

**MARTIN A. NOWAK**  
**Curriculum Vitae**

**Personal Information**

Name: Martin Andreas Nowak  
Address: Program for Evolutionary Dynamics, Harvard University  
Cambridge, Massachusetts, United States  
Phone: (617) 496-4683  
Fax: (617) 496-4629  
Email: martin\_nowak@harvard.edu  
Website: ped.fas.harvard.edu & martinnowak.com  
Degrees: M.Sc. Vienna  
Ph.D. Vienna  
M.A. (honoris causa) Oxford  
A.M. (honoris causa) Harvard  
Ph.D. (honoris causa) Cuza University of Iasi  
Ph.D. (honoris causa) Dominican School of Philosophy and Theology

**Current Position**

Professor, Mathematics and Biology, Harvard University  
Director, Program for Evolutionary Dynamics, Harvard University

**Education**

1975-1983 Albertus Magnus Gymnasium in Vienna  
1983-1989 University of Vienna, studying Biochemistry and Mathematics  
1985 First Diploma: Biochemistry (first class honors)  
1987 Diploma thesis: Theoretical Chemistry  
1987 Second Diploma: Biochemistry (first class honors; finished one year faster)  
1987-1989 Doctoral thesis: Mathematics  
1989 Final exams for degree *Doctor rerum naturalium* (with highest honors)

**Scientific Career**

*Vienna:*

1987-1988 Institute for Theoretical Chemistry, Peter Schuster  
1987-1989 Institute for Mathematics, Karl Sigmund  
1988 Max Planck Institute for Biophysical Chemistry, Göttingen, Manfred Eigen  
1993 "Habilitation" at the Institute of Mathematics, University of Vienna

*Oxford:*

1989-1990 Erwin Schrödinger Scholarship to work with Robert May (Lord May of Oxford)  
1990-1992 Guy Newton Junior Research Fellow, Wolfson College  
1991 Royal Society Research Grant  
1992-1998 Wellcome Trust Senior Research Fellow in Biomedical Sciences  
1993-1996 E. P. Abraham Junior Research Fellow, Keble College  
1995-1998 Head of Mathematical Biology Group  
1996-1998 Senior Research Fellow, Keble College  
1997-1998 Professor of Mathematical Biology

*Princeton:*

1998-2003 Head, Program in Theoretical Biology, Institute for Advanced Study  
1999-2003 Associated Faculty, Princeton University, Ecology and Evolutionary Biology  
2000-2003 Associated Faculty, Princeton University, Program in Applied and Computational Mathematics

*Harvard:*

2003 - Professor, Biology and Mathematics  
Director, Program for Evolutionary Dynamics

### Prizes, Named Lectures, Memberships

1990 *Promotion sub auspiciis praesidentis rei publicae* (a distinction given to those who have passed all major exams during school and university with the best mark)

1990 Prize from the Austrian Science Minister

1995 Richardson Lecture, Keble College

1996 Weldon Memorial Prize (given every 2-3 years for outstanding contributions to Biometric Science; previous winners include: Ronald Fisher, JBS Haldane, Sewall Wright, Motoo Kimura, Robert May, David Cox)

1997 Shanks Lecture, Vanderbilt University, Nashville, Tennessee

1998 Albert Wander Prize and Memorial Lecture, University of Bern, Switzerland

1999 Porter Lecture, Rice University, Houston, Texas

1999 Erwin Schroedinger Lecture, University of Vienna, Austria

1999 Akira Okubo Prize, International and Japanese Society for Mathematical Biology

1999 Roger F. Murray Prize, Institute for Quantitative Research in Finance

2000 Gergen Lecture, Duke University

2001 Benjamin Pinkel Lecture, University of Pennsylvania

2001 Corresponding Member, Austrian Academy of Sciences

2001 Rainich Lectures, University of Michigan, Ann Arbor

2001 David Starr Jordan Prize, Stanford University, Cornell University, Indiana University

2003 Henry Dale Prize, The Royal Institution, London

2006 Invited Lecture, Congress for Mathematics, Madrid

2006 R.R. Hawkins Award for *Evolutionary Dynamics*, Professional and Scholarly Publishing Division of the American Association of Publishers

2007 Radon Lecture, Austrian Academy of Sciences

2008 Coxeter Lectures, Fields Institute, Toronto

2010 Templeton Lectures, Johns Hopkins University

2010 Doctor Honoris Causa, Alexandru Ioan Cuza University of Iasi, Romania

2011 Max Planck Lecture, Stuttgart, Germany

2012 MBI 10th Anniversary Keynote talk, Ohio State University

2012 Plenary speaker, Canadian Mathematical Society

2013 Plenary speaker, International Congress of Ecology, London, England

2013 Simons Lecture, Institute for Mathematics and its Applications, The Simons Foundation, Minneapolis

2013 Andre-Aisenstadt Chair, Centre de Recherches Mathématiques, Montreal

2014 Plenary Opening Talk, Nephrology Conference, Baden, Austria

2014 Keynote Lecture, 11th Austrian Research and Innovation Talk (ARIT), MIT Media Lab

2015 Plenary speaker, Collins Lecture Series, Massachusetts General Hospital

2015 Plenary speaker, Drug Discovery and World Therapy Congress, Boston

2016 Invited Lecture, Fermilab, Illinois

2016 Sewall Wright Speaker, University of Chicago

2016 Fannie Cox Prize for Excellence in Science Teaching

2017 AACR Team Science Award

2018 The Edmund R. Michalik Distinguished Lecture Series, University of Pittsburgh

### Research Interests

Evolutionary dynamics  
Cancer evolution and treatment  
Infection dynamics  
Quasispecies theory  
Genetic redundancy  
Evolutionary game theory  
Adaptive dynamics

Finite populations  
Evolutionary graph theory  
Evolutionary set theory  
Evolution of language  
Cooperation, fairness, reputation  
Indirect reciprocity  
Group selection  
Experimental games  
Origin of evolution, prolife  
Evolution of eusociality

## Books

**Nowak M. A** & R. M. May (2000). *Virus Dynamics: Mathematical Principles of Immunology and Virology*. Oxford: Oxford University Press.

**Nowak, M. A.** (2006). *Evolutionary Dynamics: Exploring the Equations of Life*. Cambridge, MA: Harvard University Press.

**Nowak, M. A.** & R. Highfield (2011). *SuperCooperators: Why We Need Each Other to Succeed*. Simon & Schuster.

Coakley, S. & **M. A. Nowak**, eds. (2013). *Evolution, Games, and God: The Principle of Cooperation*. Harvard University Press.

## Selected Publications

Hauser, O.P., Hilbe, C., Chatterjee, K., & **Nowak, M. A.** (2019). Social dilemmas among unequals. *Nature* 572: 524–527. DOI: [10.1038/s41586-019-1488-5](https://doi.org/10.1038/s41586-019-1488-5)

Gruber, M., Bozic, I., Leshchiner, I., Livitz, D., Stevenson, K., Rassenti, L., Rosebrock, D., Taylor-Weiner, A., Olive, O., Goyetche, R., Fernandes, S.M., Sun, J., Stewart, C., Wong, A., Cibulskis, C., Zhang, W., Reiter, J.G., Gerold, J.M., Gribben, J.G., Rai, K.R., Keating, M.J., Brown, J.R., Neuberg, D., Kipps, T.J., **Nowak, M.A.**, Getz, G. & C.J. Wu (2019). Growth dynamics in naturally progressing chronic lymphocytic leukaemia. *Nature* 570: 474–479. DOI: [10.1038/s41586-019-1252-x](https://doi.org/10.1038/s41586-019-1252-x)

Reiter, J. G., Makohon-Moore, A. P., Gerold, J. M., Heyde, A., Attiyeh, M. A., Kohutek, Z. A., Tokheim, C. J., Brown, A., DeBlasio, R. M., Niyazov, J., Zucker, A., Karchin, R., Zinkler, K. W., Iacobuzio-Donahue, C.A., Vogelstein, B. & **Nowak, M.A.** (2018). Minimal functional driver gene heterogeneity among untreated metastases. *Science* 361: 1033-1037. DOI: [10.1126/science.aat7171](https://doi.org/10.1126/science.aat7171) [PDF](#) & [SI](#)

Makohon-Moore, A. P., Matsukuma, K., Zhang, M., Reiter, J. G., Gerold, J. M., Jiao, Y., Sikkema, L., Attiyeh, M. A., Yachida, S., Sandone, C., Hruban, R. H., Klimstra, D. S., Papadopoulos, N., **Nowak, M. A.**, Kinzler, K. W., Vogelstein, B. & C.A. Iacobuzio-Donahue (2018). Precancerous neoplastic cells can move through the pancreatic ductal system. *Nature* 561: 201–205. DOI: [10.1038/s41586-018-0481-8](https://doi.org/10.1038/s41586-018-0481-8) [PDF](#) & [SI](#)

Hilbe, C., Šimsa, Š., Chatterjee, K. & **Nowak, M. A.** (2018). Evolution of cooperation in stochastic games. *Nature* 559: 246-249. DOI: [10.1038/s41586-018-0277-x](https://doi.org/10.1038/s41586-018-0277-x) [PDF](#) & [SI](#)

Hilbe, C., Chatterjee, K., & **Nowak, M. A.** (2018). Partners and rivals in direct reciprocity. *Nat. Hum. Behav.* 2: 469–477. DOI: [10.1038/s41562-018-0320-9](https://doi.org/10.1038/s41562-018-0320-9) [PDF](#) & [SI](#)

Noble C., Olejarz, J., Esvelt, K., Church, G., **Nowak, M. A.** (2017). Evolutionary dynamics of CRISPR gene drives. *Sci. Adv.* 3: e1601964. DOI: [10.1126/sciadv.1601964](https://doi.org/10.1126/sciadv.1601964) [PDF](#) & [SI](#)

- Allen, B., Lippner, G., Chen, Y.T., Fotouhi, B., Momeni, N., Yau, S.T., **Nowak**, M. A. (2017). Evolutionary dynamics on any population structure. *Nature* 544: 227–230. DOI: [10.1038/nature21723](https://doi.org/10.1038/nature21723) [PDF](#) & [SI](#)
- Landau, D., Tausch, E., Taylor-Weiner, A. N., Stewart, C., Reiter, J. G., Bahlo, J., Kluth, S., Bozic, I., Lawrence, M., Böttcher, S., Carter, S. L., Cibulskis, K., Mertens, D., Sougnez, C. L., Rosenberg, M., Hess, J. M., Edelman, J., Kless, S., Kneba, M., Ritgen, M., A., Fischer, K., Gabriel, S., Lander, E. S., **Nowak**, M. A., Döhner, H., Hallek, M., Neuberg, D., Getz, G., Stilgenbauer S. & C. J. Wu (2015). Mutations driving CLL and their evolution in progression and relapse. *Nature* 526: 525-530. DOI: [10.1038/nature15395](https://doi.org/10.1038/nature15395) [PDF](#) & [SI](#)
- Waclaw, B., Bozic, I., Pittman, M.E., Rhuban, R.H., Vogelstein, B., **Nowak**, M. A. (2015). A spatial model predicts that dispersal and cell turnover limit intratumour heterogeneity. *Nature* 525: 261-264. DOI: [10.1038/nature14971](https://doi.org/10.1038/nature14971) [PDF](#) & [SI](#)
- Hauser, O.P., Rand, D.G., Peysakhovich, A., **Nowak**, M. A. (2014). Cooperating with the future. *Nature* 511: 220-223. DOI: [10.1038/nature13530](https://doi.org/10.1038/nature13530) [PDF](#) & [SI](#)
- Rand, D.G., **Nowak**, M. A. (2013). Human cooperation. *Trends Cog. Sci.* 17: 413-425. DOI: [10.1016/j.tics.2013.06.003](https://doi.org/10.1016/j.tics.2013.06.003) [PDF](#)
- Bozic, I., Reiter, J.G., Allen, B., Antal, T., Chatterjee, K., Shah, P., Moon, Y.S., Yaqubie, A., Kelly, N., Le, D.T., Lipson, E.J., Chapman, P.B., Diaz Jr., L.A., Vogelstein, B., **Nowak**, M. A. (2013). Evolutionary dynamics of cancer in response to targeted combination therapy. *eLife* 2: e00747. DOI: [10.7554/eLife.00747](https://doi.org/10.7554/eLife.00747) [PDF](#)
- Diaz Jr., L.A., Williams, R.T., Wu, J., Kinde, I., Hecht, J.R., Berlin, J., Allen, B., Bozic, I., Reiter, J.G., **Nowak**, M. A., Kinzler, K.W., Oliner, K.S., Vogelstein, B. (2012). The molecular evolution of acquired resistance to targeted EGFR blockade in colorectal cancers. *Nature* 486: 537-540. DOI: [10.1038/nature11219](https://doi.org/10.1038/nature11219) [PDF](#) & [SI](#)
- Nowak**, M. A. (2012). Evolving cooperation. *J. Theor. Biol.* 299: 1-8. DOI: [10.1016/j.jtbi.2012.01.014](https://doi.org/10.1016/j.jtbi.2012.01.014) [PDF](#)
- Rand, D.G., Greene, J.D., **Nowak**, M. A. (2012). Spontaneous giving and calculated greed. *Nature* 489: 427-430. DOI: [10.1038/nature11467](https://doi.org/10.1038/nature11467) [PDF](#) & [SI](#)
- Rosenbloom, D.I.S., Hill, A.L., Rabi, S.A., Siliciano, R.F., **Nowak**, M. A. (2012). Antiretroviral dynamics determines HIV evolution and predicts therapy outcome. *Nat. Med.* 18: 1378-1385. DOI: [10.1038/nm.2892](https://doi.org/10.1038/nm.2892) [PDF](#) & [SI](#)
- Michel, J.B., Shen, Y.K., Presser Aiden, A., Veres, A., Gray, M.K., The Google Books Team, Pickett, J.P., Hoiberg, D., Clancy, D., Norvig, P., Orwant, J., Pinker, S., **Nowak**, M. A., Lieberman Aiden, E. (2011). Quantitative analysis of culture using millions of digitized books. *Science* 331: 176-182. DOI: [10.1126/science.1199644](https://doi.org/10.1126/science.1199644) [PDF](#)
- Nowak**, M. A., Highfield, R. (2011). *SuperCooperators: Why We Need Each Other to Succeed*. [Simon & Schuster](#)
- Yachida, S., Jones, S., Bozic, I., Antal, T., Leary, R., Fu, B., Kamiyama, M., Hruban, R.H., Eshleman, J.R., **Nowak**, M. A., Velculescu, V.E., Kinzler, K.W., Vogelstein, B., Iacobuzio-Donahue, C.A. (2010). Distant metastasis occurs late during the genetic evolution of pancreatic cancer. *Nature* 467: 1114–1117. DOI: [10.1038/nature09515](https://doi.org/10.1038/nature09515) [PDF](#) & [SI](#)
- Ohtsuki, H., Iwasa, Y., **Nowak**, M. A. (2009). Indirect reciprocity provides only a narrow margin of efficiency for costly punishment. *Nature* 457: 79-82. DOI: [10.1038/nature07601](https://doi.org/10.1038/nature07601) [PDF](#) & [SI](#)
- Rand D.G., Dreber, A., Ellingsen, T., Fudenberg, D., **Nowak**, M. A. (2009). Positive interactions promote public cooperation. *Science* 325: 1272-1275. DOI: [10.1126/science.1177418](https://doi.org/10.1126/science.1177418) [PDF](#)

Dreber, A., Rand, D.G., Fudenberg, D., **Nowak**, M. A. (2008). Winners don't punish. *Nature* 452: 348-351. DOI: [10.1038/nature06723](https://doi.org/10.1038/nature06723) [PDF](#) & [SI](#)

**Nowak**, M. A., Ohtsuki, H. (2008). Prevolutionary dynamics and the origin of evolution. *Proc. Natl. Acad. Sci. U.S.A.* 105: 14924-14927. DOI: [10.1073/pnas.0806714105](https://doi.org/10.1073/pnas.0806714105) [PDF](#)

Hauert C., Traulsen, A., Brandt, H., **Nowak**, M. A., Sigmund, K. (2007). Via freedom to coercion: The emergence of costly punishment. *Science* 316: 1905-1907. DOI: [10.1126/science.1141588](https://doi.org/10.1126/science.1141588) [PDF](#)

Lieberman E., Michel, J.B., Jackson, J., Tang, T., **Nowak**, M. A. (2007). Quantifying the evolutionary dynamics of language. *Nature* 449: 713-716. DOI: [10.1038/nature06137](https://doi.org/10.1038/nature06137) [PDF](#) & [SI](#)

**Nowak**, M. A. (2006). Five rules for the evolution of cooperation. *Science* 314: 1560-1563. DOI: [10.1126/science.1133755](https://doi.org/10.1126/science.1133755) [PDF](#)

**Nowak**, M. A. (2006). *Evolutionary Dynamics: Exploring the Equations of Life*. Cambridge, MA: [Harvard University Press](#). ([Excerpt](#), [Nature review](#), [Science review](#), [R.R. Hawkins Award](#))

Ohtsuki, H., Hauert, C., Lieberman, E., **Nowak**, M. A. (2006). A simple rule for the evolution of cooperation on graphs and social networks. *Nature* 441: 502-505. DOI: [10.1038/nature04605](https://doi.org/10.1038/nature04605) [PDF](#) & [SI](#)

Lieberman E., Hauert, C., **Nowak**, M. A. (2005). Evolutionary dynamics on graphs. *Nature* 433: 312-316. DOI: [10.1038/nature03204](https://doi.org/10.1038/nature03204) [PDF](#) & [SI](#)

Michor F., Hughes, T.P., Iwasa, Y., Branford, S., Shah, N.P., Sawyers, C.L., **Nowak**, M. A. (2005). Dynamics of chronic myeloid leukemia. *Nature* 435: 1267-1270. DOI: [10.1038/nature03669](https://doi.org/10.1038/nature03669) [PDF](#) & [SI](#)

**Nowak**, M. A., Sigmund, K. (2005). Evolution of indirect reciprocity. *Nature* 437: 1291-1298. DOI: [10.1038/nature04131](https://doi.org/10.1038/nature04131) [PDF](#)

**Nowak**, M. A., Michor, F., Iwasa, Y. (2004). Evolutionary dynamics of tumor suppressor gene inactivation. *Proc. Natl. Acad. Sci. U.S.A.* 101: 10635-10638. DOI: [10.1073/pnas.0400747101](https://doi.org/10.1073/pnas.0400747101) [PDF](#)

**Nowak**, M. A., Sasaki, A., Taylor, C., Fudenberg, D. (2004). Emergence of cooperation and evolutionary stability in finite populations. *Nature* 428: 646-650. DOI: [10.1038/nature02414](https://doi.org/10.1038/nature02414) [PDF](#)

**Nowak**, M. A., Sigmund, K. (2004). Evolutionary dynamics of biological games. *Science* 303: 793-799. DOI: [10.1126/science.1093411](https://doi.org/10.1126/science.1093411) [PDF](#)

Wei X., Decker, J.M., Wang, S., Hui, H., Kappes, J.C., Xiaoyun, W., Salazar, J.F., Salazar, M.G., Kilby, J.M., Saag, M.S., Komarova, N.L., **Nowak**, M. A., Hahn, B.H., Kwong, P.D., Shaw, G.M. (2003). Antibody neutralization and escape by HIV-1. *Nature* 422: 307-312. DOI: [10.1038/nature01470](https://doi.org/10.1038/nature01470) [PDF](#) & [SI](#)

**Nowak**, M. A., Komarova, N.L., Niyogi, P. (2002). Computational and evolutionary aspects of language. *Nature* 417: 611-617. DOI: [10.1038/nature00771](https://doi.org/10.1038/nature00771) [PDF](#)

**Nowak**, M. A., Komarova, N.L., Sengupta, A., Jallepalli, P.F., Shih, I.M., Vogelstein, B., Lengauer, C. (2002). The role of chromosomal instability in tumor initiation. *Proc. Natl. Acad. Sci. U.S.A.* 99: 16226-16231. DOI: [10.1073/pnas.202617399](https://doi.org/10.1073/pnas.202617399) [PDF](#)

**Nowak**, M. A., Komarova, N.L., Niyogi, P. (2001). Evolution of universal grammar. *Science* 291: 114-118. DOI: [10.1126/science.291.5501.114](https://doi.org/10.1126/science.291.5501.114) [PDF](#)

**Nowak**, M. A., May, R.M. (2000). *Virus Dynamics: Mathematical Principles of Immunology and Virology*. [Oxford University Press](#).

