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Education

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| Johns Hopkins Hospital Department of Medicine Fellowship in Cardiology | 1989-1992 |
| Massachusetts General Hospital Department of Medicine Intern and Resident in Internal Medicine | 1986-1989 |
| Harvard Medical School Doctor of Medicine | 1979-1986 |
| Harvard University School of Arts & Sciences Doctor of Philosophy in Biophysics | 1979-1986 |
| University of Maryland Bachelor of Science, Physics | 1975-1979 |

Professional Experience

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| Chief, Center for Molecular Medicine National Heart, Lung, and Blood Institute NIH | 2010-present |
| Chief, Translational Medicine Branch National Heart, Lung, and Blood Institute NIH | 2007-2010 |
| Chief, Cardiology Branch National Heart, Lung, and Blood Institute NIH | 2001-2007 |
| Senior Investigator National Heart, Lung, and Blood Institute NIH | 1998-2001 |

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| Investigator | 2 |
| National Heart, Lung, and Blood Institute | 1992-1998 |
| NIH | |

Academic Affiliation

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| Johns Hopkins School of Medicine | 1998-present |
| Adjunct Associate Professor of Medicine | |

Certification and Licensure

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| American Board of Internal Medicine | 1989-present |
| Internal Medicine | |

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| Licensure—State of Maryland | 2000-present |
| # D0058062 | |

Selected Honors and Awards

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| Summa Cum Laude | 1979 |
| Highest Honors in Physics | 1979 |
| MIT-Harvard Health Science and Technology Program | 1979-1986 |
| Medical Science Training Program | 1980-1986 |
| American Heart Association Louis N. Katz Basic Science Research Prize for Young Investigators—Finalist | 1992 |
| American Society for Clinical Research | 2002 |
| Ellison Medical Foundation Senior Scholar in Aging Award | 2006-2010 |
| Association of American Physicians | 2009 |
| Fellow, American Association for the Advancement of Science | 2013 |
| NHLBI Director's Award- Outstanding Translational Science | 2015 |
| NHLBI Orloff Innovation Award | 2016 |

Selected Committee Assignments and Administrative Services

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| NHLBI Technology Evaluation and Advisory Committee | 1997-2001 |
| NHLBI Molecular Genetics Advisory Group | 1998-2002 |
| NHLBI Internal Scientific Review Committee | 2000-2010 |
| American Heart Association Louis N. Katz Basic Science Research Prize Selection Committee | 2000-2003 |
| NHLBI Promotions and Tenure Committee | 2001-2012 |
| Institutional Review Board, NHLBI | 2002-2003 |
| American Heart Association Basic Science Leadership Council | 2003-2005 |
| Steering Committee for the NIH Bone Marrow Stromal Cell Transplantation Center | 2010-present |
| NHLBI iPS Oversight Committee | 2011-present |

Patents

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| Efficient and Selective Adenoviral-Mediated Gene Transfer into Vascular Neointima Patent | Patent #6,682,728 |
| Restenosis/Atherosclerosis diagnosis, prophylaxis and therapy | Patent #6,183,752 |
| Method for the Diagnosis and Treatment of Vascular Diseases | Patent #7,708,977 |

Selected Oral Presentations (2004-present)

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| Duke University 7 th Annual Reves Lecture, Durham, NC | January 2004 |
| Cardiovascular Cell and Gene Therapy Conference, Boston, MA | April 2004 |
| Nobel Conference #46: Karolinska Institute, Stockholm, Sweden | June 2004 |
| Cell Press: Conference on Aging, Tuscany, Italy | December 2004 |
| University of Turku TUBS Symposium, Turku, Finland | June 2005 |
| Buck Institute for Aging Research, Novato, CA | July 2005 |
| University of Nebraska 3 rd Annual Redox symposium, Lincoln, NE | September 2005 |
| CNIO Cancer and Aging, Madrid, Spain | November 2005 |
| EMBO Workshop on Redox Signaling, Rome, Italy | April 2006 |
| American Association for Cancer Research, Washington, DC | April 2006 |
| American Association of Aging Meeting, Boston, MA | June 2006 |
| American Diabetes Association, Washington, DC | June 2006 |
| Gordon Conference on Thiol-Based Signaling, Biddeford, Maine | June 2006 |

