

Bibliography

1. Carson, R., *The Sense of Wonder*. 1998: Harper; Reprint Edition. 112 pp.
2. Bryson, B., *A Short History of Nearly Everything*. 2003: Broadway Books. 544 pp.
3. Hawking, S., and L. Mlodinow, *The Grand Design*. 1st ed. 2010: 198 pp.
4. Bohacek, R. S., C. McMartin, and W. C. Guida, The art and practice of structure-based drug design: a molecular modeling perspective. *Med. Res. Rev.*, **16**: pp. 3–50, 1996.
5. Yuthavong, Y., *Tapping the Molecular Wilderness*. 2016: Pan Stanford, Singapore. 134 pp.
6. Watson, J. D., and F. H. Crick, Molecular structure of nucleic acids; a structure for deoxyribose nucleic acid. *Nature*. **171**(4356): pp. 737–738, 1953.
7. Lovelock, J., *The Ages of Gaia. A Biography of Our Living Earth*. 2nd ed. 2000: Oxford University Press. 267 pp.
8. REN21, *Renewables 2015 Global Status Report*. 2015. <http://www.ren21.net/status-of-renewables/global-status-report/>.
9. IPCC, *Climate Change 2013. The Physical Science Basis*. 2014: Cambridge University Press. 1552 pp.
10. Rockström, J., *Big World, Small Planet: Abundance within Planetary Boundaries*. 2015: Max Ström, Stockholm. 206 pp.
11. Eliot, T. S., *The Rock: A Pageant Play Written for Performance at Sadler's Wells Theatre 28 May - 9 June 1934 on behalf of the Forty-Five Church Funds of the Diocese*. 1934: Faber and Faber. 86 pp.
12. P21, *Partnership for 21st Century Learning*. 2016. <http://www.p21.org/>.
13. US National Research Council, *STEM Learning Is Everywhere: Summary of a Convocation on Building Learning Systems*, eds. S. Olson and J.

- Labov (rapporteurs). 2014: National Academies Press, Washington DC. 90 pp.
14. Heckman, J., Presenting the Heckman equation, in *The Heckman Equation*. 2016. <http://heckmanequation.org/blog>.
 15. Robinson, K., *Out of Our Minds. Learning to Be Creative*. 2011: Courier Westford, Westford, MA. 286 pp.
 16. Einstein, A., *Einstein on Cosmic Religion and Other Opinions and Aphorisms*. 2009: Dover, New York. 97 pp.
 17. Gibran, K., *The Prophet*. 1923: Alfred A. Knopf. 107 pp.
 18. Gardner, H., *Frames of Mind. Theory of Multiple Intelligences*. 1983: Basic Books. 496 pp.
 19. Doidge, N., *The Brain That Changes Itself*. 2007: Viking Press, New York. 427 pp.
 20. Moravcsik, M. J., *How to Grow Science*. 1980: Universe Books, New York. 206 pp.
 21. Chemical Heritage Foundation, *August Kekulé and Archibald Scott Couper*. 2016 (cited Mar. 1, 2016). <http://www.chemheritage.org/discover/online-resources/chemistry-in-history/themes/molecular-synthesis-structure-and-bonding/kekule-and-couper.aspx>.
 22. Watson, J. D., *The Double Helix. A Personal Account of the Discovery of the Structure of DNA*. 1968. 256 pp.
 23. Delistraty, C. C. *Can Creativity Be Learned?* 2014. <http://www.theatlantic.com/health/archive/2014/07/can-creativity-be-learned/372605/>.
 24. Latumahina, D. *9 Lessons Richard Feynman Taught Us about Creativity*. 2007. <http://www.lifeoptimizer.org/2007/06/14/9-lessons-richard-feynman-taught-us-about-creativity/>.
 25. Jobs, S. *The Next Insanely Great Thing. The Wired Interview*. 1996. <http://www.wired.com/1996/02/jobs-2/>.
 26. Kuhn, T., *The Structure of Scientific Revolutions*. 1962: University of Chicago Press. 264 pp.
 27. Center for History of Physics, *Bright Idea: The First Laser. LaserFest, a Celebration of the 50th Anniversary of the Laser*. 2016. <https://www.aip.org/history/exhibits/laser/>.
 28. American Chemical Society, *Discovery of Fullerenes National Historic Chemical Landmark*. 2010. <http://www.acs.org/content/acs/en/education/whatischemistry/landmarks/fullerenes.html>.
 29. Godin, B., *Innovation Contested. The Ideas of Innovation over the Centuries*. 2015: Routledge, Oxford. 354 pp.

