

Curriculum Vitae

Professor LEONID A. SAZANOV, FRS

Date of Birth 22 October 1960

Nationality British

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Education

1977 - 1982 B. Sc. and M. Sc. combined course, Department of Biophysics, School of Physics, Belarusian State University, Minsk, Belarus. M. Sc. in Biophysics, first class, June 1982. M. Sc. Thesis - "Rheological properties of DNA-protein complexes."

1986 - 1990 Postgraduate course, Department of Biophysics, School of Physics, Moscow State University, Moscow, Russia. Ph. D. in Biophysics, Moscow State University, awarded in January 1990. Ph. D. Thesis - "The mechanisms of regulatory interaction between primary processes of photosynthesis and Calvin cycle in higher plants".

Employment

1984 - 1986 Research Assistant, Department of Physics, Brest State University, Brest, Belarus. Research on mathematical modelling of biological processes.

1990 - 1992 Research Fellow, Department of Biokinetics, Belozersky Institute of Physico-Chemical Biology, Moscow State University, Moscow, Russia. Group of Prof. Sergei V. Zaitsev. Research on the mechanism of interaction of neuropeptides with opioid receptors.

1992 - 1994 Research Fellow, School of Biochemistry, University of Birmingham, U. K. Group of Prof. J. Baz Jackson. Research on the mechanism and function of proton-translocating transhydrogenase.

1994 - 1997 Research Fellow, Dept. of Biochemistry, Imperial College of Science, Technology and Medicine, London. Group of Dr. Peter J. Nixon. Research on the role of chloroplast NDH complex in plants.

1997 - 2000	Research Associate, MRC Laboratory of Molecular Biology, then Dunn Human Nutrition Unit, Cambridge. Group of Prof. John E. Walker. Research on the structure of respiratory complex I.
2000 - 2006	Tenure-track Research Group Leader, then
2006 - 2015	Tenured Programme Leader, MRC Dunn Human Nutrition Unit, renamed Mitochondrial Biology Unit, Cambridge. Research interests: Structure and function of complex I (NADH:ubiquinone oxidoreductase) of respiratory chains. Cryo-electron microscopy, X-ray crystallography and functional studies.
2015 – present	Professor, Institute of Science and Technology Austria, Klosterneuburg, Austria. Research interests: Structure and function of membrane-embedded molecular machines, especially from the domain of bioenergetics. Cryo-electron microscopy, X-ray crystallography and functional studies.

Selected distinctions

2021	Awarded ERC Advanced Grant
2021	Awarded Keilin Memorial Medal and Lecture 2022
2019	Elected Fellow of the Royal Society
2018	Elected EMBO member
2016	Editorial Board member, <i>Cell stress</i>
2014	Member of the advisory board, <i>F1000Research</i>
2013	Member of Faculty of 1000
1992	Wellcome Trust fellowship

Summary of major publications

- First structure of the mammalian supercomplex CIII₂CIV reveals the unique bridging action of the assembly factor SCAF1, with implications for the regulation of the entire respiratory chain (*Nature 2021*).
- The mechanism of respiratory complex I, a long-term enigma of bioenergetics, finally resolved as an unexpected combination of long-range conformational and electrostatic interactions (*Science 2020*)
- First complete structure of mammalian ATP synthase reveals proton translocation pathway, inter-monomer interactions and a mechanism of permeability transition pore opening (*NSMB 2020*)
- First structure of the MRP antiporter complex reveals general mechanistic principles for a huge protein family spanning from MRP to membrane-bound hydrogenases to complex I (*eLife 2020*)
- First structure of mitochondrial proton-translocating transhydrogenase was determined in several redox states, allowing Leonid to propose highly unusual, but robust and elegant molecular mechanism involving volte-face of the entire nucleotide-binding domains (*Nature 2019*)
- First atomic structure of the intact entire V/A-type ATPase, determined in five different rotational states, allowed the description of the catalytic cycle of V/A-ATPases in the

