

ELAINE C. SEAVER, Ph.D.

Professor of Biology



My research interests are in the areas of developmental biology, evolution of development, and regeneration. I have been trained in the fields of molecular biology, developmental neurobiology and embryology.

I am broadly interested in the cellular and molecular control of patterning during development and regeneration. Many of our studies have utilized marine annelids, which exhibit a highly stereotypic early developmental program and have robust regenerative abilities. My lab has pioneered the use of the annelid *Capitella teleta* as a model for development and regeneration studies. We have established several cellular, molecular and imaging techniques for this animal including microinjection, laser deletion, and functional genomic manipulations. We have successfully applied functional genomic methods to our studies of early development including morpholino knockdown and CRISPR/Cas mutagenesis. I am an expert in animal husbandry of *C. teleta*, and have optimized conditions to maximize reproduction output. I was instrumental in getting a completely sequenced and annotated genome for *Capitella* by the Joint Genome Institute, which has facilitated our molecular investigations of the development and regeneration of this species. Our current focal areas include evolution of cell lineages, body axes patterning, regeneration and investigations of the relationship between somatic and germline stem cell lineages. Our long term goals are to understand how developmental programs evolve and how changes in developmental programs lead to diversity in animals.

Education:

1995 Ph.D. in Biology, University of Utah
1986 B.S. in Biology, McGill University

Professional Experience:

2012-Present Professor, Whitney Laboratory for Marine Bioscience, University of Florida
2014-Present Member, University of Florida Genetics Institute
2013-Present Graduate Faculty, Department of Biology, University of Florida
2012 Professor, Kewalo Marine Laboratory, University of Hawaii
2007-2012 Associate Professor, Kewalo Marine Laboratory, University of Hawaii
2003-2012 Graduate Faculty, Department of Zoology, University of Hawaii
2002-2007 Assistant Professor, Kewalo Marine Laboratory, University of Hawaii
2001-2002 Junior Researcher, Kewalo Marine Laboratory, University of Hawaii
1988-1989 Graduate Teaching Fellow, Department of Biology, University of Utah
1986-1987 Laboratory technician, Cornell University (Dr. Thomas Fox)
1985 Research assistant, Cornell University (with Dr. Thomas Fox)

Research Interests:

- Early embryogenesis in the spiralian embryo
- Evolution of identified cells
- Regeneration
- Neurogenesis
- Germline development and evolution
- Life history evolution
- Evolution of segmentation
- Comparative development
- Tissue patterning

Membership in Professional Societies:

- Society for Invertebrate Morphology
- Society for Integrative and Comparative Biology
- Society for Developmental Biology
- American Association of University Women

Honors:

- National Research Service Award 1F32GM19257-01, “Determinants of annelid segmental patterning”, 1997-2000
- Evelyn and Melvin Spiegel Endowed Fellow, 1998
- Post course Research Award, Marine Biological Laboratory, Woods Hole, Mass. NASA Center for Advanced Studies in the Space Life Sciences, 1997
- Society for Developmental Biology Scholarship, Marine Biological Laboratory, Woods Hole, Mass., 1997
- National Institute of Health, Genetics Training Grant, University of Utah, 1990–1994

National /International Professional Service (since 2010):

