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Curriculum Vitae
STEVEN A. FRANK

Present Address: Department of Ecology and
Evolutionary Biology
University of California
Irvine, CA 92697-2525

email: safrank@uci.edu
web: stevefrank.org

Education

University of Michigan, Ann Arbor	1987	Ph.D. (Biology)
University of Florida, Gainesville	1983	M. Statistics
University of Florida, Gainesville	1983	M.S. (Zoology)
University of Michigan, Ann Arbor	1979	B.S. (Biology)

Positions

Donald Bren Professor, UC Irvine	2016-
UCI Distinguished Professor, UC Irvine	2015-
Assistant (1988), Associate (1992), & Full (1997) Professor, UC Irvine	1988-

Major Grants

2024-2026	NSF Grant, OPUS Robustness and Complexity
2020-2023	DoD Grant, Robustness and Control
2020-2023	NSF Grant, OPUS Microbial Life History
2013-2018	NSF Grant, Evolutionary Ecology
2009-2013	NSF Grant, Theoretical Biology
2006-2011	NIH/MIDAS Grant, Influenza epidemiology & evolution, Co-PI w/R. Bush
2001-2006	NIH Grant, Antigenic variation in <i>Borrelia</i> , Co-PI w/A. Barbour
1996-2007	NSF Grant, Population Biology (renewed in 2001)
1990-1996	NIH FIRST Award
1990-1998	NSF Presidential Young Investigator Award

Fellowships

2018-2019	Visiting Professor, ETH Zürich
2014-2015	Institute for Advanced Study (Wissenschaftskolleg), Berlin
2013	Velux Visiting Professor, ETH Zürich
2011-2012	Hogge-Baer Visiting Professor in Cancer Research, University of Chicago
2006-2007	Institute for Advanced Study (Wissenschaftskolleg), Berlin
2002	Member, Institute for Advanced Study, Princeton
1996-1997	Institute for Advanced Study (Wissenschaftskolleg), Berlin
1995-1996	John Simon Guggenheim Fellowship
1987-1989	Miller Research Fellowship, University of California, Berkeley

Prizes and Honors

2012	Elected fellow, American Academy of Arts and Sciences
2009	Elected fellow, American Association for the Advancement of Science
1988	Theodosius Dobzhansky Prize, Society for the Study of Evolution
1986	Young Investigator Prize, American Society of Naturalists

Ten key publications

- Frank, S. A. 2022. *Microbial Life History: The Fundamental Forces of Biological Design*. Princeton University Press.
- Frank, S. A. 2011–2013. Natural selection. I–VII [series of seven articles on major topics]. *Journal of Evolutionary Biology*.
- Frank, S. A. 2007. *Dynamics of Cancer: Incidence, Inheritance, and Evolution*. Princeton University Press.
- Frank, S. A. 2010. Somatic evolutionary genomics: Mutations during development cause highly variable genetic mosaicism with risk of cancer and neurodegeneration. *Proceedings of the National Academy of Sciences USA* 107:1725–1730.
- Frank, S. A. 2002. *Immunology and Evolution of Infectious Disease*. Princeton University Press.
- Frank, S. A. 1996. Models of parasite virulence. *Quarterly Review of Biology* 71:37–78.
- Frank, S. A. 1998. *Foundations of Social Evolution*. Princeton University Press.
- Frank, S. A. 1995. Mutual policing and repression of competition in the evolution of cooperative groups. *Nature* 377:520–522.
- Frank, S. A. 1989. The evolutionary dynamics of cytoplasmic male sterility. *American Naturalist* 133:345–376.
- Frank, S. A. & Hurst, L. D. 1996. Mitochondria and male disease. *Nature* 383:224.

