J., Binzley, R., and Numbers, R., eds (2019). *The Idea That Wouldn't Die: The Warfare Between Science and Religion.* Johns Hopkins Univ. Press.
8. Hardin, J. and Lodolce, J. (2021). *The World of the Cell,* 10th ed. San Francisco: Pearson.

Funding History

Current Support

NIH

#R35GM145312-01

Dates: 04/01/22-03/31/27

Role: PI

Total costs: $ 2,778,480

University of Wisconsin-Madison
Wisconsin Alumni Research Foundation
Dates: 07/012017-06/30/2022
WARF Named Professorship Hardin (PI)
Total costs: $100,000

Department of INtegrqtive Biology
Dates: 07/01/2024-6/30/2026
Wayland Noland Distinguished Professor (PI):
Total costs: $60,000

Previous Support
NIH
#R01GM058038-17 Hardin (PI)
Dates: 01/01/18-11/31/22
Project Title: Tension-dependent regulation of α-catenin during morphogenesis in *C. elegans*
Total costs: $ 1,577,938

#R01GM127687-01
Project Title: Trio/CARMIL Regulation of Epithelial Cell Rearrangement
Dates: 05/01/2018-04/30/2022
Role: PI
Total costs: $1,076,448

John Templeton Foundation
Project Title: Comparing Deep Teleology in Embryos and Evolution
Dates: 6/1/16-5/31/19
Total costs: $217,000

NIH
R01 GM058038
Project Title: srGAP and the cadherin complex during morphogenesis in C. elegans
Dates: 3/1/13-2/28/17
Total costs: $1,456,500

#R21 HD072769
Project Title: Structure and regulation of beta-catenin during cell-cell adhesion
Dates: 4/01/12-3/31/15
Total costs: $405,795

NSF
#IOB 0518081
Project Title: Role of Tropomodulin during Epithelial Morphogenesis in *C. elegans*
Dates: 9/1/09-8/31/13
Total costs: $350,000

NIH
#R01 GM58038
Project Title: Mechanisms of Junctional Actin Recruitment in *C. elegans*.
Dates: 4/01/08-3/31/13
Total costs: $1,438,440

NIH
ARRA supplement to #R01 GM58038
Project Title: Mechanisms of Junctional Actin Recruitment in *C. elegans*.
Dates: 9/30/09-8/31/10
Total costs: $50,240.00

NSF
Project Title: Wnt-dependent Polarization during Cell Rearrangement in the *C. elegans* Embryo
Assignment number: #IOB 0518081
Dates: 9/1/04-8/31/09
Total costs: $ 390,000

NIH
Supplement to NIH grant #GM58038
Project Title: Development of 4D Imaging Software for Developmental Biologists
Dates: 4/1/05-3/31/07
Total direct costs: $100,000

NIH
#GM58038
Project Title: Regulation of Epithelial Junctions in *C. elegans*
Dates: 4/1/04-3/31/08
Total costs: $1,143,153

NSF
Project Title: Maternal Control of Epithelial Motility in the C. elegans Embryo
Assignment number: #IBN 0112803
Dates: 9/1/01-8/31/05
Total costs: $ 390,000

NIH
Assignment number: R01 GM58038
Dates: 8/1/98-7/31/03
Total costs: $560,000

NIH
Project Title: The Control of Epithelial Sheet Movement in *C. elegans*
Assignment number: R01 GM58038
Dates: 8/1/98-7/31/02
Total costs: $560,000

NSF
Project Title: Genetic Convergent Extensions in *C. elegans*
Assignment number: #IBN 98-08475
Dates: 7/1/98-6/30/01
Total costs: $ 360,000

NIH
Project Title: Mechanisms of Epithelial Cell Rearrangement
Assignment number: R01GM53739
Dates: 5/1/96-4/30/00
Total costs: $269,999

NSF
Project Title: High Quantum Efficiency Confocal Microscope Detector for Reviewing Living Cells (J. Pawley, PI)
Assignment number: #DBI 97-24515
Dates: 12/1/97-11/30/00
Total costs: $ 23,496

NSF
Project Title: Molecular Events During Target Recognition
Assignment number: #IBN 95-07151
Dates: 9/1/95-8/31/99
Total costs: $ 270,000

NSF
Young Investigator Award
Project Title: Cell Rearrangement during Gastrulation
Assignment Number: IBN-9357246
Dates: 9/1/93-8/31/99
Total costs: $250,000