- Nowak, M. A., Page, K.M., Sigmund, K. (2000).** Fairness versus reason in the ultimatum game. *Science* 289: 1773-1775. DOI: [10.1126/science.289.5485.1773](https://doi.org/10.1126/science.289.5485.1773) [PDF](#)
- Nowak, M. A., Plotkin, J.B., Jansen V.A.A. (2000).** The evolution of syntactic communication. *Nature* 404: 495-498. DOI: [10.1038/35006635](https://doi.org/10.1038/35006635) [PDF](#)
- Nowak, M. A., Krakauer, D. (1999).** The evolution of language. *Proc. Natl. Acad. Sci. U.S.A.* 96: 8028-8033. DOI: [10.1073/pnas.96.14.8028](https://doi.org/10.1073/pnas.96.14.8028) [PDF](#)
- Nowak, M. A., Sigmund, K. (1998).** Evolution of indirect reciprocity by image scoring. *Nature* 393: 573-577. DOI: [10.1038/31225](https://doi.org/10.1038/31225) [PDF](#)
- Bonhoeffer, S., May, R.M., Shaw, G.M., Nowak, M. A. (1997).** Virus dynamics and drug therapy. *Proc. Natl. Acad. Sci. U.S.A.* 94: 6971-6976. DOI: [10.1073/pnas.94.13.6971](https://doi.org/10.1073/pnas.94.13.6971) [PDF](#)
- Nowak, M. A., Boerlijst, M.C., Cooke, J., Maynard Smith, J. (1997).** Evolution of genetic redundancy. *Nature* 388: 167-171. DOI: [10.1038/40618](https://doi.org/10.1038/40618) [PDF](#)
- Nowak, M. A., Bangham, C.R.M. (1996).** Population dynamics of immune responses to persistent viruses. *Science* 272: 74-79. DOI: [10.1126/science.272.5258.74](https://doi.org/10.1126/science.272.5258.74) [PDF](#)
- Nowak, M. A., Bonhoeffer, S., Hill, A.M., Boehme, R., Thomas, H.C., McDade, H. (1996).** Viral dynamics in hepatitis B virus infection. *Proc. Natl. Acad. Sci. U.S.A.* 93: 4398-4402. DOI: [10.1073/pnas.93.9.4398](https://doi.org/10.1073/pnas.93.9.4398) [PDF](#)
- Nowak, M. A., May, R.M., Phillips, R.E., Rowland-Jones, S., Lalloo, D.G., McAdam, S., Klenerman, P., Köppe, B., Sigmund, K., Bangham, C.R.M., McMichael, A.J. (1995).** Antigenic oscillations and shifting immunodominance in HIV-1 infections. *Nature* 375: 606-611. DOI: [10.1038/375606a0](https://doi.org/10.1038/375606a0) [PDF](#)
- Wei, X., Ghosh, S.K., Taylor, M.E., Johnson, V.A., Emini, E.A., Deutsch, P., Lifson, J.D., Bonhoeffer, S., Nowak, M. A., Hahn, B.H., Saag, M.S., Shaw, G.M. (1995).** Viral dynamics in human immunodeficiency virus type 1 infection. *Nature* 373: 117-122. DOI: [10.1038/373117a0](https://doi.org/10.1038/373117a0) [PDF](#)
- Nowak, M. A., May, R.M. (1994).** Superinfection and the evolution of parasite virulence. *Proc. Royal Soc. B* 255: 81-89. DOI: [10.1098/rspb.1994.0012](https://doi.org/10.1098/rspb.1994.0012) [PDF](#)
- Tilman, D., May, R.M., Lehman, C.L., Nowak, M. A. (1994).** Habitat destruction and the extinction debt. *Nature* 371: 65-66. DOI: [10.1038/371065a0](https://doi.org/10.1038/371065a0) [PDF](#)
- Nowak, M. A., Sigmund, K. (1993).** A strategy of win-stay, lose-shift that outperforms tit for tat in the Prisoner's Dilemma game. *Nature* 364: 56-58. DOI: [10.1038/364056a0](https://doi.org/10.1038/364056a0) [PDF](#)
- Nowak, M. A., May, R.M. (1992).** Evolutionary games and spatial chaos. *Nature* 359: 826-829. DOI: [10.1038/359826a0](https://doi.org/10.1038/359826a0) [PDF](#)
- Nowak, M. A., Sigmund, K. (1992).** Tit for tat in heterogeneous populations. *Nature* 355: 250-253. DOI: [10.1038/355250a0](https://doi.org/10.1038/355250a0) [PDF](#)
- Nowak, M. A., Anderson, R.M., McLean, A.R., Wolfs, T.F.W., Goudsmit, J., May, R.M. (1991).** Antigenic diversity thresholds and the development of AIDS. *Science* 254: 963-969. DOI: [10.1126/science.1683006](https://doi.org/10.1126/science.1683006) [PDF](#)

## All Publications

### 1989

1. **Nowak**, M. A. & Schuster, P. (1989). Error thresholds of replication in finite populations: Mutation frequencies and the onset of Muller's ratchet. *J. Theor. Biol.* 137: 375-395. DOI: [10.1016/S0022-5193\(89\)80036-0](https://doi.org/10.1016/S0022-5193(89)80036-0) [PDF](#)
2. **Nowak**, M. A. & Sigmund, K. (1989). Game-dynamical aspects of the prisoner's dilemma. *Appl. Math. Comput.* 30: 191-213. DOI: [10.1016/0096-3003\(89\)90052-0](https://doi.org/10.1016/0096-3003(89)90052-0) [PDF](#)
3. **Nowak**, M. A. & Sigmund, K. (1989). Oscillations in the evolution of reciprocity. *J. Theor. Biol.* 137: 21-26. DOI: [10.1016/S0022-5193\(89\)80146-8](https://doi.org/10.1016/S0022-5193(89)80146-8) [PDF](#)

### 1990

4. **Nowak**, M. A. (1990). An evolutionarily stable strategy may be inaccessible. *J. Theor. Biol.* 142: 237-241. DOI: [10.1016/S0022-5193\(05\)80224-3](https://doi.org/10.1016/S0022-5193(05)80224-3) [PDF](#)
5. **Nowak**, M. A. (1990). HIV mutation rate. *Nature* 347: 522. DOI: [10.1038/347522a0](https://doi.org/10.1038/347522a0) [PDF](#)
6. **Nowak**, M. A. (1990). Stochastic strategies in the prisoner's dilemma. *Theor. Popul. Biol.* 38: 93-112. DOI: [10.1016/0040-5809\(90\)90005-G](https://doi.org/10.1016/0040-5809(90)90005-G) [PDF](#)
7. **Nowak**, M. A., May, R. M. & Anderson, R. M. (1990). The evolutionary dynamics of HIV quasispecies and the development of immunodeficiency disease. *AIDS* 4: 1095-1103. DOI: [10.1097/00002030-199011000-00007](https://doi.org/10.1097/00002030-199011000-00007) [PDF](#)
8. **Nowak**, M. A. & Sigmund, K. (1990). The evolution of stochastic strategies in the prisoner's dilemma. *Acta Appl. Math.* 20: 247-265. DOI: [10.1007/BF00049570](https://doi.org/10.1007/BF00049570) [PDF](#)

### 1991

9. Kwiatkowski, D. & **Nowak**, M. A. (1991). Periodic and chaotic host-parasite interactions in human malaria. *PProc. Natl. Acad. Sci. U.S.A.* 88: 5111-5113. DOI: [10.1073/pnas.88.12.5111](https://doi.org/10.1073/pnas.88.12.5111) [PDF](#)
10. Magurran, A.E. & **Nowak**, M. A. (1991). Another battle of the sexes: the consequences of sexual asymmetry in mating costs and predation risk in the guppy, *Poecilia reticulata*. *Proc. Royal Soc. B.* 246: 31-38. DOI: [10.1098/rspb.1991.0121](https://doi.org/10.1098/rspb.1991.0121) [PDF](#)
11. **Nowak**, M. A. (1991). The evolution of viruses. Competition between horizontal and vertical transmission of mobile genes. *J. Theor. Biol.* 150: 339-347. DOI: [10.1016/S0022-5193\(05\)80433-3](https://doi.org/10.1016/S0022-5193(05)80433-3) [PDF](#)
12. **Nowak**, M. A., Anderson, R. M., McLean, A. R., Wolfs, T. F. W., Goudsmit, J. & May, R. M. (1991). Antigenic diversity thresholds and the development of AIDS. *Science* 254: 963-969. DOI: [10.1126/science.1683006](https://doi.org/10.1126/science.1683006) [PDF](#)
13. **Nowak**, M. A. & May, R. M. (1991). Mathematical biology of HIV infections: Antigenic variation and diversity threshold. *Math. Biosci.* 106: 1-21. DOI: [10.1016/0025-5564\(91\)90037-J](https://doi.org/10.1016/0025-5564(91)90037-J) [PDF](#)
14. **Nowak**, M. A. & McLean, A. R. (1991). A mathematical model of vaccination against HIV to prevent development of AIDS. *Proc. Royal Soc. B.* 246: 141-146. DOI: [10.1098/rspb.1991.0136](https://doi.org/10.1098/rspb.1991.0136) [PDF](#)

## 1992

15. McLean, A. R. & Nowak, M. A. (1992). Competition between zidovudine sensitive and resistant strains of HIV. *AIDS* 6: 71-79. DOI: [10.1097/00002030-199201000-00009](https://doi.org/10.1097/00002030-199201000-00009) PDF
16. McLean, A. R. & Nowak, M. A. (1992). Models of interactions between HIV and other pathogens. *J. Theor. Biol.* 155: 69-86. DOI: [10.1016/S0022-5193\(05\)80549-1](https://doi.org/10.1016/S0022-5193(05)80549-1) PDF
17. Nowak, M. A. (1992). Variability in HIV infections. *J. Theor. Biol.* 155: 1-20. DOI: [10.1016/S0022-5193\(05\)80545-4](https://doi.org/10.1016/S0022-5193(05)80545-4) PDF
18. Nowak, M. A. (1992). What is a quasispecies? *Trends Ecol. Evol.* 7: 118-121. DOI: [10.1016/0169-5347\(92\)90145-2](https://doi.org/10.1016/0169-5347(92)90145-2) PDF
19. Nowak, M. A. & May, A. R. (1992). Coexistence and competition in HIV infections. *J. Theor. Biol.* 159: 329-342. DOI: [10.1016/S0022-5193\(05\)80728-3](https://doi.org/10.1016/S0022-5193(05)80728-3) PDF
20. Nowak, M. A. & R. M. May (1992). Evolutionary games and spatial chaos. *Nature* 359: 826-829. DOI: [10.1038/359826a0](https://doi.org/10.1038/359826a0) PDF
21. Nowak, M. A. & K. Sigmund (1992). Tit for tat in heterogeneous populations. *Nature* 355: 250-253. DOI: [10.1038/355250a0](https://doi.org/10.1038/355250a0) PDF
22. Nowak, M. A., Tarczy-Hornoch, K. & J. M. Austyn (1992). The optimal number of major histocompatibility complex molecules in an individual. *Proc. Natl. Acad. Sci. U.S.A.* 89: 10896-10899. DOI: [10.1073/pnas.89.22.10896](https://doi.org/10.1073/pnas.89.22.10896) PDF
23. Payne, R. J. H, Nowak, M. A. & B. S. Blumberg (1992). Analysis of a cellular model to account for the natural history of infection by the hepatitis B virus and its role in the development of primary hepatocellular carcinoma. *J. Theor. Biol.* 159: 215-240. DOI: [10.1016/S0022-5193\(05\)80703-9](https://doi.org/10.1016/S0022-5193(05)80703-9) PDF
24. Sherratt, J. A. & Nowak, M. A. (1992). Oncogenes, anti-oncogenes and the immune response to cancer: A mathematical model. *Proc. Royal Soc. B.* 248: 261-271. DOI: [10.1098/rspb.1992.0071](https://doi.org/10.1098/rspb.1992.0071) PDF

## 1993

25. Nowak, M. A. & R. M. May (1993). AIDS pathogenesis: Mathematical models of HIV and SIV infections. *AIDS* 7: S3-S18. DOI: [10.1097/00002030-199301001-00002](https://doi.org/10.1097/00002030-199301001-00002) PDF
26. Nowak, M. A. & R. M. May (1993). The spatial dilemmas of evolution. *Int. J. Bifurc. Chaos.* 3: 35-78. DOI: [10.1142/S0218127493000040](https://doi.org/10.1142/S0218127493000040) PDF
27. Nowak, M. A. & A. R. McLean (1993). Mathematical models for the pathogenesis of AIDS. In *Mathematics Applied to Biology and Medicine*, eds. J. Demongeot, V. Capasso. Winnipeg: Wuerz Publishing, 275-284.
28. Nowak, M. A. & K. Sigmund (1993). A strategy of win-stay, lose-shift that outperforms tit-for-tat in the Prisoner's Dilemma game. *Nature* 364: 56-58. DOI: [10.1038/364056a0](https://doi.org/10.1038/364056a0) PDF
29. Nowak, M. A. & K. Sigmund (1993). Chaos and the evolution of cooperation. *Proc. Natl. Acad. Sci. U.S.A.* 90: 5091-5094. DOI: [10.1073/pnas.90.11.5091](https://doi.org/10.1073/pnas.90.11.5091) PDF

## 1994

30. Berry R. M. & **Nowak**, M.A. (1994). Defective escape mutants of HIV. *J. Theor. Biol.* 171: 387-395. DOI: [10.1006/jtbi.1994.1242](https://doi.org/10.1006/jtbi.1994.1242) PDF
31. Bonhoeffer, S., & **Nowak**, M.A. (1994). Intra-host versus inter-host selection: Viral strategies of immune function impairment. *Proc. Natl. Acad. Sci. U.S.A.* 91: 8062-8066. DOI: [10.1073/pnas.91.17.8062](https://doi.org/10.1073/pnas.91.17.8062) PDF
32. Bonhoeffer, S. & **Nowak**, M.A. (1994). Mutation and the evolution of virulence. *Proc. Royal Soc. B.* 258: 133-140. DOI: [10.1098/rspb.1994.0153](https://doi.org/10.1098/rspb.1994.0153) PDF
33. May, R. M. & **Nowak**, M.A. (1994). Superinfection, metapopulation dynamics, and the evolution of diversity. *J. Theor. Biol.* 170: 95-114. DOI: [10.1006/jtbi.1994.1171](https://doi.org/10.1006/jtbi.1994.1171) PDF
34. Moxon, E. R., Rainey, P. B., **Nowak**, M. A. & R. E. Lenski (1994). Adaptive evolution of highly mutable loci in pathogenic bacteria. *Curr. Biol.* 4: 24-33. DOI: [10.1016/S0960-9822\(00\)00005-1](https://doi.org/10.1016/S0960-9822(00)00005-1) PDF
35. **Nowak**, M. A. (1994). The evolutionary dynamics of HIV infections. In *First European Congress of Mathematics: Paris, July 6-10, 1992, Vol. II*, eds. A. Joseph, F. Mignot, F. Murat, B. Prum, R. Rentschler. Basel: Birkhauser, 311-326. PDF
36. **Nowak**, M. A., Bonhoeffer, S. & R. M. May (1994). More spatial games. *Int. J. Bifurc. Chaos* 4: 33-56. DOI: [10.1142/S0218127494000046](https://doi.org/10.1142/S0218127494000046) PDF
37. **Nowak**, M. A., Bonhoeffer, S. & R. M. May (1994). Spatial games and the maintenance of cooperation. *Proc. Natl. Acad. Sci. U.S.A.* 91: 4877-4881. DOI: [10.1073/pnas.91.11.4877](https://doi.org/10.1073/pnas.91.11.4877) PDF
38. **Nowak**, M. A. & R. M. May (1994). Superinfection and the evolution of parasite virulence. *Proc. Royal Soc. B.* 255: 81-89. DOI: [10.1098/rspb.1994.0012](https://doi.org/10.1098/rspb.1994.0012) PDF
39. **Nowak**, M. A. & K. Sigmund (1994). The alternating Prisoner's Dilemma. *J. Theor. Biol.* 168: 219-226. DOI: [10.1006/jtbi.1994.1101](https://doi.org/10.1006/jtbi.1994.1101) PDF
40. Payne, R. J. H., **Nowak**, M. A. & B. S. Blumberg (1994). A cellular model to explain the pathogenesis of infection by the hepatitis B virus. *Math. Biosci.* 123: 25-58. DOI: [10.1016/0025-5564\(94\)90017-5](https://doi.org/10.1016/0025-5564(94)90017-5) PDF
41. Tilman, D., May, R. M., Lehman, C. L. & **Nowak**, M.A. (1994). Habitat destruction and the extinction debt. *Nature* 371: 65-66. DOI: [10.1038/371065a0](https://doi.org/10.1038/371065a0) PDF

## 1995

42. Bonhoeffer, S., Holmes, E.C & **Nowak**, M.A. (1995). Causes of HIV diversity. *Nature* 376: 125. DOI: [10.1038/376125a0](https://doi.org/10.1038/376125a0) PDF
43. Bonhoeffer, S., Holmes, E. C. & **Nowak**, M.A. (1995). Varying selection pressures in HIV -1 infection. *J. Acquir. Immune Defic. Syndr.* 10: 85.
44. Bonhoeffer, S. & **Nowak**, M.A. (1995). Can live attenuated virus work as post-exposure treatment? *Immunol. Today* 16: 131-135. DOI: [10.1016/0167-5699\(95\)80129-4](https://doi.org/10.1016/0167-5699(95)80129-4) PDF
45. Lipsitch, M., Herre, E. A. & **Nowak**, M.A.(1995). Host population structure and the evolution of virulence: A "law of diminishing returns." *Evolution* 49: 743-748. DOI: [10.2307/2410327](https://doi.org/10.2307/2410327) PDF

46. Lipsitch, M. & Nowak, M.A. (1995). The evolution of virulence in sexually transmitted HIV/AIDS. *J. Theor. Biol.* 174: 427-440. DOI: [10.1006/jtbi.1995.0109](https://doi.org/10.1006/jtbi.1995.0109) PDF
47. Lipsitch, M., Nowak, M. A., Ebert, D., R. M. May (1995). The population dynamics of vertically and horizontally transmitted parasites. *Proc. Royal Soc. B.* 260: 321-327. DOI: [10.1098/rspb.1995.0099](https://doi.org/10.1098/rspb.1995.0099) PDF
48. May, R. M. Bonhoeffer, S. & Nowak, M.A. (1995). Spatial games and evolution of cooperation. In *Advances in Artificial Life: Third European Conference on Artificial Life*, Granada, Spain, June 4-6, 1995, eds. F. Moran, A. Moreno, J. J. Merelo, P. Chacon. Berlin: Springer, 749-759. PDF
49. May, R. M. & Nowak, M.A. (1995). Coinfection and the evolution of parasite virulence. *Proc. Royal Soc. B.* 261: 209-215. DOI: [10.1098/rspb.1995.0138](https://doi.org/10.1098/rspb.1995.0138) PDF
50. McMichael, A. J., Rowland-Jones, S., Klenerman, P. et al (1995). Epitope variation and t-cell recognition. *J. Cell. Biochem. Suppl.* 59 (S21A): 60.
51. Nowak, M. A. (1995). AIDS pathogenesis: From models to viral dynamics in patients. *J. Acquir. Immune Defic. Syndr.* 10: S1-S5. DOI: [10.1097/00042560-199510001-00002](https://doi.org/10.1097/00042560-199510001-00002) PDF
52. Nowak, M. A. (1995). Evolutionary dynamics of HIV infections. In *Models for Infectious Human Diseases: Their Structure and Relation to Data*, eds. V. Isham & G. Medley. Cambridge: Cambridge University Press. PDF
53. Nowak, M. A., Bonhoeffer, S., Loveday, C., Balfe, P., Semple, M., Kaye, S., Tenant-Flowers, M. & R. Tedder (1995). HIV results in the frame: Results confirmed. *Nature* 375: 193. DOI: [10.1038/375193a0](https://doi.org/10.1038/375193a0) PDF
54. Nowak, M. A., May, R. M., Phillips, R. E., Rowland-Jones, S., Lalloo, D. G., McAdam, S., Klenerman, P., Köppe, B., Sigmund, K., Bangham, C. R. M. & A. J. McMichael (1995). Antigenic oscillations and shifting immunodominance in HIV-1 infections. *Nature* 375: 606-611. DOI: [10.1038/375606a0](https://doi.org/10.1038/375606a0) PDF
55. Nowak, M. A., May, R. M. & K. Sigmund (1995). Immune responses against multiple epitopes. *J. Theor. Biol.* 175: 325-353. DOI: [10.1006/jtbi.1995.0146](https://doi.org/10.1006/jtbi.1995.0146) PDF
56. Nowak, M. A., May, R. M. & K. Sigmund (1995). The arithmetics of mutual help. *Sci.Am.* 272: 76-81. DOI: [10.1038/scientificamerican0695-76](https://doi.org/10.1038/scientificamerican0695-76) PDF
57. Nowak, M. A., A. J. McMichael (1995). How HIV defeats the immune system. *Sci.Am.* 273: 58-65. DOI: [10.1038/scientificamerican0895-58](https://doi.org/10.1038/scientificamerican0895-58) PDF
58. Nowak, M. A. & K. Sigmund (1995). Invasion dynamics of the finitely repeated Prisoner's Dilemma. *Games Econ. Behav.* 11: 364-390. DOI: [10.1006/game.1995.1055](https://doi.org/10.1006/game.1995.1055) PDF
59. Nowak, M. A., Sigmund, K. & E. El-Sedy (1995). Automata, repeated games and noise. *J. Math. Biol.* 33: 703-722. DOI: [10.1007/BF00184645](https://doi.org/10.1007/BF00184645) PDF
60. Wei, X., Ghosh, S. K., Taylor, M. E., Johnson, V. A. Emini, E. A., Deutsch, P., Arnaout, R. A., Bonhoeffer, S., Nowak, M. A., Hahn, B. H., Saag, M. S. & G. M. Shaw (1995). Viral dynamics in human immunodeficiency virus type 1 infection. *Nature* 373: 117-122. DOI: [10.1038/373117a0](https://doi.org/10.1038/373117a0) PDF

## 1996

61. Antia, R., Nowak, M. A. & R. M. Anderson (1996). Antigenic variation and the within-host dynamics of parasites. *Proc. Natl. Acad. Sci. U.S.A.* 93: 985-989. DOI: [10.1073/pnas.93.3.985](https://doi.org/10.1073/pnas.93.3.985) PDF

62. Boerlijst, M. C., Bonhoeffer, S. & **Nowak**, M.A. (1996). Viral quasi-species and recombination. *Proc. R. Soc. B.* 263: 1577-1584. DOI: [10.1098/rspb.1996.0231](https://doi.org/10.1098/rspb.1996.0231) [PDF](#)
63. Bonhoeffer, S., Herz, A. M. V., Boerlijst, M. C., Nee, S., **Nowak**, M. A. & R. M. May (1996). Explaining "linguistic features" of noncoding DNA. *Science* 271: 14-15. DOI: [10.1126/science.271.5245.14b](https://doi.org/10.1126/science.271.5245.14b) [PDF](#)
64. Bonhoeffer, S., Herz, A. M. V., Boerlijst, M. C., Nee, S., **Nowak**, M. A. & R. M. May (1996). No signs of hidden language in noncoding DNA. *Phys. Rev. Lett.* 76: 1977. DOI: [10.1103/PhysRevLett.76.1977](https://doi.org/10.1103/PhysRevLett.76.1977) [PDF](#)
65. Herz, A. V. M., Bonhoeffer, S., Anderson, R. M., May, R. M. & **Nowak**, M.A. (1996). Viral dynamics in vivo: Limitations on estimates of intracellular delay and virus decay. *Proc. Natl. Acad. Sci. U.S.A.* 93: 7247-7251. DOI: [10.1073/pnas.93.14.7247](https://doi.org/10.1073/pnas.93.14.7247) [PDF](#)
66. Klenerman, P., Phillips, R. E., Rinaldo, C. R., Wahl, L. M., Ogg, G., May, R. M., McMichael, A. J. & **Nowak**, M.A. (1996). Cytotoxic T lymphocytes and viral turnover in HIV type 1 infection. *Proc. Natl. Acad. Sci. U.S.A.* 93: 15323-15328. DOI: [10.1073/pnas.93.26.15323](https://doi.org/10.1073/pnas.93.26.15323) [PDF](#)
67. Lipsitch, M., Siller, S. & **Nowak**, M.A. (1996). The evolution of virulence in pathogens with vertical and horizontal transmission. *Evolution* 50: 1729-1741. DOI: [10.2307/2410731](https://doi.org/10.2307/2410731) [PDF](#)
68. McMichael, A.J., Goulder, P., Rowland-Jones, S., **Nowak**, M. A. & R. Philips (1996). HIV escapes from cytotoxic lymphocytes. *Immunology* 89: 111.
69. **Nowak**, M. A. (1996). Immune responses against multiple epitopes: A theory for immunodominance and antigenic variation. *Semin. Virol.* 7: 83-92. DOI: [10.1006/smyv.1996.0010](https://doi.org/10.1006/smyv.1996.0010) [PDF](#)
70. **Nowak**, M. A., Anderson, R. M., Boerlijst, M. C., Bonhoeffer, S., May, R. M. & A. J. McMichael (1996). HIV-1 evolution and disease progression. *Science* 274: 1008-1011. DOI: [10.1126/science.274.5289.1008](https://doi.org/10.1126/science.274.5289.1008) [PDF](#)
71. **Nowak**, M. A. & C. R. M. Bangham (1996). Population dynamics of immune responses to persistent viruses. *Science* 272: 74-79. DOI: [10.1126/science.272.5258.74](https://doi.org/10.1126/science.272.5258.74) [PDF](#)
72. **Nowak**, M. A., Bonhoeffer, S., Hill, A. M., Boehme, R., Thomas, H. C. & H. McDade (1996). Viral dynamics in hepatitis B virus infection. *Proc. Natl. Acad. Sci. U.S.A.* 93: 4398-4402. DOI: [10.1073/pnas.93.9.4398](https://doi.org/10.1073/pnas.93.9.4398) [PDF](#)
73. **Nowak**, M. A., Bonhoeffer, S. & R. M. May (1996). Reply to Robustness of cooperation, A. Mukherji, V. Rajan & J. Slagle. *Nature* 379: 126. DOI: [10.1038/379126a0](https://doi.org/10.1038/379126a0) [PDF](#)
74. Payne, R. J. H., **Nowak**, M. A. & B. S. Blumberg (1996). The dynamics of hepatitis B virus infection. *Proc. Natl. Acad. Sci. U.S.A.* 93: 6542-6546. DOI: [10.1073/pnas.93.13.6542](https://doi.org/10.1073/pnas.93.13.6542) [PDF](#)
75. Stekel, D. J., **Nowak**, M. A. & T. R. E. Southwood (1996). Prediction of future BSE spread. *Nature* 381: 119. DOI: [10.1038/381119a0](https://doi.org/10.1038/381119a0) [PDF](#)
76. Tilman, D., Lehman, C., May, R. M. & **Nowak**, M. A. (1996). Reply to Species fragmentation or area loss? S. Budiansky. *Nature* 382: 216. DOI: [10.1038/382216a0](https://doi.org/10.1038/382216a0) [PDF](#)
- 1997**
77. Bittner, B., Bonhoeffer, S. & **Nowak**, M. A. (1997). Virus load and antigenic diversity. *Bull. Math. Biol.* 59: 881-896. DOI: [10.1016/S0092-8240\(97\)00034-7](https://doi.org/10.1016/S0092-8240(97)00034-7) [PDF](#)

