

OLEH V. LUSHCHAK
PhD, Associate Professor

AFFILIATION

Senior research fellow at MRC Laboratory of Medical Sciences and Imperial College London

Associate professor at the Department of Biochemistry and Biotechnology in Precarpathian National University (Ivano-Frankivsk, Ukraine)

Research and Development University (Ivano-Frankivsk, Ukraine)

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PERSONAL

Ukrainian, male, born May 22, 1983.

Languages – English (Fluent), German (Basic)

EDUCATION

2004 – Bachelor's degree in Biochemistry, Precarpathian University, Ivano-Frankivsk, Ukraine

2005 – Master's degree in Biochemistry, Precarpathian University, Ivano-Frankivsk, Ukraine

2009 – PhD degree in Biochemistry, Precarpathian University, Ivano-Frankivsk, Ukraine

RESEARCH EXPERIENCE AND PRACTICAL TRAININGS

2000-9 – Department of Biochemistry and Biotechnology, Vasyl Stefanyk Precarpathian National University, Ivano-Frankivsk, Ukraine.

2002 – INTAS fellow “Growth dynamics in mollusks in natural environment”, Institute of Marine Biology, Kotor, Montenegro.

2003 – DAAD research fellow “Regulation of NADH oscillations in yeast”, Department of Biophysics, Otto-von-Gurike University, Magdeburg, Germany.

2009 – JEB research fellow “*Rhodiola rosea* as learning enhancer in *D. melanogaster*”, Department of Neurobiology and Genetics, University of Wurzburg, Wurzburg, Germany.

2009 – Visiting scientist “Mechanisms of lifespan extension by dietary restriction in *D. melanogaster*”, Buck Institute for Age Research, Novato, CA, USA.

2010 – Visiting scientist “Modulation of fly learning by natural chemicals”, Department of Neurobiology and Genetics, University of Wurzburg, Wurzburg, Germany.

2011-13 – Postdoc position supported by Carl Trygger Foundation “Food odors trigger an endocrine response that affects appetite, metabolism and lifespan”, Department of Zoology, Stockholm University, Stockholm, Sweden.

2012 – Visiting scientist “Mechanisms of lifespan and metabolism regulation by mitochondria”, Institute of Biomedical Technology, University of Tampere, Tampere, Finland.

2013-2014 - Visiting scientist “Nutrition, tissue homeostasis and aging in fruit fly”, DKFZ-ZMBH Alliance, Heidelberg, Germany.

2014-2018 - Assistant Professor at Vasyl Stefanyk Precarpathian National University
 2015-2016 – Guest scientist “Epigenetic regulation of metabolism” Max-Planck-Institute of Immunology and Epigenetics, Freiburg, Germany.
 2016-present – Head of laboratory “Aging and age-related disease”, Department of Biochemistry and Biotechnology, Precarpathian National University.
 2020-present – Director of Collaborative center for Aging research, Ivano-Frankivsk, Ukraine.
 2018-present – Associate professor in Biochemistry at Precarpathian National University.
 2022-2023 – Visiting Professor at Ludwig Boltzmann Institute for Clinical and Experimental Traumatology, Vienna, Austria.
 2023-present – Senior research fellow at MRC Laboratory of Medical Sciences of Imperial College London

AWARDS AND GRANTS

2023-2025 – LMS-MRC fellowship for displaced researchers (230K Euro)
 2023-2024 - EURIZON research grant (78K Euro)
 2023 - Virtual scientist engagement fellowship Program for Ukrainian scientists (18K Euro)
 2022 – FEBS Ukrainian Short-Term Fellowship (9K Euro)
 2021 – Grant from National Research Foundation of Ukraine, Co-Principal investigator (160K Euro)
 2020 – Grant from National Research Foundation of Ukraine, Co-Principal investigator (180K Euro)
 2020 – Grant from National Research Foundation of Ukraine, Co-Principal investigator (220K Euro)
 2019 – Travel grant award from US-Ukraine Foundation (4K Euro)
 2018 – 40 under 40 in biotechnology award from US-Ukraine Foundation (2K Euro)
 2018-2019 – Stipend of President for the young scientists (10K Euro)
 2017-2018 – Research grant from STCU-MESU, Principal investigator (120K Euro)
 2017-2020 – Research grant for young scientists from MESU, Principal investigator (90K Euro)
 2016 – Initiation of collaboration grant from DFG, Co-Principal investigator (20K Euro)
 2015 – Albert Renold Fellowship from EFSD (8K Euro)
 2014-2016 – Stipend from Cabinet of Ministers of Ukraine (7K Euro).
 2013 – Platon Kostyuk Award from Ukrainian Society for Neuroscience (2K Euro).
 2013 – Best Young Scientist of Vasyl Stefanyk Precarpathian National University.
 2008 – Travel Fellowship grant from Journal of Experimental Biology (3K Euro)
 2007-2008 – SFFI grant of MESU, Project manager (10K Euro)
 2006 – Award for the best poster in "IX Congress of Ukrainian Biochemical Society" (200 Euro).