NSF
Project Title: Target Recognition during Gastrulation
Assignment number: #DCB 92-06872
Dates: 8/1/92-7/31/96
Total costs: $270,000

Lucille P. Markey Scholar Award in the Biomedical Sciences
Project title: Molecular mechanisms of epithelial morphogenesis in *C. elegans*
Dates: 7/1/90-6/30/97
Total direct costs (FY 1996-97) $75500

American Cancer Society Institutional Award, 1992

Training

Previous Pre and Postdoctoral Trainees

Trainees	**Dates**	**Previous position/degree**	**Position/ Degree obtained**	**Title of project**	**Subsequent position(s)**
Cheetham, Jan	1992-1994	Ph.D., UW-Madison	postdoc	Molecular mechanisms of mesenchyme specification in the sea urchin embryo	Information Consultant Center for Biology Education UW-Madison
Malik, Amy	1994-1995	B.S., Univ. of Michigan	MS (Zoology)	Cellular mechanisms of ventral enclosure in *C. elegans*	Pulmonologist, Univ. of Wisconsin-Madison
Williams-Masson, Ellen	1992-1996	B.S., North Carolina State. Univ.	PhD (CMB)	Cellular mechanisms of dorsal intercalation and ventral enclosure in *C. elegans*	
Raich, Bill	1993-1999	B.S., Swarthmore College	Ph.D. (CMB)	Molecular mechanisms of ventral enclosure in *C. elegans*	Postdoc with Eric Kandel, Columbia; Partner, Finnegan patent law firm
Heid, Paul	1996-1999	B.S. Univ. of Iowa	PhD (Biochem.)	Role of the transcription factor, DIE-1, in dorsal intercalation in the *C. elegans* embryo	D. Pharm., Univ. of Iowa
Hirsch, Rebecca	1998-1999	PhD, UW-Madison	postdoc	Role of twist in sea urchin development	
Kimberly, Elizabeth	1992-1999	B.S., Williams College	Ph.D. (CMB)	Mechanisms of archenteron morphogenesis in the sea urchin embryo	
Köppen, Matthias	1996-2001	B.S. (equivalent), Univ. of Bonn	Ph.D. (CMB)	Molecular investigation of the DLG-1/AJM-1 complex in the *C. elegans* embryo	Boehringer Ingelheilm, Ulm, Germany

Lindblom, Tim	2000-2001		postdoc	Role if APR-1/APC in the *C. elegans* embryo	Dean, College of Science and Mathematics, Jacksonville State Univ.
Simske, Jeff	1996-2001	PhD, Stanford Univ.	postdoc	Molecular mechanisms of VAB-9 function in the *C. elegans* embryo	Associate Professor Ramelkamp Center, Case Western U.
Thomas, Christina (Virnig)	1999-2003	B.S., North Carolina State Univ.	Ph.D. (Biomolecular Chem)	Role of the IP3 receptor, ITR-1, during morphogenesis in *C. elegans*	Senior Scientist, Stratatech Corp.; Path & Lab Medicine UW - Madison
Simokat, Kristin	1997-2005	B.S., Wesleyan Univ.	PhD (CMB)	Cellular mechanisms underlying neuroblast organization in the *C. elegans* embryo	Adjunct Professor, Ashland Univ.
Cox-Paulson, Elizabeth	2001-2006	PhD, Univ. of Illinois	postdocc	Using genomics to screen for interactions with the cadherin complex in *C. elegans*	Former Assistant Professor, SUNY Geneseo
Walson, Tim	2001-2006	M.S., Univ. of Wisconsin-Lacrosse	PhD (Genetics)	The role of Dishevelleds during morphogenesis in *C. elegans*	Dean of Science and Mathematics and Professor of Biology Truman State Univ.
Sheffield, Mark	1999-2007	B.S., Kansas State Univ.	PhD (Genetics)	The role of unc-34/Ena during morphogenesis in *C. elegans*	Scientist Covance, Inc.
Tuskey (Lockwood), Tina	2002-2007	B.S., Univ. of North Carolina	PhD (CMB)	The role of ZOO-1/ZO-1 during morphogenesis in *C. elegans*	Associate Professor, Clinical Chemistry, Univ. of Washington
Lockwood, Chris	2001-2007	B.S., Western Washington Univ.	PhD (Genetics)	Molecular analysis of DLG-1 function in the *C. elegans* embryo	Postdoctoral fellow, Biology, Washington Univ.; Staff scientist, Monsanto Corp.
Grana, Theresa	2004-2008	PhD, Univ. of North Carolina	postdoc	The role of AFD-1/AF-6 in the *C. elegans* embryo	Associate Professor, Mary Washington Univ.

