

Curriculum vitae: Andrey Zaraisky

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Shemyakin–Ovchinnikov Institute of bioorganic chemistry RAS, Moscow, Russia

Contacts

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Education

2011	Russia, Moscow		professor in molecular biology
2000	Russia, Moscow	M.V. Lomonosov Moscow State University (biological faculty)	DSc in molecular biology and developmental biology
1990	Russia, Moscow	M.V. Lomonosov Moscow State University (biological faculty)	PhD in molecular biology

IBCh positions

2018–to date	Principal research fellow
2026–2026	Professor

IBCh memberships

Dissertation council
Scientific council

Awards

2006	Премия РАН имени А.О. Ковалевского
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Scientific interests

The main scientific interests of Dr. Zaraisky are focused on structural and functional study of genes and proteins that regulate embryonic development of the brain.

Scientific societies' membership

Dr. Zaraisky is a member of the Academic and Dissertation councils of Shemyakin-Ovchinnikov Institute of Bioorganic Chemistry Russian Academy of Sciences, Editorial Boards of the journals Molecular Biology and Russian Journal of Developmental Biology.

Titles

Professor
Doctor of Science (Biological sciences)

Contacts

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Grants and projects

2014–	-Изменение скорости диффузии морфогенов как механизм регуляции морфогенетического
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2018	поля.
2023–to date	-Геномные механизмы эмбрионального развития и регенерации как фундаментальная основа для разработки медицинских технологий
2019–2021	-Поиск и изучение функций генов эмбрионального скейлинга
2018–2021	-

Publications

1. Bayramov AV, Mednikov DN, **Zaraisky AG** (2026). Evolutionary pathway and genetic mechanisms of fin-to-limb transition in vertebrates. *Front Cell Dev Biol* 14, 1784849, [10.3389/fcell.2026.1784849](#)
2. Kosykh AV, Zhigmitova EB, Evtushenko NA, Gurskaia TH, Martynova AA, Silaeva YY, Ivanova AS, Martynova NY, Tereshina MB, Rudyak SG, Panteleyev AA, Makarenkova HP, Gurskaya NG, Lukyanov SA, **Zaraisky AG** (2026). Restoring , an ancient regeneration gene lost in amniotes, accelerates skin healing in mice. *Front Cell Dev Biol* 14, 1706902, [10.3389/fcell.2026.1706902](#)
3. Parshina EA, Ziganshin RH, **Zaraisky AG**, Martynova NY (2026). Co-Immunoprecipitation-Coupled Mass Spectrometry Analysis of Zyxin's Interactome and Phosphosites in Early *Xenopus laevis* Development. *Int J Mol Sci* 27 (2), 738, [10.3390/ijms27020738](#)
4. Ermakova GV, **Zaraisky AG**, Bayramov AV (2025). Hidden Paralogy of Chordin-Like Genes in Cartilaginous and Teleost Fishes as a Potential Factor in the Emergence and Evolution of Fins. *RUSS J DEV BIOL* 56, 176–188, [10.1134/S1062360425700274](#)
5. Bayramov AV, Ermakova GV, Kucheryavyy AV, **Zaraisky AG** (2025). Embryonic Induction Mechanisms in Vertebrates: Conserved Principles and Flexible Details. *PALEONTOL J* 59 (9), 1040–1056, [10.1134/S0031030125600751](#)
6. Mednikov DN, **Zaraisky AG**, Bayramov AV (2025). Exploring the Pathways and Mechanisms of Evolutionary Transformation of Paired Appendages in Gnathostomes. *PALEONTOL J* 59 (9), 1210–1254, [10.1134/S0031030125600866](#)
7. Orlov EE, Timoshina PS, Parshina EA, Eroshkin FM, Bannikova MA, **Zaraisky AG** (2025). Optimized protocols for generating half-sized embryos from separated first two blastomeres in green sea urchin and *Xenopus laevis*. *Front Cell Dev Biol* 13, 1730288, [10.3389/fcell.2025.1730288](#)
8. Parshina EA, Orlov EE, Voronezhskaya EE, Martynova NY, **Zaraisky AG** (2025). Cytoskeletal Regulator Zyxin Stimulates Nuclear Translocation of YAP in *Xenopus laevis* Embryonic Cells. *Russ. J. Bioorganic Chem.* 51 (5), 1945–1953, [10.1134/S1068162025601727](#)
9. Ermakova GV, Meyntser IV, Lyubetsky VA, **Zaraisky AG**, Bayramov AV (2025). The subfunctionalization of *shox* and *shox2* paralogs in shark highlights both shared and distinct developmental mechanisms of branchial arches and fins. *Front Cell Dev Biol* 13, 1667637, [10.3389/fcell.2025.1667637](#)
10. Parshina EA, **Zaraisky AG**, Martynova NY (2025). Transcriptome Analysis of Zyxin Cytoskeletal Protein Levels: Influence on Metabolism and Signaling Pathways in a Model of *Xenopus laevis* Embryos. *Russ. J. Bioorganic Chem.* 51 (5), 1990–1999, [10.1134/S1068162025601983](#)
11. Ermakova GV, Meyntser IV, Mugue NS, Lyubetsky VA, **Zaraisky AG**, Bayramov AV (2025). The emergence of chordin-like1 in gnathostomes may have contributed to the evolution of paired appendages. *Front Cell Dev Biol* 13, 1649996, [10.3389/fcell.2025.1649996](#)
12. Parshina EA, **Zaraisky AG**, Martynova NY (2025). Regulation of pou5f3 Family Pluripotency Gene Transcripts Stability by Ybx1 Ribonucleoprotein Complexes in *Xenopus laevis* Early Development. *Russ. J. Bioorganic Chem.* 51 (3), 1297–1305, [10.1134/S1068162025602265](#)
13. Ivanova ED, Ziganshin RH, Parshina EA, **Zaraisky AG**, Martynova NY (2025). Mass Spectrometric Analysis of Post-Translational Modifications of *Xenopus laevis* Cytoskeletal Protein Zyxin. *Russ. J. Bioorganic Chem.* 51 (3), 1083–1091, [10.1134/S1068162024606530](#)