TEACHING

Associate Professor in Biochemistry

Courses: Molecular Biology, Introduction into Experimental Biology, Models in Aging Research, Analytical Biochemistry, Basic Principles of Scientific Research

EDITORIAL BOARDS AND EDITORIAL WORK

Biogerontology

Biochemistry and Physiology

Frontiers in Genetics – Genetics of Aging

Guest associate editor – Frontiers in Physiology, The Physiological Regulation of Energy Metabolism in Insects part I and II

SUMMARY FOR PUBLICATIONS

Experimental papers – 97; Reviews – 36; Book chapters – 15; Patents – 3.

BIBLIOMETRICS

January 2025: Scopus **h-index** – 42, **Citations** – 5447; Google Scholar **h-index** – 50, **Citations** – 7963.

* - corresponding author

** - co-corresponding author

Articles

1. Strilbytska O., Semaniuk U., Yurkevych I., Berezovskyi V., Glovyak A., Gospodaryov D., Bayliak M., **Lushchak O.*** 2,4-Dinitrophenol is toxic on a low caloric diet but extends lifespan of *Drosophila melanogaster* on nutrient-rich diets without an impact on metabolism. *Biogerontology*, **2025**, in press.
2. Blackie L., Gaspar P., Mosleh S., **Lushchak O.**, ... Miguel-Aliaga I. The sex of organ geometry. *Nature*, **2024**, 630:392-400.
3. Strilbytska O., Yurkevych I., Semaniuk U., Simpson SJ., **Lushchak O.*** Life history trade-offs in *Drosophila*: flies select a diet to maximize reproduction at the expense of lifespan. *J. Gerontol.* **2024**, 79(5), glae057.
4. Stefanyshyn N., Strilbytska O., Burdyliuk N., Zadorozhna O., Bubalo V., Yurkevych I., **Lushchak O.** Dietary protein-to-carbohydrate ratio affects development and metabolism in *drosophila* larvae and imago. *Studia Biologica*, **2024**, 18 (1):69-82.
5. **Lushchak O.**, Velykodna M., Bolman S., Strilbytska O., Berezovskyi V., Storey K. Stress, anxiety and PTSD prevalence among Ukrainians after the first year of russian invasion: results of nationwide survey. *The Lancet Regional Health – Europe*. **2024**, 36:100773.
6. Demianchuk O., Vatachchuk M., Gospodaryov D., Hurza V., Ivanochko M., Derkachov V., Berezovskyi V., **Lushchak O.**, Storey K., Bayliak M., Lushchak V. High-fat high-fructose diet and alpha-ketoglutarate affect mouse behavior that is accompanied by changes in oxidative stress response and energy metabolism in the cerebral cortex. *Biochim. Biophys. Acta Gen. Subj.* **2024**, 1868(1), 130521.
7. Matskevych V., Kamyshnyi O., Vasylyk VM, Grynovska MB, Lenchuk T, Fishchuk R, Gospodaryov D, Yurkevych I, Strilbytska O, Petakh P, **Lushchak O.*** Morphological prediction of lethal outcomes in the evaluation of lung tissue structural changes in patients on respiratory support with COVID-19: Ukrainian experience. *Pathol. Res. Pract.* **2023**, 245:154471.
8. Khatib I, Horyn O, Bodnar O, **Lushchak O.**, Rychter P, Falfushynska H. Molecular and Biochemical Evidence of the Toxic Effects of Terbutylazine and Malathion in Zebrafish. *Animals (Basel)*. **2023**, 13(6):1029.
9. Serhiyenko V., Holzmann K., Holota S., Derkach Z., Nersesyan A., Melnyk S., Chernysh O., Yatskevych O., Mišík M., Bubalo V., Strilbytska O., Vatsaba B., **Lushchak O.**, Knasmüller S., Cherkas A. An exploratory study of physiological and biochemical parameters to identify simple, robust and relevant biomarkers for therapeutic interventions for PTSD: study rationale, key element of design and a context of war in Ukraine. *Proc. Shev. Sci. Soc.* **2022**, 69, 2.