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| Society for Free Radical Research International, Davos, Switzerland | August 2006 |
| Cold Spring Harbor Redox Dependent Signal Transduction Organizer, Cold Spring Harbor, NY | December 2006 |
| Johns Hopkins Hematology Grand Rounds, Baltimore, MD | April 2007 |
| 4 th Key Symposium of Aging, Stockholm, Sweden | September 2007 |
| HHMI Meeting on Mitochondrial Function, Janelia Farms, VA | March 2008 |
| The Harvard Glenn Symposium on Aging, Boston, MA | June 2008 |
| Massachusetts General Hospital Cancer Center, Boston, MA | September 2008 |
| Mechanisms of Adult Stem Cell Aging, Reims, Germany | May 2009 |
| John B. Little Symposium, Harvard School of Public Health, Boston, MA | October 2009 |
| Organizer: The Energy of Cancer, Madrid, Spain | November 2009 |
| Cardiology Grand Rounds, University of Chicago, Chicago, IL | February 2010 |
| Cardiovascular Research Center, MGH, Boston, MA | May 2010 |
| Broad Institute, MIT, Boston, MA | May 2010 |
| Cold Spring Harbor Laboratory, Cold Spring Harbor, NY | December 2010 |
| MD Anderson Cancer Center, Houston, TX | March 2011 |
| University of Iowa: Distinguished Biomedical Scholar Lecture, Gordon Research Conference | March 2011 |
| NIA Nathan Shock Lecture Baltimore, MD | June 2011 |
| Ben May Symposium on Cancer and Metabolism, Chicago IL | May 2012 |
| The Vincent J. Cristofalo Memorial Lecture, Wistar Institute | December 2012 |
| Cold Spring Harbor Banbury Meeting (Organizer) ROS and Cancer | Feb., 2013 |
| Elizabeth L. Rodgers Lecture, Johns Hopkins Medical School | March, 2013 |
| Lectures in Life Sciences, Northwestern Medical School | Nov, 2013 |
| University of Chicago Morton Arsdorf Lecture | April, 2015 |
| Cell Press Meeting-Mitochondria | July, 2015 |
| Nature Medicine Meeting-Aging | Sept, 2015 |
| Stanford University-Seminar Series on Aging | October, 2015 |
| Brigham and Woman's Hospital, Harvard Medical School | December, 2015 |

Selected Editorial Positions

Editor in Chief

Drug Discovery Today: Disease Mechanisms 2003-2013

Associate Editor

Circulation Research 1999-2009

Aging Cell 2008-present

Molecular Aspects of Medicine 2009-present

Editorial Board

Science Magazine 2015-present

Nature Reviews Molecular Cell Biology 2005-2011

Free Radical Research 2001-2005

Journal of Biological Chemistry 2003-2005

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| <i>Antioxidants and Redox Signaling</i> | 2003-present |
| <i>IUBMB Life</i> | 2003-present |
| <i>Mechanisms of Ageing and Development</i> | 2007-present |
| <i>Clinical and Translational Science</i> | 2008-present |

Books

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| <i>Signal Transduction and Human Disease</i> , John Wiley Edited by T. Finkel and J.S. Gutkind | 2003 |
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Active Clinical Protocols

10-H0-0126: Characterization of Patients with Uncommon Presentations and/or Uncommon Diseases Associated with the Cardiovascular System

07-HG-0002: ClinSeq: A Large-Scale Medical Sequencing Clinical Research Pilot Study

Extramural Funding

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| Ellison Senior Scholar | 2006-2010 |
| US Coordinator: Leducq Transatlantic Cardiovascular Network | 2014-2019 |

Publications

Finkel T. and Wolf D.P. (1980). Membrane potential, pH and the activation of surf clam oocytes. *Gamete Research* 3:299-304.

Finkel T., Levitan H., and E.J. Carroll Jr. (1981). Fertilization in the sea urchin *arbacia punctulata* inhibited by fluorescein dyes: evidence for a plasma membrane mechanism. *Gamete Research* 4:219-229.

Finkel T. and Cooper G.M. (1984). Detection of a molecular complex between ras proteins and transferrin receptor. *Cell* 36:1115-1121.