14. Parshina EA, Ivanova ED, **Zaraisky AG**, Martynova NY (2025). The Impact of Zyxin Modifications on Its Intracellular Distribution in the *Xenopus Laevis* Embryo Model. *Russ. J. Bioorganic Chem.* 51 (2), 772–783, [10.1134/S1068162024605755](https://doi.org/10.1134/S1068162024605755)
15. Bayramov AV, Yastrebov SA, Mednikov DN, Ermakova GV, **Zaraisky AG** (2024). The Origin and Mechanisms of Development of Paired Fins in Vertebrates. *RUSS J DEV BIOL* 55 (3), 99–118, [10.1134/S1062360424700097](https://doi.org/10.1134/S1062360424700097)
16. Bayramov AV, Ermakova GV, Kucheryavyy AV, Eroshkin FM, **Zaraisky AG** (2024). Genetic Basis of Morphological Transformations: Genes of the Noggin and Foxg1 Families as a Legacy of Whole Genome Duplications in Early Vertebrate Evolution. *PALEONTOL J* 58 (12), 1367–1388, [10.1134/S0031030124601208](https://doi.org/10.1134/S0031030124601208)
17. Shitikov A, Parshina E, **Zaraisky A**, Tereshina MB (2024). An improved method for whole-mount in situ hybridization in regenerating tails of *Xenopus laevis* tadpoles. *Front Cell Dev Biol* 12, 1487644, [10.3389/fcell.2024.1487644](https://doi.org/10.3389/fcell.2024.1487644)
18. Timoshina PS, Nesterenko AM, Parshina EA, Orlov EE, Eroshkin FM, **Zaraisky AG** (2024). Dissecting the mystery of embryonic scaling: The Scalers Hypothesis and its confirmation in sea urchin embryos. *Cells and Development* 184, 203972, [10.1016/j.cdev.2024.203972](https://doi.org/10.1016/j.cdev.2024.203972)
19. Ermakova GV, Mogue NS, Mischenko AV, **Zaraisky AG**, Bayramov AV (2024). Foxg1 Genes of Acipenseriformes Support a Model of Ancestral Genomic Duplication Followed by Asynchronous Rediploidization. *RUSS J DEV BIOL* 55, 72–84, [10.1134/S1062360424700073](https://doi.org/10.1134/S1062360424700073)
20. Ermakova GV, Kucheryavyy AV, **Zaraisky AG**, Bayramov AV (2024). Three Foxg1 Genes in Lampreys: The Heritage of Whole-Genome Duplications at the Early Stages of Vertebrate Evolution. *RUSS J DEV BIOL* 55, 15–25, [10.1134/S1062360424700024](https://doi.org/10.1134/S1062360424700024)
21. Ivanova ED, Parshina EA, **Zaraisky AG**, Martynova NY (2024). Isoforms of the Cytoskeletal LIM-Domain Protein Zyxin in the Early Embryogenesis of *Xenopus laevis*. *Russ. J. Bioorganic Chem.* 50 (3), 723–732, [10.1134/S1068162024030026](https://doi.org/10.1134/S1068162024030026)
22. Parshina EA, **Zaraisky AG**, Martynova NY (2024). Ribonucleoprotein Complex Factor Ybx1 Stabilizes the Maternal mRNA of the *ssx2ip* Gene Encoding the Centrosome Maturation Protein in *Xenopus laevis* Embryogenesis. *Russ. J. Bioorganic Chem.* 50 (3), 715–722, [10.1134/S1068162024030051](https://doi.org/10.1134/S1068162024030051)