- Member, Department of Biology Advisory Committee, 2019–present
- Graduate student liason, Whitney laboratory for Marine Bioscience, 2022–present
- Associate Editor, *Frontiers in Ecology and Evolution*, 2022–present
- Editorial Board Member, *EvoDevo*, 2010–present
- Editorial Board, *BMC Evolutionary Biology*, 2017–present
- Ad Hoc reviewer, Natural Sciences and Engineering Research Council of Canada (NSERC), 2023
- Invited talk, Broadening participation in STEM: lessons learned at a marine laboratory. Conference on Developmental Biology of the Sea Urchin and Other Marine Invertebrates, 2022.
- Editorial Board, *JEZ Part B*, 2012–2021
- Coastal Ecosystems module in immersion course Biome Biodiversity, 2022
- External examiner, PhD assessment committee, Universidad Autónoma de Madrid, 2021
- Co-led virtual workshop with Dr. Chris Winchell. ‘CRISPR/Cas9 mutagenesis in annelids: effective methods for the polychaete *Capitella* and the leech *Helobdella*’ Spiraliabase Virtual Lab Meetings, 2020
- Reviewer for numerous professional journals, ongoing.
- Ad Hoc reviewer, National Science Foundation (most years since 2006)
- Co-host, round table workshop, ‘Overcoming challenges for testing gene function in post-embryonic stages’ Society for Integrative and Comparative Biology Annual Meeting, Austin, TX 2020
- Invited reviewer of book proposal, Oxford University Press, Oxford, UK, 2020
- Director, Whitney Laboratory NSF REU program, 2014–2019
- Panelist, FINESST grant proposals for NASA, 2019
- Co-Organizer, Spiralian White Paper Workshop, Whitney Laboratory, Saint Augustine, FL, 2019
- Co-Organizer, Developmental Biology of the Sea Urchin 25th Meeting, MBL, Woods Hole, MA, 2018
- Panelist, Division of Integrative and Organismal Systems, National Science Foundation, 4x
- Member, Graduate Student Admissions Committee, Dept. of Biology, U. Florida, 2016-2019
- Co-Instructor, Embryology Course, Marine Biological Laboratory, Woods Hole, MA, 2004-2007, 2009–2019
- Co-Organizer, South West Regional Developmental Biology meeting, Whitney Laboratory for Marine Bioscience, 2106
- Participant, NSF BIO REU PI workshop, Arlington, VA, 2014, 2017, 2019
- External examiner, PhD assessment committee, University of Copenhagen, 2016
- Member, Strategic Planning Committee, Dept. of Biology, 2014–2018

- Host, EDEN Research Exchange Grant recipient Kate Rawlinson from Wellcome Trust Sanger Institute, 2014
- Embryology Course Admissions Committee, Marine Biological Laboratory, Woods Hole, MA 2014
- Faculty Search Committee, Whitney Laboratory for Marine Bioscience, U. Florida, 2013, 2015
- Visiting Scholar, Sars International Centre for Marine Molecular Biology, Bergen, Norway, 2011
- Co-organizer, West Coast Regional Developmental Biology Meeting, Honolulu, HI, 2011
- Co-chair, Contributed papers for Comparative Developmental Biology. Second International Congress on Invertebrate Morphology, Harvard University, Boston, MA, 2011
- Visiting Scholar, Sars International Centre for Marine Molecular Biology, Bergen, Norway, 2011
- Nominating committee, Secretary position, Division of Evolutionary Developmental Biology, Society for Integrative and Comparative Biology, 2011
- Acting Director, Kewalo Marine Laboratory, U. Hawaii, 2008, 2010, 2011
- Invited Workshop Participant, 'Evolutionary Transitions in Marine Invertebrate Larval Forms', Colgate University, NY, 2010
- Co-organizer, Symposium on 'Spiralian Development: Conservation and Innovation', Society for Integrative and Comparative Biology Annual Meeting, 2010.
- Secretary for the Division of Evolutionary Developmental Biology, Society for Comparative and Integrative Biology, 2009-2011

Community Service:

- Lab demonstration of annelid *Capitella teleta* for PK Young high school student visit to Whitney Laboratory for Marine Bioscience, 2022
- Participant and interviewee for "Paths to Science Careers" video produced at Whitney Laboratory for local high school student classrooms. This outreach project involved answering questions on camera posed by local HS students by Whitney staff, 2021
- Seminar, 'Tracking cells through space and time' Whitney Laboratory Public Lecture Series 'Sip N Science', March, 2021
- Host Molecular Genetics Class (Instructor: Dr. Keith Choe) for lab visit, 2020.
- Digital Content, SeaverLab UTube Channel, 2020
- Facilitator for 'Girls Can', professional outreach event for 10th grade girls, Putnam County, FL, 2018
- Led panelist discussion for Flagler County local AAUW branch visit to Whitney Laboratory for Marine Bioscience, St. Augustine, FL, 2017
- Participant, Open House, Whitney Laboratory for Marine Bioscience, St. Augustine, FL, 2016
- Invited public lecture and lab visit for older adults 'Embryology in Annelids' Whitney Laboratory for Marine Bioscience, St. Augustine, FL, 2016
- Lecture, 'How to replace lost body parts: insights from worms'. Cedar Key Library, Cedar Key, FL, 2016.
- Invited lecture, UF Marine Biology Club, 2015.
- Invited lecture, Coastal Systems Masters Naturalist Course, 2015.
- Invited lecture, 'I dig worms: biodiversity, development and regeneration'. Whitney Board of Trustees, 2014.
- Invited lecture, 'I dig worms: insights into generation of animal biodiversity'. Evening at Whitney Lecture Series, Whitney Laboratory for Marine Bioscience, 2013.
- 'Wet lab' demonstration of local marine fauna to High School Student Science Training Program (University of Florida) visit to Whitney Laboratory for Marine Bioscience, St. Augustine, FL, 2013.
- 'Wet lab' demonstration of local marine fauna to University of Florida HHMI undergraduate student visit to Whitney Laboratory for Marine Bioscience, St. Augustine, FL, 2013.
- Participant in Eastern Florida State College student visit to Whitney Laboratory for Marine Bioscience, St. Augustine, FL, 2013.