All publications available at <https://stevefrank.org>

Publications

185. Frank, S. A. 2023. Robustness and complexity. *Cell Systems* 14:1015-1020.
184. Frank, S. A. 2023. Disease from opposing forces in regulatory control. *Evolution, Medicine, and Public Health* 11:348-352.
183. Kümmeli, R. & Frank, S. A. 2023. Evolutionary explanations for heterogenous behavior in clonal bacterial populations. *Trends in Microbiology* 37:665-667.
182. Frank, S. A. 2023. Robustness increases heritability: implications for familial disease. *Evolution* 77:655-659.
181. Frank, S. A. 2023. An enhanced transcription factor repressilator that buffers stochasticity and entrains to an erratic external circadian signal. *Frontiers in Systems Biology* 3:1276734.
180. Frank, S. A. 2023. Precise traits from sloppy components: perception and the origin of phenotypic response. *Entropy* 25:1162.
179. Frank, S. A. 2023. Optimizing differential equations to fit data and predict outcomes. *Ecology and Evolution* 13:e9895.
178. Frank, S. A. 2023. Numbers of mutations within multicellular bodies: why it matters. *Axioms* 12:12.
177. Frank, S. A. 2022. *Microbial Life History: The Fundamental Forces of Biological Design*. Princeton University Press.
176. Frank, S. A. 2022. The number of neutral mutants in an expanding Luria-Delbrück population is approximately Fréchet. *F1000Research* 11:1254.
175. Frank, S. A. 2022. Optimization of transcription factor genetic circuits. *Biology* 11:1294.
174. Frank, S. A. 2022. Automatic differentiation and the optimization of differential equation models in biology. *Frontiers in Ecology and Evolution* 10:1010278.
173. Kentsis, A. & Frank, S. A. 2020. Developmental mutators and early onset cancer. *Frontiers in Pediatrics* 8:189.
172. Frank, S. A. & Patten, M. M. 2020. Sexual antagonism leads to a mosaic of X-autosome conflict. *Evolution* 74:495-498.
171. Frank, S. A. 2020. Metabolic heat in microbial conflict and cooperation *Frontiers in Ecology and Evolution* 8:275.
170. Frank, S. A. & Godsoe, W. 2020. The generalized Price equation: forces that change population statistics. *Frontiers in Ecology and Evolution* 8:240.
169. Frank, S. A. & Bruggeman, F. J. 2020. The fundamental equations of change in statistical ensembles and biological populations. *Entropy* 22:1395.
168. Frank, S. A. & Fox, G. A. 2020. The inductive theory of natural selection. *Pages* 171-193

- in *The Theory of Evolution*, S. M. Scheiner and D. P. Mindell, eds. University of Chicago Press.
167. Frank, S. A. 2020. Simple unity among the fundamental equations of science. *Philosophical Transactions of the Royal Society of London B* 375:20190351.
 166. Frank, S. A. & Schmid-Hempel, P. 2019. Evolution of negative immune regulators. *PLoS Pathogens* 15:e1007913.
 165. Frank, S. A. & Bascompte, J. 2019. Invariance in ecological pattern. *F1000Research* 8:2093.
 164. Frank, S. A. 2019. Evolutionary design of regulatory control. II. Robust error-correcting feedback increases genetic and phenotypic variability. *Journal of Theoretical Biology* 468:72–82.
 163. Frank, S. A. 2019. Evolutionary design of regulatory control. I. A robust control theory analysis of tradeoffs. *Journal of Theoretical Biology* 463:121–137.
 162. Frank, S. A. 2019. The common patterns of abundance: the log series and Zipf's law. *F1000Research* 8:334.
 161. Frank, S. A. 2019. How to understand common patterns in big data: the case of human collective memory. *Behavioral Sciences* 9:40.
 160. Frank, S. A. 2018. Measurement invariance explains the universal law of generalization for psychological perception. *Proceedings of the National Academy of Sciences USA* 115:9803–9806.
 159. Frank, S. A. 2018. The Price equation program: simple invariances unify population dynamics, thermodynamics, probability, information and inference. *Entropy* 20:978.
 158. Frank, S. A. 2018. A biochemical logarithmic sensor with broad dynamic range. *F1000Research* 7:200.
 157. Frank, S. A. 2018. *Control Theory Tutorial: Basic Concepts Illustrated by Software Examples*. Springer.
 156. Frank, S. A. 2017. Receptor uptake arrays for vitamin B₁₂, siderophores and glycans shape bacterial communities. *Ecology & Evolution* 7:10175–10195.
 155. Frank, S. A. 2017. Puzzles in modern biology. V. Why are genomes overwired? *F1000Research* 6:924.
 154. Frank, S. A. 2017. Universal expressions of population change by the Price equation: Natural selection, information, and maximum entropy production. *Ecology & Evolution* 7:3381–3396.
 153. Diffey, B. L. & Frank, S. A. 2017. Age-specific acceleration of malignant melanoma. *F1000Research* 6:27.
 152. Frank, S. A. 2016. Commentary: The nature of cancer research. *International Journal of*