King, Ryan	2003-2008	B.S., UW-Madison	PhD (CMB)	The cellular and molecular mechanisms of pattern formation in the epidermis of *C. elegans*	Assistant Professor, St. Norbert College, Depere, WI
Ronen Zaidel-Bar	2006-2010	PhD, Weizmann Institute NIH fellowship	postdoc	Role of srGAP during morphogenesis in *C. elegans*	Professor, Sackler Faculty of Medicine, Tel Aviv University
Erica Hall	Dec. 2008-2010	B.S., Univ. of Georgia	M.S. (Biophysics)	Structural evolution of β-catenins in *C. elegans*	
Allison Lynch	2005-2012	B.S., Univ. of Pittsburgh	PhD (Genetics)	The role of MAGI-1 in cadherin-based adhesion in *C. elegans*	Program Administrator, Biophysics Graduate Program, Univ. of Wisconsin
Maiden, Stephanie	2005-2012	B.S., Univ. Of Missouri-Rolla	PhD (Mol. Cell. Pharm)	Structure-function analysis of a-catenin in the *C. elegans* embryo	Assistant Professor, Truman State Univ.
Mark Schramp	2011-2012	PhD, Univ. of California-Berkeley	postdoc	The role of Tes in vulval morphogenesis	Assistant Professor, Benedictine College, Atchison, KS
Lopez, Mary	2012-2014	B.S., Univ of Hawaii	Ph.D. (Cellular and Molecular Pathology)	Role of p120ctn in cell-cell adhesion	Ph.D. (Cellular and Molecular Pathology)
Loveless, Tim	2006-2014	B.S., Univ. of Montana	PhD (CMB)	Conserved residues in beta-catenin that regulate cell-cell adhesion	
Walck-Shannon, Elise	2010-Present	Truman State University	PhD (Genetics)	Mechanisms of epidermal cell rearrangement in the *C. elegans* embryo	Postdoctoral Fellow, Biocore Program, Univ, of Wisconsin-Madison
Boateng, Lindsy	2015-2016	Ph.D., Univ. of Wisconsin	Postdoctoral fellow	Cellular mechanisms of ventral enclosure	Assistant Professor, Dept. of Sciences and Mathematics, Newberry College, Newberry, SC
Lucas, Bethany	2010-2017	B.S., Univ. of Kansas	Ph.D. (Genetics)	srGAP and epithelial morphogenesis	Asst. Professor, Regis Univ.

Shao, Xianqiang	2011-2017	M.S., Shanghai Institute for Biological Sciences	Ph.D. (Genetics)	Molecular mechanisms of α-catenin function	Microbiologist/Clinical Molecular Genetics Researcher, Wisconsin State Lab Hygiene
Hegsted, Anna	2018-2020	Ph.D., SUNY Upstate	postdoc	Role of CRML-1/CARMIL in cell rearrangement	Lecturer, College of Southern Idaho
Bundus, Joanna	2018-2021	Ph.D., University of Toronto	postdoc	Evolution of β-catenin	Vice President for Research, Xylome Corp., Madison, WI
Martin, Sterling C.T. (Blake)	2014-2022	B.S., Univ. of Iowa	Ph.D. (Biophysics)	The role of FARL-11 during epithelial morphogenesis	Postdoctoral fellow Washington University in St. Louis
Serre, Joel	2014-2022	B.S., Kent State Univ.	Ph.D. (Genetics)	The role of Trio and CARMIL in embryonic morphogenesis	Scientist, Bayer Corp., St. Louis, MO
Zhu, Yuyun	2017-present	B.S., Shanghai Jiao Tong Univ	Ph.D. (Genetics)	Role of Tiam1 in cell rearrangement	Associate, McKinsey and Co., San Francisco

Current pre- and postdoctoral trainees

Trainees	**Training Period**	**Previous position/degree**	**Position/ Degree sought**	**Title of project**	**Support**
Heier, Jon	2021-present	Ph.D., University of Pittsburgh	postdoc	Role of Flightless and FLAP-1 in cadherin-dependent morphogenesis	PI's funding
Tesone, Zoe	2021-present	B.S., Ursinus College	Ph.D. (Cellular and Molecular Biology)	Transcriptional regulation of cell intercalation in the *C. elegans* embryo	PI's funding
Adelle Markle	2023-present	B.S., Maranatha Baptist Univ.	Ph.D. (Cellular and Molecular Biology)	Role of FLI-1/Flightless during embryonic morphogenesis	PI's funding
Kally Arnzen	2023-present	B.S. Univ. of Idaho	M.S. (Integrative Biology)	Regulation of cell rearrangement by PCP homologues in *C. elegans*	PI's funding