10. Bayliak M., Vatachchuk M., Gospodaryov D., Hurza V., Demianchuk O., Ivanochko M., Burdyliuk N., Storey K., **Lushchak O.**, Lushchak V. High fat high fructose diet induces mild oxidative stress and reorganizes intermediary metabolism in male mouse liver: α -ketoglutarate effects. *Biochim. Biophys. Acta Gen. Subj.* **2022**, 1866 (12), 130226.
11. Strilbytska O., Semaniuk U., Bubalo V., Storey K., **Lushchak O.*** Dietary choice reshape metabolism in *Drosophila* by affecting consumption of macronutrients. *Biomolecules.* **2022**, 12 (9), 1201.
12. Semaniuk U., Gospodaryov D., Strilbytska O., Kucharska A., Sokół-Łętowska A., Burdyliuk N., Storey K., Bayliak M., **Lushchak O.*** Chili-supplemented food decreases glutathione-S-transferase activity in *Drosophila melanogaster* females without a change in other parameters of antioxidant system. *Redox Report.* **2022**, 27 (1), 221-229.
13. Strilbyska O., Semaniuk U., Strutynska T., Burdyliuk N., Tsiumpala S., Bubalo V., **Lushchak O.*** Herbicide Roundup shows toxic effects in nontarget organism *Drosophila*. *Arch. Insect Biochem. Physiol.* **2022**, 110(4), e21893.
14. Strilbytska O., Semaniuk U., Burdyliuk N., Bubalo V., **Lushchak O.*** Developmental diet defines metabolic traits in larvae and adult *Drosophila*. *Ukr. Biochem. J.* **2022**, 94(1), 53-63.
15. Semaniuk U., Gospodaryov D., Strilbytska O., Kucharska A., Sokół-Łętowska A., Burdyliuk N., Storey K., Bayliak M., **Lushchak O.*** Chili pepper extends lifespan in a concentration-dependent manner and confers cold resistance on *Drosophila melanogaster* cohorts by influencing specific metabolic pathways. *Food Funct.* **2022**, 13(15), 8313-8328.
16. Falfushynska H., Khatib I., Kasianchuk N., **Lushchak O.**, Horyn O., Sokolova I. Toxic effects and mechanisms of common organophosphate pesticides (Roundup and chlorpyrifos) and their mixtures in a zebrafish model (*Danio rerio*). *Sci. Tot. Env.* **2022**, 833, 155236.
17. Strilbyska O., Semaniuk U., Burdyliuk N., **Lushchak O.** Evaluation of biological effects of graphene oxide using *Drosophila*. *Phys. Chem. Solid State.* **2022**, 23 (2), 242-248.
18. Strilbytska O., Semaniuk U., Burdyliuk N., **Lushchak O.**** Protein content in the parental diet affects cold tolerance and oxidative stress markers in the offspring *Drosophila*. *Ukr. Biochem. J.* **2022**, 94(1), 86-94.
19. Husak V., Strutynska T., Burdyliuk N., Pitukh A., Bubalo V., Falfushynska H., Strilbytska O., **Lushchak O.*** Low-toxic herbicides Roundup and Atrazine disturb free radical processes in *Daphnia* in environmentally relevant concentrations *EXCLI J.* **2022**, 21, 595-609.
20. Kuzub N., Smialkovska V., Momot V., Moseiko V., **Lushchak O.**, Koliada A. Evaluation of Epigenetic Age Based on DNA Methylation Analysis of Several CpG Sites in Ukrainian Population. *Front Genet.* **2022**, 12, 772298.
21. Strilbyska O., Strutynska T., Semaniuk U., Burdyliuk N., Bubalo V., **Lushchak O.****. Dietary sucrose determines stress resistance, oxidative damages and antioxidant defense system in *Drosophila*. *Scientifica.* **2022**, 7262342.
22. Strilbytska O., Zayachkivska A., Strutynska T., Semaniuk U., Vaiserman A., **Lushchak O.**** Dietary protein defines stress resistance, oxidative damages and antioxidant defense system in *Drosophila melanogaster*. *Ukr. Biochem. J.* **2021**, 93(5), 90-101.
23. Strilbytska O., Stefanyshyn N., Semaniuk U., **Lushchak O.**** Yeast concentration in the diet defines *Drosophila* metabolism of both parental and offspring generations. *Ukr. Biochem. J.* **2021**, 93(6), 119-129.
24. Mykhailovych V., Kanak A., Cojocar R., Chitoiu-Arsene E., Palamaru M., Iordan A., Korovyanko O., Diaconu A., Ciobanu V., Caruntu G., **Lushchak O.**, Fochuk P., Khalavka Y.,

