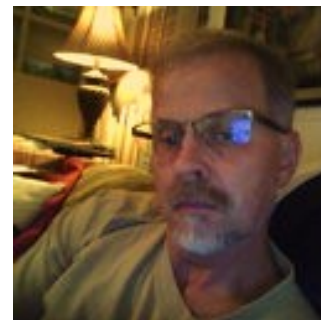


Curriculum Vitae



Personal Information:

Name: Anton V. Borovjagin
Date of Birth: August 16, 1966
Place of Birth: Moscow, Russia
Marital Status: Married
Address: 2544 Ostlin St. Birmingham, AL 35211
Citizenship: US
Degrees: MSc, PhD
Job Title: Senior Staff Researcher (V)/Laboratory Manager
Business 1670, University Blvd, University of Alabama at Birmingham (UAB),
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Education:

1983-1988 Undergraduate, Department of Biology, *M. Lomonosov Moscow State University (MSU)*,
Moscow, Russia.
1987 Bachelor's Degree/ **BSc** in Biology
1988 Master's Degree/ **MSc** in Virology
Division of Virology, Dep. of Biology, *MSU*; Research laboratory: *A.N. Belozersky
Institute of Physico-Chemical Biology*, Laboratory Head /PI: Professor Vadim I. Agol
Thesis mentor: Dr. T. Ugarova
1988-1991 Graduate (**PhD**) Program, Department of Biology, *MSU*; Research laboratory: *A.N.
Belozersky Institute of Physico-Chemical Biology*, Laboratory of Chemistry and
Biochemistry of Nucleo-Proteids (Department of Chemistry), Head of Laboratory/PI:
Professor Alexey A. Bogdanov, member of The Russian Academy of Sciences. PhD
mentor: Dr. Ivan N. Shatsky
1992 Doctor of Philosophy /**PhD** Degree in Molecular Biology (Dep. of Biology, *MSU*).

Research Experience:

1992-1993 **Junior Staff Scientist**, A.N. Belozersky Institute of Physico-Chemical Biology, *MSU*,
Moscow, Russia; PI: Dr. Ivan N. Shatsky
1993-1994 **The Royal Society (UK) Research Fellow**
Research laboratory: Div. of Biomedical Sciences, St. George's Hospital Medical School
University of London, London, UK; Chair/PI: Professor Mike Clemens,
Mentor: Dr. Ulrich A. Bommer
1994-2001 **Postdoctoral Research Associate in Biology**, Division of Biology and Medicine,
Department of Molecular Biology Cell Biology and Biochemistry (MCB) Brown
University, Providence, RI, USA. Head of laboratory/PI: Dr. Susan A. Gerbi (MCB
Department Chair)
2001-2003 **Research Assistant Professor** in Biology, Department of MCB, Brown University,
Providence, RI, USA.
2003-2004 **Scientist II**, VectorLogics Inc., Birmingham AL (*changing research field to cancer gene
therapy*).

- 2004-2007 **NIH Trainee** (NIH-sponsored T32 training program in gene therapy), University of Alabama at Birmingham (UAB), Division of Human Gene Therapy, UAB Gene Therapy Center, Birmingham AL. (*returning to academia to continue training in the field of cancer gene therapy*).
- 2007-2014 **Instructor** (research track faculty), Institute of Oral Health Research (IOHR)/ Department of Periodontics, UAB School of Dentistry, Birmingham AL
- 2014-2016 **Research Associate**, University of Alabama at Birmingham (UAB), Department of Pathology, Division of Molecular and Cellular Pathology.

Academic Appointments:

- 2001-2003 **Research Assistant Professor** in Biology, Department of MCB, Brown University, Providence, RI, USA.
- 2007-2014 **Instructor** (research track junior faculty), Institute of Oral Health Research (IOHR)/ Department of Periodontics, UAB School of Dentistry, Birmingham AL
- 2009-2010 **Associate Scientist**, UAB Gene Therapy Center, Birmingham AL
- 2012-2014 **Associate Scientist**, Global Center for Craniofacial, Oral and Dental Disorders

Teaching Experience:

