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**Curriculum Vitae**  
**STEVEN A. FRANK**

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*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),<br>& 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>**

*Preprints & Manuscripts*

188. Frank, S. A. & Yanai, I. 2024. The origin of novel traits in cancer. (*submitted*)
187. Frank, S. A. 2024. Response circuits in biology. I. Machine learning analogies. (*in prep*)
186. Frank, S. A. 2024. A biological circuit to anticipate trend. [arXiv:2404.09089](https://arxiv.org/abs/2404.09089).

*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. Kümmerli, 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* **11**:1010278.

- ogy 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. *F1000-Research* 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 B<sub>12</sub>, 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? *F1000-Research* 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 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., Stoenner, 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  $\alpha$ -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.
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