- Epidemiology* 45:638–645.
151. Frank, S. A. 2016. Invariant death. *F1000Research* 5:2076.
 150. Frank, S. A. 2016. The invariances of power law size distributions. *F1000Research* 5:2074.
 149. Frank, S. A. 2016. Common probability patterns arise from simple invariances. *Entropy* 18:192.
 148. Frank, S. A. 2016. Puzzles in modern biology. I. Male sterility, failure reveals design. *F1000Research* 5:2288.
 147. Frank, S. A. 2016. Puzzles in modern biology. II. Language, cancer and the recursive processes of evolutionary innovation. *F1000Research* 5:2289.
 146. Frank, S. A. 2016. Puzzles in modern biology. III. Two kinds of causality in age-related disease. *F1000Research* 5:2533.
 145. Frank, S. A. 2016. Puzzles in modern biology. IV. Neurodegeneration, localized origin and widespread decay. *F1000Research* 5:2537.
 144. Frank, S. A. 2015. D'Alembert's direct and inertial forces acting on populations: the Price equation and the fundamental theorem of natural selection. *Entropy* 17:7087–7100.
 143. Frank, S. A. 2014. How to read probability distributions as statements about process. *Entropy* 16:6059–6098.
 142. Frank, S. A. 2014. Somatic mosaicism and disease. *Current Biology* 24:R577–R581.
 141. Frank, S. A. 2014. Generative models versus underlying symmetries to explain biological pattern. *Journal of Evolutionary Biology* 27:1172–1178.
 140. Frank, S. A. 2014. Microbial metabolism: optimal control of uptake versus synthesis. *PeerJ* 2:e267.
 139. Frank, S. A. 2013. Input-output relations in biological systems: measurement, information and the Hill equation. *Biology Direct* 8:31.
 138. Frank, S. A. 2013. Evolution of robustness and cellular stochasticity of gene expression. *PLoS Biology* 11:e1001578.
 137. Frank, S. A. 2013. Microbial evolution: regulatory design prevents cancer-like overgrowths. *Current Biology* 23:R343–R346.
 136. Frank, S. A. 2013. A new theory of cooperation. Pages 40–47 in *Human Social Evolution: The Foundational Works of Richard D. Alexander*, K. Summers & B. Crespi, eds. Oxford University Press.
 135. Frank, S. A. 2013. Natural selection. VII. History and interpretation of kin selection theory. *Journal of Evolutionary Biology* 26:1151–1184.
 134. Frank, S. A. 2013. Natural selection. VI. Partitioning the information in fitness and characters by path analysis. *Journal of Evolutionary Biology* 26:457–471.