- 1989-1991 **Teaching Assistant** in Molecular Biology and Virology at *M. Lomonosov Moscow State University*, Moscow, Russia
- 2001-2003 **Research Trainer** at Brown University, Providence RI; teaching research methods to graduate students in the lab.
- 2004-2007 **Group Leader/Supervisor** at the UAB Gene Therapy Center. Overseeing several research projects of graduate (MD/PhD and PhD) students in the lab.
- 2009-2014 **Facilitator** in Case-Based Education (CBE) 1 and 2 courses for Dental Students, UAB School of Dentistry
- 2009-2011 **Graduate Faculty** (Ad Hoc), University of Alabama at Birmingham; serving on PhD committee.
- 2011-2014 **Graduate Faculty** (full time), University of Alabama at Birmingham.
- 2008-2012 **Research Instructor/Mentor**, Institute of Oral Health Research, UAB School of Dentistry; laboratory research training of dental (pre-doctoral) and undergraduate students; mentoring summer research projects.

Mentored/Co-mentored trainees:

- 1991-1992 Michael V. Ezrokhi, Master's Program (MSc) student, Department of Chemistry, MSU, Moscow, Russia
- 1992-1993 Dushanka Lumovich, Master's Program (MSc) student; Department of Biology, MSU, Moscow, Russia;
- 1994-1998 Michael V. Ezrokhi, Graduate/PhD student, Department of Molecular Biology, Cell biology and Biochemistry (MCB) Brown University, Providence RI, USA
- 2005-2007 Hideyo Ugai, PhD Postdoctoral Fellow; UAB Division of Human Gene Therapy, UAB Gene Therapy Center, Birmingham AL
- 2006-2007 Kristopher K. Kimball, MD, UAB Department of Obstetrics and Gynecology (ObGyn) Fellow. Co-mentor Professor Ronald D. Alvarez (UAB ObGyn)
- 2006-2010 Anand A. Annan, Graduate/MD, PhD student, UAB Department of Medicine, Division of

	Human Gene therapy, UAB Gene Therapy Center; Co-mentor Professor David T. Curiel (UAB)
2007-2010	<u>Lena J. Gamble</u> , Graduate/MD, PhD student, UAB Department of Medicine, Division of Human Gene therapy, UAB Gene Therapy Center; Co-mentor Dr. Qiana L. Matthews (UAB)
2008-2011	<u>Jason Warram</u> , Graduate/PhD student, UAB Department of Pathology Graduate Program; Co-mentor Dr. Kurt Zinn (UAB)
2008	<u>David B. Lehman</u> , Dental/DMD student, UAB School of Dentistry; Summer Research project
2010-2011	<u>Ty K. Levie</u> , Undergraduate student, Samford University, Birmingham AL; Research training in the lab
2010-2013	<u>George C. Dobbins</u> , PhD, American Cancer Society (ACS) Postdoctoral Fellow, UAB Department of Neurosurgery, Co-Mentor: Professor G. Yancey Gillespie
2012	<u>Jung In Choi</u> , High School Student, Indian Springs High School, Pelham AL; Volunteer research trainee in the lab

Individual Research awards to mentored students:

2008	Summer Trainee Fellowship, the NIH Summer Research Program “Short Term Training in Health Professional School “(T35-HL007473); <u>Recipient</u> : David B. Lehman, DART (Dental Academic Research Training) student, <u>Project period</u> : 06/01/2008-08/31/2008
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Honors and Awards:

1993	The Royal Society Fellowship (UK)
1993	The Youth Travel Fund grant (sponsored participation in the NATO-FEBS ASI on “Post transcriptional regulation of gene expression” in Spetsai, Greece, August 1993)
2008	UAB School of Dentistry Dean’s Research Development Award (2008-2009)
2010	UAB School of Dentistry Dean’s Research Development Award (2010-2011)
2012	UAB Service Award
2012	UAB School of Dentistry Variable Incentive Program Award

Intramural Services :

- Institute of Oral Health Research (UAB School of Dentistry) Laboratory Safety Officer, (2007-2014)
- Poster presentation judge for UAB School of Dentistry annual Scholar’s Symposiums.
- Member, UAB School of Dentistry Research Advisory Committee (2008-2012)
- Ad Hoc Graduate Faculty (Molecular and Cellular Pathology Graduate Program) University of Alabama at Birmingham (2009-2011).
- UAB full time Graduate Faculty (2011-2014)
- UAB School of Dentistry Accreditation Committee member (2013-2014)

Editorial activities:

- “PLoS One” reviewer
- “Journal of Dental Research” reviewer.

