

Philosophy of Biology

University of Rochester
Fall 2009

Overview

This class is an introduction to philosophy of biology focussing on issues connected with the nature and scope of biological explanations. We begin by contrasting evolutionary and design explanations. We then examine a set of foundational questions concerning the nature and scope of the explanations provided by natural selection. We conclude by examining the explanatory role of genes in development. No prior philosophy of science or biology will be assumed.

Course Details

Codes	PHL 25I, PHL 25IW, PHL 45I
Location	Lattimore Hall 413
Dates	2 September to 9 December.
Times	Mondays and Wednesdays, 12:30pm to 1:45pm.
Final Paper Due	Wednesday 9 December.
URI	http://mail.rochester.edu/~bweslake/teaching/2009/biology/ <i>Note:</i> This syllabus is provisional. The latest schedule and any announcements will always be available at this location.

Instructor

Brad Weslake
519 Lattimore Hall
bradley.weslake@rochester.edu
<http://mail.rochester.edu/~bweslake/>

Office Hours: Tuesdays 10am–12pm, or by appointment.
Note: Cancellations will always be announced on my website.

Assessment

Requirements:

- Ten 1-2 page weekly reading summaries. You should pick at least one of the readings for the class in question and summarise, as clearly and concisely as you can, the main argument. Please also indicate whether there were parts of the reading that you found unclear or confusing.
- A 10-15 minute presentation, followed by discussion.
- An in class exam, consisting of multiple choice and short answer questions.
- A second 10-12 page research paper, questions to be provided.

The final grade will be determined as follows:

Reading Summaries	10%
Presentation	20%
Exam	20%
Paper	50%

Assessment dates:

Exam	Wednesday 21 October.
Paper	Wednesday 10 December.
Reading Summaries	At each associated class.

Note: Late summaries will not be accepted.

Note: Graduate students or students enrolled for upper level writing credit will be required to write longer essays. Graduate students will also be required to read all optional readings and to submit more detailed writing summaries.

Textbooks

Our textbook is Sober (2000a).

Optional Background Reading

For those without any background in evolutionary biology, Carroll (2006) and Coyne (2009) are good recent popular introductions to the evidence for evolution, and Ridley (2004) and Futuyma (2009) are the definitive textbooks.

Dynamical and Statistical Theories

Wednesday 7 October	<i>Primary</i>	Matthen and Ariew (2002).
	<i>Secondary</i>	Walsh, Lewens, and Ariew (2002).
Monday 12 October	<i>Primary</i>	Reisman and Forber (2005).
	<i>Secondary</i>	Shapiro and Sober (2007), Abrams (2007), Matthen and Ariew (forthcoming).

Selection Of and Selection For

Wednesday 14 October	<i>Introductory</i>	Fodor (2007).
	<i>Primary</i>	Fodor (2008a).
	<i>Secondary</i>	Dennett (2008), Godfrey-Smith (2008), Sober (2008b), Fodor (2008b).

Biological Function

Monday 19 October	<i>Introductory</i>	Lewens (2007).
	<i>Primary</i>	Godfrey-Smith (1993).
	<i>Secondary</i>	Kitcher (1993a), Amundson and Lauder (1994), Cummins (2002).

Wednesday 21 October **Exam**

Levels of Selection

Monday 26 October	<i>Introductory</i>	Lloyd (2005).
	<i>Primary</i>	Sober (2000a, Chapter 4).
	<i>Secondary</i>	Sober and Lewontin (1982).
Wednesday 28 October	<i>Primary</i>	Sterelny and Kitcher (1988).
	<i>Secondary</i>	Sober (1990), Kitcher, Sterelny, and Wa- ters (1990), Sober and Wilson (1994), Okasha (2005).

Adaptationism

Monday 2 November	<i>Introductory</i>	Sober (1996), Godfrey-Smith and Wilkins (2008).
	<i>Primary</i>	Sober (2000a, Chapter 5).
	<i>Secondary</i>	Cain (1964), Smith (1978), Mayr (1983), Dennett (1995).
Wednesday 4 November	<i>Primary</i>	Gould and Lewontin (1979).
	<i>Secondary</i>	Amundson (1994), Forber (2009).

Section III: Genetics and Development

Overview Waters (2007b).