23. Паршина ЕА, **Зарайский АГ**, Мартынова НЮ (2024). Фактор рибонуклеопротеиновых комплексов Ybx1 стабилизирует материнскую мРНК гена *ssx2ip*, кодирующего белок созревания centrosом, в эмбриональном развитии лягушки *Xenopus laevis*. *Биоорганическая химия* 50 (3), 338–344, [10.31857/S0132342324030133](https://doi.org/10.31857/S0132342324030133)
24. **Zaraisky AG**, Araslanova KR, Shitikov AD, Tereshina MB (2024). Loss of the ability to regenerate body appendages in vertebrates: from side effects of evolutionary innovations to gene loss. *Biol Rev Camb Philos Soc* 99 (5), 1868–1888, [10.1111/brv.13102](https://doi.org/10.1111/brv.13102)
25. Bayramov AV, Yastrebov SA, Mednikov DN, Araslanova KR, Ermakova GV, **Zaraisky AG** (2024). Paired fins in vertebrate evolution and ontogeny. *Evol Dev* 26 (3), e12478, [10.1111/ede.12478](https://doi.org/10.1111/ede.12478)
26. Bayramov AV, Ermakova GV, **Zaraisky AG** (2024). Reconstruction of Ancestral Genomes as a Key to Understanding the Early Evolution of Vertebrate Genotype. *RUSS J DEV BIOL* 54, S1–S9, [10.1134/S1062360423070020](https://doi.org/10.1134/S1062360423070020)
27. Ermakova GV, Kucheryavyy AV, **Zaraisky AG**, Bayramov AV (2024). The Molecular Mechanism of Body Axis Induction in Lampreys May Differ from That in Amphibians. *Int J Mol Sci* 25 (4), , [10.3390/ijms25042412](https://doi.org/10.3390/ijms25042412)
28. Ermakova GV, Meyntser IV, **Zaraisky AG**, Bayramov AV (2024). Loss of *noggin1*, a classic embryonic inducer gene, in elasmobranchs. *Sci Rep* 14 (1), 3805, [10.1038/s41598-024-54435-9](https://doi.org/10.1038/s41598-024-54435-9)
29. Eroshkin FM, Fefelova EA, Bredov DV, Orlov EE, Kolyupanova NM, Mazur AM, Sokolov AS, Zhigalova NA, Prokhortchouk EB, Nesterenko AM, **Zaraisky AG** (2024). Mechanical Tensions Regulate Gene Expression in the *Xenopus laevis* Axial Tissues. *Int J Mol Sci* 25 (2), , [10.3390/ijms25020870](https://doi.org/10.3390/ijms25020870)
30. Ermakova GV, Kucheryavyy AV, Mogue NS, Mischenko AV, **Zaraisky AG**, Bayramov AV (2024). Three foxg1 paralogues in lampreys and gnathostomes—brothers or cousins? *Front Cell Dev Biol* 11, 1321317, [10.3389/fcell.2023.1321317](https://doi.org/10.3389/fcell.2023.1321317)
31. Lyubetsky VA, Rubanov LI, Tereshina MB, Ivanova AS, Araslanova KR, Uroshlev LA, Goremykina GI, Yang JR, Kanovei VG, Zverkov OA, Shitikov AD, Korotkova DD, **Zaraisky AG** (2023). Wide-scale identification of