Undergraduates research students supervised (recent)

Trainees	Training Period	Title of project	Support
Faith Petersen	2023-2024	Role of VAB-9 in morphogenesis	Independent Study
Jared Strauch	2014-2016	Role of FARL-11 in morphogenesis	PI's funding
Hunter Cochran	2015-2016	Role of Cdc42 in cell rearrangement	Independent study
Austin Walsh	2013-2014	Role of subdomains of HMP-2 /β-catenin in morphogenesis	Independent study
Trevor Ho	2012-present	Spectrins and tropomodulin during morphogenesis	Independent study
Jack Keegan	2009-2011	Genetics interactions of the srgp-1/srGAP during *C. elegans* morphogenesis	Independent study
Brian Cain	2008-2010	Sequencing alleles of hmp-1/α-catenin	PI's funding

Teaching Experience and Awards

Courses taught

1992-present — Instructor, Zoology 470, Introduction to Animal Development, Zoology (now Integrative Biology) Department, University of Wisconsin-Madison
2002-present — Instructor, Biocore 303 (now 383), Biology Core Curriculum, University of Wisconsin-Madison
2013 — Zoology 400 — Issues in Science and Religion
2012 – Chemistry 872 – Biophysics seminar
2001 — Instructor, Zoology 965, Seminar in Developmental Biology, University of Wisconsin
1993-2001 — Instructor, Biocore 333, Biology Core Curriculum, University of Wisconsin-Madison
1994 -1996 — Instructor, ILS 150, Ways of Knowing, University of Wisconsin-Madison
1993-1998 — Instructor, Zoology 650, Advanced Developmental Biology
1992-1993 — Co-instructor, Developmental Biology Laboratory, University of Wisconsin
1990—Teaching assistant, Embryology Course, Marine Biological Laboratory, Woods Hole
1983-1986—Teaching assistant in general biology, Biology Department, University of California, Berkeley
1985—Teaching assistant in general chemistry, Chemistry Department, University of California, Berkeley

Teaching Awards/Honors

2011 – Chancellor's Distinguished Teaching Award, UW-Madison
2009 - University Housing Honored Instructor's Award
2007 – Favorite Instructor Award, UW-Madison Residence Halls
2006-present – DELTA program Teaching Fellows mentor (via Biocore)
2006 – Favorite Instructor Award, UW-Madison Panhellenic Council
1998 — Presenter, Project Kaleidoscope symposium, UW-System Biology team
1997-present — Co-chair, University of Wisconsin System Worldwide Web Biology Initiative (ZooWeb)
1995-1997 — Co-chair, Instructional Technology Task Force, Teaching Academy, University of Wisconsin
1994-1997 — Executive Committee, Teaching Academy, University of Wisconsin

1994 — Founding Fellow, Teaching Academy, University of Wisconsin
1994-present — Honors Fellow, College of Letters and Science, University of Wisconsin-Madison
1993-1994 - Division of Instructional Technology "Eagle", Teaching Academy Fellow
1993—Lilly Teaching Fellow, University of Wisconsin; National Science Foundation Young Investigator
1992-99 — NSF Young Investigator Award

Teaching Service
2012-14 – Teaching Awards Selection Committee, UW-Madison
2008 – Guest editor, *CBE: Life Science Education*, special issue on developmental biology
2005-2008 - Chair, Institute for Cross-College Biology Education Steering Committee
2004-2005 – Provost's Task Force on Cross-College Biology Education (Sussman Committee)
2002-present – Editorial Board, *CBE: Life Science Education*, 2002-present;
1999-2005 – Biology Major Steering Committee
1997-1999 — Steering Committee, Biology New Media Center
1997-1998 — Lilly Fellows selection committee
1995-1998 - University Instructional Technology Committee
1999-2000 - Biostar 4 (Cell, Developmental, Neurobiology Building) proposal committee