78. Boerlijst, M. C., **Nowak**, M. A. & K. Sigmund (1997). Equal pay for all prisoners. *Am. Math. Mon.* 104:303-305. DOI: [10.2307/2974578](https://doi.org/10.2307/2974578) [PDF](#)
79. Boerlijst, M. C., **Nowak**, M. A. & K. Sigmund (1997). The logic of contrition. *J. Theor. Biol.* 185: 281-293. DOI: [10.1006/jtbi.1996.0326](https://doi.org/10.1006/jtbi.1996.0326) [PDF](#)
80. Bonhoeffer, S., Coffin, J. M. & **Nowak**, M. A. (1997). Human immunodeficiency virus drug therapy and virus load. *J. Virol.* 71: 3275-3278. [PDF](#)
81. Bonhoeffer, S., May, R. M., Shaw, G. M. & **Nowak**, M. A. (1997). Virus dynamics and drug therapy. *Proc. Natl. Acad. Sci. U.S.A.* 94: 6971-6976. DOI: [10.1073/pnas.94.13.6971](https://doi.org/10.1073/pnas.94.13.6971) [PDF](#)
82. Bonhoeffer, S. & **Nowak**, M. A. (1997). Pre-existence and emergence of drug resistance in HIV-1 infection. *Proc. Royal Soc. B.* 264: 631-637. DOI: [10.1098/rspb.1997.0089](https://doi.org/10.1098/rspb.1997.0089) [PDF](#)
83. Chun, T-W., Stuyver, L., Mizell, S. B., Ehler, L. A., Mican, J. A. M., Baseler, M., Lloyd, A. L., **Nowak**, M. A. & A. S. Fauci (1997). Presence of an inducible HIV-1 latent reservoir during highly active antiretroviral therapy. *Proc. Natl. Acad. Sci. U.S.A.* 94: 13193-13197. DOI: [10.1073/pnas.94.24.13193](https://doi.org/10.1073/pnas.94.24.13193) [PDF](#)
84. Cooke, J., **Nowak**, M. A., Boerlijst, M. C. & J. Maynard-Smith (1997). Evolutionary origins and maintenance of redundant gene expression during metazoan development. *Trends Genet.* 13: 360-364. DOI: [http://dx.doi.org/10.1016/S0168-9525\(97\)01233-X](http://dx.doi.org/10.1016/S0168-9525(97)01233-X) [PDF](#)
85. Goulder P. J. R., Phillips, R. E., Colbert, R. A., McAdam, S., Ogg, G., **Nowak**, M. A., Giangrande, P., Luzzi, G., Morgan, B., Edwards, A., McMichael, A. J. & S. Rowland-Jones (1997) Late escape from an immunodominant cytotoxic T-lymphocyte response associated with progression to AIDS. *Nat. Med.* 3:212-217. DOI: [10.1038/nm0297-212](https://doi.org/10.1038/nm0297-212) [PDF](#)
86. Goulder P. J. R., Price, D., **Nowak**, M. A., Rowland-Jones, S., Phillips, R. & A. McMichael (1997). Co-evolution of human immunodeficiency virus and cytotoxic T-lymphocyte responses. *Immunol. Rev.* 159:17-29. DOI: [10.1111/j.1600-065X.1997.tb01004.x](https://doi.org/10.1111/j.1600-065X.1997.tb01004.x) [PDF](#)
87. Arnaout, R. A., **Nowak**, M. A., Goldstein, S., Rossio, J. L., Kinter, A., Vasquez, G., Wiltrout, T. A., Brown, C., Schneider, D., Wahl, L., Lloyd, A. L., Williams, J., Elkins, W. R., Fauci, A. S. & V. M. Hirsch (1997). The extent of early viral replication is a critical determinant of the natural history of simian immunodeficiency virus infection. *J. Virol.* 71: 9508-9514. [PDF](#)
88. May, R. M., Stekel, D. J. & **Nowak**, M. A. (1997). Antigenic diversity thresholds and hazard functions. *Math. Biosci.* 139: 59-68. DOI: [10.1016/S0025-5564\(96\)00141-1](https://doi.org/10.1016/S0025-5564(96)00141-1) [PDF](#)
89. **Nowak**, M. A., Boerlijst, M. C., Cooke, J. & J. Maynard Smith (1997). Evolution of genetic redundancy. *Nature* 388: 167-171. DOI: [10.1038/40618](https://doi.org/10.1038/40618) [PDF](#)
90. **Nowak**, M. A., Bonhoeffer, S., Shaw, G. M. & R. M. May (1997). Anti-viral drug treatment: Dynamics of resistance in free virus and infected cell populations. *J. Theor. Biol.* 184: 203-217. DOI: [10.1006/jtbi.1996.0307](https://doi.org/10.1006/jtbi.1996.0307) [PDF](#)
91. **Nowak**, M. A., Lloyd, A. L., Vasquez, G. M., Wiltrout, T. A., Wahl, L. M., Bischofberger, N., Williams, J., Kinter, A., Fauci, A. S., Hirsch, V. M. & J. D. Lifson (1997). Viral dynamics of primary viremia and antiretroviral therapy in simian immunodeficiency virus infection. *J. Virol.* 71: 7518-7525. [PDF](#)
92. Sigmund, K. & **Nowak**, M.A. (1997). The natural history of mutual aid: An eye for an eye, and a meal for a meal. In *Wissenschaft als Kultur*, ed. F. Stadler. New York: Springer, 259-272.

93. Stekel, D., Parker, C. E. & **Nowak**, M.A. (1997). A model of lymphocyte recirculation. *Immunol. Today* 18: 216-221. DOI: [10.1016/S0167-5699\(97\)01036-0](https://doi.org/10.1016/S0167-5699(97)01036-0) [PDF](#)
94. Wein, L. M., Zenios, S. A. & **Nowak**, M.A. (1997). Dynamic multidrug therapies for HIV: A control theoretic approach. *J. Theor. Biol.* 185: 15-29. DOI: [10.1006/jtbi.1996.0253](https://doi.org/10.1006/jtbi.1996.0253) [PDF](#)
- 1998**
95. Goh, W. C., Rogel, M. E., Kinsey, C. M., Michael, S. F., Fultz, P. N., **Nowak**, M. A. Hahn, B. H. & M. Emerman (1998). HIV-1 Vpr increases viral expression by manipulation of the cell cycle: A mechanism for selection of Vpr in vivo. *Nat. Med.* 4: 65-71. DOI: [10.1038/nm0198-065](https://doi.org/10.1038/nm0198-065) [PDF](#)
96. Kilby, J., M. Hopkins, S., Venetta, T. M., DiMassimo, B., Cloud, G. A., Lee, J. Y., Alldredge, L., Hunter, E., Lambert, D., Bolognesi, D., Matthews, T., Johnson, M. R., **Nowak**, M. A., Shaw, G. M. & M. S. Saag (1998). Potent suppression of HIV-1 replication in humans by T-20, a peptide inhibitor of gp41-mediated virus entry. *Nat. Med.* 4: 1302-1307. DOI: [10.1038/3293](https://doi.org/10.1038/3293) [PDF](#)
97. Levin, B. R., Antia, R., Berliner, E., Bloland, P., Bonhoeffer, S., Cohen, M., DeRouin, T., Fields, P. I., Jafari, Jernigan, H. D., Lipsitch, M., McGowan, J. E., Mead, P., **Nowak**, M. A., Porco, T., Sykora, P., Simonsen, L., Spitznagel, J., Tauxe, R. & F. Tenover (1998). Resistance to antimicrobial chemotherapy: A prescription for research and action. *Am. J. Med. Sci.* 315: 87-94. DOI: [10.1097/00000441-199802000-00004](https://doi.org/10.1097/00000441-199802000-00004) [PDF](#)
98. **Nowak**, M. A., Krakauer, D. C., Klug, A. & R. M. May (1998). Prion infection dynamics. *Integr. Biol.* 1: 3-15. DOI: [10.1002/\(sici\)1520-6602\(1998\)1:1%3C3::aid-inbi2%3E3.3.co;2-0](https://doi.org/10.1002/(sici)1520-6602(1998)1:1%3C3::aid-inbi2%3E3.3.co;2-0) [PDF](#)
99. **Nowak**, M. A. & Sigmund, K. (1998). Darwins Dynamik. *DMV-Mitteilungen* 4: 37-44. [PDF](#)
100. **Nowak**, M. A. & K. Sigmund (1998). Evolution of indirect reciprocity by image scoring. *Nature* 393: 573-577. DOI: [10.1038/31225](https://doi.org/10.1038/31225) [PDF](#)
101. **Nowak**, M. A. & K. Sigmund (1998). The dynamics of indirect reciprocity. *J. Theor. Biol.* 194: 561-574. DOI: [10.1006/jtbi.1998.0775](https://doi.org/10.1006/jtbi.1998.0775) [PDF](#)
102. **Nowak**, M. A. & K. Sigmund (1998). What two legs can learn from four legs. Book review of Foundations of Social Evolution, S. A. Frank; Cooperation Among Animals, A. L. Dugatkin. *Nature* 395: 760-761. DOI: [10.1038/27368](https://doi.org/10.1038/27368) [PDF](#)
103. Ogg, G.S., Jin, X., Bonhoeffer, S., Dunbar, P. R., **Nowak**, M. A., S Monard, Segal, J. P., Cao, Y., Rowland-Jones, S. L., Cerundolo, V., Hurley, A., Markowitz, M., Ho, D. D., Nixon, D. F. & A. J. McMichael (1998). Quantitation of HIV-1-specific cytotoxic T lymphocytes and plasma load of viral RNA. *Science* 279: 2103-2106. DOI: [10.1126/science.279.5359.2103](https://doi.org/10.1126/science.279.5359.2103) [PDF](#)
104. Ostrowski, M. A., Krakauer, D. C., Li, Y., Justement, S. J., Learn, G., Ehler, L. A., Stanley, S. K., **Nowak**, M. A. & A. S. Fauci (1998). Effect of immune activation on the dynamics of human immunodeficiency virus replication and on the distribution of viral quasispecies. *J. Virol.* 72: 7772-7784. [PDF](#)
105. Regoes, R. R., Wodarz, D. & **Nowak**, M. A. (1998). Virus dynamics: The effect of target cell limitation and immune responses on virus evolution. *J. Theor. Biol.* 191: 451-462. DOI: [10.1006/jtbi.1997.0617](https://doi.org/10.1006/jtbi.1997.0617) [PDF](#)
106. Ribeiro, R. M., Bonhoeffer, S. & **Nowak**, M. A. (1998). The frequency of resistant mutant virus before anti-viral therapy. *AIDS* 12: 461-465. DOI: [10.1097/00002030-199805000-00006](https://doi.org/10.1097/00002030-199805000-00006) [PDF](#)

107. Sigmund, K., M Boerlijst & **Nowak**, M. A. (1998). Automata and inner states for repeated games. In *Game Theory, Experience, Rationality*, ed. W. Leinfeller, E. Köhler. London: Kluwer Academic Publishers, 131-139. DOI: [10.1007/978-94-017-1654-3\\_11](https://doi.org/10.1007/978-94-017-1654-3_11) PDF
108. Sigmund, K. & **Nowak**, M. A. (1998). Cyber-sociology. Book review of *The Complexity of Cooperation: Agent-Based Models of Competition and Collaboration*, R Axelrod. *Nature* 392: 457. DOI: [10.1038/33069](https://doi.org/10.1038/33069) PDF
109. Wodarz, D., Klenerman, P., **Nowak**, M. A. (1998). Dynamics of cytotoxic T-lymphocyte exhaustion. *Proc. Royal Soc. B.* 265: 191-203. DOI: [10.1098/rspb.1998.0282](https://doi.org/10.1098/rspb.1998.0282) PDF
110. Wodarz, D. & **Nowak**, M. A. (1998). Mathematical models of virus dynamics and resistance. *J. HIV Ther.* 3: 36-41. PDF
111. Wodarz, D. & **Nowak**, M. A. (1998). The effect of different immune responses on the evolution of virulent CXCR4-tropic HIV. *Proc. R. Soc. B.* 265: 2149-2158. DOI: [10.1098/rspb.1998.0552](https://doi.org/10.1098/rspb.1998.0552) PDF
- 1999**
112. Arnaout, R. A., Lloyd, A. L., O'Brien, T. R., Goedert, J. J., Leonard, J. M. & **Nowak**, M. A. (1999). A simple relationship between viral load and survival time in HIV-1 infection. *Proc. Natl. Acad. Sci. U.S.A.* 96: 11549-11553. DOI: [10.1073/pnas.96.20.11549](https://doi.org/10.1073/pnas.96.20.11549) PDF
113. Bangham, C. R. M., Hall, S. E., Jeffery, K. J. M., Vine, A. M., Witkover, A. **Nowak**, M. A., Wodarz, D., Ususku, K. & M. Osame (1999). Genetic control and dynamics of the cellular immune response to the human T-cell leukaemia virus, HTLV-I. *Philos. Trans. Royal Soc. B.* 354: 691-700. DOI: [10.1098/rstb.1999.0422](https://doi.org/10.1098/rstb.1999.0422) PDF
114. Callaway, D. S., Ribeiro, R. M. & **Nowak**, M. A. (1999). Virus phenotype switching and disease progression in HIV-1 infection. *Proc. Royal Soc. B.* 266: 2523-2530. DOI: [10.1098/rspb.1999.0955](https://doi.org/10.1098/rspb.1999.0955) PDF
115. Hockett, R. D, Kilby, J. M., Derdeyn, C. A., Saag, M. S., Sillers, M., Squires, K., Chiz, S., **Nowak**, M. A., Shaw, G. M. & R. P. Bucy (1999). Constant mean viral copy number per infected cell in tissues regardless of high, low, or undetectable plasma HIV RNA. *J. Exp. Med.* 189: 1545-1554. DOI: [10.1084/jem.189.10.1545](https://doi.org/10.1084/jem.189.10.1545) PDF
116. Jefferey, K. J. M., Usuku, K., Hall, S. E., Matsumoto, W., Taylor, G. P., Proctor, J., Bunce, M., Ogg, G. S., Welsh, K. I., Weber, J. N., Lloyd, A. L., **Nowak**, M. A., Nagai, M., Kodama, D., Izumo, S., Osame, M. & C. R. M. Bangham (1999). HLA alleles determine human T-lymphotropic virus -I (HTLV-I) proviral load and the risk of HTLV-1-associated myelopathy. *Proc. Natl. Acad. Sci. U.S.A.* 96: 3848-3853. DOI: [10.1073/pnas.96.7.3848](https://doi.org/10.1073/pnas.96.7.3848) PDF
117. Krakauer, D. C. & **Nowak**, M. A. (1999). Evolutionary preservation of redundant duplicated genes. *Semin. Cell Dev. Biol.* 10: 555-559. DOI: [10.1006/scdb.1999.0337](https://doi.org/10.1006/scdb.1999.0337) PDF
118. Krakauer, D. C. & **Nowak**, M. A. (1999). T-cell induced pathogenesis in HIV: Bystander effects and latent infection. *Proc. Royal Soc. B.* 266: 1069-1075. DOI: [10.1098/rspb.1999.0745](https://doi.org/10.1098/rspb.1999.0745) PDF
119. Masel, J., Jansen, V. A. A. & **Nowak**, M. A. (1999). Quantifying the kinetic parameters of prion replication. *Biophys. Chem.* 77: 139-152. DOI: [10.1016/S0301-4622\(99\)00016-2](https://doi.org/10.1016/S0301-4622(99)00016-2) PDF
120. **Nowak**, M. A. (1999). The mathematical biology of human infections. *Conserv. Ecol.* 3 (2): 12. DOI: [10.5751/es-00138-030212](https://doi.org/10.5751/es-00138-030212)
121. **Nowak**, M. A. & D. C. Krakauer (1999). The evolution of language. *Proc. Natl. Acad. Sci. U.S.A.* 96: 8028-8033. DOI: [10.1073/pnas.96.14.8028](https://doi.org/10.1073/pnas.96.14.8028) PDF

122. Nowak, M. A., Krakauer, D. C. & A. Dress (1999). An error limit for the evolution of language. *Proc. R. Soc. B.* 266: 2131-2136. DOI: [10.1098/rspb.1999.0898](https://doi.org/10.1098/rspb.1999.0898) PDF
123. Nowak, M. A., Plotkin, J. B. & D. C. Krakauer (1999). The evolutionary language game. *J. Theor. Biol.* 200: 147-162. DOI: [10.1006/jtbi.1999.0981](https://doi.org/10.1006/jtbi.1999.0981) PDF
124. Nowak, M. A. & K. Sigmund (1999). Aux racines de la coopération. *Recherche* 325: 38-39. PDF
125. Nowak, M. A. & K. Sigmund (1999). Phage-lift for game theory. *Nature* 398: 367-368. DOI: [10.1038/18761](https://doi.org/10.1038/18761) PDF
126. Ogg, G. S., Jin, X., Bonhoeffer, S., Moss, P., Nowak, M. A., Monard, S., Segal, J. P., Cao, Y., Rowland-Jones, S. L., Hurley, A., Markowitz, M., Ho, D. D., McMichael, A. J. & D. F. Nixon (1999). Decay kinetics of human immunodeficiency virus-specific effector cytotoxic T lymphocytes after combination antiretroviral therapy. *J. Virol.* 73: 797-800. PDF
127. Sigmund, K. & Nowak, M. A. (1999). Evolutionary game theory. *Curr. Biol.* 9: R503-R505. DOI: [10.1016/S0960-9822\(99\)80321-2](https://doi.org/10.1016/S0960-9822(99)80321-2) PDF
128. Taylor, G. P., Hall, S. E., Navarette, S., Michie, C. A., Davis, R., Witkover, A. D., Rossor, M., Nowak, M. A., Rudge, P., Matutes, E., Bangham, C. R. M. & J. N. Weber (1999). Effect of lamivudine on human T-cell leukemia virus type 1 (HTLV-1) DNA copy number, T-cell phenotype, and anti-Tax cytotoxic T-cell frequency in patients with HTLV-1 associated myelopathy. *J. Virol.* 73: 10289-10295. PDF
129. Wahl, L. M. & Nowak, M. A. (1999). The continuous Prisoner's Dilemma: I. Linear reactive strategies. *J. Theor. Biol.* 200: 307-321. DOI: [10.1006/jtbi.1999.0996](https://doi.org/10.1006/jtbi.1999.0996) PDF
130. Wahl, L. M. & Nowak, M. A. (1999). The continuous Prisoner's Dilemma: II. Linear reactive strategies with noise. *J. Theor. Biol.* 200: 323-338. DOI: [10.1006/jtbi.1999.0997](https://doi.org/10.1006/jtbi.1999.0997) PDF
131. Wodarz, D., Lloyd, A. L., Jansen, V. A. A. & Nowak, M. A. (1999). Dynamics of macrophage and T cell infection by HIV. *J. Theor. Biol.* 196: 101-113. DOI: [10.1006/jtbi.1998.0816](https://doi.org/10.1006/jtbi.1998.0816) PDF
132. Wodarz, D. & Nowak, M. A. (1999). Dynamics of HIV pathogenesis and treatment. In *Origin and Evolution of Viruses*, eds. E. Domingo, R. Webster, J. Holland. London: Academic Press, 197-223. DOI: [10.1016/b978-012220360-2/50010-6](https://doi.org/10.1016/b978-012220360-2/50010-6) PDF
133. Wodarz, D. & Nowak, M. A. (1999). Dynamics of immune escape in HIV infection. *Wien Klin Wochenschr* 111: 419-427. PDF
134. Wodarz, D. & Nowak, M. A. (1999). Evolutionary dynamics of HIV-1 induced subversion of the immune response. *Immunol. Rev.* 168: 75-89. DOI: [10.1111/j.1600-065X.1999.tb01284.x](https://doi.org/10.1111/j.1600-065X.1999.tb01284.x) PDF
135. Wodarz, D. & Nowak, M. A. (1999). Specific therapy regimes could lead to long-term immunological control of HIV. *Proc. Natl. Acad. Sci. U.S.A.* 96: 14464-14469. DOI: [10.1073/pnas.96.25.14464](https://doi.org/10.1073/pnas.96.25.14464) PDF
136. Wodarz, D., Nowak, M. A. & C. R. M. Bangham (1999). The dynamics of HTLV-I and the CTL response. *Immunol. Today* 20: 220-227. DOI: [10.1016/S0167-5699\(99\)01446-2](https://doi.org/10.1016/S0167-5699(99)01446-2) PDF

## 2000

137. Arnaout, R. A. & Nowak, M. A. (2000). Competitive coexistence in antiviral immunity. *J. Theor. Biol.* 204: 431-441. DOI: [10.1006/jtbi.2000.2027](https://doi.org/10.1006/jtbi.2000.2027) PDF