- novel/eliminated genes responsible for evolutionary transformations. *Biol Direct* 18 (1), 45, [10.1186/s13062-023-00405-6](https://doi.org/10.1186/s13062-023-00405-6)
32. Bayramov AV, Ermakova GV, Kucheryavyy AV, Meintser IV, **Zaraisky AG** (2022). Lamprey as Laboratory Model for Study of Molecular Bases of Ontogenesis and Evolutionary History of Vertebrata. *J Ichthyol* 62 (7), 1213–1229, [10.1134/S0032945222060029](https://doi.org/10.1134/S0032945222060029)
 33. Korotkova DD, Gantsova EA, Goryashchenko AS, Eroshkin FM, Serova OV, Sokolov AS, Sharko F, Zhenilo SV, Martynova NY, Petrenko AG, **Zaraisky AG**, Deyev IE (2022). Insulin Receptor-Related Receptor Regulates the Rate of Early Development in *Xenopus laevis*. *Int J Mol Sci* 23 (16), , [10.3390/ijms23169250](https://doi.org/10.3390/ijms23169250)
 34. Parshina EA, Orlov EE, **Zaraisky AG**, Martynova NY (2022). The Cytoskeletal Protein Zyxin Inhibits Retinoic Acid Signaling by Destabilizing the Maternal mRNA of the RXR γ Nuclear Receptor. *Int J Mol Sci* 23 (10), , [10.3390/ijms23105627](https://doi.org/10.3390/ijms23105627)
 35. Orlov EE, Nesterenko AM, Korotkova DD, Parshina EA, Martynova NY, **Zaraisky AG** (2022). Targeted search for scaling genes reveals matrix metalloproteinase 3 as a scaler of the dorsal-ventral pattern in *Xenopus laevis* embryos. *Dev Cell* 57 (1), 95–111.e12, [10.1016/j.devcel.2021.11.021](https://doi.org/10.1016/j.devcel.2021.11.021)
 36. Filenko PA, Chechenina AA, **Zaraisky AG**, Eroshkin FM (2022). The Effect of Myosin Inhibitors on the Expression of Mechano-Dependent Genes in the Early Development of the Clawed Frog. *Russ. J. Bioorganic Chem.* 48 (4), 854–857, [10.1134/S1068162022040094](https://doi.org/10.1134/S1068162022040094)
 37. Ermakova GV, Kucheryavyy AV, Eroshkin FM, Martynova NY, **Zaraisky AG**, Bayramov AV (2021). Study of the Early Telencephalon Genes of Cyclostomes as a Way to Restoring the Evolutionary History of This Unique Part of the Central Nervous System of Vertebrates. *PALEONTOLOGICAL JOURNAL* 55 (7), 752–765, [10.1134/S0031030121070030](https://doi.org/10.1134/S0031030121070030)
 38. Martynova NY, Parshina EA, **Zaraisky AG** (2021). Cytoskeletal protein Zyxin in embryonic development: from controlling cell movements and pluripotency to regulating embryonic patterning. *FEBS J* 290 (1), 66–72, [10.1111/febs.16308](https://doi.org/10.1111/febs.16308)
 39. Ivanova AS, Tereshina MB, Araslanova KR, Martynova NY, **Zaraisky AG** (2021). The Secreted Protein Disulfide Isomerase Ag1 Lost by Ancestors of Poorly Regenerating Vertebrates Is Required for *Xenopus laevis* Tail Regeneration. *Front Cell Dev Biol* 9, 738940, [10.3389/fcell.2021.738940](https://doi.org/10.3389/fcell.2021.738940)