133. Frank, S. A. 2012. Natural selection. V. How to read the fundamental equations of evolutionary change in terms of information theory. *Journal of Evolutionary Biology* 25:2377-2396.
132. Frank, S. A. 2012. Mitochondrial burden on male health [commentary]. *Current Biology* 22:R797-R799.
131. Frank, S. A. & Rosner, M. R. 2012. Nonheritable cellular variability accelerates the evolutionary processes of cancer. *PLoS Biology* 10:e1001296.
130. Frank, S. A. 2012. Natural selection. IV. The Price equation. *Journal of Evolutionary Biology* 25:1002-1019.
129. Frank, S. A. 2012. Natural selection. III. Selection versus transmission and the levels of selection. *Journal of Evolutionary Biology* 25:227-243.
128. Frank, S. A. 2012. Wright's adaptive landscape versus Fisher's fundamental theorem. Pages 41-57 in *The Adaptive Landscape in Evolutionary Biology*, E. Svensson and R. Calsbeek, eds. Oxford University Press.
127. Frank, S. A. 2011. Natural selection. II. Developmental variability and evolutionary rate. *Journal of Evolutionary Biology* 24:2310-2320.
126. Frank, S. A. 2011. Natural selection. I. Variable environments and uncertain returns on investment. *Journal of Evolutionary Biology* 24:2299-2309.
125. Frank, S. A. & Crespi, B. J. 2011. Pathology from evolutionary conflict, with a theory of X chromosome versus autosome conflict over sexually antagonistic traits. *Proceedings of the National Academy of Sciences USA* 108 (Suppl. 2):10886-10893.
124. Frank, S. A. 2011. Cancer: the whole story [book review]. *PLoS Biology* 9:e1001044.
123. Frank, S. A. & Smith, E. 2011. A simple derivation and classification of common probability distributions based on information symmetry and measurement scale. *Journal of Evolutionary Biology* 24:469-484.
122. Frank, S. A. 2011. Measurement scale in maximum entropy models of species abundance. *Journal of Evolutionary Biology* 24:485-496.
121. Frank, S. A. & Smith, D. E. 2010. Measurement invariance, entropy, and probability. *Entropy* 12:289-303.
120. Frank, S. A. 2010. History of science: belief, reason, and insight [book review]. *Science* 329:279-280.
119. Frank, S. A. 2010. A general model of the public goods dilemma. *Journal of Evolutionary Biology* 23: 1245-1250.
118. Frank, S. A. 2010. The trade-off between rate and yield in the design of microbial metabolism. *Journal of Evolutionary Biology* 23:609-613.
117. Frank, S. A. 2010. Microbial secretor-cheater dynamics. *Philosophical Transactions of the Royal Society B* 365:20100033.

- Royal Society of London B 365:2515-2522.
116. Frank, S. A. 2010. Demography and the tragedy of the commons. *Journal of Evolutionary Biology* 23:32-39.
 115. Frank, S. A. 2010. Somatic evolutionary genomics: Mutations during development cause highly variable genetic mosaicism with risk of cancer and neurodegeneration. *Proceedings of the National Academy of Sciences USA* 107:1725-1730.
 114. Frank, S. A. 2009. The common patterns of nature. *Journal of Evolutionary Biology* 22:1563-1585.
 113. Frank, S. A. 2009. Natural selection maximizes Fisher information. *Journal of Evolutionary Biology* 22:231-244.
 112. Frank, S. A. 2009. Evolutionary foundations of cooperation and group cohesion. Pages 3-40 in *Games, Groups, and the Global Good*, S. A. Levin, ed. Springer-Verlag.
 111. Frank, S. A. & Schmid-Hempel, P. 2008. Mechanisms of pathogenesis and the evolution of parasite virulence. *Journal of Evolutionary Biology* 21:396-404.
 110. Frank, S. A. 2008. Evolutionary dynamics of redundant regulatory control. *Journal of Theoretical Biology* 255:64-68.
 109. Frank, S. A. 2007. *Dynamics of Cancer: Incidence, Inheritance, and Evolution*. Princeton University Press.
 108. Frank, S. A. 2007. Maladaptation and the paradox of robustness in evolution. *PLoS ONE* 2(10):e1021.
 107. Frank, S. A. 2007. All of life is social. *Current Biology* 17:R648-R650.
 106. Frank, S. A. 2007. Evolution of antigenic variation. Pages 225-242 in *Encyclopedia of Infectious Diseases: Modern Methodologies*, M. Tibayrenc, ed. Wiley.
 105. Frank, S. A. & Bush, R. M. 2007. Barriers to antigenic escape by pathogens: trade-off between reproductive rate and antigenic mutability. *BMC Evolutionary Biology* 7:229.
 104. Schmid-Hempel, P. & Frank, S. A. 2007. Pathogenesis, virulence, and infective dose. *PLoS Pathogens* 3(10):e147.
 103. Barbour, A. G., Dai, Q., Restrepo, B. I., Stoermer, H. G., & Frank, S. A. 2006. Pathogen escape from host immunity by a genome program for antigenic variation. *Proceedings of the National Academy of Sciences USA* 103:18290-18295.
 102. Frank, S. A. & Barbour, A. G. 2006. Within-host dynamics of antigenic variation. *Infection, Genetics and Evolution* 6:141-146.
 101. Frank, S. A. 2006. Social selection. Pages 350-363 in *Evolutionary Genetics: Concepts and Case Studies*, C. W. Fox & J. B. Wolf, eds. Oxford University Press.