Reductionism

Monday 9 November	<i>Introductory</i>	Brigandt and Love (2007).
	<i>Primary</i>	Kitcher (1984).
	<i>Secondary</i>	Weslake (2009).
Wednesday 11 November	<i>Primary</i>	Waters (1990).
	<i>Secondary</i>	Sober (1999), Steel (2004).

Heredity

Monday 16 November	<i>Introductory</i>	Downes (2009), Block (1995).
	<i>Primary</i>	Sober (2000a, Chapter 7).
	<i>Secondary</i>	Lewontin (1974), Sober (1988).

Developmental Systems Theory

Wednesday 18 November	<i>Introductory</i>	Godfrey-Smith (2000a).
	<i>Primary</i>	Griffiths and Gray (1994).
	<i>Secondary</i>	Sterelny, Smith, and Dickison (1996), Griffiths and Gray (1997).
Monday 23 November	<i>Primary</i>	Kitcher (2000).
	<i>Secondary</i>	Oyama (2000), Griffiths (2006).

Genetic Causation

Wednesday 25 November	<i>Primary</i>	Waters (2007a).
	<i>Secondary</i>	Woodward (2006), Woodward (2009).

Genetic Information

Monday 30 November	<i>Introductory</i>	Dawkins (1998), Godfrey-Smith (2007).
	<i>Primary</i>	Griffiths (2001).
	<i>Secondary</i>	Maynard Smith (2000b), Sterelny (2000), Godfrey-Smith (2000b), Sarkar (2000), Maynard Smith (2000a).

References

- Abrams, Marshall. 2007. "How Do Natural Selection and Random Drift Interact?," in *Philosophy of Science*, Vol. 74, No. 5, December 2007, pp. 666–679. URL: <http://dx.doi.org/10.1086/525612>.

- Abrams, Marshall. 2009. "What Determines Biological Fitness? The Problem of the Reference Environment", in *Synthese*, Vol. 166, No. 1, January 2009, pp. 21–40. URL: <http://dx.doi.org/10.1007/s11229-007-9255-9>.
- Allen, Colin, Marc Bekoff, and George Lauder. 1997. *Nature's Purposes: Analyses of Function and Design in Biology*, MIT Press, Cambridge MA.
- Amundson, Ron. 1994. "Two Concepts of Constraint: Adaptationism and the Challenge from Developmental Biology", in *Philosophy of Science*, Vol. 61, No. 4, December 1994, pp. 556–578. Reprinted in Hull and Ruse (1998, pp. 93–116). URL: <http://dx.doi.org/10.2307/188335>.
- Amundson, Ron, and George V. Lauder. 1994. "Function without Purpose", in *Biology and Philosophy*, Vol. 9, No. 4, October 1994, pp. 443–469. Reprinted in Hull and Ruse (1998, pp. 227–257). URL: <http://dx.doi.org/10.1007/BF00850375>.
- Ariew, André, and Zachary Ernst. forthcoming. "What Fitness Ain't", in *Erkenntnis*, URL: http://web.missouri.edu/~ernstz/Papers_files/fitness_aint.pdf.
- Block, Ned. 1995. "How Heritability Misleads About Race", in *Cognition*, Vol. 56, No. 2, August 1995, pp. 99–128. URL: [http://dx.doi.org/10.1016/0010-0277\(95\)00678-R](http://dx.doi.org/10.1016/0010-0277(95)00678-R).
- Brandon, Robert N. 1978. "Adaptation and Evolutionary Theory", in *Studies In History and Philosophy of Science Part A*, Vol. 9, No. 3, September 1978, pp. 181–206. Reprinted in Rosenberg and Arp (2010, pp. 103–120). URL: [http://dx.doi.org/10.1016/0039-3681\(78\)90005-5](http://dx.doi.org/10.1016/0039-3681(78)90005-5).
- Brigandt, Ingo, and Alan Love. 2007. "Reductionism in Biology", in Zalta (2009). URL: <http://plato.stanford.edu/entries/reduction-biology/>.
- Buller, David J. 1999. *Function, Selection, and Design*, State University of New York Press, Albany NY.
- Cain, Arthur J. 1964. "The Perfection of Animals", in J. D. Carthy and C. L. Duddington (Ed.), *Viewpoints in Biology*, Volume 3, Butterworths, London, pp. 36–63. Reprinted in *Biological Journal of the Linnaean Society*, Vol. 36, No. 1-2, 1989, pp. 3–29. URL: <http://www.blackwellpublishing.com/ridley/classictexts/cain.pdf>.
- Carroll, Sean B. 2006. *The Making of the Fittest: DNA and the Ultimate Forensic Record of Evolution*, W. W. Norton, New York.
- Coyne, Jerry A. 2009. *Why Evolution is True*, Viking, New York.