- unprecedented detail. (*Science* 2019)
- First complete atomic structure of mammalian complex I, revealing that core subunits are conserved from bacteria, and that additional “accessory” subunits form a stabilising shell around the core, as well as provide several regulatory links to mitochondrial metabolism (*Nature* 2016a)
 - First detailed architecture of mammalian respirasome, CI+CIII₂+CIV supercomplex, a 1.7 MDa assembly with 132 TM helices, 10 Fe-S clusters and 6 hemes, revealing its possible role in reducing the production of harmful reactive oxygen species (*Nature* 2016b)
 - First atomic structure of intact, entire complex I, determined using *T. thermophilus* enzyme revealed many unexpected features, such as uniquely long enclosed quinone binding site and an axis of charged residues along the entire membrane domain (*Nature* 2013)
 - First atomic structure of the membrane domain complex I revealed a novel arrangement of symmetry-related domains leading to the formation of a single proton-translocation channel from two connected half-channels, in each of the three antiporter-like subunits (*Nature* 2011)
 - First atomic structure of the hydrophilic domain of complex I established the electron transfer pathway from NADH through the seven conserved Fe-S clusters to the quinone-binding site, allowing the interpretation of 40 years’ worth of functional data (*Science* 2006, *Science* 2005)

Invited lectures at major international meetings

21st EBEC (European bioenergetics conference), Aix-en-Provence, France, 08/2022
 Gordon Research Conference “Three Dimensional Electron Microscopy”, Maine, USA, 10/2021
 Mitocon, Mitochondrial Diseases Conference 2021 (**Keynote lecture**), Rome, Italy (online version), 09/2021
 85th Harden Conference “Dynamic Membrane Complexes: Respiration and Transport” Bonn, Germany, 08/2019
 Gordon Research Conference on bioenergetics, Andover, USA, 06/2019
 FASEB meeting “Mitochondrial Biogenesis and Dynamics in Health and Disease”, Palm Springs, USA, 05/2019
 “The Evolving Concept of Mitochondria: From Physics to Biology to Medicine” meeting at Cold Spring Harbor Laboratory, USA, 10/2018
 20th EBEC (European bioenergetics conference), Budapest, Hungary, 08/2018
 Gordon Research Conference on Cell Surfaces, Mt Snow, Vt., USA, 06/2018
 Membrane Proteins in Health and Disease, the Annual Meeting of the Canadian Society for Molecular Biosciences, Banff, Canada, 04/2018
 24th Congress of the International Union of Crystallography, Hyderabad, India, 08/2017 (**Keynote lecture**)
 19th IUPAB and 11th EBSA Biophysics congress, Edinburgh, UK, 07/2017
 Gordon Research Conference on bioenergetics, Andover, USA, 06/2017
 “Future Possible Use of Neutron and Synchrotron Sources”, Graz, Austria, 09/2016
 4th International Workshop on Solar Energy "Photosynthesis and Bioenergetics", NTU, Singapore, 03/2016
 29th European crystallographic meeting, Rovinj, Croatia, 08/2015 (**Keynote lecture**)
 40th FEBS Congress, Berlin, Germany, 07/2015
 Cold Spring Harbor Asia meeting on Membrane Proteins, Suzhou, China, 05/2015
 Keystone Symposium on Hybrid Methods in Structural Biology, Tahoe city, USA, 03/2015