Grant Support (past)

External:

Funding agency/Grant type: **NIH**, National Institute of Dental and Craniofacial Research (NIDCR), **R03 DE21785-01**

Principal Investigator (PI): Borovjagin, A

Total amount awarded: \$219,750

Funding period: 01/03/2011-02/28/2014

Project title: *“Development of EGFR-Targeted Oncolytic Adenovirus for Therapy of Oral Cancers”*

Research project goals: Development of a targeted virotherapy agent against oral cancers (OSCC) based on dual-targeting of human oncolytic adenovirus (Ad5) to cancer cells, for cancer-specific delivery and expression a therapeutic gene IL24/mda7 with cancer-selective therapeutic activity; validation of targeting benefits in a mouse xenograft model of oral cancer.

Status: completed

Internal:

Funding agency/Grant type: University of Alabama at Birmingham **SPORE** (Specialized Programs in Research Excellence) in Breast Cancer, **Pilot Project**

Principal Investigator: Borovjagin, A.

Total amount awarded: \$50,000

Funding period: 09/01/2010-08/30/2011

Project title: *“Animal Model for Targeting Validation of the First HER2-Targeted “Delta 24” CRAd”*

Research project goals: Development of a new animal model of human breast cancer adequate for evaluation of Ad tumor targeting and noninvasive validation of fluorescently labeled Her2/neu-targeted oncolytic Ad in the new model (proof-of-principle study).

Status: completed

Funding agency/grant type: UAB School of Dentistry **Research Development Program Award**

Principal Investigator: Borovjagin, A.

Total amount awarded: \$10,000

Funding period: 06/01/2010-05/30/2011

Project title: *“Development of an EGFR-targeted oncolytic adenovirus for diagnostics and therapy of oral cancers and a new animal model for its validation”*

Research project goals: The goal of this project is construction of a new EGFR-targeted CRAd agent for diagnostics and therapy of oral cancers and development of a new animal model for validation of its tumor-targeting specificity.

Status: completed

Funding agency/grant type: UAB School of Dentistry **Research Development Program Award**

Principal Investigator: Borovjagin, A.

Total amount awarded: \$10,000

Funding period: 06/01/2008-05/30/2009

Project title: *“Noninvasive imaging of a new fluorescently-labeled oncolytic adenovirus: applications for cancer therapy”*

Research project goals: Live monitoring of mCherry-labeled oncolytic adenovirus in mouse xenograft model of breast cancer using a new fluorescence spectral imaging approach.

Status: completed

Grant Support (current)

External:

Funding agency/Grant type: NIH, National Institute of Dental and Craniofacial Research (NIDCR)
1R01 DE026941

Principal Investigator (PI): Sorscher, Eric J.

2018 FY total cost by IC: \$463,582

Funding Period: 07/01/2017 – 06/30/2022

Project title: “*Intratumoral generation of F-Ade to ablate low growth fraction HNSCC*”

Research project goals: This project will develop a novel prokaryotic PNP enzyme, and innovative tumor targeting strategies to advance a mechanism for destroying the quiescent cell compartment of otherwise refractory tumors.

Role on the project Consultant; 3.60 calendar mo.

Status: ongoing

Internal:

BME Department/Dr Jianyi Zhang laboratory research grant support

Professional Presentations:

- Invited platform (oral) presentation at the Fifth International Conference on Ribosome Biogenesis and Nucleolar Function, Granlibakken CA, August 17-21, 2000;
- Invited presentation at the 7th Annual Meeting of the RNA Society, Madison, Wisconsin; May 28-June 2, 2002.
- Invited lecture at the Molecular Plant Pathology Laboratory (MPPL) at the Plant Sciences Institute (PSI) of Agricultural Research Service (ARS) of United States Department of Agriculture (USDA); May 27, 2008
- Seminar presentation at the Gamaleya Research Institute for Epidemiology and Microbiology, Russian Academy of Medical Sciences, Moscow, Russia; Host: Professor B.S. Naroditsky, December 28, 2009.

Professional/Scientific Organization Memberships:

1993-1998 Member of Russian Biochemical Society.
1997-1999 Member of American Society of Cell Biology (ASCB).
2005-2006 Member of American Society of Gene Therapy (ASGT).
2009-2011 Member of International Association of Dental Research (IADR).