100. Frank, S. A. & McKenzie, R. B. 2006. The male-female pay gap driven by coupling between labor markets and mating markets. *Journal of Bioeconomics* 8:269-274.
99. Frank, S. A. 2006. Mathematical biology: Master class in evolutionary modeling [book review]. *Science* 314:1878-1879.
98. Frank, S. A. 2005. Age-specific incidence of inherited versus sporadic cancers: A test of the multistage theory of carcinogenesis. *Proceedings of the National Academy of Sciences USA* 102:1071-1075.
97. Frank, S. A., Chen, P.-C. & Lipkin, S. M. 2005. Kinetics of cancer: a method to test hypotheses of genetic causation. *BMC Cancer* 5:163.
96. Frank, S. A. 2004. A multistage theory of age-specific acceleration in human mortality. *BMC Biology* 2:16.
95. Frank, S. A. 2004. Genetic predisposition to cancer—insights from population genetics. *Nature Reviews Genetics* 5:764-772.
94. Frank, S. A. 2004. Genetic variation in cancer predisposition: mutational decay of a robust genetic control network. *Proceedings of the National Academy of Sciences USA* 101:8061-8065.
93. Frank, S. A. 2004. Age-specific acceleration of cancer. *Current Biology* 14:242-246.
92. Frank, S. A. & Nowak, M. A. 2004. Problems of somatic mutation and cancer. *BioEssays* 26:291-299.
91. Frank, S. A. 2004. Inheritance of cancer. *Discovery Medicine* 4:396-400.
90. Frank, S. A. 2004. Mathematical models of cancer progression and epidemiology in the age of high throughput genomics [invited commentary on Armitage and Doll's classic 1954 paper]. *International Journal of Epidemiology* 33:1179-1181.
89. Lin, S.-C. J., Lee, J.-F., Nikitin, A. Y., Hilsenbeck, S. G., Cardiff, R. D., Li, A., Kang, K.-W., Frank, S. A., Lee, W.-H., & Lee, E. Y.-H. P. 2004. Somatic mutation of *p53* leads to estrogen receptor α -positive and -negative mouse mammary tumors with high frequency metastasis. *Cancer Research* 64:3525-3532.
88. André, J.-B., Gupta, S., Frank, S., Tibayrenc, M. 2004. Evolution and immunology of infectious disease: what's new? *Infection, Genetics and Evolution* 4:69-75.
87. Frank, S. A. 2003. Viral genetics: deadly partnerships [News and Views]. *Nature* 425:251-252.
86. Frank, S. A. & Nowak, M. A. 2003. Developmental predisposition to cancer. *Nature* 422:494.
85. Frank, S. A. 2003. Somatic mutation: early cancer steps depend on tissue architecture. *Current Biology* 13:R261-R263.
84. Frank, S. A., Iwasa, Y. & Nowak, M. A. 2003. Patterns of cell division and the risk of cancer.