- Cummins, Robert. 2002. “Neo-Teleology”, in André Ariew, Robert Cummins, and Mark Perlman (Ed.), *Functions: New Essays in the Philosophy of Psychology and Biology*, Oxford University Press, Oxford, pp. 157–173. Reprinted in Rosenberg and Arp (2010, pp. 164–174). URL: <https://netfiles.uiuc.edu/rcummins/www/HomePage/Papers/NeoTeleology.pdf>.
- Darwin, Charles. 1859. *On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life*, 1st edition, John Murray, London. Reprinted in facsimile with an introduction by Ernst Mayr, Harvard University Press, Cambridge MA, 1964.
- Dawkins, Richard. 1998. “The “Information Challenge””, in *The Skeptic*, Vol. 18, No. 4, pp. 21–25. Reprinted in Pennock (2001, pp. 617–632) and Dawkins (2003, pp. 91–103). URL: <http://www.skeptics.com.au/publications/articles/the-information-challenge/>.
- . 2003. *A Devil’s Chaplain: Reflections on Hope, Lies, Science, and Love*, Houghton Mifflin, Boston.
- Dennett, Daniel C. 1995. “Searching for Quality”, in *Darwin’s Dangerous Idea: Evolution and the Meanings of Life*, Simon, Schuster, New York, pp. 229–261.
- . 2008. “Fun and Games in Fantasyland”, in *Mind and Language*, Vol. 23, No. 1, February 2008, pp. 25–31. URL: <http://dx.doi.org/10.1111/j.1468-0017.2007.00325.x>.
- Downes, Stephen M. 2009. “Heredity and Heritability”, in Zalta (2009). URL: <http://plato.stanford.edu/entries/heredity/>.
- Fodor, Jerry A. 2007. “Why Pigs Don’t Have Wings”, in *London Review of Books*, Vol. 29, No. 20, 18 October, 2007, pp. 19–22. URL: http://www.lrb.co.uk/v29/n20/fodoo1_.html.
- . 2008a. “Against Darwinism”, in *Mind and Language*, Vol. 23, No. 1, February 2008, pp. 1–24. URL: <http://dx.doi.org/10.1111/j.1468-0017.2007.00324.x>.
- . 2008b. “Replies”, in *Mind and Language*, Vol. 23, No. 1, February 2008, pp. 50–57. URL: <http://dx.doi.org/10.1111/j.1468-0017.2007.00328.x>.
- Forber, Patrick. 2005. “On the Explanatory Roles of Natural Selection”, in *Biology and Philosophy*, Vol. 20, No. 2, March 2005, pp. 329–342. URL: <http://dx.doi.org/10.1007/s10539-005-5588-2>.

