Curriculum Vitae

LEONID A. SAZANOV

Date of Birth 22 October 1960

Nationality British and Russian

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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

1982 - 1984 Obligatory service as an officer in the Army after the graduation from the university.

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. Isolation and characterisation of intact enzymes and various subcomplexes from different bacterial sources. Functional studies with the purified complex. 2D and 3D crystallisation of the entire complex and subcomplexes. Structural studies by X-ray crystallography. Cryo-electron microscopy and single particle analysis.

2015 – present Professor, Institute of Science and Technology Austria, Klosterneuburg, Austria. Research interests: Structure and Function of membrane protein complexes, including proteins related to respiratory complex I. X-ray crystallography, cryo-electron microscopy and functional studies.

Invited lectures at major international meetings

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 Rauischholzhausen, 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 Rauischholzhausen, 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

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

Selected distinctions

2018 Elected EMBO member
2016 Editorial Board member, *Cell stress*
2014 Member of the advisory board, *F1000Research*
2013 Member of Faculty of 1000
1992 Wellcome Trust fellowship

Supervision of graduate students and postdoctoral fellows

2000 – present. Supervised 16 PhD students, 11 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.

Institutional responsibilities

Head of IST electron microscopy facility.

Commissions of trust

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

Referee for Mega-Grants program of Russian federation

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 (10 most significant publications are marked with an asterix)

1. Fiedorczuk, K. and **Sazanov L.A.** (2018) Mammalian Mitochondrial Complex I Structure and Disease-Causing Mutations. ***Trends Cell Biol.,*** doi: 10.1016/j.tcb.2018.06.006. [Epub ahead of print]
2. 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.
3. 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.
4. ***** 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.
5. 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.

6. * Letts, J.A., Fiedorczuk, K., and **Sazanov L.A.** (2016) The architecture of respiratory supercomplexes. ***Nature***, 537, 644-648.
7. 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.
8. Berrisford, J.M., Baradaran, R. and **Sazanov, L.A.** (2016) Structure of bacterial respiratory complex I. ***Biochim. Biophys. Acta***, ***1857***, 892-901.
9. 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.
10. * **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.
11. 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*).**
12. **Sazanov, L.A.** (2014) The mechanism of coupling between electron transfer and proton translocation in respiratory complex I**. *J. Bioenerg. Biomembr***. 46, 247-53.
13. 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*).**
14. **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.
15. * 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.
16. 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.
17. 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*)**
18. * Efremov, R. G. and **Sazanov, L. A.** (2011) Structure of the membrane domain of respiratory complex I. ***Nature***, 476, 414-20.
19. Efremov, R. G. and **Sazanov, L. A.** (2011) Respiratory complex I: 'steam engine' of the cell? ***Curr. Opin. Str. Biol.,*** 21, 532-40.
20. 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.
21. * Efremov, R.G., Baradaran, R. and **Sazanov, L.A.** (2010) The architecture of respiratory complex I, ***Nature***, 465, 441-445. **(*Cover feature, News & Views*.)**
22. * Berrisford, J.M. and **Sazanov, L. A.** (2009) Structural basis for the mechanism of respiratory complex I, ***J. Biol. Chem***. 284, 29773-29783.
23. 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.
24. 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.

25. 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.
26. **Sazanov, L. A.** (2007). Respiratory complex I: mechanistic and structural insights provided by the crystal structure of the hydrophilic domain. ***Biochemistry***, **46**, 2275-2288.
27. 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.
28. *** Sazanov, L.A.** and Hinchliffe, P. (2006) Structure of the hydrophilic domain of respiratory complex I from *Thermus thermophilus*. ***Science*** 311, 1430-1436.
29. 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.
30. ***** Hinchliffe, P. and **Sazanov, L.A.** (2005) Organization of iron-sulfur clusters in respiratory complex I. ***Science*** 309, 771-774.
31. 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.
32. 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.
33. **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.
34. **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.
35. **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.
36. *** 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.
37. 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.
38. **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.
39. **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.
40. 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.
41. **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.

42. **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.
43. **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*)**
44. 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.
45. **Sazanov, L.A**. and Jackson, J.B. (1993) Activation and inhibition of mitochondrial transhydrogenase by metal ions. ***Biochim. Biophys. Acta*** 1144, 225-228.
46. 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.
47. **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.
48. 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-Ala^2]-methionine enkephalinamide. ***FEBS Lett***. 291, 84-86.
49. **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.