- Genetics 163:1527-1532.
83. Frank, S. A. 2003. Somatic mosaicism and cancer: inference based on a conditional Luria-Delbrück distribution. *Journal of Theoretical Biology* 223:405-412.
 82. Michor, F., Nowak, M. A., Frank, S. A., & Iwasa, Y. 2003. Stochastic elimination of cancer. *Proceedings of the Royal Society of London B* 270:2017-2024.
 81. Michor, F., Frank, S. A., May, R. M., Iwasa, Y., & Nowak, M. A. 2003. Somatic selection for and against cancer. *Journal of Theoretical Biology* 225:377-382.
 80. Frank, S. A. & Barr, C. M. 2003. Programmed cell death and hybrid incompatibility. *Journal of Heredity* 94:181-183.
 79. Frank, S. A. 2003. Repression of competition and the evolution of cooperation. *Evolution* 57:693-705.
 78. Frank, S. A. 2003. Mergers and acquisitions [book review of *Darwin's Blind Spot*]. *Nature* 421:579-580.
 77. Frank, S. A. 2003. Genetic variation of polygenic characters and the evolution of genetic degeneracy. *Journal of Evolutionary Biology* 16:138-142.
 76. Frank, S. A. 2002. *Immunology and Evolution of Infectious Disease*. Princeton University Press.
 75. Frank, S. A. 2002. A touchstone in the study of adaptation [book review of *Sex Ratios: Concepts and Research Methods*]. *Evolution* 56:2561-2564.
 74. Frank, S. A. 2002. Immune response to parasitic attack: evolution of a pulsed character. *Journal of Theoretical Biology* 219:281-290.
 73. Frank, S. A. 2002. George Price. Pages 930-931 in *Encyclopedia of Evolution*, M. Pagel, ed. Oxford University Press.
 72. Frank, S. A. 2001. Multiplicity of infection and the evolution of hybrid incompatibility in segmented viruses. *Heredity* 87:522-529.
 71. Frank, S. A. & Barr, C. M. 2001. Spatial dynamics of cytoplasmic male sterility. Pages 219-243 in *Integrating Ecology and Evolution in a Spatial Context*, J. Silvertown and J. Antonovics, eds. Blackwell Scientific, Oxford.
 70. Frank, S. A. & Jeffrey, J. S. 2001. The probability of severe disease in zoonotic and commensal infections. *Proceedings of the Royal Society of London B* 268:53-60.
 69. Frank, S. A. 2000. Within-host spatial dynamics of viruses and defective interfering particles. *Journal of Theoretical Biology* 206:279-290.
 68. Frank, S. A. 2000. Polymorphism of attack and defense. *Trends in Ecology and Evolution* 15:167-171.
 67. Frank, S. A. 2000. Specific and non-specific defense against parasitic attack. *Journal of*

- Theoretical Biology* 202:283–304.
- 66. Frank, S. A. 2000. Sperm competition and female avoidance of polyspermy mediated by sperm-egg biochemistry. *Evolutionary Ecology Research* 2:613–625.
 - 65. Frank, S. A. 1999. Development of colony phenotype in social insects controlled by frequency-dependent thresholds among workers. *Evolutionary Ecology Research* 1:1003–1007.
 - 64. Frank, S. A. 1999. A model for the sequential dominance of antigenic variants in African trypanosome infections. *Proceedings of the Royal Society of London B* 266:1397–1401.
 - 63. Frank, S. A. 1999. Population and quantitative genetics of regulatory networks. *Journal of Theoretical Biology* 197:281–294.
 - 62. Frank, S. A. 1998. Inducible defence and the social evolution of herd immunity. *Proceedings of the Royal Society of London B* 265:1911–1913.
 - 61. Frank, S. A. & Amarasekare, P. 1998. Increasing resource specialization among competitors shifts control of diversity from local to spatial processes. *Ecology Letters* 1:3–5.
 - 60. Frank, S. A. 1998. Dynamics of cytoplasmic incompatibility with multiple *Wolbachia* infections. *Journal of Theoretical Biology* 192:213–218.
 - 59. Frank, S. A. 1998. *Foundations of Social Evolution*. Princeton University Press.
 - 58. Frank, S. A. 1997. Multivariate analysis of correlated selection and kin selection, with an ESS maximization method. *Journal of Theoretical Biology* 189:307–316.
 - 57. Frank, S. A. 1997. The Price Equation, Fisher's fundamental theorem, kin selection, and causal analysis. *Evolution* 51:1712–1729.
 - 56. Frank, S. A. 1997. Models of symbiosis. *American Naturalist* 150:S80–S99.
 - 55. Frank, S. A. 1997. Cytoplasmic incompatibility and population structure. *Journal of Theoretical Biology* 184:327–330.
 - 54. Frank, S. A. 1997. The design of adaptive systems: optimal parameters for variation and selection in learning and development. *Journal of Theoretical Biology* 184:31–39.
 - 53. Frank, S. A. 1997. Developmental selection and self-organization. *BioSystems* 40:237–243.
 - 52. Frank, S. A. 1997. Spatial processes in host-parasite genetics. Pages 325–352 in *Metapopulation Biology: Ecology, Genetics, and Evolution*, I. Hanski & M. Gilpin, eds. Academic Press, New York.
 - 51. Frank, S. A. 1996. Policing and group cohesion when resources vary. *Animal Behaviour* 52:1163–1169.
 - 50. Frank, S. A. & Hurst, L. D. 1996. Mitochondria and male disease. *Nature* 383:224.