Teaching Outreach/Presentations
2010 –Invited speaker, Education session speaker, Northwest Regional Developmental Biology Meetings, Friday Harbor, WA; presentation on fluorescence microscopy in Physics 208 honors seminar
2009 – Interview on "Office Hours" (Big Ten Network television show), "Darwin at 200"; Invited speaker, Education session speaker, Midwest Regional Developmental Biology Meetings, Iowa City, IA
2008 – Presenter at "Evolution in the 21st Century" Symposium, Biopharmaceutical Technology Center, Promega Corp.
2007 – UW Center for Humanities panel discussion on Teaching and Evolution
2006 - Panelist, Darwin Day outreach, UW-Madison; UW-Isthmus Society event on Evolution, UW-Madison; Moderator, Isthmus Society event on stem cell research, UW-Madison
2005 – Workshop organizer, "Biology in the 21st Century", UW Teaching and Learning Symposium

Teaching Materials Produced and Distributed
1996 – present — Dynamics of Development web tutorials:
(**https://worms.zoology.wisc.edu/embryo_main/embryology_main.html**)
Version 2.0: **(https://worms.zoology.wisc.edu/dd2/**)
The Dynamics of Development materials have been used by educators around the world to teach fundamental dynamic concepts in developmental biology. The materials have been used in Eastern Europe, Southeast Asia, throughout North America and Western Europe.
2019 — Contributed figures to Barresi and Gilbert, *Developmental Biology, 12e* (Sinauer)
2016 — Contributed figures to Gilbert and Barresi, *Developmental Biology, 11e* (Sinauer)
2013 — Contributed figures to Scott Gilbert, *Developmental Biology, 10e* (Sinauer)
2010 — Contributed figures to Scott Gilbert, *Developmental Biology, 9e* (Sinauer)

2007 — Contributed figures to Scott Gilbert, *Developmental Biology, 8e* (Sinauer)
2002 — Contributed figures to Fred Wilt, *Principles of Developmental Biology* (W.W. Norton & Company)
2002—Contributed movie to Alberts et al. *Essential Cell Biology Interactive* (Garland Publishing, forthcoming)
1999 — Contributed movie to Alberts et al. *Essential Cell Biology Interactive*(Garland Publishing)
2001 — Contributed figures to Klaus Kalthoff, *Analysis of Biological Development* (McGraw-Hill)
1997 — Contributed figures to Scott Gilbert, *Developmental Biology, 5e* (Sinauer)
1996 — Contributed figures to Klaus Kalthoff, *Analysis of Biological Development* (McGraw-Hill)
1995 — Contributed figures to Leland Johnson, *Patterns and Experiments in Developmental Biology*, 2e (Wm. C. Brown)

Teaching publications
Articles
Savage, M.P., Fallon, J.F., and Hardin, J. (2003). Gilbert's seventh hits all the right notes: A synthesis for everyone. *Dev. Dyn.* 227, 615–616.

Savage, M.P., Fallon, J.F., and Hardin, J. (2003). Teaching the essential principles of development. *Bioessays* 25,301–302.

Hardin J. (2008). Focus: issues in developmental biology education.
CBE Life Sci Educ. 7:1-2.

Hardin, J. (2008). The missing dimension in developmental biology education. CBE Life Sci Educ. 7:13-6.

Teaching grants
2007 – Engage Podcast Award, UW-Madison Division of Information Technology
2005 – Engage Adaptation Award (online quiz development), UW-Madison Division of Information Technology

Training of scientist/educators
Trainees who are currently engaged in academic education

Trainees	**Dates**	**Previous position/degree**	**Position/ Degree obtained**	**Current position**
Cheetham, Jan	1992-1994	Ph.D., UW-Madison	postdoc	T4 program Division of Information Technology UW-Madison
Lindblom, Tim	2000-2001	Ph.D., Univ, of Georgia	postdoc	Dean, College of Science and Mathematics, Jacksonville State University (Alabama)
Simokat, Kristin	1997-2005	B.S., Wesleyan Univ.	PhD (CMB)	Adjunct Professor, Ashland Univ.
Cox, Elizabeth	2001-2006	PhD, Univ. of Illinois	postdocc	Assistant Professor, SUNY Geneseo

Walson, Tim	2001-2006	M.S., Univ. of Wisconsin-Lacrosse	PhD (Genetics)	Professor and Dean of Science and Mathematics, Truman State Univ.
Grana, Theresa	2004-2008	PhD, Univ. of North Carolina	postdoc	Associate Professor, Mary Washington Univ.
Schramp, Mark	2011-2012	Ph.D., Univ. of California-Berkeley	postdoc	Associate Professor, Benedictine Univ., Atchison, KS
Maiden, Stephanie	2005-2012	B.S., Univ. Of Missouri-Rolla	PhD (Mol. Cell. Pharm)	Associate Professor, Truman State Univ.
King, Ryan	2003-2008	B.S., UW-Madison	PhD (CMB)	Assistant Professor, St. Norbert College
Boateng, Lindsy	2015-2016	Ph.D., Univ. of Wisconsin-Madison	postdoc	Assistant Professor, Newberry College, Newberry, SC
Hegsted, Anna	2018-2020	Ph.D, SUNY Upstate	postdoc	Lecturer, College of Southern Idaho