Finkel T., Der C.J., and Cooper G.M. (1984). Activation of ras genes in human tumors does not affect localization, modification or nucleotide binding properties of p21. *Cell* 37:151-158.

Finkel T. (1985). The Biology and Biochemistry of Ras Proteins, Thesis, Harvard University.

Der C.J., Finkel T., and Cooper G.M. (1986). Biological and biochemical properties of human ras genes mutated at codon 61. *Cell* 44:167-176.

Carney W.P., Petit D., Hamer P., Der C.J., Finkel T., Cooper G.M., Lefebue M., Mobtaker H., Delellis R., Tischler A.S., Dayal Y., Wolfe H., and Rabin H. (1986). Monoclonal antibody

specific for activated ras proteins. *Proc. Natl. Acad. Sci. U.S.A.* 83:7485-7489.

Fearon E.R., Finkel T., Gillison M., Tomaselli G., and Dang C.V. (1992). Karyoplasmic interaction selection strategy (KISS). A general method for detection of protein-protein interaction in mammalian cells. *Proc. Natl. Acad. Sci. U.S.A.* 89:7958-7962.

Finkel T., Duc J., Fearon E.R., Dang C.V., and Tomaselli G.F. (1993). Detection and modulation in vivo of helix-loop-helix protein-protein interactions. *J. Biol. Chem.* 266:5-8.

Guzman R.J., Lemarchand P., Crystal R.G., Epstein S.E., and Finkel T. (1993). Efficient and selective adenoviral-mediated gene transfer into areas of vascular injury. *Circulation* 88:2838-2848.

Epstein S.E., Speir E., and Finkel T. (1993). Do antisense approaches to the problem of restenosis make sense? *Circulation* 88:1351-1353.

Guzman R.J., Lemarchand P., Crystal R.G., Epstein S.E., and Finkel T. (1993). Efficient gene transfer into myocardium by direct injection of adenoviral vectors. *Circ. Res.* 73:1202-1207.

Finkel T., Theriot J.A., Tomaselli G.F., and Goldschmidt P.J. (1994). Dynamic actin structures are regulated by profilin. *Proc. Natl. Acad. Sci. U.S.A.* 91:1510-1514.

Speir E., Modali R., Huang E.S., Leon M., Shawl F., Finkel T., and Epstein S.E. (1994). Potential role of human cytomegalovirus and p53 interaction in coronary restenosis. *Science* 265:391-394.

Irani K., Herzlinger S., and Finkel T. (1994). Ras proteins regulate multiple mitogenic pathways in A10 vascular smooth muscle cells. *BBRC* 202(3):1252-1258.

Epstein S.E., Speir E., Unger E.F., Guzman R.J., and Finkel T. (1994). The basis of molecular strategies for treating coronary restenosis following angioplasty. *JACC* 23:1278-1288.

Guzman R.J., Hirschowitz E.A., Brody S.L., Crystal R.G., Epstein S.E., and Finkel T. (1994). In vivo suppression of injury-induced vascular smooth muscle cell accumulation using adenovirus-mediated transfer of the herpes simplex thymidine kinase gene. *Proc. Natl. Acad. Sci. U.S.A.* 91:10732-10736.

Sundaresan M., Yu Z.-Y., Ferrans V.J., Irani K., and Finkel T. (1995). Requirement for generation of H₂O₂ for platelet-derived growth factor signal transduction. *Science* 270:296-299.

Finkel T. and Epstein S.E. (1995). Gene therapy for vascular disease. *FASEB J.* 9:843-851.

Sundaresan M., Yu Z.Y., Ferrans V.J., Gutkind J.S., Irani K., Goldschmidt-Clermont P.J., and Finkel T. (1996). Rac1 regulates reactive oxygen species generation in fibroblasts. *Biochem. J.* 318(2):379-382.

Zhou Y.F., Leon M.B., Waclawiw M., Popma J.J., Yu Z.Y., Finkel T., and Epstein S.E. (1996). Prior infection with cytomegalovirus markedly increases the risk of restenosis following

directional coronary atherectomy. *N. Engl. J. Med.* 335:624-630.