- Forber, Patrick. 2009. "Spandrels and a Pervasive Problem of Evidence", in *Biology and Philosophy*, Vol. 24, No. 2, March 2009, pp. 247–266. URL: <http://dx.doi.org/10.1007/s10539-008-9144-8>.
- Futuyma, Douglas J. 2009. *Evolution*, 2nd edition, Sinauer Associates, Sunderland MA.
- Godfrey-Smith, Peter. 1993. "Functions: Consensus Without Unity", in *Pacific Philosophical Quarterly*, Vol. 74, No. 3, September 1993, pp. 196–208. Reprinted in Hull and Ruse (1998, pp. 280–292) and Buller (1999, pp. 185–198). URL: <http://www.people.fas.harvard.edu/~pgs/PGSFunctions1993PPQ.pdf>.
- . 2000a. "Explanatory Symmetries, Preformation, and Developmental Systems Theory", in *Philosophy of Science*, Vol. 67, September 2000, pp. S322–S331. URL: <http://dx.doi.org/10.2307/188678>.
- . 2000b. "Information, Arbitrariness, and Selection: Comments on Maynard Smith", in *Philosophy of Science*, Vol. 67, No. 2, June 2000, pp. 202–207.
- . 2007. "Information in Biology", in Hull and Ruse (2007), pp. 103–119.
- . 2008. "Explanation in Evolutionary Biology: Comments on Fodor", in *Mind and Language*, Vol. 23, No. 1, February 2008, pp. 32–41. URL: <http://dx.doi.org/10.1111/j.1468-0017.2007.00326.x>.
- Godfrey-Smith, Peter, and Jon F. Wilkins. 2008. "Adaptationism", in Sarkar and Plutynski (2008), pp. 186–202.
- Gould, Stephen Jay, and Richard C. Lewontin. 1979. "The Spandrels of San Marco and the Panglossian Paradigm: A Critique of the Adaptationist Programme", in *Proceedings of the Royal Society of London Series B: Biological Sciences*, Vol. 205, No. 1161, 21 September, 1979, pp. 581–598. Reprinted in Sober (2006, pp. 79–98).
- Griffiths, Paul E. 2001. "Genetic Information: A Metaphor in Search of a Theory", in *Philosophy of Science*, Vol. 68, No. 3, September 2001, pp. 394–412. URL: <http://dx.doi.org/10.2307/3080926>.
- . 2006. "The Fearless Vampire Conservator: Philip Kitcher, Genetic Determinism and the Informational Gene", in Eva M. Neumann-Held and Christoph Rehmann-Sutter (Ed.), *Genes in Development: Re-reading the Molecular Paradigm*, Duke University Press, Durham, pp. 175–198. URL: <http://philsci-archive.pitt.edu/archive/00000728/>.

- Griffiths, Paul E., and Russell D. Gray. 1994. "Developmental Systems and Evolutionary Explanation", in *The Journal of Philosophy*, Vol. 91, No. 6, June 1994, pp. 277–304. Reprinted in Hull and Ruse (1998, pp. 117–145).
- . 1997. "Replicator II — Judgement Day", in *Biology and Philosophy*, Vol. 12, No. 4, October 1997, pp. 471–492. URL: <http://dx.doi.org/10.1023/A:1006551516090>.
- Hull, David L., and Michael Ruse. 1998. *The Philosophy of Biology*, Oxford University Press, Oxford.
- . 2007. *The Cambridge Companion to the Philosophy of Biology*, Cambridge University Press, Cambridge.
- Kitcher, Philip. 1984. "1953 and all That. A Tale of Two Sciences", in *Philosophical Review*, Vol. 93, No. 3, July 1984, pp. 335–373. Reprinted in Kitcher (2003, pp. 3–30) and Sober (2006, pp. 261–282).
- . 1985. "Darwin's Achievement", in Nicholas Rescher (Ed.), *Reason and Rationality in Natural Science*, University Press of America, Lanham MD, pp. 127–189. Reprinted in Kitcher (1993b, pp. 11–57), Kitcher (2003, pp. 45–93) and Lange (2006, pp. 154–188).
- . 1993a. "Function and Design", in Peter A. French, Theodore E. Uehling Jr. and Howard K. Wettstein (Ed.), *Philosophy of Science*, Midwest Studies in Philosophy, Volume 18, University of Notre Dame Press, Notre Dame, pp. 379–397. Reprinted in Allen, Bekoff, and Lauder (1997a, pp. 479–504), Hull and Ruse (1998a, pp. 258–279), Buller (1999a, pp. 159–184) and Kitcher (2003a, pp. 159–176). URL: <http://www.chass.utoronto.ca/~sousa/teach/KITCHER.pdf>.
- . 1993b. *The Advancement of Science: Science without Legend, Objectivity without Illusions*, Oxford University Press, Oxford. URL: <http://dx.doi.org/10.1093/0195096533.001.0001>.
- . 2000. "Battling the Undead: How (and How Not) to Resist Genetic Determinism", in Singh et al. (2000), pp. 396–414. Reprinted in Kitcher (2003, pp. 283–300).
- . 2003. *In Mendel's Mirror: Philosophical Reflections on Biology*, Oxford University Press, Oxford.
- Kitcher, Philip, Kim Sterelny, and C. Kenneth Waters. 1990. "The Illusory Riches of Sober's Monism", in *The Journal of Philosophy*, Vol. 87, No. 3, March 1990, pp. 158–161.