- Invited lecture for docents of 'Day at Whitney' marine science educational program for 5th graders, Whitney Laboratory for Marine Bioscience, St. Augustine, FL, 2013.
- Member, Medical Research Advisory Committee, Hawaii Community Foundation, 2011–2013.
- Judge, Hawaii State Science and Engineering Fair, Hawaii Academy of Science, 2006, 2007, 2009.
- Organized and hosted Waipahu High School Marine Science student visit to Kewalo Marine Laboratory, 2008.

Recent Publications (2010-Present):

*Indicates undergraduate or graduate student mentee co-authors

Total citations: 6100

h-index: 34

i10-index: 51

Seaver, E. C. 2022. Sifting through the mud: a tale of building the annelid *Capitella teleta* for EvoDevo studies. *Current Topics in Developmental Biology* 147:401-432. DOI: 10.1016/bs.ctdb.2021.12.018. PMID: 35337457.

Seaver, E. C. and de Jong, D. M. 2021. Regeneration in the segmented annelid *Capitella teleta*. *Genes* 12, 1769 <https://doi.org/10.3390/genes12111769>.

Lanza*, A. R. and **Seaver, E. C.** 2020. Functional role for activin/Nodal signaling in establishment of the dorsal-ventral axis in the spiralian annelid *Capitella teleta*. *Development* 147: dev189373 doi:10.1242/dev.189373

Wu, L., Hiebert, L.S., Klann, M., Passamaneck, Y., Bastin, B. R., Schneider, S. Q., Martindale, M. Q., **Seaver, E. C.**, Maslakova, S. A., and Lambert, J. D. 2020. Genes with spiralian-specific protein motifs are expressed in spiralian ciliary bands. *Nat Commun* 11, 4171. doi.org/10.1038/s41467-020-17780-7

Lanza*, A. R. and **Seaver, E. C.** 2020. Activin/Nodal signaling mediates dorsal-ventral axis formation before third quartet formation in embryos of the annelid *Chaetopterus pergamentaceus*. *EvoDevo* 11:17. doi.org/10.1186/s13227-020-00161-y

Klann, M. and **Seaver, E. C.** 2019. Distinct functional roles of the paired domain and homeodomain of pax6 in eye and nervous system development in the annelid *Capitella teleta*. *Developmental Biology* 456 (1): 86-103. doi.org/10.1016/j.ydbio.2019.08.011

Neal*, S., de Jong, D. M. and **Seaver, E. C.** 2019. CRISPR/Cas9 mutagenesis of r-opsin blocks phototaxis in a marine larva. *Proc. R. Soc. B* 286: 20182491.

Dannenberg*, L. C. and **Seaver, E. C.** 2018. Regeneration of the germline in the annelid *Capitella teleta*. *Developmental Biology* 440(2):74-87.

Lanza*, A. R. and **Seaver, E. C.** 2018. An organizing role for the TGF- β signaling pathway in axes formation of the annelid *Capitella teleta*. *Developmental Biology* 435 (1): 26- 40. *This article was selected for the cover image.

de Jong, D. M. and Seaver, E. C. 2017. Investigation into the cellular origins of posterior regeneration in the annelid *Capitella teleta*. *Regeneration* 00:1-17. DOI: 10.1002/reg2.94

Sur, A., Magie, C. R., **Seaver, E. C.** and Meyer, N. P. 2017. Spatiotemporal regulation of nervous system development in the annelid *Capitella teleta*. *EvoDevo* 8:13 (<https://doi.org/10.1186/s13227-017-0076-8>)

Seaver, E. C. 2017. Annelids shed light on the evolution of spiralian development. *Canadian Journal of Zoology* (<https://doi.org/10.1139/cjz-2016-0261>).