Publications (first author: **15**; senior author: **5**; total: **61**, h-index: **26**, RG score: **35.31**):

Full-text peer-reviewed research articles (45):

1. **Borovjagin AV**, A.G. Evstafieva, T. Yu. Ugarova, I.N. Shatsky (1990). A factor that specifically binds to the 5'-untranslated region of encephalomyocarditis virus RNA. ***FEBS Lett.*** 261 (2): 237-240. PMID: 2155820.
2. **Borovjagin AV**, M. V. Ezrokhi, Y. M. Rostapshev, T.Yu. Ugarova, T.F. Bystrova, I. N. Shatsky (1991). RNA-protein interactions within the internal translation initiation region of encephalomyocarditis virus RNA. ***Nucl. Acids Res.***, 119(18): 4999-5005. PMID: 1656384. PMCID: 328802.
3. Evstafieva AG, Beletsky AV, **Borovjagin AV**, Bogdanov AA (1993). The Internal Ribosome Entry Site of encephalomyocarditis virus RNA is unable to direct translation in *Sacharomyces cerevisiae*”. ***FEBS Lett.*** 335: 273-276. PMID: 8253211.

4. **Borovjagin AV**, T.V. Pestova, I.N. Shatsky (1994). Polypyrimidine Tract Binding Protein strongly stimulates in vitro encephalomyocarditis virus RNA translation at the level of pre-initiation complex formation. *FEBS Lett.* 351: 299-302. PMID: 8082784.
5. **Boroviagin AV**, Ezrokhi MV, Shatskii IN (1995). Internal initiation of translation in eukaryotes. Chemical probing of the encephalomyocarditis virus RNA IRES-element in the 48S pre-initiation complex. *Mol Biol (Rus.)* 29(3):679-88.
6. **Borovjagin AV**, Russell P, Clemens MJ, Greagg MA, Bommer UA. (1995) Features of the translational regulation of the mammalian growth-related protein P23. *Biochem Soc Trans.* 23(2):316S. PMID:7672347
7. Lange TS, **Borovjagin A**, Maxwell ES, Gerbi SA (1998). Conserved boxes C and D are essential nucleolar localization elements of U14 and U8 snoRNAs. *EMBO J.* 17(11): 3176-87. PMID: 9606199. PMCID: PMID: 9606199.
8. Lange TS, **Borovjagin AV**, Gerbi SA (1998). Nucleolar localization elements in U8 snoRNA differ from sequences required for rRNA processing. *RNA*, 4(7): 789-800. PMID: 9671052. PMCID: 1369659.
9. Lange TS, Ezrokhi M, **Borovjagin AV**, Rivera-Léon R, North MT, Gerbi SA (1998). Nucleolar localization elements of *Xenopus laevis* U3 small nucleolar RNA. *Mol. Biol. Cell.* 9 (10): 2973-85. PMID: 9763456. PMCID: 25574.