138. Arnaout, R. A., **Nowak**, M. A. & D. Wodarz (2000). HIV-1 dynamics revisited: Biphasic decay by cytotoxic T-lymphocyte killing? *Proc. Royal Soc. B.* 267: 1347-1354. DOI: [10.1098/rspb.2000.1149](https://doi.org/10.1098/rspb.2000.1149) [PDF](#)
139. Barchet, W., Oehen, S., Klenerman, P., Wodarz, D., Bocharov, G., Lloyd, A. L., **Nowak**, M. A., Hengartner, H., Zinkernagel, R. M. & S. Ehl (2000). Direct quantitation of rapid elimination of viral antigen-positive lymphocytes by antiviral CD8+ T cells in vivo. *Eur. J. Immunol.* 30: 1356-1363. DOI: [10.1002/\(SICI\)1521-4141\(200005\)30:5%3C1356::AID-IMMU1356%3E3.0.CO;2-K](https://doi.org/10.1002/(SICI)1521-4141(200005)30:5%3C1356::AID-IMMU1356%3E3.0.CO;2-K) [PDF](#)
140. Krakauer, D. C. & **Nowak**, M. A. (2000). Book review of *Fragile Dominion: Complexity and the Commons*, S. Levin. *Notices Am. Math. Soc.* 147: 564-568. [PDF](#)
141. Lifson, J. D., Rossio, J. L., Arnaout, R., Li, L., Parks, T. L., Schneider, D. K., Kiser, R. F., Coalter, V. J., Walsh, G., Imming, R. J., Fisher, B., Flynn, B. M., Bischofberger, N., Piatak, M., Hirsch, V. M., **Nowak**, M. A. & D. Wodarz (2000). Containment of simian immunodeficiency virus infection: Cellular immune responses and protection from rechallenge following transient postinoculation antiretroviral treatment. *J. Virol.* 74: 2584-2593. DOI: [10.1128/JVI.74.6.2584-2593.2000](https://doi.org/10.1128/JVI.74.6.2584-2593.2000) [PDF](#)
142. **Nowak**, M. A. (2000). Evolutionary biology of language. *Philos. Trans. Royal Soc. B.* 355: 1615-1622. DOI: [10.1098/rstb.2000.0723](https://doi.org/10.1098/rstb.2000.0723) [PDF](#)
143. **Nowak**, M. A. (2000). Homo grammaticus. *Nat. Hist.* 109: 36-44. [PDF](#)
144. **Nowak**, M. A. (2000). The basic reproductive ratio of a word, the maximum size of a lexicon. *J. Theor. Biol.* 204: 179-189. DOI: [10.1006/jtbi.2000.1085](https://doi.org/10.1006/jtbi.2000.1085) [PDF](#)
145. **Nowak**, M. A. & R. M. May (2000). *Virus Dynamics: Mathematical Principles of Immunology and Virology*. Oxford: [Oxford University Press](#). ISBN: 9780198504177
146. **Nowak**, M. A., Page, K. M. & K. Sigmund (2000). Fairness versus reason in the ultimatum game. *Science* 289: 1773-1775. DOI: [10.1126/science.289.5485.1773](https://doi.org/10.1126/science.289.5485.1773) [PDF](#)
147. **Nowak**, M. A., Plotkin, J. B. & V. A. A. Jansen (2000). The evolution of syntactic communication. *Nature* 404: 495-498. DOI: [10.1038/35006635](https://doi.org/10.1038/35006635) [PDF](#)
148. **Nowak**, M. A. & K. Sigmund (2000). Cooperation versus competition. *Financ. Anal. J.* 56: 13-22. DOI: [10.2469/faj.v56.n4.2370](https://doi.org/10.2469/faj.v56.n4.2370) [PDF](#)
149. **Nowak**, M. A. & K. Sigmund (2000). Games on grids. In *The Geometry of Ecological Interactions*, eds. U. Dieckmann, R. Law, J. A. J Metz. Cambridge: Cambridge University Press, 135-150. [PDF](#)
150. **Nowak**, M. A. & K. Sigmund (2000). Shrewd investments. *Science* 288: 819-820. DOI: [10.1126/science.288.5467.819](https://doi.org/10.1126/science.288.5467.819) [PDF](#)
151. Page, K. M. & **Nowak**, M. A. (2000). A generalized adaptive dynamics framework can describe the evolutionary ultimatum game. *J. Theor. Biol.* 209: 173-179. DOI: [10.1006/jtbi.2000.2251](https://doi.org/10.1006/jtbi.2000.2251) [PDF](#)
152. Page, K. M., **Nowak**, M. A. & K. Sigmund (2000). The spatial ultimatum game. *Proc. R. Soc. B.* 267: 2177-2182. DOI: [10.1098/rspb.2000.1266](https://doi.org/10.1098/rspb.2000.1266) [PDF](#)
153. Plotkin, J. B. & **Nowak**, M. A. (2000). Language evolution and information theory. *J. Theor. Biol.* 205:147-159. DOI: [10.1006/jtbi.2000.2053](https://doi.org/10.1006/jtbi.2000.2053) [PDF](#)
154. Plotkin, J. B., Potts, M. D., Yu, D. W., Bunyavejchewin, S., Condit, R., Foster, R., Hubbell, S., LaFrankie, J., Manokaran, N., Seng, L. H., Sukumar, R., **Nowak**, M. A. & P. S. Ashton (2000). Predicting species diversity in tropical forests. *Proc. Natl. Acad. Sci. U.S.A.* 97: 10850-10854. DOI: [10.1073/pnas.97.20.10850](https://doi.org/10.1073/pnas.97.20.10850) [PDF](#)

155. Regoes, R.R., **Nowak**, M. A. & S. Bonhoeffer (2000). Evolution of virulence in a heterogeneous host population. *Evolution* 54: 64-71. DOI: [10.1554/0014-3820\(2000\)054\[0064:EOVIAH\]2.0.CO;2](https://doi.org/10.1554/0014-3820(2000)054[0064:EOVIAH]2.0.CO;2) [PDF](#)
156. Sigmund, K. & **Nowak**, M. A. (2000). A tale of two selves. *Science* 290: 949-950. DOI: [10.1126/science.290.5493.949](https://doi.org/10.1126/science.290.5493.949) [PDF](#)
157. Sigmund, K. & **Nowak**, M. A. (2000). Playing for keeps. Book review of Game Theory Evolving: A Problem-Centered Introduction to Modeling Strategic Interaction, H Gintis. *Science* 290: 281. DOI: [10.1126/science.290.5490.281](https://doi.org/10.1126/science.290.5490.281) [PDF](#)
158. Trapa, P. E. & **Nowak**, M. A. (2000). Nash equilibria for an evolutionary language game. *J. Math. Biol.* 41: 172-188. DOI: [10.1007/s002850070004](https://doi.org/10.1007/s002850070004) [PDF](#)
159. Wahl, L. M., Bittner, B. & **Nowak**, M. A. (2000). Immunological transitions in response to antigenic mutation during viral infection. *Int. Immunol.* 12: 1371-1380. DOI: [10.1093/intimm/12.10.1371](https://doi.org/10.1093/intimm/12.10.1371) [PDF](#)
160. Wahl, L. M. & **Nowak**, M. A. (2000). Adherence and drug resistance: Predictions for therapy outcome. *Proc. Royal Soc. B.* 267: 835-843. DOI: [10.1098/rspb.2000.1079](https://doi.org/10.1098/rspb.2000.1079) [PDF](#)
161. Wodarz, D., Arnaout, R. A., **Nowak**, M. A. & J. D. Lifson (2000). Transient antiretroviral treatment during acute simian immunodeficiency virus infection facilitates long-term control of the virus. *Phil. Trans. R. Soc. B.* 355: 1021-1029. DOI: [10.1098/rstb.2000.0639](https://doi.org/10.1098/rstb.2000.0639) [PDF](#)
162. Wodarz, D., May, R. M. & **Nowak**, M. A. (2000). The role of antigen-independent persistence of memory cytotoxic T lymphocytes. *Int. Immunol.* 12: 467-477. DOI: [10.1093/intimm/12.4.467](https://doi.org/10.1093/intimm/12.4.467) [PDF](#)
163. Wodarz, D. & **Nowak**, M. A. (2000). CD8 memory, immunodominance, and antigenic escape. *Eur. J. Immunol.* 30: 2704-2712. DOI: [10.1002/1521-4141\(200009\)30:9%3C2704::AID-IMMU2704%3E3.0.CO;2-0](https://doi.org/10.1002/1521-4141(200009)30:9%3C2704::AID-IMMU2704%3E3.0.CO;2-0) [PDF](#)
164. Wodarz, D. & **Nowak**, M. A. (2000). Correlates of cytotoxic T-lymphocyte-mediated virus control: Implications for immuno-suppressive infections and their treatment. *Philos. Trans. Royal Soc. B.* 355: 1059-1070. DOI: [10.1098/rstb.2000.0643](https://doi.org/10.1098/rstb.2000.0643) [PDF](#)
165. Wodarz, D. & **Nowak**, M. A. (2000). HIV therapy: Managing resistance. *Proc. Natl. Acad. Sci. U.S.A.* 97: 8193-8195. DOI: [10.1073/pnas.97.15.8193](https://doi.org/10.1073/pnas.97.15.8193) [PDF](#)
166. Wodarz, D. & **Nowak**, M. A. (2000). Immune responses and viral phenotype: Do replication rate and cytopathogenicity influence virus load? *J. Theor. Med.* 2: 113-127. DOI: [10.1080/10273660008833041](https://doi.org/10.1080/10273660008833041) [PDF](#)
167. Wodarz, D., Page, K. M., Arnaout, R. A., Thomsen, A. R., Lifson, J. D. & **Nowak**, M. A. (2000). A new theory of cytotoxic T-lymphocyte memory: Implications for HIV treatment. *Philos. Trans. Royal Soc. B.* 355: 329-343. DOI: [10.1098/rstb.2000.0570](https://doi.org/10.1098/rstb.2000.0570) [PDF](#)

## 2001

168. Komarova, N. L., Niyogi, P. & **Nowak**, M. A. (2001). The evolutionary dynamics of grammar acquisition. *J. Theor. Biol.* 209: 43-59. DOI: [10.1006/jtbi.2000.2240](https://doi.org/10.1006/jtbi.2000.2240) [PDF](#)
169. Komarova, N. L. & **Nowak**, M. A. (2001). Natural selection of the critical period for language acquisition. *Proc. Royal Soc. B.* 268: 1189-1196. DOI: [10.1098/rspb.2001.1629](https://doi.org/10.1098/rspb.2001.1629) [PDF](#)

170. Komarova, N. L. & **Nowak**, M. A. (2001). Evolutionary dynamics of the lexical matrix. *Bull. Math. Biol.* 63: 451-484. DOI: [10.1006/bulm.2000.0222](https://doi.org/10.1006/bulm.2000.0222) PDF
171. Krakauer, D. C. & **Nowak**, M. A. (2001). Genetic redundancy. In *Encyclopedia of Genetics*, eds. S. Brenner, J. Miller. London: Academic Press, 845-846. DOI: [10.1006/rwgn.2001.0519](https://doi.org/10.1006/rwgn.2001.0519) PDF
172. Lifson, J. D., Rossio, J. L., Piatak, M., Parks, T., Li, L., Kiser, R., Coalter, V., Fisher, B., Flynn, B. M., Hirsch, V. M., Means, R. E., Czajak, S., Reimann, K. A., Schmitz, J. E., Ghayeb, J., Bischofberger, N., **Nowak**, M. A., Desrosiers, R. C. & D. Wodarz (2001). Role of CD8+ lymphocytes in control of simian immunodeficiency virus infection and resistance to rechallenge after transient early antiretroviral treatment. *J. Virol.* 75: 10187-10199. DOI: [10.1128/JVI.75.21.10187-10199.2001](https://doi.org/10.1128/JVI.75.21.10187-10199.2001) PDF
173. **Nowak**, M. A. & N. L. Komarova (2001). Towards an evolutionary theory of language. *Trends Cogn. Sci.* 5: 288-295. DOI: [10.1016/S1364-6613\(00\)01683-1](https://doi.org/10.1016/S1364-6613(00)01683-1) PDF
174. **Nowak**, M. A. Komarova, N. L. & P. Niyogi (2001). Evolution of universal grammar. *Science* 291: 114-118. DOI: [10.1126/science.291.5501.114](https://doi.org/10.1126/science.291.5501.114) PDF
175. Plotkin, J. B. & **Nowak**, M. A. (2001). Major transitions in language evolution. *Entropy* 3: 227-246. DOI: [10.3390/e3040227](https://doi.org/10.3390/e3040227) PDF
176. Sigmund, K., Hauert, C. & **Nowak**, M. A. (2001). Reward and punishment. *Proc. Natl. Acad. Sci. U.S.A.* 98: 10757-10762. DOI: [10.1073/pnas.161155698](https://doi.org/10.1073/pnas.161155698) PDF
177. Sigmund, K. & **Nowak**, M. A. (2001). Evolution: Tides of tolerance. *Nature* 414: 403-405. DOI: [10.1038/35106672](https://doi.org/10.1038/35106672) PDF
178. Wodarz, D., Hall, S. E., Usuku, K., Osame, M., Ogg, G. S., McMichael, A. J., **Nowak**, M. A. & C. R. M. Bangham (2001). Cytotoxic T-cell abundance and virus load in human immunodeficiency virus type 1 and human T-cell leukemia virus type 1. *Proc. Royal Soc. B.* 268: 1215-1221. DOI: [10.1098/rspb.2001.1608](https://doi.org/10.1098/rspb.2001.1608) PDF
- 2002**
179. Belz, G. T., Wodarz, D., Diaz, G., **Nowak**, M. A. & P. C. Doherty (2002). Compromised influenza virus-specific CD8+-T-cell memory in CD4+-T-cell-deficient mice. *J. Virol.* 76: 12388-12393. DOI: [10.1128/JVI.76.23.12388-12393.2002](https://doi.org/10.1128/JVI.76.23.12388-12393.2002) PDF
180. Komarova, N. L., Lengauer, C., Vogelstein, B. & **Nowak**, M. A. (2002). Dynamics of genetic instability in sporadic and familial colorectal cancer. *Cancer Biol. Ther.* 1: 685-692. DOI: [10.4161/cbt.321](https://doi.org/10.4161/cbt.321) PDF
181. Komarova, N. L. & **Nowak**, M. A. (2002). Population dynamics of grammar acquisition. In *Simulating the Evolution of Language*, eds. A. Cangelosi, D. Parisi. London: Springer Verlag, 149-163. DOI: [10.1007/978-1-4471-0663-0\\_7](https://doi.org/10.1007/978-1-4471-0663-0_7) PDF
182. Michor, F. & **Nowak**, M. A. (2002). Evolution: The good, the bad and the lonely. *Nature* 419: 677-679. DOI: [10.1038/419677a](https://doi.org/10.1038/419677a) PDF
183. Michor, F. & **Nowak**, M. A. (2003). Immunology tomorrow. Book review of Immunology and Evolution of Infectious Disease, S. A. Frank. *Nature* 420: 741-742. DOI: [10.1038/420741b](https://doi.org/10.1038/420741b) PDF
184. **Nowak**, M. A. (2002). From quasispecies to universal grammar. *Z. Phys. Chem.* 16: 5-20. DOI: [10.1524/zpch.2002.216.1.005](https://doi.org/10.1524/zpch.2002.216.1.005) PDF

185. **Nowak**, M. A., Komarova, N. L. & P. Niyogi (2002). Computational and evolutionary aspects of language. *Nature* 417: 611-617. DOI: [10.1038/nature00771](https://doi.org/10.1038/nature00771) [PDF](#)
186. **Nowak**, M. A., Komarova, N. L., Sengupta, A., Jallepalli, P. F., Shih, I. M., Vogelstein, B., Lengauer, C., (2002). The role of chromosomal instability in tumor initiation. *Proc. Natl. Acad. Sci. U.S.A.* 99: 16226-16231. DOI: [10.1073/pnas.202617399](https://doi.org/10.1073/pnas.202617399) [PDF](#)
187. **Nowak**, M. A. & K. Sigmund (2002). Biodiversity: Bacterial game dynamics. *Nature* 418: 138-139. DOI: [10.1038/418138a](https://doi.org/10.1038/418138a) [PDF](#)
188. **Nowak**, M. A. & K. Sigmund (2002) Super- and coinfection: The two extremes. In *Adaptive Dynamics of Infectious Diseases: In Pursuit of Virulence Management*, eds. U. Dieckmann, J. A. J. Metz, M. Sabelis & K. Sigmund. Cambridge: Cambridge University Press, 124-138. DOI: [10.1017/cbo9780511525728.013](https://doi.org/10.1017/cbo9780511525728.013) [PDF](#)
189. Page, K. M. & **Nowak**, M. A. (2002). Empathy leads to fairness. *Bull. Math. Biol.* 64: 1101-1116. DOI: [10.1006/bulm.2002.0321](https://doi.org/10.1006/bulm.2002.0321) [PDF](#)
190. Page, K. M. & **Nowak**, M. A. (2002). Unifying evolutionary dynamics. *J. Theor. Biol.* 219: 93-98. DOI: [10.1006/jtbi.2002.3112](https://doi.org/10.1006/jtbi.2002.3112) [PDF](#)
191. Plotkin, J. B. & **Nowak**, M. A. (2002). The different effects of apoptosis and DNA repair on tumorigenesis. *J. Theor. Biol.* 214: 453-467. DOI: [10.1006/jtbi.2001.2471](https://doi.org/10.1006/jtbi.2001.2471) [PDF](#)
192. Sigmund, K., Fehr, E. & **Nowak**, M. A. (2002). The economics of fair play. *Sci. Am.* 286: 82-87. DOI: [10.1038/scientificamerican0102-82](https://doi.org/10.1038/scientificamerican0102-82) [PDF](#)
193. Wodarz, D. & **Nowak**, M. A. (2002). Mathematical models of HIV pathogenesis and treatment. *Bioessays* 24: 1178-1187. DOI: [10.1002/bies.10196](https://doi.org/10.1002/bies.10196) [PDF](#)
- 2003**
194. Frank, S. A., Iwasa, Y. & **Nowak**, M. A. (2003). Patterns of cell division and the risk of cancer. *Genetics* 163: 1527-1532. [PDF](#)
195. Frank, S.A. & **Nowak**, M. A. (2003). Cell biology: Developmental predisposition to cancer. *Nature* 422:494. DOI: [10.1038/422494a](https://doi.org/10.1038/422494a) [PDF](#)
196. Iwasa, Y., Michor, F. & **Nowak**, M. A. (2003). Evolutionary dynamics of escape from biomedical intervention. *Proc. Royal Soc. B.* 270: 2573-2578. DOI: [10.1098/rspb.2003.2539](https://doi.org/10.1098/rspb.2003.2539) [PDF](#)
197. Komarova, N. L. & **Nowak**, M. A. (2003). Language dynamics in finite populations. *J. Theor. Biol.* 221: 445-457. DOI: [10.1006/jtbi.2003.3199](https://doi.org/10.1006/jtbi.2003.3199) [PDF](#)
198. Komarova, N. L. & **Nowak**, M. A. (2003). Language, learning and evolution. In *Language Evolution*, eds. MH Christiansen, S Kirby. Oxford University Press, 317-337. DOI: [10.1093/acprof:oso/9780199244843.003.0017](https://doi.org/10.1093/acprof:oso/9780199244843.003.0017) [PDF](#)
199. Komarova, N. L., Sengupta, A. & **Nowak**, M. A. (2003). Mutation-selection networks of cancer initiation: Tumor suppressor genes and chromosomal instability. *J. Theor. Biol.* 223: 433-450. DOI: [10.1016/S0022-5193\(03\)00120-6](https://doi.org/10.1016/S0022-5193(03)00120-6) [PDF](#)
200. Michor, F., Frank, S. A., May, R. M., Iwasa, Y. & **Nowak**, M. A. (2003). Somatic selection for and against cancer. *J. Theor. Biol.* 225: 377-382. DOI: [10.1016/S0022-5193\(03\)00267-4](https://doi.org/10.1016/S0022-5193(03)00267-4) [PDF](#)

201. Michor, F., Iwasa, Y., Komarova, N. L. & **Nowak**, M. A. (2003). Local regulation of homeostasis favors chromosomal instability. *Curr. Biol.* 13: 581-584. DOI: [10.1016/S0960-9822\(03\)00172-6](https://doi.org/10.1016/S0960-9822(03)00172-6) [PDF](#)
202. Michor, F., **Nowak**, M. A., Frank, S. A. & Y. Iwasa (2003). Stochastic elimination of cancer cells. *Proc. Royal Soc. B.* 270: 2017-2024. DOI: [10.1098/rspb.2003.2483](https://doi.org/10.1098/rspb.2003.2483) [PDF](#)
203. Mitchener, G. & **Nowak**, M. A. (2003). Competitive exclusion and coexistence of universal grammars. *Bull. Math. Biol.* 65: 67-93. DOI: [10.1006/bulm.2002.0322](https://doi.org/10.1006/bulm.2002.0322) [PDF](#)
204. **Nowak**, M. A., Michor, F., & Y. Iwasa (2003). The linear process of somatic evolution. *Proc. Natl. Acad. Sci. U.S.A.* 100: 14966-14969. DOI: [10.1073/pnas.2535419100](https://doi.org/10.1073/pnas.2535419100) [PDF](#)
205. Rajagopalan, H., **Nowak**, M. A., Vogelstein, B. & C. Lengauer (2003). The significance of unstable chromosomes in colorectal cancer. *Nat. Rev. Cancer* 3: 695-701. DOI: [10.1038/nrc1165](https://doi.org/10.1038/nrc1165) [PDF](#)
206. Sasaki, A. & **Nowak**, M. A. (2003) Mutation landscapes. *J. Theor. Biol.* 224: 241-247. DOI: [10.1016/S0022-5193\(03\)00161-9](https://doi.org/10.1016/S0022-5193(03)00161-9) [PDF](#)
207. Wei, X., Decker, J. M., Wang, S., Hui, H., Kappes, J. C., Wu, X., Salazar-Gonzalez, J. F., Salazar, M. G., Kilby, J. M., Saag, M. S., Komarova, N. L., **Nowak**, M. A., Hahn, B. H., Kwong, P. D. & G. M. Shaw (2003). Antibody neutralization and escape by HIV-1. *Nature* 422: 307-312. DOI: [10.1038/nature01470](https://doi.org/10.1038/nature01470) [PDF](#) & [SI](#)
- 2004**
208. Frank, S. & **Nowak**, M. A. (2004). Problems of somatic mutation and cancer. *Bioessays* 26: 291-299. DOI: [10.1002/bies.20000](https://doi.org/10.1002/bies.20000) [PDF](#)
209. Iwasa, Y., Michor, F. & **Nowak**, M. A. (2004). Evolutionary dynamics of invasion and escape. *J. Theor. Biol.* 226: 205-214. DOI: [10.1016/j.jtbi.2003.08.014](https://doi.org/10.1016/j.jtbi.2003.08.014) [PDF](#)
210. Iwasa, Y., Michor, F. & **Nowak**, M. A. (2004). Some basic properties of immune selection. *J. Theor. Biol.* 229:179-188. DOI: [10.1016/j.jtbi.2004.03.013](https://doi.org/10.1016/j.jtbi.2004.03.013) [PDF](#)
211. Iwasa, Y., Michor, F. & **Nowak**, M. A. (2004). Stochastic tunnels in evolutionary dynamics. *Genetics* 166: 1571-1579. DOI: [10.1534/genetics.166.3.1571](https://doi.org/10.1534/genetics.166.3.1571) [PDF](#)
212. Jones, N. A., Wei, X., Flower, D. R., Wong, M. L., Michor, F., Saag, M. S., Hahn, B. H., **Nowak**, M. A. & G. M. Shaw (2004). Determinants of human immunodeficiency virus type 1 escape from the primary CD8+ cytotoxic T lymphocyte response. *J. Exp. Med.* 200:1243-1256. DOI: [10.1084/jem.20040511](https://doi.org/10.1084/jem.20040511) [PDF](#)
213. Matsen, F. A. & **Nowak**, M. A. (2004). Win-stay, lose-shift in language learning from peers. *Proc. Natl. Acad. Sci. U.S.A.* 101: 18053-18057. DOI: [10.1073/pnas.0406608102](https://doi.org/10.1073/pnas.0406608102) [PDF](#)
214. Michor, F., Iwasa, Y. & **Nowak**, M. A. (2004). Dynamics of cancer progression. *Nat. Rev. Cancer* 4: 197-205. DOI: [10.1038/nrc1295](https://doi.org/10.1038/nrc1295) [PDF](#)
215. Michor, F., Iwasa, Y., Rajagopalan, H., Lengauer, C. & **Nowak**, M. A. (2004). Linear model of colon cancer initiation. *Cell Cycle* 3: 358-362. DOI: [10.4161/cc.3.3.690](https://doi.org/10.4161/cc.3.3.690) [PDF](#)
216. Mitchener, W. G. & **Nowak**, M. A. (2004). Chaos and language. *Proc. Royal Soc. B.* 271: 701-704. DOI: [10.1098/rspb.2003.2643](https://doi.org/10.1098/rspb.2003.2643) [PDF](#)
217. **Nowak**, M. A. (2004). Prisoners of the dilemma. *Nature* 427: 491. DOI: [10.1038/427491a](https://doi.org/10.1038/427491a) [PDF](#)