Seaver, E. C. 2016. Annelid models I: *Capitella teleta*. *Current Opinion in Genetics and Development* 39: 35–41. <http://dx.doi.org/10.1016/j.gde.2016.05.025>

de Jong, D.M., **Seaver, E.C.** 2016. A Stable Thoracic Hox Code and Epimorphosis Characterize Posterior Regeneration in *Capitella teleta*. *PLOS ONE* 11(2): e0149724. doi: 10.1371/journal.pone.0149724

Yamaguchi*, E., and **Seaver, E. C.** 2016. Regulative capacity for eye formation by first quartet micromeres of the polychaete *Capitella teleta*. *Developmental Biology* 410 (1): 119 – 130. (doi: 10.1016/j.ydbio.2015.12.009).

Meyer, N. P., Carrillo-Baltodano, A, Moore*, R. E. and **Seaver, E. C.** 2015. Nervous system development in lecithotrophic larval and juvenile stages of the annelid *Capitella teleta*. *Frontiers in Zoology* 12: 15 (doi:10.1186/s12983-015-0108-y).

Seaver, E. C. 2014. Variation in spiralian development: insights from polychaetes. *International Journal of Developmental Biology* 58: 457-467. 10.1387/ijdb.140154es.

Boyle*, M. J., Yamaguchi*, E. and **Seaver, E. C.** 2014. Molecular conservation of metazoan gut formation: Evidence from expression of 'endomesoderm genes' in *Capitella teleta* (Annelida) *EvoDevo* 5:39.

Yamaguchi*, E., and **Seaver, E. C.** 2013. The importance of larval eyes in the polychaete *Capitella teleta*: effects of eye deletion on formation of the adult eye. *Invertebrate Biology* 132 (4): 352-367 (doi: 10.1111/ivb.12034).

Amiel, A., Henry, J. Q. and **Seaver, E. C.** 2013. An organizing activity is required for head patterning and cell fate specification in the polychaete annelid *Capitella teleta*: new insights into cell-cell signaling in Lophotrochozoa. *Developmental Biology* 379: 107-122 (doi: 10.1016/j.ydbio.2013.04.011).

Simakov, O., Marletaz, F., Cho, S.-J., Edsinger-Gonzales, E., Havlak, P., Hellsten, U., Kuo, D.-H., Larsson, T., Lv, J., Arendt, D., Savage, R., Osoegawa, K., de Jong, P., Grimwood, J., Chapman, J. A., Shapiro, H., Kuo, A., Otilar, R. P., Terry, A. Y., Boore, J. L., Grigoriev, I. V., Lindberg, D. R., **Seaver, E. C.**, Weisblat, D. A., Putnam, N. H., Rokhsar, D. S. 2013. Insights into bilaterian evolution from three spiralian genomes. *Nature* 493(7433): 526-531 (doi: 10.1038/nature11696.).

Pernet, B., Amiel, A. and **Seaver, E. C.** 2012. Effects of maternal investment on larvae and juveniles of the annelid *Capitella teleta* determined by experimental reduction of embryo energy content. *Invertebrate Biology* 131(2): 82-95 (DOI: 10.1111/j.1744-7410.2012.00263.x).

Seaver, E. C., Yamaguchi, E*, Richards*, G. S. and Meyer, N. P. 2012. Expression of the pair-rule gene homologues *runt*, *Pax3/7*, *even-skipped-1* and *even-skipped-2* during larval and juvenile development of the polychaete annelid *Capitella teleta* does not support a role in segmentation. *EvoDevo* 3:8.

Giani*, V. C. Jr., Yamaguchi, E. and **Seaver, E. C.** 2011. Somatic and germ line expression of *piwi* throughout the life cycle of the polychaete annelid *Capitella teleta*. *EvoDevo* 2:10.

Jackson, D. J., Meyer, N. P., **Seaver, E. C.**, Pang K., McDougall, C., Moy, V. N., Gordon, K., Degnan, B. M., Martindale, M. Q., Burke, R. and Peterson, K. J. 2010. Developmental expression of COE across the Metazoa supports a conserved role in neuronal cell-type specification and mesodermal development. *Development, Genes and Evolution* 220:221-234.

Layden, M. J., Meyer N. P., Pang K., **Seaver, E. C.** and Martindale, M. Q. 2010. Expression and phylogenetic analysis of the *zic* gene family in the evolution and development of metazoans. *EvoDevo* 1:12.

Meyer, N. P., Boyle*, M. J., Martindale, M. Q. and **Seaver, E. C.** 2010. A comprehensive fate map by intracellular injection of identified blastomeres in the marine polychaete *Capitella teleta*. *EvoDevo* 1:8.