10. **Borovjagin AV** and Gerbi SA (1999). U3 small nucleolar RNA is essential for cleavage at sites 1, 2 and 3 in pre-rRNA and determines which rRNA processing pathway is taken in *Xenopus* oocytes. *J. Mol. Biol.* 286 (5): 1347-63, PMID: 10064702.
11. **Borovjagin AV** and Gerbi SA (2000). The spacing between functional cis-elements of U3 snoRNA is critical for rRNA processing. *J. Mol. Biol.* 300 (1): 57-74. PMID: 10864498.
12. **Borovjagin AV** and Gerbi SA (2001). GAC-box A' and box A sequence elements in *Xenopus* U3 small Nucleolar RNA have distinct functional roles in rRNA processing. *Mol. Cell Biol.*, 21(18): 6210-21). PMID: 11509664. PMCID: 87338.
13. Bommer U-A, **Borovjagin AV**, Greagg MA, Jeffrey IW, Russell P, Lee M, Clemens MJ (2002). The mRNA of the translationally controlled tumor protein TCTP/P23 is a highly structured RNA, which binds to and activates the dsRNA-dependent protein kinase PKR. *RNA*, 8: 478-496. PMID: 11991642. PMCID: 1370270.
14. Gerbi SA, **Borovjagin AV**, Odreman FE, Lange TS (2003). U4 snRNA nucleolar localization requires the 15.5-kD protein binding site but not Sm protein or U6 snRNA association. *J. Cell Biol.*, 162 (5): 821-32. PMID: 12939253. PMCID: 2172826.
15. **Borovjagin AV** and Gerbi SA (2004). *Xenopus* U3 snoRNA docks on pre-rRNA through a novel base-pairing interaction. *RNA*, 10(6): 942-53. PMID: 15146078. PMCID: 1370586.
16. **Borovjagin AV** and Gerbi SA (2005). An evolutionary intra-molecular shift in the preferred U3 snoRNA binding site on pre-ribosomal RNA. *Nucl. Acids Res.*, 33(15): 4995-5005. PMID: 16147982. PMCID: 1199564.
17. **Borovjagin AV**, Krendelchtchikov A, Ramesh N, Yu D-C, Douglas JT, Curiel DT (2005). Complex mosaicism is a novel approach to infectivity enhancement of adenovirus type 5-based vectors. *Cancer Gene Therapy.* 12(5):475-86. PMID: 15706356.
18. Tyler MA, Ulasov IV, **Borovjagin AV**, Sonabend AM, Khramtsov A, Curiel DT, Lesniak MS (2006). Enhanced transduction of malignant glioma with a double-targeted Ad5/3-RGD fiber modified adenovirus *Mol. Cancer Ther.* 5(9): 2408-2416. PMID: 16985075.