Johnson T.M., Yu Z.Y., Ferrans V.J., Lowenstein R.A., and Finkel T. (1996). Reactive oxygen species are downstream mediators of p53-dependent apoptosis. *Proc. Natl. Acad. Sci. U.S.A.* 93:11848-11852.

Crawford L.E., Milliken E.E., Irani K., Zweir J.L., Becker L.C., Finkel T., and Goldschmidt-Clermont P.J. (1996). Superoxide-mediated actin response in post-hypoxic endothelial cells. *J. Biol. Chem.* 43:26863-26867.

Epstein S.E., Speir E., Zhou Y.F., Guetta E., Leon M., and Finkel T. (1996). The role of infection in restenosis and atherosclerosis: focus on cytomegalovirus. *Lancet* 348:13-17.

Zhou Y.F., Guetta E., Yu Z.X., Finkel T., and Epstein S.E. (1996). Human cytomegalovirus increases oxidized LDL uptake and scavenger receptor mRNA expression in vascular smooth muscle cells. *J. Clin. Invest.* 98:2129-2138.

Sulciner D., Iran K., Yu Z.Y., Ferrans V.J., Goldschmidt P.J. and Finkel T. (1996). Rac1 regulates a cytokine-stimulated, redox-dependent pathway required for NF- κ B activation. *Mol. Cell Biol.* 16:7115-7121.

Johnson T.M., Epstein S.E., and Finkel T. (1996). Apoptosis in vascular disease: Opportunities for genetic therapeutic intervention. *Seminars in Interv. Cardiol.* 1:195-202.

Moldovan N.I., Milliken E.E., Irani K., Chen J., Sohn R.H., Finkel T., and Goldschmidt-Clermont P.J. (1997). Regulation of endothelial cell adhesion by profilin. *Curr. Biol.* 7:24-30.

Irani K., Xia Y., Zweir J.L., Sollot S., Rosolowski L., Feason E.R., Sundaresan M., Finkel T., and Goldschmidt-Clermont P.J. (1997). Superoxide mediates mitogenic signaling in Ras-transformed fibroblasts. *Science* 275:1649-1652.

Harrell R.L., Rajanayagam M.A.S., Guzman R.J., Hirschowitz E.A., Crystal R.G., Epstein S.E., and Finkel T. (1997). Inhibition of vascular smooth muscle cell proliferation and neointimal accumulation by adenoviral-mediated gene transfer of cytosine deaminase. *Circulation* 96:621-627.

Moore K.A., Sethi R., Doanes A.M., Johnson T.M., Pracyk J.B., Kirby M., Irani K., Goldschmidt-Clermont P.J., and Finkel T. (1997). Rac1 is required for cell proliferation and G2/M progression. *Biochem. J.* 326:17-20.

Kim K-S., Kazuyo T., Tanaka K., Pracyk J.B., Yu Z-X., Ferrans V.J., Bruder J.T., Kovesdi I., Irani K., Goldschmidt-Clermont P., and Finkel T. (1998). Protection from reoxygenation injury by inhibition of rac-dependent pathways. *J. Clin. Invest.* 101:1821-1826.

Doanes A.M., Irani K., Goldschmidt-Clermont P.J., and Finkel T. (1998). A requirement for rac1 in the PDGF-stimulated migration of fibroblasts and vascular smooth muscle cells. *Biochem. Mol. Biol. Int.* 45:279-287.

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Lee L., Irani K., and Finkel T. (1998). Bcl-2 expression inhibits the activation of the c-Jun N-terminal kinase (JNK) by IL-1 β and hydrogen peroxide. *Mol. Genet. and Metab.* 64:19-24.

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Tanaka K., Pracyk J.B., Takeda K., Yu Z.-X., Ferrans V.J., Hwang P.M., Lowenstein C.J., and Finkel T. (1998). Expression of Id1 results in apoptosis of cardiac myocytes through a redox-dependent mechanism. *J. of Biol. Chem.* 273:25922-25928.

Doanes A.M., Hegland D.D., Sethi R., Kovesdi I., Bruder J.T., and Finkel T. (1999). VEGF stimulates MAPK through a pathway that is unique for receptor tyrosine kinases. *Biochem. Biophys. Res. Comm.* 255:545-548.