Service Activities (selected recent)

Departmental service

2008-present – Chair, Department of Zoology (now Integrative Biology)
2002-2020 – Faculty Director, Biology Core Curriculum
1997 – present — Zoology Instructional Program Committee
2001, 2005, 2007 — Associate Chair, Cell and Developmental Biology subgroup

Campus service

2023 – President, Phi Beta Kappa alpha chapter
2022 – Vice President, Phi Beta Kappa alpha chapter
2021-2022 - Internal Biocore campus review; L&S Biology task force on creation of a unified L&S Biology entity;
2021-pesent - Steering Committee, Biocore; Astrobiology Cluster Hire Committee.
2020-2021 – Interim Chair, Molecular and Cellular Biology major
2019 – Phi Beta Kappa alpha chapter selection committee
2018-19 – Sophomore Research fellowship review committee
2014 – Search and screen committee, Chair of Genetics
2013 – Chair, Search and screen committee, Dean of Letters & Science, UW-Madison
2012-13 – Ad hoc task force on restructuring of the Biology Major
2012-13 – Teaching Awards Selection Committee, UW-Madison
1993-present - Academic advisor, Biology, Molecular Biology, and Zoology majors
2010 – Introductory Biology Memorandum of Understanding task force
2009 – External reviewer, Dept. of Communicative Disorders review
2008 – Phi Beta Kappa selection committee
2006-present – College of Letters & Science Facilities Planning Committee
2005-2008 - Chair, Institute for Cross-College Biology Education Steering Committee;
2001-2005 - University Academic Planning Committee
2005 - Genetics Graduate Program Admission Committee
2004-2005 – Provost's Task Force on Cross-College Biology Education

1999-2005 – Biology Major Steering Committee
1997-2002 — Organizer, joint *C. elegans* group meetings, University of Wisconsin-Madison
2001 – 2004 — Chair, Developmental Biology focus group, Cellular & Molecular Biology program
1999-2000 - Biostar 4 (Cell, Developmental, Neurobiology Building) proposal committee
1997-1999 — Steering Committee, Biology New Media Center
1997-1998 — Lilly Fellows selection committee
1995-1998 - University Instructional Technology Committee

National/International Service (recent)
Reviewer for *Cell, Nature, Nature Cell Biology, Science, PNAS, Developmental Cell, Development, Developmental Biology, Current Biology, Developmental Dynamics, Mechanisms of Development, Trends in Genetics, Trends in Cell Biology, Journal of Cell Science, PLoS Genetics, Nature Reviews Molecular & Cellular Biology*
2017, External review of Department of Genetics, Cell and Developmental Biology, Univ. of Minnesota;
2015, External review of Department of Cell and Systems Biology, Univ. of Toronto;
2007 - Invited co-chair, Amer. Soc. for Cell Bio. National meetings, minisymposium on cell migration;
2006 - Review committee, postdoctoral awards, Amer. Soc. for Cell Biology; Co-organizer, C. elegans Development & Evolution Meetings
2002 — Consultant, State of Kansas COBRE proposal (NIH)
2002 — Local organizing committee, Society for Developmental Biology National Meeting, Madison, WI

Grant Review Panels
F05 Q Cell Bio., Dev. Bio., and Bioengineering Study section, Nov. 2023; NASA Artemis II model organism program, January 2023
DEV1 Study section, NIH, Feb. 2021; Chair, ZRG CB-Z (02), NIH, July 2020;
ZRG1 CB-D (02), NIH, Oct. 2019; Chair, ZRG1 CB-T(55), NIH, May 2019;
Reviewer, Israeli Science Foundation, 2019;
John Templeton Foundation ad hoc reviewer, 2016-present;
DEV1 Study section, NIH, Nov. 2017;
SEP, Developmental Biology R15 awards, NIH, Spring 2016, Summer 2016;
ZRG1 CB-G (02) SEP, 2015;
SEP, ZRG1 CB-D (02), NIH, Spring 2015;
SEP, Developmental Biology R15 awards, NIH, Spring 2013;
SEP, Developmental Biology R15 awards, NIH, Fall 2011; CB-P (55) study section, NIH, 2011; NIH, ICI Study section, 2007-2010; NIH, DEV-2 Study section, 2004-5; NIH, MDCN1 Study Section, 2003-05; NIH, CDF-5 Study Section, 2000; NSF, Biocomplexity Panel, 2000; NSF, Animal Developmental Mechanisms Panel, 1995-98, 2005; NIH, HED-2 Study Section, 1998