49. Frank, S. A. 1996. Host control of symbiont transmission: the separation of symbionts into germ and soma. *American Naturalist* 148:1113-1124.
48. Frank, S. A. 1996. Host-symbiont conflict over the mixing of symbiotic lineages. *Proceedings of the Royal Society of London B* 263:339-344.
47. Taylor, P. D. & Frank, S. A. 1996. How to make a kin selection model. *Journal of Theoretical Biology* 180:27-37.
46. Frank, S. A. 1996. Problems inferring the specificity of plant-pathogen genetics [a reply to M. Parker]. *Evolutionary Ecology* 10:323-325.
45. Frank, S. A. 1996. Statistical properties of polymorphism in host-parasite genetics. *Evolutionary Ecology* 10:307-317.
44. Frank, S. A. 1996. The design of natural and artificial adaptive systems. Pages 451-505 in *Adaptation*, M. R. Rose & G. V. Lauder, eds. Academic Press, New York.
43. Frank, S. A. 1996. Models of parasite virulence. *Quarterly Review of Biology* 71:37-78.
42. Frank, S. A. 1995. The origin of synergistic symbiosis. *Journal of Theoretical Biology* 176: 403-410.
41. Frank, S. A. 1995. Mutual policing and repression of competition in the evolution of cooperative groups. *Nature* 377:520-522.
40. Frank, S. A. 1995. George Price's contributions to evolutionary genetics. *Journal of Theoretical Biology* 175:373-388.
39. Frank, S. A. 1995. Sex allocation in solitary bees and wasps. *American Naturalist* 146:316-323.
38. Frank, S. A. 1994. Recognition and polymorphism in host-parasite genetics. *Philosophical Transactions of the Royal Society of London B* 346:283-293.
37. Frank, S. A. 1994. Kin selection and virulence in the evolution of protocells and parasites. *Proceedings of the Royal Society of London B* 258:153-161.
36. Frank, S. A. 1994. Genetics of mutualism: the evolution of altruism between species. *Journal of Theoretical Biology* 170:393-400.
35. Frank, S. A. 1994. Polymorphism of bacterial restriction-modification systems: the advantage of diversity. *Evolution* 48:1470-1477.
34. Frank, S. A. 1994. Spatial polymorphism of bacteriocins and other allelopathic traits. *Evolutionary Ecology* 8:369-386.
33. Olivieri, I. & Frank, S. A. 1994. The evolution of nodulation in *Rhizobium*: altruism in the rhizosphere. *Journal of Heredity* 85:46-47.
32. Frank, S. A. 1994. Coevolutionary genetics of hosts and parasites with quantitative inheritance. *Evolutionary Ecology* 8:74-94.

31. Frank, S. A. 1993. Evolution of host-parasite diversity. *Evolution* 47:1721-1732.
30. Frank, S. A. 1993. Specificity versus detectable polymorphism in host-parasite genetics. *Proceedings of the Royal Society of London B* 254:191-197.
29. Frank, S. A. 1993. A model of inducible defense. *Evolution* 47:325-327.
28. Frank, S. A. 1993. Coevolutionary genetics of plants and pathogens. *Evolutionary Ecology* 7:45-75.