Meyer, N. P. and **Seaver, E. C.** 2010. Cell lineage and fate map of the primary somatoblast of the polychaete annelid *Capitella teleta*. *Integrative and Comparative Biology* 50(5):756-67.

Boyle*, M. J. and **Seaver, E. C.** 2010. Expression of *FoxA* and *GATA* transcription factors correlates with regionalized gut development in two lophotrochozoan marine worms: *Chaetopterus* (Annelida) and *Themiste lageniformis* (Sipuncula). *EvoDevo* 1:2.

Cho, S.-J., Valles, Y., Giani*, V. C., **Seaver, E. C.** and Weisblat, D. A. 2010. Evolutionary dynamics of the Wnt gene family: a lophotrochozoan perspective. *Molecular Biology and Evolution* 27(7): 1645-1658 doi:10.1093/molbev/msq052.

Shimeld, S. M., Boyle*, M. J., Brunet, T., Luke, G. N. and **Seaver, E. C.** 2010. Clustered Fox genes in lophotrochozoans and the evolution of the bilaterian Fox gene cluster. *Developmental Biology* 340: 234-248.

Research Support:

Current

Co-PI, NSF IOS 1923429 (09/01/2019 – 08/31/2023) “EDGE CT: Catalyzing regeneration research by developing functional tools for postembryonic stages” (total: \$935,322)

Co-PI, NSF (03/01/2016 – 02/28/2024) “REU site: Marine Biodiversity: lessons from molecules, development and behavior” (\$431,912)

Previous

PI, NSF, (02/01/2015 – 01/31/2019) “Collaborative Proposal: Cellular and molecular dissection of “organizing activity” during development in the Spiralia” (\$600,418)

Co-PI, NSF DBI-1156528, (03/01/2012-02/29/2016). “REU Site: Research in molecular, cellular, neuroand population biology using marine and other comparative models at the Whitney Laboratory for Marine Bioscience.” (\$240,409)

PI, NSF IOS09-23754, (7/1/09 – 6/30/14). “Mechanisms of neurogenesis in a segmented polychaete” (\$400,000)

Co-PI, NSF, (7/1/2013 – 6/30/2014). “FSML: Upgrading the Whitney Laboratory's capability for marine genomics” (\$343,111)

PI, Hawaii Community Foundation (5/16/12 – 2/01/13), “An emerging model for regeneration studies” (\$50,000)

Co-PI, NSF, (6/1/2010 – 5/31/2013). “FSML: Pacific Ocean Marine Lab Technology and Research Space Optimization” (\$350,000)

Co-PI, NSF DBI-0922789, (9/1/09 – 8/31/11). “MRI: Acquisition of a versatile single cell labeling and high resolution multi-channel imaging system” (\$470,751)

PI, NSF IOB05-44869, (6/1/06 – 5/31/10). “Multiple origins of mesoderm in a model polychaete” (\$300,000)

PI, NSF, 07/01/08. REU supplement to “Multiple origins of mesoderm in a model polychaete” (\$6000)

PI, Hawaii Community Foundation HCF42992, 11/01/08-6/04/10, “Functional investigations of early neurogenesis”. (\$50,000)

Co-PI, NSF EF05-31558, (1/1/06 – 12/31/09) “ATOL: Collaborative proposal: Assembling the protostome tree of life” (PI: Gonzalo Giribet, Harvard University), (\$975,000)

PI, Hawaii Community Foundation, 5/10/07 – 11/10/2008, “Functional investigations of cell fate specification during embryonic and adult nervous system formation” (\$50,000)

Co-PI, NSF EAR-0120646, 10/1/01 – 6/30/2007, “Wormnet: Reconstructing the early evolution of segmented annelid worms”. (PI: Ken Halanych, Auburn University), (\$212, 503)

Co-PI, NSF EF03-34871, 1/1/04 – 12/31/06, “Assembling the tree of life: Collaborative Research: An integrated approach to the origin and diversification of protostomes” (PI: Gonzalo Giribet, Harvard University) (\$370,349)

PI, Hawaii Community Foundation, 1/1/04-12/31/05, “Molecular regulation of asymmetric segregation of developmental regulatory genes in identified embryonic cells”. (\$44,625)

Co-PI, NSF IBN00-94925, 1/1/01 – 12/31/2004, “The formation and evolution of the metameric body plan in basal annelids”. (PI: Mark Martindale, University of Hawaii) (\$258,566)