218. **Nowak**, M. A. (2004). Theory is available light. *Curr. Biol.* 14: R406-R407. DOI: [10.1016/j.cub.2004.05.027](https://doi.org/10.1016/j.cub.2004.05.027) PDF
219. **Nowak**, M. A., Michor, F., Komarova, N. L. & Y. Iwasa (2004). Evolutionary dynamics of tumor suppressor gene inactivation. *Proc. Natl. Acad. Sci. U.S.A.* 101: 10635-10638. DOI: [10.1073/pnas.0400747101](https://doi.org/10.1073/pnas.0400747101) PDF
220. **Nowak**, M. A., Sasaki, A., Taylor, C. & D. Fudenberg (2004). Emergence of cooperation and evolutionary stability in finite populations. *Nature* 428: 646-650. DOI: [10.1038/nature02414](https://doi.org/10.1038/nature02414) PDF
221. **Nowak**, M. A. & K. Sigmund (2004). Evolutionary dynamics of biological games. *Science* 303: 793-799. DOI: [10.1126/science.1093411](https://doi.org/10.1126/science.1093411) PDF
222. **Nowak**, M. A. & K. Sigmund (2004). Population dynamics in evolutionary ecology. In *Life Sciences for the 21st Century*, eds. E. Keinan, I. Schechter, M. Sela. Weinham: Wiley-VCH, 327-343. PDF
223. Taylor, C., Fudenberg, D., Sasaki, A. & **Nowak**, M. A. (2004). Evolutionary game dynamics in finite populations. *Bull. Math. Biol.* 66: 1621-1644. DOI: [10.1016/j.bulm.2004.03.004](https://doi.org/10.1016/j.bulm.2004.03.004) PDF
- 2005**
224. Imhof, L. A., Fudenberg, D. & **Nowak**, M. A. (2005). Evolutionary cycles of cooperation and defection. *Proc. Natl. Acad. Sci. U.S.A.* 102: 10797-10800. DOI: [10.1073/pnas.0502589102](https://doi.org/10.1073/pnas.0502589102) PDF
225. Iwasa, Y., Michor, F., Komarova, N. L. & **Nowak**, M. A. (2005). Population genetics of tumor suppressor genes. *J. Theor. Biol.* 233: 15-23. DOI: [10.1016/j.jtbi.2004.09.001](https://doi.org/10.1016/j.jtbi.2004.09.001) PDF
226. Iwasa, Y., Michor, F. & **Nowak**, M. A. (2005). Virus evolution within patients increases pathogenicity. *J. Theor. Biol.* 232: 17-26. DOI: [10.1016/j.jtbi.2004.07.016](https://doi.org/10.1016/j.jtbi.2004.07.016) PDF
227. Lieberman, E., Hauert, C. & **Nowak**, M. A. (2005). Evolutionary dynamics on graphs. *Nature* 433: 312-316. DOI: [10.1038/nature03204](https://doi.org/10.1038/nature03204) PDF & SI
228. Michor, F., Hughes, T. P., Iwasa, Y., Branford, S., Shah, N. P., Sawyers, C. L. & **Nowak**, M. A. (2005). Dynamics of chronic myeloid leukemia. *Nature* 435: 1267-1270. DOI: [10.1038/nature03669](https://doi.org/10.1038/nature03669) PDF & SI
229. Michor, F., Iwasa, Y., Lengauer, C. & **Nowak**, M. A. (2005). Dynamics of colorectal cancer. *Semin. Cancer Biol.* 15: 484-493. DOI: [10.1016/j.semcancer.2005.06.005](https://doi.org/10.1016/j.semcancer.2005.06.005) PDF
230. Michor, F., Iwasa, Y., Vogelstein, B., Lengauer, C. & **Nowak**, M. A. (2005). Can chromosomal instability initiate tumorigenesis? *Semin. Cancer Biol.* 15: 43-45. DOI: [10.1016/j.semcancer.2004.09.007](https://doi.org/10.1016/j.semcancer.2004.09.007) PDF
231. **Nowak**, M. A. & Komarova, N.L. (2005). The evolution of altruism: From game theory to human language. In *Spiritual Information*, ed. Harper, C. Templeton Foundation Press, 308-314. PDF
232. **Nowak**, M. A. & Sigmund, K. (2005). Evolution of indirect reciprocity. *Nature* 437: 1291-1298. DOI: [10.1038/nature04131](https://doi.org/10.1038/nature04131) PDF
233. Traulsen, A., Sengupta, A. & **Nowak**, M. A. (2005). Stochastic evolutionary dynamics on two levels. *J. Theor. Biol.* 235: 393-401. DOI: [10.1016/j.jtbi.2005.01.019](https://doi.org/10.1016/j.jtbi.2005.01.019) PDF
234. Willensdorfer, M. & **Nowak**, M. A. (2005). Mutation in evolutionary games can increase average fitness at equilibrium. *J. Theor. Biol.* 237: 355-362. DOI: [10.1016/j.jtbi.2005.04.020](https://doi.org/10.1016/j.jtbi.2005.04.020) PDF

## 2006

235. Bürger, R., Willensdorfer, M. & Nowak, M. A. (2006). Why are phenotypic mutation rates much higher than genotypic mutation rates? *Genetics* 172: 197-206. DOI: [10.1534/genetics.105.046599](https://doi.org/10.1534/genetics.105.046599) PDF
236. Dingli, D. & Nowak, M. A. (2006). Cancer biology: Infectious tumour cells. *Nature* 443: 35-36. DOI: [10.1038/443035a](https://doi.org/10.1038/443035a) PDF
237. Fudenberg, D., Nowak, M. A., Taylor, C. & L. Imhof (2006). Evolutionary game dynamics in finite populations with strong selection and weak mutation. *Theor. Popul. Biol.* 70: 352-363. DOI: [10.1016/j.tpb.2006.07.006](https://doi.org/10.1016/j.tpb.2006.07.006) PDF
238. Hauert, C., Michor, F., Nowak, M. A. & M. Doebeli (2006). Synergy and discounting of cooperation in social dilemmas. *J. Theor. Biol.* 239: 195-202. DOI: [10.1016/j.jtbi.2005.08.040](https://doi.org/10.1016/j.jtbi.2005.08.040) PDF
239. Imhof, L. A. & Nowak, M. A. (2006). Evolutionary game dynamics in a Wright-Fisher process. *J. Math. Biol.* 52: 667-681. DOI: [10.1007/s00285-005-0369-8](https://doi.org/10.1007/s00285-005-0369-8) PDF
240. Iwasa, Y., Michor, F., Nowak, M. A. (2006). Evolution of resistance during clonal expansion. *Genetics* 172: 2557-2566. DOI: [10.1534/genetics.105.049791](https://doi.org/10.1534/genetics.105.049791) PDF
241. Michor, F., Iwasa, Y. & Nowak, M. A. (2006). The age incidence of chronic myeloid leukemia can be explained by a one-mutation model. *Proc. Natl. Acad. Sci. U.S.A.* 103: 14931-14934. DOI: [10.1073/pnas.0607006103](https://doi.org/10.1073/pnas.0607006103) PDF
242. Michor, F., Nowak, M. A. & Y. Iwasa (2006). Evolution of resistance to cancer therapy. *Curr. Pharm. Design* 12: 261-271. DOI: [10.2174/138161206775201956](https://doi.org/10.2174/138161206775201956) PDF
243. Michor, F., Nowak, M. A. & Y. Iwasa (2006). Stochastic dynamics of metastasis formation. *J. Theor. Biol.* 240: 521-530. DOI: [10.1016/j.jtbi.2005.10.021](https://doi.org/10.1016/j.jtbi.2005.10.021) PDF
244. Nowak, M. A. (2006). *Evolutionary Dynamics: Exploring the Equations of Life*. Cambridge, MA: [Harvard University Press](https://www.harvard.edu/). ISBN: 9780674023383
245. Nowak, M. A. (2006). Five rules for the evolution of cooperation. *Science* 314: 1560-1563. DOI: [10.1126/science.1133755](https://doi.org/10.1126/science.1133755) PDF
246. Nowak, M. A., Michor, F. & Iwasa, Y. (2006). Genetic instability and clonal expansion. *J. Theor. Biol.* 241: 26-32. DOI: [10.1016/j.jtbi.2005.11.012](https://doi.org/10.1016/j.jtbi.2005.11.012) PDF
247. Ohtsuki, H., Hauert, C., Lieberman, E. & Nowak, M. A. (2006). A simple rule for the evolution of cooperation on graphs and social networks. *Nature* 441: 502-505. DOI: [10.1038/nature04605](https://doi.org/10.1038/nature04605) PDF & SI
248. Ohtsuki, H. & Nowak, M. A. (2006). Evolutionary games on cycles. *Proc. Royal Soc. B.* 273: 2249-2256. DOI: [10.1098/rspb.2006.3576](https://doi.org/10.1098/rspb.2006.3576) PDF
249. Ohtsuki, H. & Nowak, M. A. (2006). The replicator equation on graphs. *J. Theor. Biol.* 243: 86-97. DOI: [10.1016/j.jtbi.2006.06.004](https://doi.org/10.1016/j.jtbi.2006.06.004) PDF
250. Pacheco, J. M., Traulsen, A. & Nowak, M. A. (2006). Active linking in evolutionary games. *J. Theor. Biol.* 243: 437-443. DOI: [10.1016/j.jtbi.2006.06.027](https://doi.org/10.1016/j.jtbi.2006.06.027) PDF
251. Pacheco, J. M., Traulsen, A. & Nowak, M. A. (2006). Coevolution of strategy and structure in complex networks with dynamical linking. *Phys. Rev. Lett.* 97: 258103. DOI: [10.1103/PhysRevLett.97.258103](https://doi.org/10.1103/PhysRevLett.97.258103) PDF

252. Pfeiffer, T. & Nowak, M. A. (2006). Climate change: All in the game. *Nature* 441: 583-584. DOI: [10.1038/441583a](https://doi.org/10.1038/441583a) PDF
253. Pfeiffer, T. & Nowak, M. A. (2006). Digital cows grazing on digital grounds. *Curr. Biol.* 16: R946-R949. DOI: [10.1016/j.cub.2006.10.011](https://doi.org/10.1016/j.cub.2006.10.011) PDF
254. Taylor, C., Iwasa, Y. & Nowak, M. A. (2006). A symmetry of fixation times in evolutionary dynamics. *J. Theor. Biol.* 243: 245-251. DOI: [10.1016/j.jtbi.2006.06.016](https://doi.org/10.1016/j.jtbi.2006.06.016) PDF
255. Taylor, C. & Nowak, M. A. (2006). Evolutionary game dynamics with non-uniform interaction rates. *Theor. Popul. Biol.* 69: 243-252. DOI: [10.1016/j.tpb.2005.06.009](https://doi.org/10.1016/j.tpb.2005.06.009) PDF
256. Traulsen, A. & Nowak, M. A. (2006). Evolution of cooperation by multilevel selection. *Proc. Natl. Acad. Sci. U.S.A.* 103: 10952-10955. DOI: [10.1073/pnas.0602530103](https://doi.org/10.1073/pnas.0602530103) PDF
257. Traulsen, A., Nowak, M. A. & Pacheco, J. M. (2006). Stochastic dynamics of invasion and fixation. *Phys. Rev. E.* 74: 011909. DOI: [10.1103/PhysRevE.74.011909](https://doi.org/10.1103/PhysRevE.74.011909) PDF
- 2007**
258. Beerenwinkel, N., Antal, T., Dingli, D., Traulsen, A., Kinzler, K. W., Velculescu, V. E., Vogelstein, B. & Nowak, M. A. (2007). Genetic progression and the waiting time to cancer. *PLoS Comput. Biol.* 3: e225. DOI: [10.1371/journal.pcbi.0030225](https://doi.org/10.1371/journal.pcbi.0030225) PDF
259. Hauert, C., Traulsen, A., Brandt, H., Nowak, M. A. & Sigmund, K. (2007). Via freedom to coercion: The emergence of costly punishment. *Science* 316: 1905-1907. DOI: [10.1126/science.1141588](https://doi.org/10.1126/science.1141588) PDF
260. Imhof, L. A., Fudenberg, D. & Nowak, M. A. (2007). Tit-for-tat or win-stay, lose-shift? *J. Theor. Biol.* 247: 574-580. DOI: [10.1016/j.jtbi.2007.03.027](https://doi.org/10.1016/j.jtbi.2007.03.027) PDF
261. Iwasa, Y., Michor, F. & Nowak, M. A. (2007). Directional evolution of virus within a host under immune selection. In *Mathematics for Life Science and Medicine*, Vol. 2, eds. Y. Takeuchi, K. Sato, Y. Iwasa. Springer: New York, 155-176. DOI: [10.1007/978-3-540-34426-1\\_7](https://doi.org/10.1007/978-3-540-34426-1_7) PDF
262. Lieberman, E., Michel, J. B., Jackson, J., Tang, T. & Nowak, M. A. (2007). Quantifying the evolutionary dynamics of language. *Nature* 449: 713-716. DOI: [10.1038/nature06137](https://doi.org/10.1038/nature06137) PDF & SI
263. Nowak, M. A. & S. Roch (2007). Upstream reciprocity and the evolution of gratitude. *Proc. Royal Soc. B.* 274: 605-609. DOI: [10.1098/rspb.2006.0125](https://doi.org/10.1098/rspb.2006.0125) PDF
264. Nowak, M. A. & K. Sigmund (2007). How populations cohere: Five rules for cooperation. In *Theoretical Ecology: Principles and Applications*, eds. R. M. May, A. McLean. Oxford: Oxford University Press, 7-16. PDF
265. Ohtsuki, H., Bordalo, P. & Nowak, M. A. (2007). The one third law of evolutionary dynamics. *J. Theor. Biol.* 249: 289-295. DOI: [10.1016/j.jtbi.2007.07.005](https://doi.org/10.1016/j.jtbi.2007.07.005) PDF
266. Ohtsuki, H. & Nowak, M. A. (2007). Direct reciprocity on graphs. *J. Theor. Biol.* 247: 462-470. DOI: [10.1016/j.jtbi.2007.03.018](https://doi.org/10.1016/j.jtbi.2007.03.018) PDF
267. Ohtsuki, H., Nowak, M. A. & J. M. Pacheco (2007). Breaking the symmetry between interaction and replacement in evolutionary dynamics on graphs. *Phys. Rev. Lett.* 98: 108106. DOI: [10.1103/PhysRevLett.98.108106](https://doi.org/10.1103/PhysRevLett.98.108106) PDF

268. Ohtsuki, H., Pacheco, J. M. & **Nowak**, M. A. (2007). Evolutionary graph theory: Breaking the symmetry between interaction and replacement. *J. Theor. Biol.* 246: 681-694. DOI: [10.1016/j.jtbi.2007.01.024](https://doi.org/10.1016/j.jtbi.2007.01.024) PDF
269. Taylor, C. & **Nowak**, M. A. (2007). Transforming the dilemma. *Evolution* 61: 2281-2292. DOI: [10.1111/j.1558-5646.2007.00196.x](https://doi.org/10.1111/j.1558-5646.2007.00196.x) PDF
270. Traulsen, A., Iwasa, Y. & **Nowak**, M. A. (2007). The fastest evolutionary trajectory. *J. Theor. Biol.* 249: 617-623. DOI: [10.1016/j.jtbi.2007.08.012](https://doi.org/10.1016/j.jtbi.2007.08.012) PDF
271. Traulsen, A. & **Nowak**, M. A. (2007). Chromodynamics of cooperation in finite populations. *PLoS ONE* 2: e270. DOI: [10.1371/journal.pone.0000270](https://doi.org/10.1371/journal.pone.0000270) PDF
272. Traulsen, A., **Nowak**, M. A. & J. M. Pacheco (2007). Stochastic payoff evaluation increases the temperature of selection. *J. Theor. Biol.* 244: 349-356. DOI: [10.1016/j.jtbi.2006.08.008](https://doi.org/10.1016/j.jtbi.2006.08.008) PDF
273. Traulsen, A., Pacheco, J. M. & **Nowak**, M. A. (2007). Pairwise comparison and selection temperature in evolutionary game dynamics. *J. Theor. Biol.* 246: 522-529. DOI: [10.1016/j.jtbi.2007.01.002](https://doi.org/10.1016/j.jtbi.2007.01.002) PDF
274. Willensdorfer, M., Bürger, R. & **Nowak**, M. A. (2007). Phenotypic mutation rates and the abundance of abnormal proteins in yeast. *PLoS Comput. Biol.* 3: e203. DOI: [10.1371/journal.pcbi.0030203](https://doi.org/10.1371/journal.pcbi.0030203) PDF
- 2008**
275. Dingli, D. & **Nowak**, M. A. (2008). Evolutionary dynamics of cancer. Book review of Dynamics of Cancer: Incidence, Inheritance, and Evolution, S. A. Frank. *Trends Ecol. Evol.* 25: 254-255. DOI: [10.1016/j.tree.2007.12.007](https://doi.org/10.1016/j.tree.2007.12.007) PDF
276. Dreber, A. & **Nowak**, M. A. (2008). Gambling for global goods. *Proc. Natl. Acad. Sci. U.S.A.* 105: 2261-2262. DOI: [10.1073/pnas.0800033105](https://doi.org/10.1073/pnas.0800033105) PDF
277. Dreber, A., Rand, D. G., Fudenberg, D. & **Nowak**, M. A. (2008). Winners don't punish. *Nature* 452: 348-351. DOI: [10.1038/nature06723](https://doi.org/10.1038/nature06723) PDF & SI
278. Fu, F., Hauert, C., **Nowak**, M. A. & Wang, L. (2008). Reputation-based partner choice promotes cooperation in social networks. *Phys. Rev. E.* 78: 026117. Republished in Virtual Journal of Biological Physics Research 165. DOI: [10.1103/PhysRevE.78.026117](https://doi.org/10.1103/PhysRevE.78.026117) PDF
279. Hauert, C., Traulsen, A., Brandt, H., **Nowak**, M. A. & Sigmund, K. (2008). Public goods with punishment and abstaining in finite and infinite populations. *Biol. Theory* 3(2): 114-122. DOI: <http://dx.doi.org/10.1162/biot.2008.3.2.114> PDF
280. Jones, S., Chen, W., Parmigiani, G., Diehl, F., Beerenwinkel, N., Antal, T., Traulsen, A., **Nowak**, M. A., Siegel, C., Velculescu, V. E., Kinzler, K. W., Vogelstein, B., Willis, J., & Markowitz, S. D. (2008). Comparative lesion sequencing provides insights into tumor evolution. *Proc. Natl. Acad. Sci. U.S.A.* 105: 4283-4288. DOI: [10.1073/pnas.0712345105](https://doi.org/10.1073/pnas.0712345105) PDF
281. Langer, P., **Nowak**, M. A. & Hauert, C. (2008). Spatial invasion of cooperation. *J. Theor. Biol.* 250: 634-641. DOI: [10.1016/j.jtbi.2007.11.002](https://doi.org/10.1016/j.jtbi.2007.11.002) PDF
282. **Nowak**, M. A. (2008). Generosity: A winner's advice. *Nature* 456: 579. DOI: [10.1038/456579a](https://doi.org/10.1038/456579a) PDF
283. **Nowak**, M. A. & Ohtsuki, H. (2008). Prevolutionary dynamics and the origin of evolution. *Proc. Natl. Acad. Sci. U.S.A.* 105: 14924-14927. DOI: [10.1073/pnas.0806714105](https://doi.org/10.1073/pnas.0806714105) PDF
284. Ohtsuki, H. & **Nowak**, M. A. (2008). Evolutionary stability on graphs. *J. Theor. Biol.* 251: 698-707. DOI: [10.1016/j.jtbi.2008.01.005](https://doi.org/10.1016/j.jtbi.2008.01.005) PDF