19. Smith BF, Curiel DT, Ternovoi VV, **Borovjagin AV**, Baker HJ, Cox N, Siegal GP (2006). Administration of a Conditionally Replicative Oncolytic Canine Adenovirus in Normal Dogs. *Cancer Biotherapy & Radiopharmaceuticals* 21 (6): 601-6. PMID: 17257075.
20. Ugai H, **Borovjagin AV**, Le LP, Wang M, Curiel DT (2007). Thermostability/Infectivity Defect Caused by Deletion of the Core Protein V Gene in Human Adenovirus Type 5 Is Rescued by Thermo-selectable Mutations in the Core Protein X Precursor. *J. Mol. Biol.* 366(4):1142-60. PMID: 17208253. PMCID: 2203208.
21. Saini V, Martyshekin DV, Mirov SB, Perez A, Perkins G, Ellisman MH, Towner VD, Wu H, Pereboeva L, **Borovjagin A**, Curiel DT, Everts M (2008). An Adenoviral Platform for Selective Self-Assembly and Targeted Delivery of Nanoparticles (pNA). *Small* 4(2): 262-9. PMID: 18200644.
22. San Martin C., Glasgow JN; **Borovjagin A**, Beatty MS, Kashentseva EA, Curiel DT, Marabini R, Dmitriev IP (2008). Localization of the N-terminus of minor coat protein IIIa in the adenovirus capsid. *J. Mol. Biol.* 383(4):923-34; PMID: 18786542.
23. Kimball K.J., Rivera A.A., Zinn K.R., Icyuz M., Saini V., Zhu Z.B., Siegal G.P., Douglas J.T. Curiel D.T., Alvarez R.D., **Borovjagin A.V.** (2009) A Novel Infectivity-Enhanced Oncolytic Adenovirus with a Capsid-Incorporated Dual Imaging Moiety for Monitoring Virotherapy in Ovarian Cancer. *Mol. Imaging* 8(5): 264-77 PMID: 19796604.
24. **Borovjagin AV**, McNally LR, Wang M, MacDougall MJ, Zinn KR (2010). Noninvasive Monitoring of mRFP1- and mCherry-Labeled Oncolytic Adenoviruses in Orthotopic Breast Cancer Model by Spectral Imaging. *Mol Imaging* 9(2): 59-75. PMID: 20236604
25. Matthews QL, Fatima A, Tang Y, Perry BA, Tsuruta Y, Komarova S, Timares L, **Borovjagin AV**, Blackwell J, Stewart PL, Wu H and Curiel DT (2010). HIV Antigen Incorporation within Adenovirus Hexon Hypervariable Region 2 for a Novel HIV Vaccine Approach. *PLoS One* 5(7):e11815 PMID: 20676400
26. Warram J.M., **Borovjagin A.V.**, Zinn K.R. (2011) A genetic strategy for combined screening and localized imaging of breast cancer. *Mol Imaging Biol.* 13(3):452-61; PMID: 20658194
27. **Borovjagin AV**, Dong J, Passineau MJ, Ren C, Lamani E, et al. (2011) Adenovirus Gene Transfer to *Amelogenesis Imperfecta* Ameloblast-Like Cells. *PLoS ONE* 6 (10): e24281. PMID:22003382
28. Gamble LJ, Ugai H., Wang M., **Borovjagin AV**, Matthews QL (2012) Therapeutic efficacy of an oncolytic adenovirus containing RGD ligand in minor capsid protein IX and Fiber, Δ 24DoubleRGD, in an ovarian cancer model. *J Mol Biochem.* 1, 26-39
29. Warram J.M., Sorace A.G., Saini R., **Borovjagin A.V.**, Hoyt K., Zinn K.R (2012). Systemic Delivery of a Breast Cancer-Detecting Adenovirus Using Targeted Microbubbles. *Cancer Gene Therapy* 19(8):545-52, PMID: 22653385
30. Ulasov IV, Thaci B, Saravaiya P, Yi R, Guo D, Pytel P, Zhang L, Kim SH, **Borovjagin A**, Dey M, Baryshnikov AY, Lesniak MS. (2013) "Inhibition of MMP14 potentiates the therapeutic effect of temozolomide and radiation in gliomas". *Cancer Med.* 2 (4): 457-467
31. Ulasov IV, **Borovjagin AV**, Kaverina N, Schroeder B, Shah N, Lin B, Baryshnikov A, and Cobbs C (2015). MT1-MMP silencing by a shRNA-armed glioma-targeted oncolytic adenovirus improves anti-tumor potency of the agent *in vitro* and *in vivo*. *Cancer Letters* 365(2):240-50; PMID: 26052095
32. Kaverina N, **Borovjagin AV**, Kadagidze Z, Baryshnikov A, Baryshnikova M, Malin D, Ghosh D, Shah N, Welch DR, Gabikian P, Karseladze A, Cobbs C, Ulasov IV (2017) Astrocytes promote progression of breast cancer metastases to the brain via a KISS1-mediated autophagy. *Autophagy.* 13(11):1905-1923; PMID: 28981380