30. Ziman, J., A neural net model of innovation. *Sci. Public Policy*, **18**: pp. 65–75, 1991.
31. Goldacre, B., *Bad Science*. 2008: Fourth Estate, London. 370 pp.
32. Schumacher, E. F., *Small Is Beautiful. A Study of Economics As If People Mattered*. 1973: Blond&Briggs. 288 pp.
33. Horgan, J., *The End of Science: Facing the Limits of Knowledge in the Twilight of the Scientific Age*. 1996: Helix Books, Addison Wesley. 320 pp.
34. Brockman, J., *The Next Fifty Years*. 2002: Vintage Books.
35. Kurzweil, R., *The Singularity Is Near*. 2006: Viking.
36. Roco, M. C., et al., *Convergence of Knowledge, Technology and Society*. 2013: Springer, Heidelberg. 558 pp.
37. UNESCO Institute of Statistics, *Science, Technology and Innovation. Gross Domestic Expenditure on R&D (GERD)*. 2016. <http://data.uis.unesco.org/>.
38. World Health Organization, *World Malaria Report 2016*. 2016: Geneva. 186 pp.
39. World Health Organization, *Global Tuberculosis Report 2016*. 2016: Geneva. 201 pp.
40. Alexandratos, N., and J. Bruinsma, *World Agriculture towards 2030/2050: The 2012 Revision*. ESA working paper no. 12-03. 2012: Rome.
41. Prahalad, C. K., and S. L. Hart, *The Fortune at the Bottom of the Pyramid. Eradicating Poverty through Profits*. 2004: Wharton School, Philadelphia. 432 pp.
42. World Resources Institute and International Finance Corporation, *The Next Four Billion. Market Size and Business Strategy at the Base of the Pyramid*. 2007: World Resources Institute. 150 pp.
43. Avery, G. C., and H. Bergsteiner (eds.), *Sufficiency Thinking. Thailand's Gift to an Unsustainable World*. 2016: Allen and Unwin, Sydney. 293 pp.
44. Waldholz, M., and H. Pickersgill, *Grand Challenges in Global Health: 2005-2015*. 2015: Bill and Melinda Gates Foundation. 114 pp.
45. Cressey, D., Hippocratic oath for scientists, *Nature*. 2007.
46. Raup, D. M., and J. J. Sepkoski, Mass extinctions in the marine fossil record. *Science*. **215**: pp. 1501–1503, 1982.
47. Diamond, J., *Collapse*. 2005: Penguin Group, London. 575 pp.
48. Carson, R., *Silent spring*. 1962: Riverside Press, Boston. 368 pp.

49. Meadows, D. H., et al., *Limits to Growth*. 1972: Universe Books.
50. World Commission on Environment and Development, *Our Common Future*. 1987: Oxford University Press.
51. United Nations, *Earth Summit. UN Conference on Environment and Development (1992)*. 1997. <http://www.un.org/geninfo/bp/enviro.html>.
52. Grossman, N. (ed.), *Thailand's Sustainable Development Sourcebook*. 2015: Editions Didier Millet, Bangkok. 416 pp.
53. Baxter, W., N. Grossman, and N. Wegner (eds.), *A Call to Action. Thailand and the Sustainable Development Goals*. 2016: Editions Didier Millet, Bangkok. 183 pp.
54. Sachs, J. D., *The Age of Sustainable Development*. 2015: Columbia University Press, New York. 543 pp.
55. Motesharrei, S., J. Rivas, and E. Kalnay, Human and nature dynamics (HANDY): modeling inequality and use of resources in the collapse or sustainability of societies. *Ecol. Econ.*, **101**: pp. 90–102, 2014.
56. Sachs, J., et al., *SDG Index and Dashboards: Global Report*. 2016: Bertelsman Stiftung and Sustainable Development Solutions Network, New York.
57. Helliwell, J., R. Layard, and J. D. Sachs, *World Happiness Report 2016, Update (Vol. I)*. 2016: Sustainable Development Solutions Network, New York.
58. Jeffrey, K., H. Wheatley, and S. Abdallah, *The Happy Planet Index: 2016. A Global Index of Sustainable Well-Being*. 2016: New Economics Foundation, London.
59. Vinge, V., *The Coming Technological Singularity: How to Survive in the Post-Human Era*, in *VISION 21 Symposium*. 1993.
60. Kurzweil, R., *The Singularity Is Near: When Humans Transcend Biology*. 2006: Viking Adult, 652 pp.

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