Lee A.C., Fenster B.E., Takeda K., Bac N.S., Hirai T., Ya Z.X., Ferrans V.J., Howard B.H., and Finkel, T. (1999). Ras proteins induce senescence by altering the intracellular level of reactive oxygen species. *J. Biol. Chem.* 274:7936-7940.

Tanaka K., Zou J.P., Takeda K., Ferrans V.J., Sandford G.R., Johnson T., Finkel T., and Epstein S.E. (1999). Effects of human cytomegalovirus immediate-early proteins on apoptosis in coronary artery smooth muscle cells. *Circulation* 99:1656-1659.

Moldovan L., Irani K., Moldovan N.I., Finkel T., and Goldschmidt-Clermont P.J. (1999). The actin cytoskeleton reorganization induced by rac1 requires the production of superoxide. *Antioxid. Redox Signal.* 1:29-43.

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Li A., Prasad A., Mincemoyer R., Satorius C., Epstein N., Finkel T., and Quyyumi A.A. (1999). The role of the C242T p22phox gene polymorphism in coronary artery disease and endothelial function. *Am. J. Med. Genet.* 86:57-61.

Li A.E., Ito H., Kim K.S., Takeda K., Yu Z.Y., Ferrans V.J., and Finkel T. (1999). The role of reactive oxygen species in anoikis. *Circ. Res.* 85:304-310.

Finkel T. (1999). Myocyte Hypertrophy: The Long and Winding RhoA'd. *J. Clin. Invest.* 103:1619-1620.

Zhou Y.F., Shou M., Guetta E., Guzman R., Unger E.F., Yu Z.X., Zhang J., Finkel T., and

- Epstein S.E. (1999). Cytomegalovirus infection of rats increases the neointimal response to vascular injury without consistent evidence of direct infection of the vascular wall. *Circulation* 100: 1569-1575.
- Finkel T. (1999). Thinking Globally acting Locally, The Promise of Cardiovascular Gene Therapy. *Circ. Res.* 84:1471-1472.
- Ito H., Rovira I.I., Bloom M.L., Takeda K., Ferrans V.J., Quyyumi A.A., and Finkel T. (1999). Endothelial progenitor cells as putative targets for angiostatin. *Cancer Res.* 59:5875-5877.
- Hsich E., Segal B.H., Pagano P.J., Rey F.E., Paigen B., DeLeonardis J., Hoyt R.F., Holland S.M., and Finkel T. (2000). Vascular effects following homozygous disruption of p47(phox)-An essential component of the NADPH oxidase. *Circulation* 101:1234-1236.
- Xu D., Neville R., and Finkel T. (2000). Homocysteine accelerates endothelial cell senescence. *FEBS Lett.* 470:20-24.
- Finkel T. and Sullivan D. (2000). Signal Transduction by Reactive Oxygen Species. *Signal Networks and Cell Cycle Control*, J. Silvo Gutkind ed., Humana Press, 365-377.
- Nemoto S., Takeda K., Yu Z-X., Ferrans V.J., and Finkel T. (2000). A role for mitochondrial oxidants as regulators of cellular metabolism. *Mol. Cell Biol.* 20:7311-7318.
- Finkel T. (2000). Redox-dependent signal transduction. *FEBS Lett.* 476:52-54.
- Sullivan D., Wehr N., Fergusson M., Levine R.L., and Finkel T. (2000). Identification of oxidant sensitive proteins: TNF- α induces protein glutathionylation. *Biochemistry* 39: 11121-11128.
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- Sullivan D. and Finkel T. (2000). Adenoviral mediated expression of small GTPases. *Meth. In Enzym.* 325:303-314.
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- Xu D., Rovira I.I., and Finkel T. (2002). Oxidants painting the cysteine chapel: Redox regulation of PTPs. *Dev. Cell* 2:251-252.
- Nemoto S. and Finkel T. (2002). Redox regulation of forkhead proteins through a p66shc-dependent signaling pathway. *Science* 295:2450-2452.
- Savitsky P. and Finkel T. (2002). Redox regulation of Cdc25C. *J. Biol. Chem.* 277:20535-20540.