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 26. Semaniuk U, Gospodaryov D, Mishchanyk K, Storey K, **Lushchak O.*** Drosophila insulin-like peptides regulate concentration-dependent changes of appetite to different carbohydrates. *Zoology (Jena)*. **2021**, 146, 125927.
 27. Strilbytska O., Strutynska T., Semaniuk U., Burdyliuk N., Storey K., **Lushchak O.** Parental dietary sucrose affects metabolic and antioxidant enzyme activities in *Drosophila*. *Entomol. Sci.* **2021**, 24(3), 270-280.
 28. Bulyhina T., Zdrovenko E., Varbanets L., Shashkov A., Kadykova A., Knirel Y., **Lushchak O.** Structure of O-Polysaccharide and Lipid A of *Pantoea Agglomerans* 8488. *Biomolecules*. **2020**, 10(5):804.
 29. Vaiserman A., Romanenko M., Piven L., Moseiko V., **Lushchak O.**, Kryzhanovska N., Guryanov V., Koliada A. Differences in the gut *Firmicutes* to *Bacteroidetes* ratio across age groups in healthy Ukrainian population. *BMC Microbiol.* **2020**, 20(1):221.
 30. Strilbytska O., Zayachkivska A., Koliada A., Galeotti F., Volpi N., Storey K., Vaiserman A., **Lushchak O.*** Anise Hyssop *Agastache foeniculum* Increases Lifespan, Stress Resistance, and Metabolism by Affecting Free Radical Processes in *Drosophila*. *Front. Physiol.* **2020**, 11:596729.
 31. Koliada A., Moseiko V., Romanenko M., Piven L., **Lushchak O.**, Kryzhanovska N., Guryanov V., Vaiserman A. Seasonal variation in gut microbiota composition: cross-sectional evidence from Ukrainian population. *BMC Microbiol.* **2020**, 20, 100.
 32. Strilbytska O., Strutynska T., Semaniuk U., Burdyliuk O., **Lushchak O.*** Dietary sucrose defines *Drosophila* lifespan and metabolism. *Ukr. Biochem. J.* **2020**, 92(5), 97-105.
 33. Yurkevych I., Gray L., Gospodaryov D., Burdyliuk N., Storey K., Simpson S., **Lushchak O.*** Development of fly tolerance to consuming a high-protein diet requires physiological, metabolic and transcriptional changes. *Biogerontology*. **2020**, 21(5), 619-636.
 34. Koliada A., Gavriluk K., Burdyliuk N., Strilbytska O., Storey K., Kuharskii V., **Lushchak O.**, Vaiserman A. Mating status affects *Drosophila* lifespan, metabolism and antioxidant system. *Comp. Biochem. Physiol. A*. **2020**, 246, 110716.
 35. Strilbytska O., Storey K., **Lushchak O.*** TOR signaling inhibition in intestinal stem and progenitor cells affects physiology and metabolism in *Drosophila*. *Comp. Biochem. Physiol. B*. **2020**, 243-244, 110424
 36. Strilbytska O., Semaniuk U., Storey K., Yurkevych I., **Lushchak O.*** Insulin signaling in intestinal stem and progenitor cells as an important determinant of physiological and metabolic traits in *Drosophila*. *Cells*. **2020**, 9 (4), 803.
 37. Gospodaryov D., Strilbytska O., Semaniuk U., Perkhulyn N., Rovenko B., Yurkevych I., Barata A.G., Dick T.P., **Lushchak O.**, Jacobs H.T. Alternative NADH dehydrogenase extends lifespan and increases resistance to xenobiotics in *Drosophila*. *Biogerontology*. **2020**, 21, 155-171.
 38. Strilbytska O., Velianyk V., Burdyliuk N., Yurkevych I., Vaiserman A., Storey K., Pospisilik A., **Lushchak O.*** Parental dietary protein-to-carbohydrate ratio affects offspring lifespan and metabolism in *Drosophila*. *Comp. Biochem. Physiol. A*. **2020**, 241, 110622.