Meeting “Current Trends in Structural Biology”, Crete, Greece, 09/2014 (**Keynote lecture**)
15th International Conference on the Crystallization of Biological Macromolecules, Hamburg, Germany, 09/2014 (**Keynote lecture**)
18th EBEC (European bioenergetics conference), Lisbon, Portugal, 07/2014 (Plenary lecture)
Mitochondrial Medicine 2014, Pittsburgh, USA, 06/2014 (Platform lecture)
German Society for Biochemistry and Molecular Biology (GBM) meeting, Schloss Rauschholzhausen, Germany, 05/2014
ComBio meeting, Perth, Australia, 09/2013 (Plenary lecture)
38th FEBS Congress, St. Petersburg, Russia, 07/2013
Gordon research conference on bioenergetics, Andover, USA, 06/2013
Structural Biology Network meeting, Tallberg, Sweden, 06/2013 (**Keynote lecture**)
"Structural Biology of Membrane Proteins", HHMI/Janelia Farm, Ashburn, USA, 05/2013
3rd Joint German/UK bioenergetics conference, Schloss Rauschholzhausen, Germany, 04/2013
Joint Anglo-Israeli mitochondrial conference, Rehovot, Israel, 02/2013
Asian Crystallographic Association Conference, Adelaide, Australia, 12/2012
17th EBEC (European bioenergetics conference), Freiburg, Germany, 09/2012 (Plenary lecture)
“Proton transfer in Biology”, Telluride, USA, 07/2012
Gordon research conference on protons and membrane reactions, Ventura, USA, 02/2012
Biophysical Society Meeting, San Diego, USA, 02/2012
Symposium on Membrane proteins, Grenoble, France, 11/2011
22nd World Congress of International Union of Crystallography, Madrid, Spain, 08/2011
17th International Symposium on Flavins and Flavoproteins, San Francisco, USA, 07/2011
FASEB Research Conference on Mitochondrial Assembly, Colorado, USA, 07/2011
Gordon research conference on bioenergetics, Andover, USA, 06/2011
16th EBEC (European bioenergetics conference), Warsaw, Poland, 07/2010
“Allosteric cooperativity in hemoproteins”, Bari, Italy, 04/2010
15th EBEC (European bioenergetics conference), Dublin, Ireland, 07/2008
2nd Joint German/UK bioenergetics conference, Edinburgh, UK, 04/2008
Gordon research conference on bioenergetics, New Hampshire, USA, 06/2007
Biophysical Society Meeting, Baltimore, Maryland, USA, 03/2007
3rd International Friedrich’s Ataxia Scientific Conference, Maryland, USA, 11/2006
14th EBEC (European bioenergetics conference), Moscow, Russia, 07/2006 (Plenary lecture)
“Structure, Dynamics and Function of Proteins in Biological Membranes”, Ascona, Switzerland, 05/2006.
“Mitochondria, from Molecular Insight to Physiology and Pathology”, Bari, Italy, 12/2005.
Gordon research conference on bioenergetics, Andover, USA, 06/2005.
13th EBEC (European bioenergetics conference), Pisa, Italy, 08/2004.
“Molecular bioenergetics”, Bad Naurod, Germany, 02/2004.

Other invited lectures

Padova University, Italy; Max-Planck Institute of Biophysics, Frankfurt, Germany; University of California, Davis; Purdue University, USA; MRC Laboratory of Molecular Biology, Cambridge; Oxford University; Cambridge University; Imperial College London; University College London; University of Birmingham; Lund University, Sweden; Scripps Research Institute, La Jolla, USA; Stockholm University, Sweden; Institute of Structural Biology, Grenoble, France; University of the Basque Country, Bilbao, Spain; Max Planck Institute for Medical Research, Heidelberg, Germany; Boehringer Ingelheim, Biberach, Germany; BASF, Ludwigshafen, Germany; Bayer Healthcare, Berlin, Germany, *etc.*

Organisation of scientific meetings

2017 Chair of session “Molecular and cellular processes of energy transduction” at the International Biophysics Congress, Edinburgh, UK.

2010 Chair of session on Complex I at the 16th EBEC (European bioenergetics conference), Warsaw, Poland

2006 Chair of session on Complex I at the 14th EBEC (European bioenergetics conference), Moscow, Russia

Supervision of graduate students and postdoctoral fellows

2000 – present. Supervised ~20 PhD students, ~15 post-docs.

Teaching activities

Current Teaching “Structural Biology” course in IST Austria.

2000 – 2015 Taught “Bioenergetics” course in the University of Cambridge and in the MRC Mitochondrial Biology Unit.

Commissions of trust

Referee for NIH, NSF (USA); MRC, Wellcome Trust, BBSRC (UK); ANR (France); Helmholtz, DFG (Germany) and other funding bodies

Referee for faculty recruitment and promotion committees in Imperial College London, University College London, University of Southern California, Institute for Basic Science Korea.

Current peer review activities

Reviewer for Nature, Science, PNAS, Nature Communications, Nature Structural and Molecular Biology, EMBO Journal and other high-impact publications (~ 30 papers per year)

PUBLICATIONS

Textbooks: Structures of complex I are included in such textbooks as “Fundamentals of Biochemistry” by Voet, “Biochemistry” by Garrett and Grisham, “Cell and Molecular Biology” by Karp and “Bioenergetics” by Nicholls and Ferguson.

Books

Martinovich G.G., **Sazanov L.A.** and Cherenkevich S.N. “Cellular Bioenergetics”, Textbook (in Russian), Moscow, Russia, 2016.