27. Frank, S. A. 1992. A kin selection model for the evolution of virulence. *Proceedings of the Royal Society of London B* 250:195-197.
26. Frank, S. A. 1992. Models of plant-pathogen coevolution. *Trends in Genetics* 8:213-219.
25. Frank, S. A. & Slatkin, M. 1992. Fisher's fundamental theorem of natural selection. *Trends in Ecology and Evolution* 7:92-95.

24. Frank, S. A. 1991. Haldane's rule: a defense of the meiotic drive theory. *Evolution* 45:1714-1717.
23. Frank, S. A. 1991. Ecological and genetic models of host-pathogen coevolution. *Heredity* 67:73-83.
22. Frank, S. A. 1991. Divergence of meiotic drive-suppression systems as an explanation for sex-biased hybrid sterility and inviability. *Evolution* 45:262-267.
21. Frank, S. A. 1991. Spatial variation in coevolutionary dynamics. *Evolutionary Ecology* 5:193-217.

20. Frank, S. A. 1990. Sex allocation theory for birds and mammals. *Annual Review of Ecology and Systematics* 21:13-55.
19. Frank, S. A. & Slatkin, M. 1990. Evolution in a variable environment. *American Naturalist* 136:244-260.
18. Frank, S. A. 1990. When to copy or avoid an opponent's strategy. *Journal of Theoretical Biology* 145:41-46.
17. Frank, S. A. & Slatkin, M. 1990. The distribution of allelic effects under mutation and selection. *Genetical Research* 55:111-117.
16. Slatkin, M. & Frank, S. A. 1990. The quantitative genetic consequences of pleiotropy under stabilizing and directional selection. *Genetics* 125:207-213.

15. Frank, S. A. 1989. Ecological and evolutionary dynamics of fig communities. *Experientia* 45:674-680.
14. Frank, S. A. & Crespi, B. J. 1989. Synergism between sib rearing and sex ratio in Hymenoptera. *Behavioral Ecology and Sociobiology*. 24:155-162.
13. Frank, S. A. 1989. The evolutionary dynamics of cytoplasmic male sterility. *American*

- Naturalist 133:345–376.
12. Frank, S. A. & Swingland, I. R. 1988. Sex ratio under conditional sex expression. *Journal of Theoretical Biology* 135:415–418
 11. Frank, S. A. 1987. Demography and sex ratio in social spiders. *Evolution* 41:1267–1281
 10. Frank, S. A. 1987. Variable sex ratio among colonies of ants. *Behavioral Ecology and Sociobiology* 20:195–201.
 9. Frank, S. A. 1987. Individual and population sex allocation patterns. *Theoretical Population Biology* 31:47–74.
 8. Frank, S. A. 1987. Weapons and fighting in fig wasps. *Trends in Ecology and Evolution* 2:259–260.
 7. Frank, S. A. 1986. Dispersal polymorphisms in subdivided populations. *Journal of Theoretical Biology* 122:303–309.
 6. Frank, S. A. 1986. The genetic value of sons and daughters. *Heredity* 56:351–354.
 5. Frank, S. A. 1986. Hierarchical selection theory and sex ratios. I. General solutions for structured populations. *Theoretical Population Biology* 29:312–342.
 4. Frank, S. A. 1985. Hierarchical selection theory and sex ratios. II. On applying the theory, and a test with fig wasps. *Evolution* 39:949–964.
 3. Frank, S. A. 1985. Are mating and mate competition by the fig wasp *Pegoscapus assuetus* (Agaonidae) random within a fig? *Biotropica* 17:170–172.
 2. Frank, S. A. 1984. The behavior and morphology of the fig wasps *Pegoscapus assuetus* and *P. jimenezi*: Descriptions and suggested behavioral characters for phylogenetic studies. *Psyche* 91:289–308.
 1. Frank, S. A. 1983. A hierarchical view of sex-ratio patterns. *Florida Entomologist* 66:42–75.