33. Oduk Y, Zhu W, Kannappan R, Zhao M, **Borovjagin AV**, Oparil S, Zhang J (2017) VEGF Nanoparticles Repair Heart after Myocardial Infarction. *Am J Physiol Heart Circ Physiol.* 314 (2):H278-H284. doi: 10.1152/ajpheart.00471.2017. Epub 2017 Nov 3. PMID: 29101176
34. Gao L, Gregorich ZR, Zhu W, Mattapally S, Oduk Y, Lou X, Kannappan R, **Borovjagin AV**, Walcott GP, Pollard AE, Fast VG, Hu X, Lloyd SG, Ge Y, Zhang J. (2017). Large Cardiac-Muscle Patches Engineered from Human Induced-Pluripotent Stem-Cell-Derived Cardiac Cells Improve Recovery from myocardial Infarction in Swine. *Circulation.* 137 (16): 1712-1730; PMID: 29233823
35. Platonov ME, **Borovjagin AV**, Kaverina N, Xiao T, Kadagidze Z, Lesniak M, Baryshnikova M, Ulasov IV (2018) KISS1 tumor suppressor restricts angiogenesis of breast cancer brain metastases and sensitizes them to oncolytic virotherapy in vitro. *Cancer Lett.*; 417: 75-88; PMID: 29269086
36. Mattapally S, Zhu W, Fast VG, Gao L, Worley C, Kannappan R, **Borovjagin AV**, Zhang J. (2018) Spheroids of cardiomyocytes derived from human induced-pluripotent stem cells improve recovery from myocardial injury in mice. *Am J Physiol Heart Circ Physiol.* doi:10.1152/ajpheart.00688.2017 PMID: 29631371
37. Kaverina NV, Kadagidze ZG, **Borovjagin AV**, Karseladze AI, Kim CK, Lesniak MS, Miska J, Zhang P, Baryshnikova MA, Xiao T, Ornelles D, Cobbs C, Khramtsov A, Ulasov IV. (2018) Tamoxifen overrides autophagy inhibition in Beclin-1-deficient glioma cells and their resistance to adenovirus-mediated oncolysis via upregulation of PUMA and BAX. *Oncogene* doi: 10.1038/s41388-018-0395-9 [Epub ahead of print]; PMID: 29991800
38. Zhu W, Zhang E, Zhao M, Chong Z, Fan C, Tang Y, Hunter JD, **Borovjagin AV**, Walcott GP, Chen JY, Qin G, Zhang J. (2018) Regenerative Potential of Neonatal Porcine Hearts. *Circulation.* doi: 10.1161/CIRCULATIONAHA.118.034886. [Epub ahead of print].
39. Zhao M, Fan Ch, Ernest PJ, Tang Y, **Borovjagin AV**, Zhou L, Zhang J, Zhu W. (2019), Y-27632 Preconditioning Enhances Transplantation of Human Induced Pluripotent Stem Cell-Derived Cardiomyocytes in Myocardial Infarction Mice. *Cardiovasc Res.* 115 (2): 343-356. doi: 10.1093/cvr/cvy207.
40. Gentile CM, **Borovjagin AV**, Richter JR, Jani AH, Wu H, Zinn KR, Warram JM. (2019) Genetic strategy to decrease complement activation with adenoviral therapies. *PLoS One.* 14 (4): e0215226. doi: 10.1371/journal.pone.0215226. eCollection 2019.
41. Fan C, Tang M, Wu S, Yuan S, **Borovjagin AV**, Yang J. (2019). Reabsorbable Pins can Reinforce an Early Sternal Stability After Median Sternotomy in Young Children with Congenital Heart Disease. *J. Pediatr Cardiol.* Sep 23. 40(8):1728-1734. doi: 10.1007/s00246-019-02212-1. Epub 2019 Sep 23 PMID:31549187
42. Ulasov I, **Borovjagin A**, Fares J, Yakushov S, Malin D, Timashev P, Lesniak MS. (2020) MicroRNA 345 (miR345) regulates KISS1-E-cadherin functional interaction in breast cancer brain metastases. *Cancer Lett.* 481:24-31. doi: 10.1016/j.canlet.2020.03.025. Epub 2020 Apr 1. PMID:32246957
43. Lu A, Pallero MA, Owusu BY, **Borovjagin AV**, Lei W, Sanders PW, Murphy-Ullrich JE (2020), Calreticulin is important for the development of renal fibrosis and dysfunction in diabetic nephropathy. *Matrix Biol Plus*, 8:100034. doi: 10.1016/j.mbplus.2020.100034. eCollection 2020 Nov. PMID: 33543033, PMCID: PMC7852315
44. Chen W, Iroegbu CD, Xie X, Zhou W, Wu M, Wu X, Fan C, **Borovjagin AV**, Yang J. (2021), Individualized Surgical Reconstruction of the Right Ventricle Outflow Tract in Double Outlet Right Ventricle with Mirror Image-Dextrocardia. *Front. Pediatr.* 9:611007. doi: 10.3389/fped.2021.611007. eCollection 2021
45. Zhao M, Nakada Y, Wei Y, Bian W, Chu Y, **Borovjagin AV**, Xie M, Zhu W, Nguyen T, Zhou Y, Serpooshan V, Walcott GP, Zhang J. (2021) Cyclin D2 Overexpression Enhances the Efficacy of