- Lange, Marc. 2006. *Philosophy of Science: An Anthology*, Blackwell, Malden MA.
- Levins, Richard, and Richard C. Lewontin. 1985. *The Dialectical Biologist*, Harvard University Press, Cambridge MA.
- Lewens, Tim. 2007. “Functions”, in Matthen and Stephens (2007), pp. 525–547. URL: <http://dx.doi.org/10.1016/B978-0-444-51543-8/50024-1>.
- Lewontin, Richard C. 1974. “The Analysis of Variance and the Analysis of Causes”, in *American Journal of Human Genetics*, Vol. 26, No. 3, May 1974, pp. 400–411. Reprinted in Levins and Lewontin (1985, pp. 109–122) and in *International Journal of Epidemiology*, Vol. 35, No. 3, June 2006, pp. 520–525.
- . 2001. *The Triple Helix: Gene, Organism, and Environment*, Harvard University Press, Cambridge MA.
- Lloyd, Elisabeth A. 2005. “Units and Levels of Selection”, in Zalta (2009). Revised version published as Lloyd (2007). URL: <http://plato.stanford.edu/entries/selection-units/>.
- . 2007. “Units and Levels of Selection”, in Hull and Ruse (2007), pp. 44–65. URL: <http://dx.doi.org/10.1017/CCOL9780521851282.003>.
- Matthen, Mohan, and André Ariew. 2002. “Two Ways of Thinking about Fitness and Natural Selection”, in *The Journal of Philosophy*, Vol. 99, No. 2, February 2002, pp. 55–83.
- . forthcoming. “Selection and Causation”, in *Philosophy of Science*, URL: http://web.missouri.edu/~ariewa/Selection_Cause.pdf.
- Matthen, Mohan, and Christopher Stephens. 2007. *Philosophy of Biology*, Volume 3, Handbook of the Philosophy of Science, Elsevier, Amsterdam.
- Maynard Smith, John. 2000a. “Reply to Commentaries”, in *Philosophy of Science*, Vol. 67, No. 2, June 2000, pp. 214–218.
- . 2000b. “The Concept of Information in Biology”, in *Philosophy of Science*, Vol. 67, No. 2, June 2000, pp. 177–194. URL: <http://dx.doi.org/10.2307/188717>.
- Mayr, Ernst. 1983. “How to Carry Out the Adaptationist Program?”, in *The American Naturalist*, Vol. 121, No. 3, March 1983, pp. 324–334. Reprinted in Mayr (1988, pp. 148–160), Rosenberg and Arp (2010, pp. 137–144). URL: <http://dx.doi.org/10.2307/2461153>.

- Mayr, Ernst. 1988. *Toward a New Philosophy of Biology: Observations of an Evolutionist*, Harvard University Press, Cambridge MA.
- Mills, Susan K., and John H. Beatty. 1979. “The Propensity Interpretation of Fitness”, in *Philosophy of Science*, Vol. 46, No. 2, June 1979, pp. 263–286. Reprinted in Sober (2006, pp. 3–24).
- Okasha, Samir. 2005. “Multilevel Selection and the Major Transitions in Evolution”, in *Philosophy of Science*, Vol. 72, No. 5, December 2005, pp. 1013–1025. URL: <http://dx.doi.org/10.1086/508102>.
- Oyama, Susan. 2000. “Causal Democracy and Causal Contributions in Developmental Systems Theory”, in *Philosophy of Science*, Vol. 67, Supplement, 2000, pp. S332–S347. URL: <http://dx.doi.org/10.2307/188679>.
- Pennock, Robert T. 2001. *Intelligent Design Creationism and Its Critics: Philosophical, Theological and Scientific Perspectives*, MIT Press, Cambridge MA.
- Pigliucci, Massimo, and Jonathan Kaplan. 2006. *Making Sense of Evolution: The Conceptual Foundations of Evolutionary Biology*, University of Chicago Press, Chicago.
- Plutynski, Anya, and Warren J. Ewens. 2005. “Population Genetics”, in Sahotra Sarkar and Jessica Pfeifer (Ed.), *The Philosophy of Science: An Encyclopedia*, Routledge, New York, pp. 578–585.
- Reisman, Kenneth, and Patrick Forber. 2005. “Manipulation and the Causes of Evolution”, in *Philosophy of Science*, Vol. 72, No. 5, December 2005, pp. 1113–1123. URL: <http://dx.doi.org/10.1086/508120>.
- Ridley, Mark. 2004. *Evolution*, 3rd edition, Blackwell, Malden MA.
- Rosenberg, Alexander, and Robert Arp. 2010. *Philosophy of Biology: An Anthology*, Blackwell, Malden MA.
- Rosenberg, Alexander, and Frederic Bouchard. 2009. “Fitness”, in Zalta (2009). URL: <http://plato.stanford.edu/entries/fitness/>.
- Ruse, Michael. 2008. *The Oxford Handbook of Philosophy of Biology*, Oxford University Press, Oxford.
- Sarkar, Sahotra. 2000. “Information in Genetics and Developmental Biology: Comments on Maynard Smith”, in *Philosophy of Science*, Vol. 67, No. 2, June 2000, pp. 208–213.
- Sarkar, Sahotra, and Anya Plutynski. 2008. *A Companion to the Philosophy of Biology*, Blackwell, Malden MA.