Sazanov, L. A., editor, “A structural perspective on respiratory complex I”. Springer, 2012. ISBN 978-94-007-4138-6

Book chapters

1. Sazanov, L. A. (2017). Structure of respiratory complex I: “minimal” bacterial and “de luxe” mammalian versions, in *Mechanisms of Primary Energy Transduction in Biology*. The Royal Society of Chemistry.
2. Berrisford, J. M., Baradaran, R. and Sazanov, L. A. (2014). Entire respiratory complex I from *Thermus thermophilus*, in *Encyclopedia of Inorganic and Bioinorganic Chemistry*. John Wiley & Sons; Chichester.
3. Berrisford, J. M., and Sazanov, L. A. (2013). Structure of respiratory complex I, in *Encyclopedia of Biological Chemistry*, 2nd edition, Elsevier. ISBN: 9780123786319
4. Sazanov, L.A. (2010) Hydrophilic domain of respiratory complex I from *Thermus thermophilus*, in *Handbook of Metalloproteins*, ed A. Messerschmidt, John Wiley & Sons; Chichester. DOI: 10.1002/0470028637.met244.

Papers

1. Vercellino, I. and Sazanov, L.A. Structure and assembly of mammalian mitochondrial supercomplex CIII₂CIV. (2021) *Nature* 598(7880):364-367.
2. Vercellino, I. and Sazanov, L.A. The assembly, regulation and function of the mitochondrial respiratory chain. (2021) *Nature Rev. Mol. Cell. Biol.* doi: 10.1038/s41580-021-00415-0.
3. Kampjut, D., Steiner, J. and Sazanov, L.A. (2021) Cryo-EM grid optimization for membrane proteins. *iScience*, 24(3):102139.
4. Abas, L., Kolb, M., Stadlmann, J., Janacek, D.P., Lukic, K., Schwechheimer, C., Sazanov, L.A., Mach, L., Friml, J. and Hammes, U.Z.. (2021) Naphthylphthalamic acid associates with and inhibits PIN auxin transporters. *Proc. Natl. Acad. USA*, 118(1):e2020857118.
5. Kampjut, D. and Sazanov, L.A. (2020) The coupling mechanism of mammalian respiratory complex I. *Science*, 370(6516):eabc4209.
6. Pinke G., Zhou L. and Sazanov L.A. (2020) Cryo-EM structure of the entire mammalian F-type ATP synthase. *Nat. Struct. Mol. Biol.*, 27(11):1077-1085.
7. Steiner J. and Sazanov L. (2020) Structure and mechanism of the Mrp complex, an ancient cation/proton antiporter. *Elife* 9, e59407.
8. Gutierrez-Fernandez J., Kaszuba K., Minhas G.S., Baradaran R., Tambalo M., Gallagher D.T., Sazanov L.A. (2020) Key role of quinone in the mechanism of respiratory complex I. *Nature communications*, 11, 4135.
9. Gupta C., Khaniya U., Chan C.K., Dehez F., Shekhar M., Gunner M.R., Sazanov L., Chipot C., Singharoy A. (2020) Charge Transfer and Chemo-Mechanical Coupling in Respiratory Complex I. *J. Am. Chem. Soc.*, 142, 9220-9230.
10. Adjobo-Hermans M.J.W., de Haas R., Willems P., Wojtala A., van Emst-de Vries S.E., Wagenaars J.A., van den Brand M., Rodenburg R.J., Smeitink J.A.M., Nijtmans L.G., Sazanov L.A., Wieckowski M.R., Koopman W.J.H. (2020) NDUFS4 deletion triggers loss of NDUFA12 in *Ndufs4*(-/-) mice and Leigh syndrome patients: A stabilizing role for NDUFAF2. *Biochim. Biophys. Acta*, 1861, 148213.
11. Kampjut, D. and Sazanov, L.A. (2019) Structure and mechanism of mitochondrial proton-translocating transhydrogenase. *Nature*, 573, 291–295.
12. Zhou, L. and Sazanov, L.A. (2019) Structure and Conformational Plasticity of the Intact *Thermus thermophilus* V/A-type ATPase. *Science*, 365, eaaw9144.
13. Letts, J.A., Fiedorczuk, K., Degliesposti, G., Skehel, M. and Sazanov L.A. (2019) Structures of Respiratory Supercomplex I+III₂ Reveal Functional and Conformational Crosstalk. *Molecular Cell*, DOI 10.1016/j.molcel.2019.07.022.