 40. Bayramov AV, Ermakova GV, Kucheryavyy AV, **Zaraisky AG** (2021). Genome Duplications as the Basis of Vertebrates' Evolutionary Success. *RUSS J DEV BIOL* 52, 141–163, [10.1134/S1062360421030024](https://doi.org/10.1134/S1062360421030024)
 41. Martynova NY, Parshina EA, **Zaraisky AG** (2021). Protocol for separation of the nuclear and the cytoplasmic fractions of *Xenopus laevis* embryonic cells for studying protein shuttling. *STAR Protocols* 2 (2), 100449, [10.1016/j.xpro.2021.100449](https://doi.org/10.1016/j.xpro.2021.100449)
 42. Martynova NY, Parshina EA, **Zaraisky AG** (2021). Using RNA-binding proteins for immunoprecipitation of mRNAs from *Xenopus laevis* embryos. *STAR Protocols* 2 (2), 100552, [10.1016/j.xpro.2021.100552](https://doi.org/10.1016/j.xpro.2021.100552)
 43. Ермакова ГВ, Кучерявый АВ, **Зарайский АГ**, Байрамов АВ (2021). СПРАВНИТЕЛЬНЫЙ АНАЛИЗ ПАТТЕРНОВ ЭКСПРЕССИИ ГЕНОВ СЕМЕЙСТВА NOGGIN НА РАННИХ СТАДИЯХ РАЗВИТИЯ ГОЛОВНЫХ СТРУКТУР ЕВРОПЕЙСКОЙ РЕЧНОЙ МИНОГИ LAMPETRA FLUVIATILIS. *Ontogenez* 52 (1), 46–55, [10.31857/S0475145021010031](https://doi.org/10.31857/S0475145021010031)
 44. Байрамов АВ, Ермакова ГВ, Кучерявый АВ, **Зарайский АГ** (2021). ГЕНОМНЫЕ ДУПЛИКАЦИИ КАК ОСНОВА ЭВОЛЮЦИОННОГО УСПЕХА ПОЗВОНОЧНЫХ. *Ontogenez* 52 (3), 170–194, [10.31857/S0475145021030022](https://doi.org/10.31857/S0475145021030022)
 45. Ermakova GV, Kucheryavyy AV, **Zaraisky AG**, Bayramov AV (2021). Comparative Analysis of Expression Patterns of the Noggin Gene Family Genes at the Early Development Stages of Head Structures in the European River Lamprey *Lampetra fluviatilis*. *RUSS J DEV BIOL* 52, 33–41, [10.1134/S1062360421010033](https://doi.org/10.1134/S1062360421010033)
 46. Parshina E, **Zaraisky AG**, Martynova NY (2020). The Role of Maternal pou5f3.3/oct60 Gene in the Regulation of Initial Stages of Tissue Differentiation during *Xenopus laevis* Embryogenesis. *Russ. J. Bioorganic Chem.* 46 (6), 1172–1180, [10.1134/S1068162020060242](https://doi.org/10.1134/S1068162020060242)
 47. Паршина ЕА, **Зарайский АГ**, Мартынова НЮ (2020). Роль материнского гена pou5f3.3/oct60 в регуляции начальных этапов дифференцировки тканей в эмбриогенезе шпорцевой лягушки *Xenopus laevis*. *Bioorg Khim* 46 (6), 719–728, [10.31857/S013234232006024X](https://doi.org/10.31857/S013234232006024X)
 48. Parshina EA, Eroshkin FM, Orlov EE, Gyoeva FK, Shokhina AG, Staroverov DB, Belousov VV, Zhigalova NA, Prokhortchouk EB, **Zaraisky AG**, Martynova NY (2020). Cytoskeletal Protein Zyxin Inhibits the Activity of