- Shapiro, Lawrence A., and Elliott Sober. 2007. "Epiphenomenalism—The Do's and the Don'ts", in Peter Machamer and Gereon Wolters (Ed.), *Thinking about Causes: From Greek Philosophy to Modern Physics*, Pittsburgh-Konstanz Series in the Philosophy and History of Science, University of Pittsburgh Press, Pittsburgh, pp. 235–264. URL: <http://philosophy.wisc.edu/sober/shapiro%20and%20sober%20epi%20i%20i%20o%20o%20o%20o6.pdf>.
- Singh, Rama Shankar, et al. 2000. *Thinking about Evolution: Historical, Philosophical, and Political Perspectives*, Cambridge University Press, Cambridge.
- Smith, John Maynard. 1978. "Optimization Theory in Evolution", in *Annual Review of Ecology and Systematics*, Vol. 9, November 1978, pp. 31–56. Reprinted in Sober (2006, pp. 99–130). URL: <http://dx.doi.org/10.1146/annurev.es.09.110178.000335>.
- Sober, Elliott. 1984a. *Conceptual Issues in Evolutionary Biology: An Anthology*, 1st edition, MIT Press, Cambridge MA.
- . 1984b. *The Nature of Selection: Evolutionary Theory in Philosophical Focus*, MIT Press, Cambridge MA. Reprinted by University of Chicago Press, 1993.
- . 1988. "Apportioning Causal Responsibility", in *The Journal of Philosophy*, Vol. 85, No. 6, June 1988, pp. 303–318. Reprinted in Sober (1994, pp. 184–200). URL: <http://dx.doi.org/10.2307/2026721>.
- . 1990. "The Poverty of Pluralism: A Reply to Sterelny and Kitcher", in *The Journal of Philosophy*, Vol. 87, No. 3, March 1990, pp. 151–158.
- . 1994. *From a Biological Point of View: Essays in Evolutionary Philosophy*, Cambridge University Press, Cambridge.
- . 1996. "Evolution and Optimality: Feathers, Bowling Balls, and the Thesis of Adaptationism", in *Philosophic Exchange*, Vol. 26, pp. 41–57. Excerpted as Sober (1998).
- . 1998. "Six Sayings About Adaptationism", in Hull and Ruse (1998), pp. 72–86.
- . 1999. "The Multiple Realizability Argument Against Reductionism", in *Philosophy of Science*, Vol. 66, No. 4, December 1999, pp. 542–564. Reprinted in Sober (2006, pp. 301–324).
- . 2000a. *Philosophy of Biology*, 2nd edition, Westview Press, Boulder CO.