- Sullivan D., Levine R., and Finkel T. (2002). Detection and Affinity Purification of Oxidant Sensitive Proteins Using Biotinylated Glutathione Ethyl Ester. *Meth. In Enzym.* 353:101-113.
- Nguyen D.T., Rovira I.I., and Finkel T. (2002). Regulation of the Werner helicase through a direct interaction with a subunit of protein kinase A. *FEBS Lett.* 521:170-174.
- Xu D. and Finkel T. (2002). A role for mitochondria as potential regulators of cellular life span. *Biochem. Biophys. Res. Comm.* 294:245-248.
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- Rovira I.I. and Finkel T. (2002). Surviving an Aerobic Environment: Aging under oxidative stress. *Geriatric Times* 3:19-22.
- Ichida M., Nemoto S., and Finkel T. (2002). Identification of a specific molecular repressor of the peroxisome proliferator-activated receptor gamma coactivator-1 alpha. *J. Biol. Chem.* 277:50991-50995.
- Hill J.M., Zalos G., Halcox J.P.J., Schenke W.H., Walclawiw M.A., Quyyumi A.A., and Finkel T. (2003). Circulating Endothelial Progenitor Cells, Vascular Function, and Cardiovascular Risk. *New England J. Med.* 348:593-600.
- Finkel T. (2003). Neutrophils with a license to kill. Permeabilized, Not Stirred. *Dev. Cell* 4:146-148.
- Finkel T. (2003). Oxidant Signals and Oxidative Stress. *Current Opinions in Cell Biology* 15:247-254.
- Finkel T. (2003). A Toast to Long Life. *Nature* 425:132-133.
- Mills E.M., Banks M.L., Sprague J.E., and Finkel T. (2003). Uncoupling Agony from Ecstasy. *Nature* 426:403-404.
- Nemoto S. and Finkel T. (2004). Ageing and the mystery at Arles. *Nature* 429:149-152.
- Ohtsubo T., Rovira I.I., Starost M. F., Liu C., and Finkel T. (2004). Xanthine oxidoreductase is an endogenous regulator of cyclooxygenase-2. *Circ. Res.* 95:1118-1124.
- Nemoto S., Fergusson M., and Finkel T. (2004). Nutritional stress links forkhead proteins to SIRT1. *Science* 306:2105-2108.
- Powell T.M., Paul J.D., Hill J.M., Thompson M., Benjamin M., Rodrigo M., McCoy J.P., Read E.J., Khuu H.M., Leitman S.F., *et al.* (2005). Granulocyte Colony-Stimulating Factor Mobilizes Functional Endothelial Progenitor Cells in Patients With Coronary Artery Disease. *Arterioscler. Thromb. Vasc. Biol.* 25:296-301
- Khakoo A. and Finkel T. (2005). Endothelial Progenitor Cells, *Ann. Rev. Med.* 56:79-101.

Balaban R., Nemoto S., and Finkel T. (2005). Mitochondria, Oxidants and Aging, *Cell* 120:483-495.

Nemoto S., Fergusson M.M., and Finkel T. (2005). SIRT1 functionally interacts with the metabolic regulator and transcriptional coactivator PGC-1 α . *J. Biol. Chem.* 280:16456-60.

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Colavitti R. and Finkel T. (2005). Reactive oxygen species as mediators of cellular senescence. *IUBMB Life* 57:277-282.

Liu H., Colavitti R., Rovira I.I., and Finkel T. (2005). Redox-dependent transcriptional regulation, *Circ. Res.* 97:967-974.

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Nemoto S., Combs C.A., French S., Ahn B.H., Fergusson M.M., Balaban R.S., and Finkel T. (2006). The mammalian longevity-associated gene product p66shc regulates mitochondrial metabolism. *J. Biol. Chem.* 281:10555-10560.

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Finkel T. (2006). Intracellular redox regulation by the family of small GTPases. *Antioxid. Redox Signal.* 8:1857-1863.

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- Liu C. and Finkel T. (2006). Cancer Gets the Chk'ered Flag. *Nature Medicine* 12:1354-1356.
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- Schieke S.M. and Finkel T. (2007). TOR and Aging: less is more. *Cell Metab.* 5:233-235.
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