39. Bashynska V., Koliada A., Murlanova K., Zahorodnia O., Borysovykh O., Moseiko V., **Lushchak O.**, Vaiserman A. Prevalence of Some Genetic Risk Factors for Nicotine Dependence in Ukraine. *Genet. Res. International*. **2019**, 2483270.
40. **Lushchak O.**, Karaman H., Kozeretska I., Koliada A., Zabuga O., Pisaruk A., Koshel N., Mechova L., Inomistova M., Khranovska N., Vaiserman A. Larval crowding results in hormesis-like effects on longevity in *Drosophila*: timing of eclosion as a model. *Biogerontology*. **2019**, 20, 191-201.
41. Gubina N., Naudi A., Stefanatos R., Jove M., Scialo F., Fernandez-Ayala D., Rantapero T., Yurkevych I., Portero-Otin M., Nykter M., **Lushchak O.**, Navas P., Pamplona R., Alberto Sanz Essential physiological differences characterize short and long-lived strains of *Drosophila melanogaster*. *J Gerontol*. **2019**, 74, 1835-1843.
42. Michels B., Zwaka H., Bartels R., **Lushchak O.**, Franke K., Endres T., Fendt M., Song I., Bakr M., Budragchaa T., Westermann B., Mishra D., Eschbach C., Schreyer S., Lingnau A., Vahl C., Hilker M., Menzel R., Kähne T., Leßmann V., Dityatev A., Wessjohann L., Gerber B. Memory enhancement by ferulic acid ester across species. *Sci. Adv*. **2018**, 4, eaat6994.
43. Semaniuk U., Gospodaryov D., Feden'ko K., Yurkevych I., Vaiserman A., Storey K., Simpson SJ., **Lushchak O.*** Insulin-Like Peptides Regulate Feeding Preference and Metabolism in *Drosophila*. *Front. Physiol*. **2018**, 9:1083.
44. Nuzhyna N., Baglay K., Golubenko A., **Lushchak O.** Anatomically distinct representatives of Cactaceae Juss. family have different response to acute heat shock stress. *Flora*. **2018**, 242, 137-145.
45. Semaniuk U., Feden'ko K., Yurkevych I., Storey K., Simpson S., **Lushchak O***. Within-diet variation in rates of macronutrient consumption and reproduction do not accompany changes in lifespan in *Drosophila melanogaster*. *Entomol. Exp. Appl*. **2018**, 166(1), 74-80.
46. Strilbytska O., Koliada A., Storey K., Mudra S., Vaiserman A., **Lushchak O***. Longevity and stress resistance are affected by activation of TOR/Myc in progenitor cells of drosophila gut. *Open Life Sci*. **2017**, 12(1), 429-442.
47. Koliada A., Syzenko G., Moseiko V., Budovska L., Puchkov K., Perederiy V., Gavalko Y., Dorofeyev A., Romanenko M., Tkach S., Sineok L., **Lushchak O.**, Vaiserman A. Association between body mass index and Firmicutes/Bacteroidetes ratio in an adult Ukrainian population. *BMC Microbiol*. **2017**, 17(1), 120.
48. Perkhulyn N., Rovenko B., **Lushchak O.**, Storey J., Storey K., Lushchak V. Exposure to sodium molybdate results in mild oxidative stress in *Drosophila melanogaster*. *Redox Report*. **2017**, 22(3), 137-146.
49. Strilbytska O., Semaniuk U., Storey K., Edgar B., **Lushchak O.*** Activation of TOR/MYC signaling axis in intestinal stem and progenitor cells affects longevity, stress resistance and metabolism in *Drosophila*. *Comp. Biochem. Physiol*. **2017**, 203, 92-99.
50. Kubrak O., **Lushchak O.**, Meet Zandawala M., Nässel D. A novel GnRH-like signaling to adipocytes modulates stress responses and metabolism in *Drosophila*. *Open Biol*. **2016**, 11, 160152.
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52. Rovenko B., Kubrak O., Gospodaryov D., Perkhulyn N., Yurkevych I., Sanz A., **Lushchak O.****, Lushchak V. High sucrose consumption promotes obesity whereas its low consumption induces oxidative stress in *Drosophila melanogaster*. *J. Insect Physiol*. **2015**, 79, 42-54.