285. Pacheco, J. M., Traulsen, A., Ohtsuki, H. & **Nowak**, M. A. (2008). Repeated games and direct reciprocity under active linking. *J. Theor. Biol.* 250: 723-731. DOI: [10.1016/j.jtbi.2007.10.040](https://doi.org/10.1016/j.jtbi.2007.10.040) PDF
286. Pinker, S., **Nowak**, M. A. & Lee, J.J. (2008). The logic of indirect speech. *Proc. Natl. Acad. Sci. U.S.A.* 105: 833-838. DOI: [10.1073/pnas.0707192105](https://doi.org/10.1073/pnas.0707192105) PDF
287. Traulsen, A., Shores, N. & **Nowak**, M. A. (2008). Analytical results for individual and group selection of any intensity. *Bull. Math. Biol.* 70: 1410-1424. DOI: [10.1007/s11538-008-9305-6](https://doi.org/10.1007/s11538-008-9305-6) PDF
- 2009**
288. Antal, T., & **Nowak**, M. A., & Traulsen, A. (2009). Strategy abundance in 2x2 games for arbitrary mutation rates. *J. Theor. Biol.* 257: 340-344. DOI: [10.1073/pnas.0902528106](https://doi.org/10.1073/pnas.0902528106) PDF
289. Antal, T., Ohtsuki, H., Wakeley, J. Taylor, P. D. & **Nowak**, M. A. (2009). Evolution of cooperation by phenotypic similarity. *Proc. Natl. Acad. Sci. U.S.A.* 106: 8597-8600. DOI: [10.1016/j.jtbi.2008.11.023](https://doi.org/10.1016/j.jtbi.2008.11.023) PDF
290. Antal, T., Traulsen, A., Ohtsuki, H., Tarnita, C. E. & **Nowak**, M. A. (2009). Mutation–selection equilibrium in games with multiple strategies. *J. Theor. Biol.* 258: 614-622. DOI: [10.1016/j.jtbi.2009.02.010](https://doi.org/10.1016/j.jtbi.2009.02.010) PDF
291. Fu, F., Wang, L., & **Nowak**, M. A. & Hauert, C. (2009). Evolutionary dynamics on graphs: Efficient method for weak selection. *Phys. Rev. E* 79: 046707. DOI: [10.1103/PhysRevE.79.046707](https://doi.org/10.1103/PhysRevE.79.046707) PDF
292. Gokhale, C.S., Iwasa, Y., **Nowak**, M. A. & Traulsen, A. (2009). The pace of evolution across fitness valleys. *J. Theor. Biol.* 259: 613-620. DOI: [10.1016/j.jtbi.2009.04.011](https://doi.org/10.1016/j.jtbi.2009.04.011) PDF
293. Manapat, M., Ohtsuki, H., Bürger, R. & **Nowak**, M. A. (2009). Originator dynamics. *J. Theor. Biol.* 256: 586–595. DOI: [10.1016/j.jtbi.2008.10.006](https://doi.org/10.1016/j.jtbi.2008.10.006) PDF
294. Nathanson, C. G., Tarnita, C. E. & **Nowak**, M. A. (2009). Calculating evolutionary dynamics in structured populations. *PLoS Comput. Biol.* 5: e1000615. DOI: [10.1371/journal.pcbi.1000615](https://doi.org/10.1371/journal.pcbi.1000615) PDF
- Nathanson, C. G., Tarnita, C. E. & **Nowak**, M. A. (2010) Correction: Calculating Evolutionary Dynamics in Structured Populations. *PLoS Comput. Biol.* 6 (1). DOI: [10.1371/annotation/064a9048-e6f7-4cf8-b259-f40cfb6696ba](https://doi.org/10.1371/annotation/064a9048-e6f7-4cf8-b259-f40cfb6696ba) PDF
295. Ohtsuki, H., Iwasa, Y. & **Nowak**, M. A. (2009). Indirect reciprocity provides only a narrow margin of efficiency for costly punishment. *Nature* 457: 79-82. DOI: [10.1038/nature07601](https://doi.org/10.1038/nature07601) PDF & SI
296. Ohtsuki, H. & **Nowak**, M. A. (2009). Pre-life catalysts and replicators. *Proc. Royal Soc. B.* 276: 3783-3790. DOI: [10.1098/rspb.2009.1136](https://doi.org/10.1098/rspb.2009.1136) PDF
297. Rand, D. G., Dreber, A., Ellingsen, T., Fudenberg, D. & **Nowak**, M. A. (2009). Positive interactions promote public cooperation. *Science* 325: 1272-1275. DOI: [10.1126/science.1177418](https://doi.org/10.1126/science.1177418) PDF
298. Rand, D. G. & **Nowak**, M. A. (2009). Name and shame: How reputation could save the Earth. *New Scientist* 204 (2734): 28-29. DOI: [10.1016/S0262-4079\(09\)62991-2](https://doi.org/10.1016/S0262-4079(09)62991-2) PDF
299. Rand, D. G., Ohtsuki, H. & **Nowak**, M. A. (2009). Direct reciprocity with costly punishment: Generous tit-for-tat prevails. *J. Theor. Biol.* 256: 45-57. DOI: [10.1016/j.jtbi.2008.09.015](https://doi.org/10.1016/j.jtbi.2008.09.015) PDF
300. Tarnita, C. E., Antal, T. & **Nowak**, M. A. (2009). Mutation-selection equilibrium in games with mixed strategies. *J. Theor. Biol.* 261: 50-57. DOI: [10.1016/j.jtbi.2009.07.028](https://doi.org/10.1016/j.jtbi.2009.07.028) PDF

301. Tarnita, C. E., Antal, T., Ohtsuki, H. & Nowak, M. A. (2009). Evolutionary dynamics in set structured populations. *Proc. Natl. Acad. Sci. U.S.A.* 106: 8601-8604. DOI: [10.1073/pnas.0903019106](https://doi.org/10.1073/pnas.0903019106) PDF
302. Tarnita, C. E., Ohtsuki, H., Antal, T., Fu, F. & Nowak, M. A. (2009). Strategy selection in structured populations. *J. Theor. Biol.* 259: 570-581. DOI: [10.1016/j.jtbi.2009.03.035](https://doi.org/10.1016/j.jtbi.2009.03.035) PDF
303. Taylor, C. & Nowak, M. A. (2009). How to evolve cooperation. Pages 41-56. In *Games, Groups, and the Global Good*, ed. S. Levin. New York: Springer. DOI: [10.1007/978-3-540-85436-4\\_2](https://doi.org/10.1007/978-3-540-85436-4_2) PDF
304. Traulsen, A., Hauert, C., Brandt De Silva, H., Nowak, M. A. & Sigmund, K. (2009). Exploration dynamics in evolutionary games. *Proc. Natl. Acad. Sci. U.S.A.* 106: 709-712. DOI: [10.1073/pnas.0808450106](https://doi.org/10.1073/pnas.0808450106) PDF
305. Wakano, J. Y., Nowak, M. A. & Hauert, C. (2009). Spatial dynamics of ecological public goods. *Proc. Natl. Acad. Sci. U.S.A.* 106: 7910-7914. DOI: [10.1073/pnas.0812644106](https://doi.org/10.1073/pnas.0812644106) PDF

## 2010

306. Bozic, I., Antal, T., Ohtsuki, H., Carter, H., Kim, D., Chen, S., Karchin, R., Kinzler, K. W., Vogelstein, B. & Nowak, M. A. (2010). Accumulation of driver and passenger mutations during tumor progression. *Proc. Natl. Acad. Sci. U.S.A.* 107 (43): 18545–18550. DOI: [10.1073/pnas.1010978107](https://doi.org/10.1073/pnas.1010978107) PDF
307. Fu, F., Nowak, M. A. & Hauert, C. (2010). Invasion and expansion of cooperators in lattice populations: Prisoner's dilemma vs. Snowdrift games. *J. Theor. Biol.* 266 (3): 358-366. DOI: [10.1016/j.jtbi.2010.06.042](https://doi.org/10.1016/j.jtbi.2010.06.042) PDF
308. Hill, A. L., Rand, D. G., Nowak, M. A. & Christakis, N. A. (2010). Emotions as infectious diseases in a large social network: the SISa model. *Proc. Royal Soc. B.* 277(1701): 3827-3835. DOI: [10.1098/rspb.2010.1217](https://doi.org/10.1098/rspb.2010.1217) PDF
309. Hill, A. L., Rand, D. G., Nowak, M. A. & Christakis, N. A. (2010). Infectious disease modeling of social contagion in networks. *PLoS Comput Biol* 6(11): e1000968. DOI: [10.1371/journal.pcbi.1000968](https://doi.org/10.1371/journal.pcbi.1000968) PDF
310. Imhof, L. A & Nowak, M.A. (2010). Stochastic evolutionary dynamics of direct reciprocity. *Proc. Royal Soc. B.* 277(1680): 463-468. DOI: [10.1098/rspb.2009.1171](https://doi.org/10.1098/rspb.2009.1171) PDF
311. Manapat, M. L., Chen, I. A. & Nowak, M.A. (2010). The basic reproductive ratio of life. *J. Theor. Biol.* 263 (3): 317-327. DOI: [10.1016/j.jtbi.2009.12.020](https://doi.org/10.1016/j.jtbi.2009.12.020) PDF
312. Nowak, M. A., Tarnita, C. E. & Antal, T. (2010). Evolutionary dynamics in structured populations. *Philos. Trans. Royal Soc. B.* 365 (1537): 19-30. DOI: [10.1098/rstb.2009.0215](https://doi.org/10.1098/rstb.2009.0215) PDF
313. Nowak, M. A., Tarnita, C. E. & Wilson, E. O. (2010). The evolution of eusociality. *Nature* 466(7310):1057-1062. DOI: [10.1038/nature09205](https://doi.org/10.1038/nature09205) PDF
314. Ojosnegros, S., Beerenwinkel, N., Antal, T., Nowak, M. A., Escarmis, C. & Domingo, E. (2010). Competition-colonization dynamics in an RNA virus. *Proc. Natl. Acad. Sci. U.S.A.* 107 (5): 2108-2112. DOI: [10.1073/pnas.0909787107](https://doi.org/10.1073/pnas.0909787107) PDF
315. Rajamani, S., Ichida, J. K., Antal, T., Treco, D. A., Leu, K., Nowak, M. A., Szostak, J. W. & I. A. Chen (2010). Effect of stalling after mismatches on the error catastrophe in nonenzymatic nucleic acid replication. *J. Am. Chem. Soc.* 132 (16): 5880–5885. DOI: [10.1021/ja100780p](https://doi.org/10.1021/ja100780p) PDF

316. Yachida, S., Jones, S., Bozic, I., Antal, T., Leary, R., Fu, B., Kamiyama, M., Hruban, R. H., Eshleman, J. R., **Nowak**, M. A., Velculescu, V. E., Kinzler, K.W., Vogelstein, B. & C. A. Iacobuzio-Donahue (2010). Distant metastasis occurs late during the genetic evolution of pancreatic cancer. *Nature* 467 (7319): 1114– 1117. DOI: [10.1038/nature09515](https://doi.org/10.1038/nature09515) [PDF](#) & [SI](#)

## 2011

317. Beale, N., Rand, D. G., Battey, H., Croxson, K., May, R. M. & **Nowak**, M.A. (2011). Individual versus systemic risk and the Regulator's Dilemma. *Proc. Natl. Acad. Sci. U.S.A.* 108 (31): 12647-12652. DOI: [10.1073/pnas.1105882108](https://doi.org/10.1073/pnas.1105882108) [PDF](#)

318. Fu, F., Rosenbloom, D. I., Wang, L. & **Nowak**, M.A. (2011). Imitation dynamics of vaccination behaviour on social networks. *Proc. Royal Soc. B.* 278 (1702): 42-49. DOI: [10.1098/rspb.2010.1107](https://doi.org/10.1098/rspb.2010.1107) [PDF](#)

319. Michel, J. B., Shen, Y. K., Presser Aiden, A., Veres, A. & Gray, M. K. The Google Books Team, J. P. Pickett, D. Hoiberg, D. Clancy, P. Norvig, J. Orwant, S. Pinker, **Nowak**, M.A. & Lieberman, E.A. (2011). Quantitative analysis of culture using millions of digitized books. *Science* 331 (6014): 176-182. DOI: [10.1126/science.1199644](https://doi.org/10.1126/science.1199644) [PDF](#)

320. **Nowak**, M. A. & Highfield, R. (2011). SuperCooperators: Why We Need Each Other to Succeed. [Simon & Schuster](#). ISBN: 9781451626636.

321. **Nowak**, M. A., Tarnita, C. E. & Wilson, E. O. (2011). Nowak et al. reply. *Nature* 471 (7339): E9-E10. DOI: [10.1038/nature09836](https://doi.org/10.1038/nature09836) [PDF](#)

322. Rand, D. G. & **Nowak**, M.A. (2011). The evolution of antisocial punishment in optional public goods games. *Nat. Commun.* 2: 434. DOI: [10.1038/ncomms1442](https://doi.org/10.1038/ncomms1442) [PDF](#)

323. Tarnita, C. E., Wage, N. & **Nowak**, M.A. (2011). Multiple strategies in structured populations. *Proc. Natl. Acad. Sci. U.S.A.* 108 (6): 2334-2337. DOI: [10.1073/pnas.1016008108](https://doi.org/10.1073/pnas.1016008108) [PDF](#)

324. van Veelen, M. & **Nowak**, M.A. (2011). Evolution: Selection for positive illusions. *Nature* 477 (7364): 282-283. DOI: [10.1038/477282a](https://doi.org/10.1038/477282a) [PDF](#)

## 2012

325. Allen, B. & **Nowak**, M.A. (2012). Evolutionary shift dynamics on a cycle. *J. Theor. Biol.* 311: 28-39. DOI: [10.1016/j.jtbi.2012.07.006](https://doi.org/10.1016/j.jtbi.2012.07.006) [PDF](#)

326. Allen, B., Traulsen, A., Tarnita, C. E. & **Nowak**, M.A. (2012). How mutation affects evolutionary games on graphs. *J. Theor. Biol.* 299: 97-105. DOI: [10.1016/j.jtbi.2011.03.034](https://doi.org/10.1016/j.jtbi.2011.03.034) [PDF](#)

327. Bozic, I., Allen, B. & **Nowak**, M.A. (2012). Dynamics of targeted cancer therapy. *Trends Mol. Med.* 18 (6): 311-316. DOI: [10.1016/j.molmed.2012.04.006](https://doi.org/10.1016/j.molmed.2012.04.006) [PDF](#)

328. Cavaliere, M., Sedwards, S., Tarnita, C. E., **Nowak**, M. A. & Csikász-Nagy, A. (2012). Prosperity is associated with instability in dynamical networks. *J. Theor. Biol.* 299: 126-138. DOI: [10.1016/j.jtbi.2011.09.005](https://doi.org/10.1016/j.jtbi.2011.09.005) [PDF](#)

329. Chatterjee, K., Reiter, J. G. & **Nowak**, M.A. (2012). Evolutionary dynamics of biological auctions. *Theor. Popul. Biol.* 81 (1): 69-80. DOI: [10.1016/j.tpb.2011.11.003](https://doi.org/10.1016/j.tpb.2011.11.003) [PDF](#)

330. Chatterjee, K., Zufferey, D. & **Nowak**, M.A. (2012). Evolutionary game dynamics in populations with different learners. *J. Theor. Biol.* 301: 161-173. DOI: [10.1016/j.jtbi.2012.02.021](https://doi.org/10.1016/j.jtbi.2012.02.021) PDF
331. Chen, I. & **Nowak**, M.A. (2012). From prelife to life: how chemical kinetics become evolutionary dynamics. *Acc. Chem. Res.* 45 (12): 2088-2096. DOI: [10.1021/ar2002683](https://doi.org/10.1021/ar2002683) PDF
332. Derr, J., Manapat, M. L., Rajamani, S., Leu, K., Xulvi-Brunet, R., Joseph, I., **Nowak**, M. A. & Chen, I. A. (2012). Prebiotically plausible mechanisms increase compositional diversity of nucleic acid sequences. *Nucl. Acids Res.* 40 (10): 4711-4722. DOI: [10.1093/nar/gks065](https://doi.org/10.1093/nar/gks065) PDF
333. Diaz, Jr., L. A., Williams, R. T., Wu, J., Kinde, I., Hecht, J. R., Berlin, J., Allen, B., Bozic, I., Reiter, J. G., **Nowak**, M. A., Kinzler, K. W., Oliner, K. S. & Vogelstein, B. (2012). The molecular evolution of acquired resistance to targeted EGFR blockade in colorectal cancers. *Nature* 486 (7404): 537-540. DOI: [10.1038/nature11219](https://doi.org/10.1038/nature11219) PDF & SI
334. Fu, F., **Nowak**, M. A., Christakis, N. A. & Fowler, J. H. (2012). The evolution of homophily. *Sci. Rep.* 2: 845. DOI: [10.1038/srep00845](https://doi.org/10.1038/srep00845) PDF
335. Fu, F., Tarnita, C. E., Christakis, N. A., Wang, L., Rand, D. G. & **Nowak**, M.A. (2012). Evolution of in-group favoritism. *Sci Rep.* 2: 460. DOI: [10.1038/srep00460](https://doi.org/10.1038/srep00460) PDF
336. Hill, A. L., Rosenbloom, D. I. S. & **Nowak**, M.A. (2012). Evolutionary dynamics of HIV at multiple spatial and temporal scales. *J. Mol. Med.* 90 (5): 543-561. DOI: [10.1007/s00109-012-0892-1](https://doi.org/10.1007/s00109-012-0892-1) PDF
337. Manapat, M. L., Rand, D. G., Pawlowitsch, C. & **Nowak**, M.A. (2012). Stochastic evolutionary dynamics resolve the Traveler's Dilemma. *J. Theor. Biol.* 303: 119-127. DOI: [10.1016/j.jtbi.2012.03.014](https://doi.org/10.1016/j.jtbi.2012.03.014) PDF
338. **Nowak**, M. A. (2012). Evolving cooperation. *J. Theor. Biol.* 299: 1-8. DOI: [10.1016/j.jtbi.2012.01.014](https://doi.org/10.1016/j.jtbi.2012.01.014) PDF
339. **Nowak**, M. A. (2012). Why we help. *Sci. Am.* 307 (1): 34-39. DOI: [10.1038/scientificamerican0712-34](https://doi.org/10.1038/scientificamerican0712-34) PDF
340. Rand, D. G., Greene, J. G. & **Nowak**, M.A. (2012). Spontaneous giving and calculated greed. *Nature* 489 (7416): 427-430. DOI: [10.1038/nature11467](https://doi.org/10.1038/nature11467) PDF & SI
341. Rand, D. G. & **Nowak**, M.A. (2012). Evolutionary dynamics in finite populations can explain the full range of cooperative behaviors observed in the centipede game. *J. Theor. Biol.* 300: 212-221. DOI: [10.1016/j.jtbi.2012.01.011](https://doi.org/10.1016/j.jtbi.2012.01.011) PDF
342. Rosenbloom, D. I. S, Hill, A. L., Rabi, S. A., Siliciano, R. F. & **Nowak**, M.A. (2012). Antiretroviral dynamics determines HIV evolution and predicts therapy outcome. *Nat. Med.* 18 (9): 1378-1385. DOI: [10.1038/nm.2892](https://doi.org/10.1038/nm.2892) PDF & SI
343. van Gestel, J., **Nowak**, M. A. & Tarnita, C. E. (2012). The evolution of cell-to-cell communication in a sporulating bacterium. *PLoS Comput. Biol.* 8 (12): e1002818. DOI: [10.1371/journal.pcbi.1002818](https://doi.org/10.1371/journal.pcbi.1002818) PDF
344. van Veelen, M, García, J, Rand, D. G. & **Nowak**, M.A. (2012). Direct reciprocity in structured populations. *Proc. Natl. Acad. Sci. U.S.A.* 109 (25): 9929-9934. DOI: [10.1073/pnas.1206694109](https://doi.org/10.1073/pnas.1206694109) PDF
345. van Veelen, M. & **Nowak**, M.A. (2012). Multi-player games on the cycle. *J. Theor. Biol.* 292: 116-128. DOI: [10.1016/j.jtbi.2011.08.031](https://doi.org/10.1016/j.jtbi.2011.08.031) PDF

## 2013

346. Allen, B., Gore, J. & Nowak, M.A. (2013). Spatial dilemmas of diffusible public goods. *eLife* 2: e01169. DOI: [10.7554/eLife.01169](https://doi.org/10.7554/eLife.01169) PDF
347. Allen, B. & Nowak, M.A. (2013). Cooperation and the fate of microbial societies. *PLoS Biol.* 11 (4): e1001549. DOI: [10.1371/journal.pbio.1001549](https://doi.org/10.1371/journal.pbio.1001549) PDF
348. Allen, B. & Nowak, M.A. (2013). O Brave New World with Such Games. *Science* 341 (6148): 844-844. DOI: [10.1126/science.1241750](https://doi.org/10.1126/science.1241750) PDF
349. Allen, B., Nowak, M. A. & U. Dieckmann (2013). Adaptive dynamics with interaction structure. *Am. Nat.* 181 (6): E139-E163. DOI: [10.1086/670192](https://doi.org/10.1086/670192) PDF
350. Allen, B., Nowak, M. A. & E. O. Wilson (2013). Limitations of inclusive fitness. *Proc. Natl. Acad. Sci. U.S.A.* 110 (50): 20135-20139. DOI: [10.1073/pnas.1317588110](https://doi.org/10.1073/pnas.1317588110) PDF
351. Bianconi, G., Zhao, K., Chen, I. & Nowak, M.A. (2013). Selection for replicases in protocells. *PLoS Comput. Biol.* 9 (5): e1003051. DOI: [10.1371/journal.pcbi.1003051](https://doi.org/10.1371/journal.pcbi.1003051) PDF
352. Bozic, I. & Nowak, M.A. (2013). Unwanted evolution. *Science* 342 (6161): 938-939. DOI: [10.1126/science.1247887](https://doi.org/10.1126/science.1247887) PDF
353. Bozic, I., Reiter, J. G., Allen, B., Antal, T., Chatterjee, K., Shah, P., Moon, Y. S., Yaquibie, A., Kelly, N., Le, D. T., Lipson, E. J., Chapman, P. B., Diaz Jr., L. A., Vogelstein, B. & Nowak, M.A.(2013). Evolutionary dynamics of cancer in response to targeted combination therapy. *eLife* 2: e00747. DOI: [10.7554/eLife.00747](https://doi.org/10.7554/eLife.00747) PDF
354. Coakley, S. & Nowak, M.A., eds. (2013). Evolution, Games, and God: The Principle of Cooperation. [Harvard University Press](https://www.harvard.edu/). ISBN: 9780674047976.
355. Ellingsen, T., Herrmann, B., Nowak, M. A., Rand, D. G. & C. E. Tarnita (2013). Civic capital in two cultures: The nature of cooperation in Romania and USA. *IDEAS Working Paper Series* from RePEc, St. Louis. DOI: [10.2139/ssrn.2179575](https://doi.org/10.2139/ssrn.2179575) PDF
356. Fu, F. & Nowak, M.A. (2013). Global migration can lead to stronger spatial selection than local migration. *J. Stat. Phys.* 151: 637-653. DOI: [10.1007/s10955-012-0631-6](https://doi.org/10.1007/s10955-012-0631-6) PDF
357. Hilbe, C., Nowak, M. A. & Sigmund, K. (2013). The evolution of extortion in iterated Prisoner's Dilemma games. *Proc. Natl. Acad. Sci. U.S.A.* 110 (17): 6913–6918. DOI: [10.1073/pnas.1214834110](https://doi.org/10.1073/pnas.1214834110) PDF
358. Hilbe, C., Nowak, M. A. & Traulsen, A. (2013). Adaptive dynamics of extortion and compliance. *PLoS ONE* 8: e77886. DOI: [10.1371/journal.pone.0077886](https://doi.org/10.1371/journal.pone.0077886) PDF
359. Manapat, M. L., Nowak, M. A., & Rand, D. G. (2013). Information, irrationality, and the evolution of trust. *J. Econ. Behav. Organ.* 90 (Suppl): S57–S75. DOI: [10.1016/j.jebo.2012.10.018](https://doi.org/10.1016/j.jebo.2012.10.018) PDF
360. Novak, S., Chatterjee, K. & Nowak, M.A. (2013). Density games. *J. Theor. Biol.* 334: 26-34. DOI: [10.1016/j.jtbi.2013.05.029](https://doi.org/10.1016/j.jtbi.2013.05.029) PDF
361. Randles, A. P., Rand, D. G., Lee, C., Morrisett, G., Sircar, J., Nowak, M. A. & Pfister, H. (2013). Massively parallel model of extended memory use in evolutionary game dynamics. *IPDPS*: 1217-1228. DOI: [10.1109/IPDPS.2013.102](https://doi.org/10.1109/IPDPS.2013.102) PDF
362. Rand, D. G., Greene, J. D. & Nowak, M.A. (2013). Rand et al. reply. *Nature* 498 (7452): E2-E3. DOI: [10.1038/nature12195](https://doi.org/10.1038/nature12195) PDF