14. Fiedorczuk, K. and Sazanov L.A. (2018) Mammalian Mitochondrial Complex I Structure and Disease-Causing Mutations. *Trends Cell Biol.*, 28, 835-867
15. Letts, J. A. and Sazanov, L. A. (2017) Clarifying the Supercomplex: The higher-order organization of the mitochondrial electron transport chain. *Nature Struct. Mol. Biol.*, 24, 800-808.
16. Hardie, R.A., van Dam, E., Cowley, M., Han, T.L., Balaban, S., Pajic, M., Pinese, M., Iconomou, M., Shearer, R.F., McKenna, J., Miller, D., Waddell, N., Pearson, J.V., Grimmond, S.M., Australian Pancreatic Cancer Genome Initiative, Sazanov, L., Biankin, A.V., Villas-Boas, S., Hoy, A.J., Turner, N. and Saunders D.N. (2017) Mitochondrial mutations and metabolic adaptation in pancreatic cancer. *Cancer Metab.*, 5:2.
17. Fiedorczuk, K., Letts, J.A., Degliesposti, G., Kaszuba, K., Skehel, M., and Sazanov L.A. (2016) Atomic structure of the entire mammalian mitochondrial complex I. *Nature*, 538, 406-410.
18. Letts, J. A., Degliesposti, G., Fiedorczuk, K., Skehel, M. and Sazanov, L. A. (2016) Purification of Ovine Respiratory Complex I Results in a Highly Active and Stable Preparation. *J. Biol. Chem.*, 291, 24657-24675.
19. Letts, J.A., Fiedorczuk, K., and Sazanov L.A. (2016) The architecture of respiratory supercomplexes. *Nature*, 537, 644-648.
20. Holt, P.J., Efremov, R.G., Nakamaru-Ogiso, E., and Sazanov L.A. (2016) Reversible FMN dissociation from Escherichia coli respiratory complex I. *Biochim. Biophys. Acta*, 1857, 1777-1785.
21. Berrisford, J.M., Baradaran, R. and Sazanov, L.A. (2016) Structure of bacterial respiratory complex I. *Biochim. Biophys. Acta*, 1857, 892-901.
22. Letts, J.A., Sazanov, L. A. (2015) Gaining Mass: the structure of respiratory complex I – from bacterial towards mitochondrial versions. *Curr. Opin. Struct. Biol.*, 33, 135-145.
23. Sazanov, L.A. (2015) A giant molecular proton pump: structure and mechanism of respiratory complex I. *Nature Rev. Mol. Cell. Biol.* 16 (6), 375-88.
24. Garvin, M.R., Bielawski, J.P., Sazanov, L.A., and Gharrett, A.J. (2015) Review and Meta-Analysis of Natural Selection in Mitochondrial Complex I in Metazoans. *J. Zool. Syst. and Evol. Res.*, 53(1), 1-17 (*Editor's choice*).
25. Sazanov, L.A. (2014) The mechanism of coupling between electron transfer and proton translocation in respiratory complex I. *J. Bioenerg. Biomembr.* 46, 247-53.
26. Heikal, A, Nakatani, Y, Dunn, E, Weimar, M.R., Day, C.L., Baker, E.N., Lott, J.S., Sazanov, L.A. and Cook, G.M. (2014) Structure of the bacterial type II NADH dehydrogenase: a monotopic membrane protein with an essential role in energy generation. *Mol. Microbiol.* 91, 950-64 (*Cover feature*).
27. Sazanov, L.A., Baradaran, R., Efremov, R. G., Berrisford, J.M. and Minhas, G. S. (2013) A long road towards the structure of respiratory complex I, a giant molecular proton pump. *Biochem. Soc. Trans.* 41, 1265-1271.
28. Baradaran, R., Berrisford, J.M., Minhas, G. S. and Sazanov, L.A. (2013) Crystal structure of the entire respiratory complex I. *Nature*, 494, 443-8.
29. Efremov, R. G. and Sazanov, L. A. (2012) The coupling mechanism of respiratory complex I - a structural and evolutionary perspective. *Biochim. Biophys. Acta*, 1817, 1785-95.
30. Efremov, R. G. and Sazanov, L. A. (2012) Structure of Escherichia coli *OmpF* porin from lipidic mesophase. *J. Struct. Biol.* 178, 311-8. (*Cover feature*)
31. Efremov, R. G. and Sazanov, L. A. (2011) Structure of the membrane domain of respiratory complex I. *Nature*, 476, 414-20.