53. Rovenko B., Kubrak O., Gospodaryov D., Yurkevych I., Sanz A., **Lushchak O.****, Lushchak V. Restriction in glucose and fructose causes mild oxidative stress independently of mitochondrial activity and reactive oxygen species in *Drosophila melanogaster*. *Comp. Biochem. Physiol.* **2015**, 187, 27-39.
54. **Lushchak O.**, Carlsson M., Nässel D. Food odors trigger an endocrine response that affects food ingestion and metabolism. *Cell. Mol. Life Sci.* **2015**, 72, 3143–3155.
55. Perkhulyn N., Rovenko B., Zvarych T., **Lushchak O.**, Storey J., Storey K., Lushchak V. Sodium chromate demonstrates some insulin-mimetic properties in the fruit fly *Drosophila melanogaster*. *Comp. Biochem. Physiol.* **2015**, 167, 74-80.
56. Rovenko B., Perkhulyn N., Gospodaryov D., Sanz A., **Lushchak O.****, Lushchak V. High fructose consumption rather than glucose promotes diet-induced obese phenotype in *Drosophila melanogaster*. *Comp. Biochem. Physiol.* **2015**, 180, 75-85.
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58. Luo J., **Lushchak O.**, Goergen P., Williams M., Nässel D. *Drosophila* insulin-producing cells are differently modulated by serotonin and octopamine receptors and affect aggressive behavior. *PLoS one.* **2014**, 9(6), e99732.
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60. **Lushchak O.***, Gospodaryov D., Rovenko B., Yurkevych I., Perkhulyn N., Lushchak V. Specific dietary carbohydrates differentially influence the lifespan and fecundity of *Drosophila melanogaster*. *J Gerontol.* **2014**, 69(1), 3-12.
61. Rovenko B., Lushchak V., **Lushchak O.** Carbohydrate restriction in the larval diet causes oxidative stress in adult insects of *Drosophila melanogaster*. *Ukr. Biochem. J.* **2013**, 85(5), 61-72.
62. Lozinsky O., **Lushchak O.**, Storey J., Storey K., Lushchak V. The mitochondrial uncoupler 2,4-dinitrophenol attenuates sodium nitroprusside-induced toxicity in *Drosophila melanogaster*: Potential involvement of free radicals. *Comp. Biochem. Physiol.* **2013**, 158(4), 244-52.
63. Lozinsky O., **Lushchak O.**, Lushchak V. 2,4-dinitrophenol partially alleviates ferrocyanide induced toxicity in *Drosophila melanogaster*. *Arch. Insect Biochem. Physiol.* **2013**, 84(3), 157-73.
64. Gospodaryov D., Yurkevych I., **Lushchak O.****, Lushchak V. Lifespan extension and delay of age-related functional decline caused by *Rhodiola rosea* depends on dietary macronutrient balance. *Longevity & Healthspan.* **2013**, 2:12.
65. Lozinsky O., **Lushchak O.**, Kryshchuk N., Shchypanska N., Riabkina A., Skarbek S., Maksymiv I., Storey J., Storey K., Lushchak V. S-nitrosoglutathione-induced toxicity in *Drosophila melanogaster*: Delayed pupation and induced mild oxidative/nitrosative stress in eclosed flies. *Comp. Biochem. Physiol.* **2013**, 164(1), 162-170.
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67. Rovenko B., **Lushchak O.***, Lozinsky O., Kubrak O., Lushchak V. Mild oxidative stress in fruit fly *Drosophila melanogaster* induced by sucrose. *Ukr. Biochem. J.* **2012**, 84 (5), 97-105.

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69. **Lushchak O.***, Gospodaryov D., Rovenko B., Glovyak A., Yurkevych I., Klyuba V., Shcherbij M., Lushchak V. Balance between macronutrients affects lifespan and functional senescence in fruit fly *Drosophila melanogaster*. *J. Gerontol. A Biol. Sci.* **2012**, 67(2), 118-125.
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