363. Rand, D. G. & Nowak, M.A. (2013). Human cooperation. *Trends Cogn. Sci.* 17 (8): 413-425. DOI: [10.1016/j.tics.2013.06.003](https://doi.org/10.1016/j.tics.2013.06.003) PDF
364. Rand, D. G., Tarnita, C. E., Ohtsuki, H., & Nowak, M.A. (2013). Evolution of fairness in the one-shot anonymous Ultimatum Game. *Proc. Natl. Acad. Sci. U.S.A.* 110 (7): 2581-2586. DOI: [10.1073/pnas.1214167110](https://doi.org/10.1073/pnas.1214167110) PDF
365. Reiter, J. G., Bozic, I., Allen, B., Chatterjee, K. & Nowak, M.A. (2013). The effect of one additional driver mutation on tumor progression. *Evol. Appl.* 6 (1): 34-45. DOI: [10.1111/eva.12020](https://doi.org/10.1111/eva.12020) PDF
366. Reiter, J. G., Bozic, I., Chatterjee, K. & Nowak, M.A. (2013). TTP: Tool for Tumor Progression. *Lect. Notes Comput. Sci.* 8044: 101-106. DOI: [10.1007/978-3-642-39799-8\\_6](https://doi.org/10.1007/978-3-642-39799-8_6) PDF
367. Suchow, J. W., Allen, B., Nowak, M. A. & Alvarez, G. A. (2013). Evolutionary dynamics of visual memory. *J. Vis.* 13(9): 20. DOI: [10.1167/13.9.20](https://doi.org/10.1167/13.9.20)
368. Tarnita, C. E., Taubes, C. H. & Nowak, M.A. (2013). Evolutionary construction by staying together and coming together. *J. Theor. Biol.* 320: 10-22. DOI: [10.1016/j.jtbi.2012.11.022](https://doi.org/10.1016/j.jtbi.2012.11.022) PDF
369. Yoeli, E., Hoffman, M., Rand, D. G. & Nowak, M.A. (2013). Powering up with indirect reciprocity in a large-scale field experiment. *Proc. Natl. Acad. Sci. U.S.A.* 110 (Suppl 2): 10424-10429. DOI: [10.1073/pnas.1301210110](https://doi.org/10.1073/pnas.1301210110) PDF
370. Zagorsky, B. M., Reiter, J. G., Chatterjee, K. & Nowak, M.A. (2013). Forgiver triumphs in alternating Prisoner's Dilemma. *PLoS ONE* 8 (12): e80814. DOI: [10.1371/journal.pone.0080814](https://doi.org/10.1371/journal.pone.0080814) PDF

## 2014

371. Adlam, B. & Nowak, M.A. (2014). Universality of fixation probabilities in randomly structured populations. *Nature Sci. Rep.* 4: 6692. DOI: [10.1038/srep06692](https://doi.org/10.1038/srep06692) PDF
372. Allen, B. & Nowak, M.A. (2014). Games on graphs. *EMS Surv. Math. Sci.* 1(1): 115-151. DOI: [10.4171/EMSS/3](https://doi.org/10.4171/EMSS/3)
373. Bozic, I. & Nowak, M.A. (2014) Timing and heterogeneity of mutations associated with drug-resistance in metastatic cancers. *Proc. Natl. Acad. Sci. U.S.A.* 111 (45): 15964-15968. DOI: [10.1073/pnas.1412075111](https://doi.org/10.1073/pnas.1412075111) PDF
374. Chatterjee, K., Pavlogiannis, A., Adlam, B. & Nowak, M.A. (2014). The time scale of evolutionary trajectories. *PLoS Comput. Biol.* 10(9): e1003818. DOI: [10.1371/journal.pcbi.1003818](https://doi.org/10.1371/journal.pcbi.1003818) PDF
375. Fu, F., Kocher, S. D. & Nowak, M.A. (2014) The risk-return trade-off between solitary and eusocial reproduction. *Ecol. Lett.* 18(1): 74-84. DOI: [10.1111/ele.12392](https://doi.org/10.1111/ele.12392) PDF
376. Ghang, W. & Nowak, M.A. (2014). Stochastic evolution of staying together. *J. Theor. Biol.* 360: 129-136. DOI: [10.1016/j.jtbi.2014.06.026](https://doi.org/10.1016/j.jtbi.2014.06.026) PDF
377. Hauser, O. P., Nowak, M. A. & Rand, D. G. (2014). Punishment does not promote cooperation under exploration dynamics when anti-social punishment is possible. *J. Theor. Biol.* 360: 163-171. DOI: [10.2139/ssrn.2298851](https://doi.org/10.2139/ssrn.2298851) PDF
378. Hauser, O. P., Rand, D. G., Peysakhovich, A. & Nowak, M.A. (2014). Cooperating with the future. *Nature* 511: 220-223. DOI: [10.1038/nature13530](https://doi.org/10.1038/nature13530) PDF & SI

379. Hauser, O. P., Traulsen, A. & **Nowak**, M.A. (2014). Heterogeneity in background fitness acts as a suppressor of selection. *J. Theor. Biol.* 343(21):178-185. DOI: [10.1016/j.jtbi.2013.10.013](https://doi.org/10.1016/j.jtbi.2013.10.013) PDF
380. Hilbe, C., Wu, B., Traulsen, A. & **Nowak**, M.A. (2014) Cooperation and control in multiplayer social dilemmas. *Proc. Natl. Acad. Sci. U.S.A.* 111(46): 16425-16430. DOI: [10.1073/pnas.1407887111](https://doi.org/10.1073/pnas.1407887111) PDF
381. Hill, A. L. & **Nowak**, M.A. (2014). Mind over matter. *Trends Ecol. Evol.* 29(2):74-75. DOI: [10.1016/j.tree.2013.10.004](https://doi.org/10.1016/j.tree.2013.10.004) PDF
382. Hill, A. L., Rosenbloom, D. L. S., Fu, F., **Nowak**, M. A. & Siliciano, R. F. (2014). Predicting the outcomes of treatment to eradicate the latent reservoir for HIV-1. *Proc. Natl. Acad. Sci. U.S.A.* 111: 37:134756-13480. DOI: [10.1073/pnas.1406663111](https://doi.org/10.1073/pnas.1406663111) PDF
383. Humplik, J., Hill, A. L. & **Nowak**, M.A. (2014). Evolutionary dynamics of infectious diseases in finite populations. *J. Theor. Bio.* 360: 149-162 DOI: [10.1016/j.jtbi.2014.06.039](https://doi.org/10.1016/j.jtbi.2014.06.039) PDF
384. Jeong, H-C., Oh, S-Y., Allen, B. & **Nowak**, M.A. (2014). Optional games on cycles and complete graphs. *J. Theor. Biol.* 356(7): 98-112. DOI: [10.1016/j.jtbi.2014.04.025](https://doi.org/10.1016/j.jtbi.2014.04.025) PDF
385. Kocher, S. D., Pellissier, L., Veller, C., Purcell, J., **Nowak**, M. A., Chapuisat, M. & Pierce, N. E. (2014). Transitions in social complexity along elevational gradients reveal a combined impact of season length and development time on social evolution. *Proc. Royal Soc. B.* 281 (1787) DOI: [10.1098/rspb.2014.0627](https://doi.org/10.1098/rspb.2014.0627) PDF
386. Markvoort, A. J., Sinai, S. & **Nowak**, M.A. (2014). Computer simulations of cellular group selection reveal mechanism for sustaining cooperation. *J. Theor. Biol.* 357: 123-133. DOI: [10.1016/j.jtbi.2014.04.029](https://doi.org/10.1016/j.jtbi.2014.04.029) PDF
387. Olejarz, J. W. & **Nowak**, M.A. (2014). Evolution of staying together in the context of diffusible public goods. *J. Theor. Biol.* 360:1-12. DOI: [10.1016/j.jtbi.2014.06.023](https://doi.org/10.1016/j.jtbi.2014.06.023) PDF
388. Peysakhovich, A., **Nowak**, M. A. & Rand, D. G. (2014). Humans display a 'cooperative phenotype' that is domain general and temporally stable. *Nature Commun.* DOI: [10.1038/ncomms5939](https://doi.org/10.1038/ncomms5939) PDF
389. Rand, D. G., Dreber, A., Haque, O. S., Kane, R. J., **Nowak**, M. A. & Coakley, S. (2014). Religious motivations for cooperation: an experimental investigation using explicit primes. *Religion Brain Behav.* 4 (1):31-48. DOI: [10.2139/ssrn.2123243](https://doi.org/10.2139/ssrn.2123243) PDF
390. Rand, D. G., Peysakhovich, A., Kraft-Todd, G. T., Newman, G. E., Wurzbacher, O., **Nowak**, M. A. & Greene, J. D. (2014). Social heuristics shape intuitive cooperation. *Nat. Commun.* 5: 1-12. DOI: [10.1038/ncomms4677](https://doi.org/10.1038/ncomms4677) PDF
391. Szabó, G., Bodó, K. S., Allen, B. & **Nowak**, M.A. (2014). Fourier decomposition of payoff matrix for symmetric three-strategy games. *Phys. Rev. E* 90 (4), 042811 DOI: [10.1103/PhysRevE.90.042811](https://doi.org/10.1103/PhysRevE.90.042811) PDF
392. Rand, D. G., **Nowak**, M. A., Fowler, J. H. & Christakis, N. A. (2014) Static network structure can stabilize human cooperation. *Proc. Natl. Acad. Sci. U.S.A.* 111(48):17093-17098. DOI: [10.1073/pnas.1400406111](https://doi.org/10.1073/pnas.1400406111) PDF
393. Wilson, E. O. & **Nowak**, M.A. (2014). Natural selection drives the evolution of ant lifecycles. *Proc. Natl. Acad. Sci. U.S.A.* 111(35): 12585-12590. DOI: [10.1073/pnas.1405550111](https://doi.org/10.1073/pnas.1405550111) PDF

394. Adlam, B., Chatterjee, K. & **Nowak**, M.A. (2015). Amplifiers of Selection. *Proc. Royal Soc. A.* 471(2181). DOI: [10.1098/rspa.2015.0114](https://doi.org/10.1098/rspa.2015.0114) [PDF](#)
395. Allen, B., Sample, C., Dementieva, Y. A., Medeiros, R. C., Paoletti, C. & **Nowak**, M.A. (2015). The molecular clock of neutral evolution can be accelerated or slowed by asymmetric spatial structure. *PLoS Comput. Biol.* 11(2): e1004108. DOI: [10.1371/journal.pcbi.1004108](https://doi.org/10.1371/journal.pcbi.1004108) [PDF](#)
396. Allen, B. & **Nowak**, M.A. (2015). Games among relatives revisited. *J. Theor. Biol.* 378: 103-116. DOI: [10.1016/j.jtbi.2015.04.031](https://doi.org/10.1016/j.jtbi.2015.04.031) [PDF](#)
397. Antal, T., Krapivsky, P. L. & **Nowak**, M.A. (2015). Spatial evolution of tumors with successive driver mutations. *Phys. Rev. E* 92(2), 022705. DOI: [10.1103/PhysRevE.92.022705](https://doi.org/10.1103/PhysRevE.92.022705) [PDF](#)
398. Fu, F., **Nowak** M. A. & Bonhoeffer, S. (2015). Spatial heterogeneity in drug concentrations can facilitate the emergence of resistance to cancer therapy. *PLoS Comput. Biol.* 11(3): e1004142. DOI: [10.1371/journal.pcbi.1004142](https://doi.org/10.1371/journal.pcbi.1004142) [PDF](#)
399. Ghang W. & **Nowak**, M.A. (2015). Indirect reciprocity with optional interactions. *J. Theor. Biol.* 365: 1-11. DOI: [10.1016/j.jtbi.2014.09.036](https://doi.org/10.1016/j.jtbi.2014.09.036) [PDF](#)
400. Hilbe, C., Hoffman, M. & **Nowak**, M.A. (2015). Cooperate without looking in a non-repeated game. *Games* 6(4), 458-472. DOI: [10.3390/g6040458](https://doi.org/10.3390/g6040458) [PDF](#)
401. Hilbe, C., Wu, B., Traulsen, A. & **Nowak**, M.A. (2015). Evolutionary performance of zero-determinant strategies in multiplayer games. *J. Theor. Biol.* 374: 115-124 DOI: [10.1016/j.jtbi.2015.03.032](https://doi.org/10.1016/j.jtbi.2015.03.032) [PDF](#)
402. Hoffman, M., Yoeli, E. & **Nowak**, M.A. (2015) Cooperate without looking: Why we care what people think and not just what they do. *Proc. Natl. Acad. Sci. U.S.A.* 112(6), 1727-1732. DOI: [10.1073/pnas.1417904112](https://doi.org/10.1073/pnas.1417904112) [PDF](#)
403. Hoffman, M., Suetens, S., Gneezy, U. & **Nowak**, M.A. (2015) An experimental investigation of evolutionary dynamics in the Rock-Paper-Scissors game. *Sci. Rep.* 5, 8817. DOI: [10.1038/srep08817](https://doi.org/10.1038/srep08817) [PDF](#)
404. Ibsen-Jensen R, Chatterjee, K. & **Nowak**, M.A. (2015). Computational complexity of ecological and evolutionary spatial dynamics. *Proc. Natl. Acad. Sci. U.S.A.* ePub 7 Dec 2015. DOI: [10.1073/pnas.1511366112](https://doi.org/10.1073/pnas.1511366112) [PDF](#)
405. Landau, D., Tausch, E., Taylor-Weiner, A. N., Stewart, C., Reiter, J. G., Bahlo, J., Kluth, S., Bozic, I., Lawrence, M., Böttcher, S., Carter, S. L., Cibulskis, K., Mertens, D., Sougnez, C. L., Rosenberg, M., Hess, J. M., Edlmann, J., Kless, S., Kneba, M., Ritgen, M., A., Fischer, K., Gabriel, S., Lander, E. S., **Nowak**, M. A., Döhner, H., Hallek, M., Neuberger, D., Getz, G., Stilgenbauer, S. & Wu, C. J. (2015). Mutations driving CLL and their evolution in progression and relapse. *Nature* 526: 525-530. DOI: [10.1038/nature15395](https://doi.org/10.1038/nature15395) [PDF](#)
406. Leventhal, G., Hill, A. L., **Nowak**, M. A. & Bonhoeffer, S. (2015). Evolution and emergence of infectious diseases on theoretical and real-world networks. *Nat. Commun.* 6(6101) DOI: [10.1038/ncomms7101](https://doi.org/10.1038/ncomms7101) [PDF](#)
407. Misale, S., Bozic, I., Tong, J., Peraza-Penton, A., Lallo, A., Baldi, F., Lin, K., Trusolino, L., Bertotti, A., Di Nicolantonio, F., **Nowak**, M. A., Zhang, L., Wood, K. & Bardelli, A. (2015). Vertical suppression of the EGFR pathway prevents onset of resistance in colorectal cancers. *Nat. Commun.* 6(8305). DOI: [10.1038/ncomms9305](https://doi.org/10.1038/ncomms9305) [PDF](#)
408. Moreno-Gómez, S., Hill, A. L., Rosenbloom, D. I. R., Petrov, D., **Nowak** M. A. & Pennings, P. (2015). Imperfect drug penetration leads to spatial monotherapy and rapid evolution of multi-drug resistance. *Proc. Natl. Acad. Sci. U.S.A.* 112(22) E2874-E2883. DOI: [10.1073/pnas.1424184112](https://doi.org/10.1073/pnas.1424184112) [PDF](#)

409. **Nowak**, M. A. (2015). Obituary: John Forbes Nash (1928 - 2015). *Nature* 522:420. DOI: [10.1038/522420a](https://doi.org/10.1038/522420a) [PDF](#)
410. **Nowak**, M. A. & Allen, B. (2015) Inclusive Fitness Theorizing Invokes Phenomena That Are Not Relevant for the Evolution of Eusociality. *PLoS Biol.* 13(4): e1002134. DOI: [10.1371/journal.pbio.1002134](https://doi.org/10.1371/journal.pbio.1002134) [PDF](#)
411. Ohtsuki, H., Iwasa, Y. & **Nowak**, M. A. (2015). Reputation effects in public and private interactions. *PLOS Comp. Biol.* 11(11): e1004527 DOI: [10.1371/journal.pcbi.1004527](https://doi.org/10.1371/journal.pcbi.1004527) [PDF](#)
412. Olejarz, J., Allen, B., Veller, C. & **Nowak**, M. A. (2015). The evolution of non-reproductive workers in insect colonies with haplodiploid genetics. *eLife* 4: e08918. DOI: [10.7554/eLife.08918](https://doi.org/10.7554/eLife.08918) [PDF](#)
413. Olejarz, J., Ghang, W. & **Nowak**, M. A. (2015). Indirect Reciprocity with Optional Interactions and Private Information. *Games* 6(4), 438-457. DOI: [10.3390/g6040438](https://doi.org/10.3390/g6040438) [PDF](#)
414. Pavlogiannis, A., Chatterjee, K., Adlam, B. & **Nowak**, M. A. (2015). Cellular cooperation with shift updating and repulsion. *Sci Rep.* 5:17147. DOI: [10.1038/srep17147](https://doi.org/10.1038/srep17147) [PDF](#)
415. Rand, D. G. & **Nowak**, M. A. (2015). Cooperation among humans. In *Global Cooperation and the Human Factor in International Relations*. Ed. Dirk Messner, Ed. Silke Weinlich. New York: Routledge, 113-138. Print. DOI: [10.4324/9781315691657](https://doi.org/10.4324/9781315691657) [PDF](#)
416. Reiter, J. G., Kanodia, A., Gupta, R., **Nowak**, M. A. & Chatterjee, K. (2015) Biological auctions with multiple rewards. *Proc. Royal Soc. B.* 282: 20151041. DOI: [10.1098/rspb.2015.1041](https://doi.org/10.1098/rspb.2015.1041) [PDF](#)
417. Szabó, G., Bodó, K. S., Allen, B. & **Nowak**, M. A. (2015). Four classes of interactions for evolutionary games. *Phys. Rev. E* 92(2). DOI: [10.1103/PhysRevE.92.022820](https://doi.org/10.1103/PhysRevE.92.022820) [PDF](#)
418. Tomasetti, C., Marchionni, L., **Nowak**, M. A., Parmigiani, G. & Vogelstein, B. (2015). Only three driver gene mutations are required for development of lung and colorectal cancers. *Proc. Natl. Acad. Sci. U.S.A.* 112(1):118-123. DOI: [10.1073/pnas.1421839112](https://doi.org/10.1073/pnas.1421839112) [PDF](#)
419. Veller, C., **Nowak**, M. A. & Davis, C. C. (2015). Extended flowering intervals of bamboos evolved by discrete multiplication. *Ecol. Lett.* 18(7):653-9. DOI: [10.1111/ele.12442](https://doi.org/10.1111/ele.12442) [PDF](#)
420. Vukov, J., Varga, L., Allen, B., Veller, C., **Nowak**, M. A. & Szabó, G. (2015). Payoff components and their effects in a spatial three-strategy evolutionary social dilemma. *Phys. Rev. E* 92, 012813 DOI: [10.1103/PhysRevE.92.012813](https://doi.org/10.1103/PhysRevE.92.012813) [PDF](#)
421. Waclaw, B., Bozic, I., Pittman, M. E., Rhuban, R. H., Vogelstein, B. & **Nowak**, M.A. (2015). A spatial model predicts that dispersal and cell turnover limit intratumour heterogeneity. *Nature* 525(7568):261-4. DOI: [10.1038/nature14971](https://doi.org/10.1038/nature14971) [PDF](#) & [SI](#)

## 2016

422. Allen, B. & **Nowak**, M.A. (2016). There is no inclusive fitness at the level of the individual. *Curr. Opin. Behav. Sci.* 12: 122-128. DOI: [10.1016/j.cobeha.2016.10.002](https://doi.org/10.1016/j.cobeha.2016.10.002) [PDF](#)
423. Baek, S. K., Jeong, H. C., Hilbe, C. & **Nowak**, M.A. (2016). Comparing reactive and memory-one strategies of direct reciprocity. *Sci. Rep.* 6 (25676). DOI: [10.1038/srep25676](https://doi.org/10.1038/srep25676) [PDF](#)
424. Bozic I, Gerold, J. M. & **Nowak**, M.A. (2016). Quantifying clonal and subclonal passenger mutations in cancer evolution. *PLoS Comput. Biol.* 12(2): e1004731. DOI: [10.1371/journal.pcbi.1004731](https://doi.org/10.1371/journal.pcbi.1004731) [PDF](#) & [SI](#)