- Genes Responsible for Embryonic Stem Cell Status. *Cell Rep* 33 (7), 108396, [10.1016/j.celrep.2020.108396](https://doi.org/10.1016/j.celrep.2020.108396)
49. Martynova NY, Parshina EA, Eroshkin FM, **Zaraisky AG** (2020). The Cytoskeletal Protein Zyxin Modulates the Expression of the Target Genes of the Shh Signaling Cascade in the Cells of the Neural Plate of Embryos of the Spur-Toed Frog *Xenopus laevis*. *Russ. J. Bioorganic Chem.* 46 (4), 530–536, [10.1134/S1068162020040147](https://doi.org/10.1134/S1068162020040147)
 50. Ermakova GV, Kucheryavyy AV, **Zaraisky AG**, Bayramov AV (2020). Publisher Correction: Discovery of four Noggin genes in lampreys suggests two rounds of ancient genome duplication. *Commun Biol* 3 (1), 532, [10.1038/s42003-020-01272-x](https://doi.org/10.1038/s42003-020-01272-x)
 51. Ermakova GV, Kucheryavyy AV, **Zaraisky AG**, Bayramov AV (2020). Discovery of four Noggin genes in lampreys suggests two rounds of ancient genome duplication. *Commun Biol* 3 (1), 501, [10.1038/s42003-020-01234-3](https://doi.org/10.1038/s42003-020-01234-3)
 52. Ermakova GV, Kucheryavyy AV, **Zaraisky AG**, Bayramov AV (2020). Heterochrony of the Expression of *Lanf* and *Foxg1* in the Lamprey Confirms the Appearance of the Telencephalon as an Evolutionarily Young Superstructure in the Central Nervous System of Vertebrates. *RUSS J DEV BIOL* 51, 246–254, [10.1134/S1062360420040049](https://doi.org/10.1134/S1062360420040049)
 53. Bayramov AV, Ermakova GV, **Zaraisky AG** (2020). Genetic Mechanisms of the Early Development of the Telencephalon, a Unique Segment of the Vertebrate Central Nervous System, as Reflecting Its Emergence and Evolution. *RUSS J DEV BIOL* 51, 162–175, [10.1134/S1062360420030054](https://doi.org/10.1134/S1062360420030054)
 54. Rubanov LI, **Zaraisky AG**, Shilovsky GA, Seliverstov AV, Zverkov OA, Lyubetsky VA (2019). Screening for mouse genes lost in mammals with long lifespans. *BioData Min* 12 (1), 20, [10.1186/s13040-019-0208-x](https://doi.org/10.1186/s13040-019-0208-x)
 55. Korotkova DD, Lyubetsky VA, Ivanova AS, Rubanov LI, Seliverstov AV, Zverkov OA, Martynova NY, Nesterenko AM, Tereshina MB, Peshkin L, **Zaraisky AG** (2019). Bioinformatics Screening of Genes Specific for Well-Regenerating Vertebrates Reveals *c-answr*, a Regulator of Brain Development and Regeneration. *Cell Rep* 29 (4), 1027–1040.e6, [10.1016/j.celrep.2019.09.038](https://doi.org/10.1016/j.celrep.2019.09.038)
 56. Ermakova GV, Kucheryavyy AV, **Zaraisky AG**, Bayramov AV (2019). The expression of *FoxG* in the early development of the European river lamprey *Lampetra fluviatilis* demonstrates significant heterochrony with that in other vertebrates. *Gene Expr Patterns* 34, 119073, [10.1016/j.gep.2019.119073](https://doi.org/10.1016/j.gep.2019.119073)
 57. Nesterenko AM, **Zaraisky AG** (2019). The Mechanisms of Embryonic Scaling. *RUSS J DEV BIOL* 50 (3), 95–101, [10.1134/S1062360419030044](https://doi.org/10.1134/S1062360419030044)
 58. Tereshina MB, Ivanova AS, Eroshkin FM, Korotkova DD, Nesterenko AM, Bayramov AV, Solovieva EA, Parshina EA, Orlov EE, Martynova NY, **Zaraisky AG** (2019). *Agr2*-interacting *Prod1*-like protein *Tfp4* from *Xenopus laevis* is necessary for early forebrain and eye development as well as for the tadpole appendage regeneration. *Genesis* 57 (5), e23293, [10.1002/dvg.23293](https://doi.org/10.1002/dvg.23293)
 59. Ivanova AS, Korotkova DD, Ermakova GV, Martynova NY, **Zaraisky AG**, Tereshina MB (2018). Ras-dva small GTPases lost during evolution of amniotes regulate regeneration in anamniotes. *Sci Rep* 8 (1), 13035, [10.1038/s41598-018-30811-0](https://doi.org/10.1038/s41598-018-30811-0)
 60. Байрамов АВ, Ермакова ГВ, Кучерявый АВ, **Зарайский АГ** (2018). Миноги – “живые ископаемые” в исследованиях раннего развития и регенерации позвоночных. *Ontogenez* 49 (5), S3–S14, [10.1134/S0475145018080013](https://doi.org/10.1134/S0475145018080013)
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 62. Eroshkin FM, Kremnev SV, Ermakova GV, **Zaraisky AG** (2018). Development of Methods and Techniques to Visualize Mechanical Tension in Embryos Using Genetically Encoded Fluorescent Mechanosensors. *RUSS J DEV BIOL* 49 (6), 362–369, [10.1134/S1062360418060024](https://doi.org/10.1134/S1062360418060024)
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