32. Efremov, R. G. and Sazanov, L. A. (2011) Respiratory complex I: 'steam engine' of the cell? *Curr. Opin. Str. Biol.*, 21, 532-40.
33. Yip, C. Y., Harbour, M. E., Jayawardena, K., Fearnley, I. M. and Sazanov, L. A. (2011) Evolution of respiratory complex I: "supernumerary" subunits are present in the alpha-proteobacterial enzyme. *J. Biol. Chem.* 286, 5023-33.
34. Efremov, R.G., Baradaran, R. and Sazanov, L.A. (2010) The architecture of respiratory complex I, *Nature*, 465, 441-445. (Cover feature, News & Views.)
35. Berrisford, J.M. and Sazanov, L. A. (2009) Structural basis for the mechanism of respiratory complex I, *J. Biol. Chem.* 284, 29773-29783.
36. Berrisford, J. M., Thompson, C. J., and Sazanov, L. A. (2008) Chemical and NADH-induced, ROS-dependent, cross-linking between subunits of complex I from *Escherichia coli* and *Thermus thermophilus*, *Biochemistry*, 47, 10262-10270.
37. Morgan, D. J., and Sazanov, L. A. (2008) Three-dimensional structure of respiratory complex I from *Escherichia coli* in ice in the presence of nucleotides, *Biochim. Biophys. Acta*, 1777, 711-718.
38. Baranova, E. A., Morgan, D. J. and Sazanov, L. A. (2007). Single particle analysis confirms distal location of subunits NuoL and NuoM in *Escherichia coli* complex I. *J. Struct. Biol.* 159, 238-242.
39. Sazanov, L. A. (2007). Respiratory complex I: mechanistic and structural insights provided by the crystal structure of the hydrophilic domain. *Biochemistry*, 46, 2275-2288.
40. Baranova, E. A., Holt, P. J. and Sazanov, L. A. (2007). Projection structure of the membrane domain of *Escherichia coli* respiratory complex I at 8 Å resolution. *J. Mol. Biol.* 366, 140-54.
41. Sazanov, L.A. and Hinchliffe, P. (2006) Structure of the hydrophilic domain of respiratory complex I from *Thermus thermophilus*. *Science* 311, 1430-1436.
42. Hinchliffe, P., Carroll, J. and Sazanov, L.A. (2006) Identification of a novel subunit of respiratory complex I from *Thermus thermophilus*. *Biochemistry* 45, 4413-4420.
43. Hinchliffe, P. and Sazanov, L.A. (2005) Organization of iron-sulfur clusters in respiratory complex I. *Science* 309, 771-774.
44. Mamedova, A.A., Holt, P.J., Carroll, J. and Sazanov, L.A. (2004) Substrate-induced conformational change in bacterial complex I. *J. Biol. Chem.* 279, 23830-23836.
45. Holt, P.J., Morgan, D.J. and Sazanov, L.A. (2003) The location of NuoL and NuoM subunits in the membrane domain of the *Escherichia coli* complex I: implications for the mechanism of proton pumping. *J. Biol. Chem.* 278, 43114-43120.
46. Sazanov, L.A., Carroll, J., Holt, P., Toime, L. and Fearnley, I.M. (2003) A role for native lipids in the stabilization and two-dimensional crystallization of the *Escherichia coli* NADH-ubiquinone oxidoreductase (Complex I). *J. Biol. Chem.* 278, 19483-19491.
47. Sazanov, L.A. and Walker, J.E. (2000) Cryo-electron crystallography of two sub-complexes of bovine complex I reveals the relationship between the membrane and peripheral arms. *J. Mol. Biol.* 302, 455-464.
48. Sazanov, L.A., Peak-Chew S.Y, Fearnley, I.M. and Walker, J.E. (2000) Resolution of the membrane domain of bovine complex I into subcomplexes: implications for the structural organisation of the enzyme. *Biochemistry* 39, 7229-7235.
49. Sazanov, L.A., Burrows, P. A. and Nixon, P.J. (1998) The plastid *ndh* genes code for an NADH-specific dehydrogenase - isolation of a complex I analogue from pea thylakoid membranes. *Proc. Natl. Acad. USA* 95, 1319-1324.
50. Burrows, P.A, Sazanov, L.A., Svab, Z., Maliga, P. and Nixon, P.J. (1998) Identification of a functional respiratory complex in chloroplasts through analysis of tobacco mutants containing disrupted plastid *ndh* genes. *EMBO J.* 17, 868-876.