425. Burger, J. A., Landau, D. A., Taylor-Weiner, A., Bozic, I., Zhang, H., Sarosiek, K., Wang, L., Stewart, C., Fan, J., Hoellenriegel, J., Sivina, M., Dubuc, A. M., Fraser, C., Han, Y., Li, S., Livak, K. J., Zou, L., Wan, Y., Konoplev, S., Sougnez, C., Brown, J. R., Abruzzo, L.V., Carter, S. L., Keating, M. J., Davids, M. S., Wierda, W. G., Cibulskis, K., Zenz, T., Werner, L., Dal Cin, P., Kharchenko, P., Neuberg, D., Kantarjian, H., Lander, E., Gabriel, S., O'Brien, S., Letai, A., Weitz, D. A., **Nowak**, M.A., Getz, G. & Wu, C.J. (2016) Clonal evolution in patients with chronic lymphocytic leukaemia developing resistance to BTK inhibition. *Nat Commun.* 7(11589). DOI: [10.1038/ncomms11589](https://doi.org/10.1038/ncomms11589) PDF & SI
426. Chen, Y., McAvoy, A. & **Nowak**, M.A. (2016). Fixation probabilities for any configuration of two strategies on regular graphs. *Sci. Rep.* 6:39181. DOI: [10.1038/srep39181](https://doi.org/10.1038/srep39181) PDF
427. van Gestel, J. & **Nowak**, M.A. (2016). Phenotypic heterogeneity and the evolution of bacterial life cycles. *PLoS Comput. Biol.* 12(2): e1004764. DOI: [10.1371/journal.pcbi.1004764](https://doi.org/10.1371/journal.pcbi.1004764) PDF
428. Hauser, O., Hendriks, A., Rand, D. G. & **Nowak**, M.A. (2016). Think global, act local: Preserving the global commons. *Sci. Rep.* 6:36079 DOI: [10.1038/srep36079](https://doi.org/10.1038/srep36079) PDF
429. Kaveh, K., Veller, C. & **Nowak**, M.A. (2016). Games of multicellularity. *J. Theor. Bio.* 403:143-158. DOI: [10.1016/j.jtbi.2016.04.037](https://doi.org/10.1016/j.jtbi.2016.04.037) PDF
430. Olejarz, J., Allen, B., Veller, C., Gadagkar, R. & **Nowak**, M.A. (2016). Evolution of worker policing. *J. Theor. Bio.* 399: 103-116. DOI: [10.1016/j.jtbi.2016.03.001](https://doi.org/10.1016/j.jtbi.2016.03.001) PDF
431. Paterson, C., **Nowak**, M. A. & Waclaw, B. (2016). An exactly solvable, spatial model of mutation accumulation in cancer. *Sci. Rep.* 6:39511 DOI: [10.1038/srep39511](https://doi.org/10.1038/srep39511) PDF
432. Rand, D. G., Jordan, J., Hoffman, M. & **Nowak**, M.A. (2016). Uncalculating cooperation is used to signal trustworthiness. *Proc. Natl. Acad. Sci. U.S.A.* epub 21 July 2016. DOI: [10.1073/pnas.1601280113](https://doi.org/10.1073/pnas.1601280113) PDF
433. Reiter, J. G., Makohon-Moore, A., Gerold, J., Bozic, I., Chatterjee, K., Iacobuzio-Donahue, C., Vogelstein, B. & **Nowak**, M.A. (2016). Reconstructing the evolutionary history of metastatic cancers. *Cancer Res.* 76(14 Supplement), 2374-2374. DOI: [10.1158/1538-7445.AM2016-2374](https://doi.org/10.1158/1538-7445.AM2016-2374) PDF
434. Veller, C., Haig, D. & **Nowak**, M.A. (2016). The Trivers-Willard hypothesis: sex ratio or investment? *Proc. Royal Soc. B.* 283(1830). DOI: [10.1098/rspb.2016.0126](https://doi.org/10.1098/rspb.2016.0126) PDF
435. Yamamoto, Y., Offord, C. P., Kimura, G., Kuribayashi, S., Takeda, H., Tsuchiya, S., Shimojo, H., Kanno, H., Bozic, I., **Nowak**, M. A., Bajzer, Ž. & Dingli, D. (2016). Tumor and immune cell dynamics explain the PSA bounce after prostate cancer brachytherapy. *Br. J. Cancer* 115: 195–202. DOI: [10.1038/bjc.2016.171](https://doi.org/10.1038/bjc.2016.171) PDF & SI
436. Yeates, J. A. M., Hilbe, C., Zwick, M., **Nowak**, M. A. & Lehman, N. (2016). Dynamics of prebiotic RNA reproduction illuminated by chemical game theory. *Proc. Natl. Acad. Sci. U.S.A.* DOI: [10.1073/pnas.1525273113](https://doi.org/10.1073/pnas.1525273113) PDF

## 2017

437. Allen, B., Lippner, G., Chen, Y-T., Fotouhi, B., Momeni, N., Yau, S-T. & **Nowak**, M.A. (2017). Evolutionary dynamics on any population structure. *Nature* 544: 227–230. DOI: [10.1038/nature21723](https://doi.org/10.1038/nature21723) PDF & SI
438. Altrock, P. M., Traulsen, A. & **Nowak**, M.A. (2017). Evolutionary games on cycles with strong selection. *Phys. Rev. E* 95: 022407. DOI: [10.1103/PhysRevE.95.022407](https://doi.org/10.1103/PhysRevE.95.022407) PDF
439. Bozic, I. & **Nowak**, M.A. (2017). Resisting Resistance. *Annu. Rev. Cancer Biol.* 2017 1:10.1–10.19. DOI: [10.1146/annurev-cancerbio-042716-094839](https://doi.org/10.1146/annurev-cancerbio-042716-094839) PDF

440. Chatterjee, K., Ibsen-Jensen, R. & **Nowak**, M.A. (2017). Faster Monte-Carlo Algorithms for Fixation Probability of the Moran Process. In K. G. Larsen, H. L. Bodlaender, J-F. Raskin (eds.), *42nd International Symposium on Mathematical Foundations of Computer Science (MFCS 2017)*, 61:1--61:13. Dagstuhl, Germany: Schloss Dagstuhl--Leibniz-Zentrum fuer Informatik. DOI: [10.4230/LIPIcs.MFCS.2017.61](https://doi.org/10.4230/LIPIcs.MFCS.2017.61) PDF
441. Hilbe, C., Martinez-Vaquero, L. A., Chatterjee, K. & **Nowak**, M.A. (2017). Memory-n strategies of direct reciprocity. *Proc. Natl. Acad. Sci. U.S.A.* 114 (18): 4715-4720. DOI: [10.1073/pnas.1621239114](https://doi.org/10.1073/pnas.1621239114) PDF & SI
442. Kinsler, G., Sinai, S., Lee, N. K. & **Nowak**, M.A. (2017). Prebiotic selection for motifs in a model of template-free elongation of polymers within compartments. *PLoS ONE* 12(7): e0180208. DOI: [10.1371/journal.pone.0180208](https://doi.org/10.1371/journal.pone.0180208) PDF
443. Knoll, A. & **Nowak**, M.A. (2017). The Timetable of Evolution. *Sci. Adv.* 3(5): e1603076. DOI: [10.1126/sciadv.1603076](https://doi.org/10.1126/sciadv.1603076) PDF
444. Krieger, M., McAvoy, A. & **Nowak**, M.A. (2017). Effects of motion in structured populations. *J. Royal Soc. Interface* 14(135) DOI: [10.1098/rsif.2017.0509](https://doi.org/10.1098/rsif.2017.0509) PDF & SI
445. Makohon-Moore, A. P., Zhang, M., Reiter, J. G., Bozic, I., Allen, B., Kundu, D., Chatterjee, K., Wong, F., Jiao, Y., Kohutek, Z. A., Hong, J., Attiyeh, M., Javier, B., Wood, L. D., Hruban, R. H., **Nowak**, M. A., Papadopoulos, N., Kinzler, K. W., Vogelstein, V. & Iacobuzio-Donahue, C. A. (2017). Limited heterogeneity of known driver gene mutations among the metastases of individual pancreatic cancer patients. *Nat. Genet.* DOI: [10.1038/ng.3764](https://doi.org/10.1038/ng.3764) PDF & SI
446. Naxerova, K., Reiter, J. G., Brachtel, E., Lennerz, J. K., van de Wetering, M., Rowan, A., Cai, T., Clevers, H., Swanton, C., **Nowak**, M. A., Elledge, S. J. & Jain, R. K. (2017). Origins of lymphatic and distant metastases in human colorectal cancer. *Science* 357(6346): 55-60. DOI: [10.1126/science.aai8515](https://doi.org/10.1126/science.aai8515) PDF & SI
447. Noble, C., Olejarz, J., Esvelt, K., Church, G. & **Nowak**, M.A. (2017). Evolutionary dynamics of CRISPR gene drives. *Sci. Adv.* 3(4), e1601964. DOI: [10.1126/sciadv.1601964](https://doi.org/10.1126/sciadv.1601964) PDF & SI
448. **Nowak**, M. A., Allen, B., McAvoy, A. & Wilson, E. O. (2017). The general form of Hamilton's rule makes no predictions and cannot be tested empirically. *Proc. Natl. Acad. Sci. U.S.A.* 114 (22): 5665-5670. DOI: [10.1073/pnas.1701805114](https://doi.org/10.1073/pnas.1701805114) PDF
449. **Nowak**, M. A. & Waclaw, B. (2017). Genes, environment, and "bad luck" (2017). *Science* 355 (6331): 1266-1267. DOI: [10.1126/science.aam9746](https://doi.org/10.1126/science.aam9746) PDF
450. **Nowak**, M. A. & Sigmund, K. (2017). How Virtue Was Born (2017). *Gerontology* epub 6 Dec 2017. DOI: [10.1159/000484479](https://doi.org/10.1159/000484479) PDF
451. Olejarz, J., Veller, C. & **Nowak**, M.A. (2017). The evolution of queen control over worker reproduction in the social Hymenoptera. *Ecol. Evol.* epub 10 Sep 2017. DOI: [10.1002/ece3.3324](https://doi.org/10.1002/ece3.3324) PDF
452. Pavlogiannis, A., Tkadlec, J., Chatterjee, K. & **Nowak**, M.A. (2017). Amplification on Undirected Population Structures: Comets Beat Stars. *Sci. Rep.* 7(82). DOI: [10.1038/s41598-017-00107-w](https://doi.org/10.1038/s41598-017-00107-w) PDF & SI
453. Priklopil, T., Chatterjee, K. & **Nowak**, M.A. (2017). Optional interactions and suspicious behaviour facilitates trustful cooperation in prisoners dilemma. *J. Theor. Bio.* epub 1 Sep 2017. DOI: [10.1016/j.jtbi.2017.08.025](https://doi.org/10.1016/j.jtbi.2017.08.025) PDF
454. Reiter, J. G., Makohon-Moore, A., Gerold, J., Bozic, I., Chatterjee, K., Iacobuzio-Donahue, C., Vogelstein, V. & **Nowak**, M.A. (2017). Reconstructing metastatic seeding patterns of human cancers. *Nat. Commun.* 8(14114). DOI: [10.1038/ncomms14114](https://doi.org/10.1038/ncomms14114) PDF & SI

455. Sinai, S., Kelsic, E., Church, G. M. & **Nowak**, M.A. (2017). Variational auto-encoding of protein sequences. DOI: <https://arxiv.org/abs/1712.03346> (NIPS workshop MLCB oral presentation) [PDF](#)
456. Veller, C., Hayward, L. K., Hilbe, C. & **Nowak**, M.A. (2017). The Red Queen and King in finite populations. *Proc. Natl. Acad. Sci. U.S.A.* 114(27): E5396-E5405. DOI: [10.1073/pnas.1702020114](https://doi.org/10.1073/pnas.1702020114) [PDF](#)
457. Veller, C., Muralidhar, P., Constable, G. W. A. & **Nowak**, M.A. (2017). Drift-induced selection between male and female heterogamety. *Genetics* 207(2). DOI: [10.1534/genetics.117.300151](https://doi.org/10.1534/genetics.117.300151) [PDF](#) & [SI](#)
- 2018**
458. Fotouhi, B., Momeni, N., Allen, B. & **Nowak**, M.A. (2018). Conjoining uncooperative societies facilitates evolution of cooperation. *Nat. Hum. Behav.* 2: 492-499. DOI: [10.1038/s41562-018-0368-6](https://doi.org/10.1038/s41562-018-0368-6) [PDF](#) & [SI](#)
459. Hilbe, C., Schmid, L., Tkadlec, J., Chatterjee, K. & **Nowak**, M.A. (2018). Indirect reciprocity with private, noisy, and incomplete information. *Proc. Natl. Acad. Sci. U.S.A.* 115(48): 12241– 12246. DOI: [10.1073/pnas.1810565115](https://doi.org/10.1073/pnas.1810565115) [PDF](#) & [SI](#)
460. Hilbe, C., Šimsa, Š., Chatterjee, K. & **Nowak**, M.A. (2018). Evolution of cooperation in stochastic games. *Nature* 246(559): 246-249. DOI: [10.1038/s41586-018-0277-x](https://doi.org/10.1038/s41586-018-0277-x) [PDF](#) & [SI](#)
461. Hilbe, C., Chatterjee, K. & **Nowak**, M.A. (2018). Partners and rivals in direct reciprocity. *Nat. Hum. Behav.* 2: 4690477. DOI: [10.1038/s41562-018-0320-9](https://doi.org/10.1038/s41562-018-0320-9) [PDF](#) & [SI](#)
462. Hill A. L., Rosenbloom, D. I. S., **Nowak**, M. A. & Silciano, R. F. (2018). Insight into treatment of HIV infection from viral dynamics models. *Immunol. Rev.* 285: 9-25. DOI: [10.1111/imr.12698](https://doi.org/10.1111/imr.12698) [PDF](#)
463. Hoffman, M., Hilbe C. & **Nowak**, M.A. (2018). The signal-burying game can explain why we obscure positive traits and good deeds. *Nat. Hum. Behav.* 2: 397–404. DOI: [10.1038/s41562-018-0354-z](https://doi.org/10.1038/s41562-018-0354-z) [PDF](#) & [SI](#)
464. Ibsen-Jensen, R., Tkadlec, J., Chatterjee, K. & **Nowak**, M.A. (2018). Language acquisition with communication between learners. *J. Royal Soc. Interface* 15: 20180073. DOI: [10.1098/rsif.2018.0073](https://doi.org/10.1098/rsif.2018.0073) [PDF](#)
465. Kirtane, A. R., Abouzeid, O., Minahan, D., Bensel, T., Hill, A. L., Selinger, C., Bershteyn, A., Mo ,S. S., Craig, M., Mazdiyasi, H., Cleveland, C., Rogner, J., Lee, Y. A. L., Booth, L., Javid, F., Wu, S. J., Grant, T., Bellinger, A. M., Nikolic, B., Hayward, A., Wood, L., Eckhoff, P. A., **Nowak**, M. A., Langer, R. & Traverso, G. (2018). Development of an oral once-weekly drug delivery system for HIV antiretroviral therapy. *Nat. Commun.* 9(2). DOI: [10.1038/s41467-017-02294-6](https://doi.org/10.1038/s41467-017-02294-6) [PDF](#)
466. Makohon-Moore, A. P., Matsukuma, K., Zhang, M., Reiter, J. G., Gerold, J. M., Jiao, Y., Sikkema, L., Attiyeh, M. A., Yachida, S., Sandone, C., Hruban, R. H., Klimstra, D. S., Papadopoulos, N., **Nowak**, M. A., Kinzler, K. W., Vogelstein, B. & Iacobuzio-Donahue, C.A. (2018). Precancerous neoplastic cells can move through the pancreatic ductal system. *Nature* **561**: 201–205. DOI: [10.1038/s41586-018-0481-8](https://doi.org/10.1038/s41586-018-0481-8) [PDF](#) & [SI](#)
467. McAvoy, A., Adlam, B., Allen, B. & **Nowak**, M.A. (2018). Stationary frequencies and mixing times for neutral drift processes with spatial structure. *Proc. Royal Soc. A.* 474: 20180238. DOI: [10.1098/rspa.2018.0238](https://doi.org/10.1098/rspa.2018.0238) [PDF](#)
468. McAvoy, A., Hauert, C., Wakeley, J., **Nowak**, M. A. & Fraiman, N. (2018). Public goods games in populations with fluctuating size. *Theor. Popul. Biol.* 121: 72-84. DOI: [10.1016/j.tpb.2018.01.004](https://doi.org/10.1016/j.tpb.2018.01.004) [PDF](#)

469. Neagu, I. A., Freeman, M., Olejarz, J., **Nowak**, M. A. & Hill, A. L. (2018). Life Cycle Synchronization as a Viral Drug Resistance Mechanism. *PLOS Comput. Bio.* 14 (2), e1005947  
DOI: [10.1371/journal.pcbi.1005947](https://doi.org/10.1371/journal.pcbi.1005947) [PDF](#) & [SI](#)
470. Noble, C., Adlam, B., Church, G. M., Esvelt, K. M. & **Nowak**, M.A. (2018). Current CRISPR gene drive systems are likely to be highly invasive in wild populations. *eLife* 7: e33423. DOI: [10.7554/eLife.33423](https://doi.org/10.7554/eLife.33423) [PDF](#)
471. Olejarz, J., Kaveh, K., Veller, C. & **Nowak**, M.A. (2018). Selection for synchronized cell division in simple multicellular organisms. *J. Theor. Biol.* 457. DOI: [10.1016/j.jtbi.2018.08.038](https://doi.org/10.1016/j.jtbi.2018.08.038) [PDF](#)
472. Pavlogiannis, A., Tkadlec, J., Chatterjee, K. & **Nowak**, M.A. (2018). Strong Amplifiers of Natural Selection: Proofs. DOI: <https://arxiv.org/abs/1802.02509> [PDF](#)
473. Pavlogiannis, A., Tkadlec, J., Chatterjee, K. & **Nowak**, M.A. (2018). Construction of arbitrarily strong amplifiers of natural selection using evolutionary graph theory. *Nat. Commun. Biol.* 1(1): 71.  
DOI: [10.1038/s42003-018-0078-7](https://doi.org/10.1038/s42003-018-0078-7) [PDF](#) & [SI](#)
474. Priklopil, T., Chatterjee, K. & **Nowak**, M.A. (2018). Optional interactions and suspicious behavior facilitates trustful cooperation in prisoners dilemma. *J. Theor. Biol.* 433: 64-72.  
DOI: [10.1016/j.jtbi.2017.08.025](https://doi.org/10.1016/j.jtbi.2017.08.025) [PDF](#) & [SI](#)
475. Reiter, J., Hilbe, C., Rand, D., Chatterjee, K. & **Nowak**, M.A. (2018). Crosstalk in concurrent repeated games impedes direct reciprocity and requires stronger levels of forgiveness. *Nat. Commun.* 9(555).  
DOI: [10.1038/s41467-017-02721-8](https://doi.org/10.1038/s41467-017-02721-8) [PDF](#) & [SI](#)
476. Reiter, J. G., Makohon-Moore, A. P., Gerold, J. M., Heyde, A., Attiyeh, M. A., Kohutek, Z. A., Tokheim, C. J., Brown, A., DeBlasio, R. M., Niyazov, J., Zucker, A., Karchin, R., Zinkler, K. W., Iacobuzio-Donahue, C.A., Vogelstein, B. & **Nowak**, M.A. (2018). Minimal functional driver gene heterogeneity among untreated metastases. *Science* 361(6404): 1033-1037. DOI: [10.1126/science.aat7171](https://doi.org/10.1126/science.aat7171) [PDF](#) & [SI](#)
477. Sinai, S., Olejarz, J., Neagu, I. A. & **Nowak**, M.A. (2018). Primordial Sex Facilitates the Emergence of Evolution. *J. Royal Soc. Interface* 15 (139): 20180003 DOI: [10.1098/rsif.2018.0003](https://doi.org/10.1098/rsif.2018.0003) [PDF](#)
- 2019**
478. Allen, B., Lippner, G. & **Nowak**, M. A. (2019). Evolutionary Games on Isothermal Graphs. *Nat. Commun* 10: 5107. DOI: [10.1038/s41467-019-13006-7](https://doi.org/10.1038/s41467-019-13006-7)
479. Craig, M., Kaveh, K., Woosley, A., Brown, A.S., Goldman, D., Eton, E., Mehta, R.M., Dhawan, A., Arai, K., Rahman, M.M., Chen, S., **Nowak**, M.A. & Goldman, A. (2019). Cooperative adaptation to therapy (CAT) confers resistance in heterogeneous non-small cell lung cancer. *PLOS Comput. Biol* 15(8): e1007278. DOI: [10.1371/journal.pcbi.1007278](https://doi.org/10.1371/journal.pcbi.1007278) [PDF](#)
480. Fotouhi, B., Momenti, N., Allen, B. & **Nowak**, M.A. (2019). Evolution of cooperation on large networks with community structure. *J. Royal Soc. Interface* 16: 20180677. DOI: [10.1098/rsif.2018.0677](https://doi.org/10.1098/rsif.2018.0677) [PDF](#)
481. Gruber, M., Bozic, I., Leshchiner, I., Livitz, D., Stevenson, K., Rassenti, L., Rosebrock, D., Taylor-Weiner, A., Olive, O., Goyette, R., Fernandes, S.M., Sun, J., Stewart, C., Wong, A., Cibulskis, C., Zhang, W., Reiter, J.G., Gerold, J.M., Gribben, J.G., Rai, K.R., Keating, M.J., Brown, J.R., Neuberg, D., Kipps, T.J., **Nowak**, M.A., Getz, G. & Wu, C.J. (2019). Growth dynamics in naturally progressing chronic lymphocytic leukaemia. *Nature* 570: 474–479. DOI: [10.1038/s41586-019-1252-x](https://doi.org/10.1038/s41586-019-1252-x) [PDF](#)
482. Hauser, O.P., Hilbe, C., Chatterjee, K. & **Nowak**, M.A. (2019). Social dilemmas among unequals. *Nature* 572: 524–527. DOI: [10.1038/s41586-019-1488-5](https://doi.org/10.1038/s41586-019-1488-5) [PDF](#)

483. Heyde, A., Reiter, J.G., Naxerova, K. & Nowak, M.A. (2019). Consecutive seeding and transfer of genetic diversity in metastasis. *Proc. Natl. Acad. Sci. U.S.A* 116: 14129-14137. DOI: [10.1073/pnas.1819408116](https://doi.org/10.1073/pnas.1819408116) PDF
484. Kaveh, K., McAvoy, A. & Nowak, M.A. (2019). Environmental fitness heterogeneity in the Moran process. *Royal Soc. Open Sci.* 5: 181661. DOI: <http://dx.doi.org/10.1098/rsos.181661> PDF
485. McAvoy, A. & Nowak, M.A. (2019). Reactive learning strategies for iterated games. *Proc. Royal Soc. A* 475: 20180819. DOI: [10.1098/rspa.2018.0819](https://doi.org/10.1098/rspa.2018.0819) PDF
486. Reiter, J.G., Baretta, M., Gerold, J.M., Makohon-Moore, A.P., Daud, A., Iacobuzio-Donahue, C.A., Azad, N.S., Kinzler, K.W., Nowak, M.A. & Vogelstein, B. (2019). An analysis of genetic heterogeneity in untreated cancers. *Nat. Rev. Cancer* 19: 639-650. DOI: [10.1038/s41568-019-0185-x](https://doi.org/10.1038/s41568-019-0185-x) PDF
487. Su, Q., McAvoy, A., Wang, L. & Nowak, M.A. (2019). Evolutionary dynamics with stochastic game transitions. *Proc. Natl. Acad. Sci. U.S.A.* 116: 25398-25404. DOI: [10.1073/pnas.1908936116](https://doi.org/10.1073/pnas.1908936116)
488. Tkadlec, J., Pavlogiannis, A., Chatterjee, K. & Nowak, M.A. (2019). Population structure determines the tradeoff between fixation probability and fixation time. *Nat. Commun. Biol.* 2: 138. DOI: [10.1038/s42003-019-0373-y](https://doi.org/10.1038/s42003-019-0373-y) PDF
489. Veller, C., Kleckner, N. & Nowak, M.A. (2019). A rigorous measure of genome-wide genetic shuffling that takes into account crossover positions and Mendel's second law. *Proc. Natl. Acad. Sci. U.S.A.* 116: 1659-1668. DOI: [10.1073/pnas.1817482116](https://doi.org/10.1073/pnas.1817482116) PDF
490. Wakeley, J. & Nowak, M.A. (2019). A two-player iterated survival game. *Theor. Popul. Biol.* 125: 38-55. DOI: [10.1016/j.tpb.2018.12.001](https://doi.org/10.1016/j.tpb.2018.12.001) PDF

## 2020

491. Tkadlec, J., Pavlogiannis, A., Chatterjee, K. & Nowak, M.A. (2020). Limits on amplifiers of natural selection under death-Birth updating. *PLoS Comput. Biol.* 16(1): e1007494. DOI: [10.1371/journal.pcbi.1007494](https://doi.org/10.1371/journal.pcbi.1007494)

## Forthcoming

492. Schmid, L., Hilbe, C., Chatterjee, K. & Nowak, M.A. (in review). A unified framework of direct and indirect reciprocity. *Nat. Hum. Behav.*