- Sober, Elliott. 2000*b*. “The Two Faces of Fitness”, in Singh et al. (2000*b*), pp. 309–321. Reprinted in Sober (2006*b*, pp. 25–40).
- . 2006. *Conceptual Issues in Evolutionary Biology: An Anthology*, 3rd edition, MIT Press, Cambridge MA.
- . 2008*a*. *Evidence and Evolution: The Logic Behind the Science*, Cambridge University Press, Cambridge.
- . 2008*b*. “Fodor’s *Bubbe Meise* Against Darwinism”, in *Mind and Language*, Vol. 23, No. 1, February 2008, pp. 42–49. URL: <http://dx.doi.org/10.1111/j.1468-0017.2007.00327.x>.
- . 2008*c*. “Intelligent Design”, in Sober (2008*a*), pp. 109–188.
- Sober, Elliott, and Richard C. Lewontin. 1982. “Artifact, Cause, and Genic Selection”, in *Philosophy of Science*, Vol. 49, No. 2, June 1982, pp. 157–180. Reprinted in Sober (1984*a*, pp. 210–231) and Rosenberg and Arp (2010, pp. 297–312).
- Sober, Elliott, and David Sloan Wilson. 1994. “A Critical Review of Philosophical Work on the Units of Selection Problem”, in *Philosophy of Science*, Vol. 61, No. 4, December 1994, pp. 534–555. Reprinted in Hull and Ruse (1998). URL: <http://dx.doi.org/10.1086/289821>.
- Steel, Daniel. 2004. “Can a Reductionist be a Pluralist?”, in *Biology and Philosophy*, Vol. 19, No. 1, January 2004, pp. 55–73. URL: <http://dx.doi.org/10.1023/B:BIPH.0000013263.35121.5a>.
- Stephens, Christopher. 2007. “Natural Selection”, in Matthen and Stephens (2007), pp. 111–127.
- Sterelny, Kim. 2000. “The “Genetic Program” Program: A Commentary on Maynard Smith on Information in Biology”, in *Philosophy of Science*, Vol. 67, No. 2, June 2000, pp. 195–201.
- . 2001. *The Evolution of Agency and Other Essays*, Cambridge University Press, Cambridge.
- Sterelny, Kim, and Philip Kitcher. 1988. “The Return of the Gene”, in *The Journal of Philosophy*, Vol. 85, No. 7, July 1988, pp. 339–361. Reprinted in Sterelny (2001, pp. 29–52), Kitcher (2003, pp. 94–112) and Rosenberg and Arp (2010, pp. 313–326).

- Sterelny, Kim, Kelly C. Smith, and Michael Dickison. 1996. "The Extended Replicator", in *Biology and Philosophy*, Vol. 11, No. 3, July 1996, pp. 377–403. URL: <http://dx.doi.org/10.1007/BF00128788>.
- Walsh, Denis M. 1998. "The Scope of Selection: Sober and Neander on What Natural Selection Explains", in *Australasian Journal of Philosophy*, Vol. 76, No. 2, June 1998, pp. 250. URL: <http://dx.doi.org/10.1080/00048409812348391>.
- Walsh, Denis M., Tim Lewens, and André Ariew. 2002. "The Trials of Life: Natural Selection and Random Drift", in *Philosophy of Science*, Vol. 69, No. 3, September 2002, pp. 429–446. URL: <http://dx.doi.org/10.1086/342454>.
- Waters, C. Kenneth. 1990. "Why the Anti-Reductionist Consensus Won't Survive: The Case of Classical Mendelian Genetics", in *PSA: Proceedings of the Biennial Meeting of the Philosophy of Science Association*, Vol. 1, pp. 125–139. Reprinted in Sober (2006, pp. 283–300).
- . 2007a. "Causes that Make a Difference", in *Journal of Philosophy*, Vol. 104, No. 11, November 2007, pp. 551–579. URL: <http://philsci-archive.pitt.edu/archive/00003833/>.
- . 2007b. "Molecular Genetics", in Zalta (2009b). URL: <http://plato.stanford.edu/entries/molecular-genetics/>.
- Weslake, Brad. 2009. "Explanatory Depth". Under review. 2009. URL: http://mail.rochester.edu/~bweslake/research/papers/weslake_depth.pdf.
- Woodward, James. 2006. "Sensitive and Insensitive Causation", in *The Philosophical Review*, Vol. 115, No. 1, January 2006, pp. 1–50. URL: <http://dx.doi.org/10.1215/00318108-115-1-1>.
- . 2009. "Causation in Biology: Stability, Specificity, and the Choice of Levels of Explanation". 2009. URL: <http://philsci-archive.pitt.edu/archive/00004813/>.
- Zalta, Edward N. 2009. *Stanford Encyclopedia of Philosophy*, Stanford University, Stanford. URL: <http://plato.stanford.edu/>.