Editorial Boards
Molecular Biology of the Cell, 2012-present; *CBE: Life Science Education*, 2002-present; *Organogenesis*, 2004-present; *Developmental Dynamics*, 2003-2016

Science Outreach
2009 – Interview on “Office Hours” (Big Ten Network television show), “Darwin at 200”

2008 – Presenter at "Evolution in the 21st Century" Symposium, Biopharmaceutical Technology Center, Promega Corp.
2007 – UW Center for Humanities panel discussion on Teaching and Evolution
2006 - Panelist, Darwin Day outreach, UW-Madison; UW-Isthmus Society event on Evolution, UW-Madison; Moderator, Isthmus Society event on stem cell research, UW-Madison

Religious Studies Activities/Service (selected)
Affiliate, UW-Madison Religious Studies Program 1996-present;
Advisor, Science for Seminaries, Dialogue on Science, Ethics, and Religion (AAAS; advising Trinity Evangelical Divinity School), 2021 - 2023; Advisor, Bush Center, Southeastern Baptist Theological Seminary Science for the Church Advisory Committee, 2019-present
Chair, Board of Directors, BioLogos Foundation, 2014-2020; Board of Directors, BioLogos Foundation, 2013-2023;
Templeton Prize nominator, John Templeton Foundation, 2020-2021;
Purposive Processes in Nature Advisory Committee, John Templeton Foundation, 2019-present;
AAAS/DoSER Advisory Committee, "Engaging Scientists in the Science and Religion Dialogue", 2017-2019
2009-present – Webmaster, UW-Madison Faculty/Staff Fellowship
Chair, Evolution and Christian Faith grant program, BioLogos Foundation, 2012-2018;
Co-organizer, May, 2015, "The Idea that Wouldn't Die": The Warfare between Science and Religion conference, Madison, Wisconsin**;**
Int'l Advisory Board, John Templeton Foundation, 2012-2014; Presenter, Philosophy division, John Templeton Foundation International Advisory Board meetings, 2012;
Ad hoc grant reviewer, John Templeton Foundation, 2010-present;
Faculty Advisor, InterVarsity Science Integration Group, UW-Madison, 2000-present; Co-Director, Isthmus Society, UW-Madison, 2005-present;
Steering Committee, Lubar Institute for the Study of Abrahamic Religions, 2004-2014;
Member, Religious Studies program, UW-Madison, 1996-present;
RS Program Steering Committee 1998-2003;
Faculty advisor, InterVarsity Graduate Christian Fellowship, UW-Madison, 2003-present;
National advisory board, InterVarsity Christian Fellowship National Faculty Ministry, 2005-present;
Elder, Blackhawk Evangelical Free Church, 2000-2003; Elder, Geneva Campus Church, 2011-2016;
UW faculty ministry Steering Committee, 2002-2015, 2020-preent

Religious Studies Related Talks/Presentations (recent selected)
2024 - Faculty Theological Collaborative, Duke Univ.; Global Genome Observatory for Genome editing (March, September); Association of Christian Biologists

2023 - Faraday Institute, Cambridge Univ., Summer Course; Southeastern Baptist Theological Seminary, Science/faith dialogue program; Faraday Institute Summer Course invited speaker; Christian scholarship in the public university, Bradley Center, Virginia Tech University

2022 –Panelist, John Templeton Foundation Program, Southeastern Baptist Theological Seminary; John Stott award lecturer, City Reformed Church; Keynote lecturer, Christian Study Center Association, Upper House, Madison, WI

2021 – Keynote speaker, book launch for *Wonders of the Living World* (Lion), Faraday Institute, Cambridge University; Keynote speaker, Conference on Faith and Science, Arizona State University; Upper House, Madison, WI, Faculty group; Invited participant, Dabar Conference, Trinity Evangelical Divinity School; Invited Speaker, Church of the Savior, Philadelphia, PA; Invited Speaker, Resurrection Church, Philadelphia, PA