51. Sazanov, L. A., Burrows, P. A. & Nixon, P. J. (1998) The chloroplast Ndh complex mediates the dark reduction of the plastoquinone pool in response to heat stress in tobacco leaves. *FEBS Lett.* 429, 115-118.
52. Sazanov, L.A., Burrows, P. and Nixon, P.J. (1996) Detection and characterization of a complex I-like NADH-specific dehydrogenase from pea thylakoids. *Biochem. Soc. Trans.* 24, 739-743.
53. Bizouarn, T., Sazanov, L.A., Auburg, S. and Jackson, J.B. (1996) Estimation of the H^+/H^- ratio of the reaction catalyzed by the nicotinamide nucleotide transhydrogenase in chromatophores from over-expressing strains of *Rhodospirillum rubrum* and in liposomes inlaid with the purified bovine enzyme. *Biochim. Biophys. Acta* 1273, 4-12.
54. Sazanov, L.A., Burrows, P. and Nixon, P.J. (1995) Presence of a large protein complex containing the *ndhK* gene product and possessing NADH-specific dehydrogenase activity in thylakoid membranes of higher plant chloroplasts. In: Mathis, P. (ed) *Photosynthesis: from light to biosphere*, Vol.2, 705-708. Kluwer Academic Publishers.
55. Sazanov, L.A. and Jackson, J.B. (1995) Cyclic reactions catalyzed by detergent-dispersed and reconstituted transhydrogenase from beef-heart mitochondria; implications for the mechanism of proton translocation. *Biochim. Biophys. Acta* 1231, 304-312.
56. Sazanov, L.A. and Jackson, J.B. (1994) Proton-translocating transhydrogenase and NAD- and NADP-linked isocitrate dehydrogenases operate in a substrate cycle which contributes to fine regulation of the tricarboxylic acid cycle activity in mitochondria. *FEBS Lett.* 344, 109-116. (Cover feature)
57. Efanov, A.M., Koshkin, A.A., Sazanov, L.A., Borodulina, O.I., Varfolomeev, S.D. and Zaitsev, S.V. (1994) Inhibition of the respiratory burst in mouse macrophages by ultra-low doses of an opioid peptide is consistent with a possible adaptation mechanism. *FEBS Lett.* 355, 114-116.
58. Sazanov, L.A. and Jackson, J.B. (1993) Activation and inhibition of mitochondrial transhydrogenase by metal ions. *Biochim. Biophys. Acta* 1144, 225-228.
59. Jackson, J.B., Hutton, M., Williams, R., Bizouarn, T., Sazanov, L.A., Cotton, N.P.J. and Thomas, C.M. (1993) Proton-translocating transhydrogenase from bacteria. *Biochem. Soc. Trans.* 21, 1010-1013.
60. Sazanov, L.A. and Zaitsev, S.V. (1992) Action of ultra low doses of biologically active substances - common properties and possible mechanisms. *Biochemistry -Russia* 57, 1443-1460.
61. Zaitsev, S.V., Sazanov, L.A., Koshkin, A.A., Sud'ina, G.F. and Varfolomeev, S.D. (1991) Respiratory burst inhibition in human neutrophils by ultra low doses of [D-Ala²]-methionine enkephalinamide. *FEBS Lett.* 291, 84-86.
62. Sazanov, L.A., Karavaev, V.A. and Kukushkin, A.K. (1988) Mathematical model of photosynthesis regulation accounts for the effects of changes in external conditions and for observed oscillations. *J. Phys. Chem. - Russia* 52, 3351-3354.