2020 – Keynote speaker, Veritas Forum, Arizona State Univ., "Beyond Human: Genome Editing and Ethics"; Keynote speaker, Conference on Faith and Science, Grand Canyon University

2019 – Science for Seminaries event, Southeastern Baptist Theological Seminary, Wake Forest, NC, "Genome Editing and the Christian" and "Fearfully and Wonderfully Made: Embryos and Ethics"; Pastor-Theologian Conference, Oak park, IL, "Fearfully and Wonderfully Made: Embryos and Ethics"; Sinai and Synapses, New York, NY, Genetic Ethics: Religious Perspectives; Pastor theologian; Plenary speaker, BioLogos National Conference, "Fearfully and Wonderfully Made: Embryos and Ethics"; Warfare event; Cru talk; Plenary Speaker, Common Call Conference, Clemson Univ.; Badger Cru, UW-Madison, "Intersection of Science and Faith"

2018 – Anselm House, Anderson Memorial Lecture, Genome Editing and the Christian; Anselm House, Faculty Roundtable on Genome Editing; Wheaton; ASA; Upper House, "Genome Editing and the Christian"; Interview, Elaine Howard Ecklund, Religion and Science in Public Life, Rice University; Plenary Speaker, Dabar Conference, Trinity Evangelical Divinity School, Adam, Augustine, and Modern Science; Workshop on Purposive Processes in Biology, John Templeton Foundation, Chicago, IL; Plenary Speaker, Common Call, Madison, WI;

2017 – Veritas Forum moderator, UW-Madison; Keynote Speaker, Blackhawk Church Science and Faith Seminar; Moderator, BioLogos National Conference, Grand Rapids, MI; Invited Speaker, Wheaton College; Genome Editing and the Christian, American Scientific Affiliation, Naperville, IL; invited speaker, InterVarsity Graduate Christian Fellowship, UW-Madison; Perspectives on Evolution and Christian Faith – Legacy Christian School, Minneapolis, MN

2016 – Plenary Speaker, Dabar Conference, Trinity Evangelical Divinity School, Deerfield, IL; Faraday Institute, Biology and Belief Short Course; Upper House, Madison, WI; Scientists in Congregations talk, St. Andrew's Presbyterian Church, Houston, TX; Plenary speaker, Common Call Conference, Minneapolis MN

2015 – Participant, Let the Conversation Evolve (BioLogos dialogue event), Univ, of Wisconsin-Madison; "The New Atheists" ("The Idea that Wouldn't Die": The Warfare between Science and Religion conference, Madison, Wisconsin)**;** Moderator, Science and Faith seminar, Upper House, Madison, WI;

2014 – Plenary speaker, Faith Angle Forum Conference on Religion, Politics & Public Life, South Beach, Florida; Chair of session, Celebrating Creation conference (BioLogos

Foundation, New York City); Co-organizer, and Session Chair, Evolution and Christian Faith summer workshop, Oxford Univ.

2013 – Presenter, Science and Faith seminar, Blackhawk Church

Religious Studies Related Publications

Featured/interviewed in Bancewicz, R. *Wonders of the Living World: Curiosity, Awe, and the Meaning of Life*. London: Lion/Hudson, 2021.

Advisor for Bryant, S., Henderson, L. and Marshall, S. *God Made Animals. London:* Faraday Kids/Lion-Hudson, 2020.

Contributor, "Is Beauty in Nature Important?" *101 Great Big Questions about God and Science*. London: Faraday Kids/ Lion Hudson IP Ltd., 2020.

Hardin, J., Binzley, R., and Numbers, R., eds (2019). *The Idea That Wouldn't Die: The Warfare Between Science and Religion.* Johns Hopkins Univ. Press.

Numbers, R. and Hardin, J., "The New Atheists". In Hardin, J., Binzley, R., and Numbers, R., eds (2019). *The Idea That Wouldn't Die: The Warfare Between Science and Religion.* Johns Hopkins Univ. Press, pp. 220-238.

Interviewed/featured in Bancewicz, R. *God in the Lab: How Science Enhances Faith.* London: Lion/Hudson, 2015.

Hardin, J. "Embracing the Lord of Life", In Applegate, K. and Stump, J.B., *How I Changed My Mind about Evolution*. Downers Grove, IL: InterVarsity Press, 2016, pp. 54-61.

Hardin, J. (2001). What Is the Perspective from Bioscience? Proceedings from "Asking the Right Questions: Christian Faith and the Choice of Research Topic in the Natural and Applied Sciences". *Perspectives on Science and Chrsitian Faith* **53**: 248-257.