Human Induced Pluripotent Stem Cell-Derived Cardiomyocytes for Myocardial Repair in a Swine Model of Myocardial Infarction. *Circulation*, 144(3):210-228 doi: 10.1161/CIRCULATIONAHA.120.049497. PMID: 33951921

46. Li H, Yu H, Song Y, Tong L, Zhao M, **Borovjagin AV**, Dong N, Wu L. (2021) Successful Surgical Treatment of a Giant Left Coronary Artery Aneurysm with Fistula. *Heart Surg Forum.*, 24(5): E868-E869. doi: 10.1532/hsf.3877. PMID: 34623255
47. Rab R, Ehrhardt A, Achyut BR, Joshi D, Borovjagin AV, Parker WB, Sorscher EJ, Hong JS. Evaluating antitumor activity of *E. coli* PNP against head and neck patient-derived xenografts. *Cancer Reports* (In press).

Review Articles and Book Chapters (14):

1. S.A. Gerbi and **A.V. Borovjagin (1997)**, U3 snoRNA may recycle through different compartments of the nucleolus. *Chromosoma* 105(7-8): 401-06.
2. S.A. Gerbi, **A.V. Borovjagin**, M. V. Ezrokhi, and T.S. Lange (2001), Ribosome biogenesis: role of small nucleolar RNAs in maturation of eukaryotic rRNA. *Cold Spring Harbor Symposia on Quantitative Biology*, LXVI, pp575-590.
3. S.A. Gerbi, **A.V. Borovjagin**, T.S. Lange (2003), The nucleolus: a site of ribonucleoprotein maturation. *Curr. Opin. Cell Biol.* 15(3):318-25.
4. S.A. Gerbi and **A.V. Borovjagin (2004)**, Pre-ribosomal RNA processing in vertebrates; in *Olson, M.O.J. (Ed.) "The Nucleolus"*. *Kluwer Academic/Plenum Publishers*, New York, pp170-198.
5. Gerbi SA, **Borovjagin AV**. Pre-Ribosomal RNA Processing in Multicellular Organisms; in *Madame Curie Bioscience Database* [Internet], *Landes Bioscience*, Austin, TX
6. M. V. Lopez, Q.L. Matthews, K. R. Zinn, D. T. Curiel and **A.V. Borovjagin (2010)**, Imaging of Gene Therapy (Chapter 42) in *Molecular Imaging: Principles and Practice*, R. Weissleder, S.S. Gambhir, B.D. Ross, A. Rehemtulla (Eds.); *BC Decker Inc, Publisher*
7. L.G. Gamble LG, **A.V. Borovjagin** and Q.L. Matthews (2010); The role of RGD-containing ligands in targeting cellular integrins: applications for ovarian cancer virotherapy. *Experimental and Therapeutic Medicine*, 1 (2): 233-240; PMID: 21494315
8. **A.V. Borovjagin**, J.G. Gomez-Gutierrez, H. Shirwan, Q.L. Matthews (2014). Adenovirus-based Vectors for the Development of Prophylactic and Therapeutic Vaccines (Chapter 9) in Lukashevich LS & Shirwan H (Eds.) *Novel Technologies for Vaccine Development: Viral Vectors for Infectious Diseases Control and Therapeutic Cancer Treatment*. *Springer-Verlag GmbH*, Wien, Austria
9. Ulasov IV, **Borovjagin AV**, Schroeder BA, Baryshnikov AY (2014) Oncolytic adenoviruses: A thorny path to glioma cure. *Genes Dis.* 1(2): 214-226.
10. **Borovjagin AV**, Ogle BM, Berry JL, Zhang J. (2017); From Microscale Devices to 3D Printing: Advances in Fabrication of 3D Cardiovascular Tissues. *Circ Res.* 120 (1):150-165. PMID: 28057791
11. Ulasov IV, **Borovjagin AV**, Timashev P, Cristofanili M, Welch DR (2019) KISS1 in Breast Cancer Progression and Autophagy. *Cancer and Metastasis Rev.*, 38(3):493-506. doi: 10.1007/s10555-019-09814-4. Review, PMID:31705228
12. Mijanović O, Branković A, **Borovjagin A**, Butnaru DV, Bezrukov EA, Sukhanov RB, Shpichka A, Timashev P, Ulasov I. (2020) Battling Neurodegenerative Diseases with Adeno-Associated Virus-Based Approaches. *Viruses*. Apr 18; 12(4). pii: E460. doi: 10.3390/v12040460. Review. PMID: 32325732

13. Laevskaya A, **Borovjagin A**, Timashev PS, Lesniak MS, Ulasov I. (2021) Metabolome-Driven Regulation of Adenovirus-Induced Cell Death. *Int J. Mol Sci.* 22 (1): 464. Review, PMID: 33466472
14. Ulasov IV, **Borovjagin AV**, Laevskaya A, Kamynina M, Timashev P, Cerchia L, Rozhkova EA, (2021). The IL-13R alpha2 paves the way for anti-glioma nanotherapy. *Genes Dis.* Review. <https://doi.org/10.1016/j.gendis.2021.08.006> (In press, available online 15 September 2021).

Selected Published Abstracts:

1. **A.V. Borovjagin**, T.S. Lange, M. Ezrokhi and S.A. Gerbi (2001). Ribosome biogenesis: role of *Xenopus* U3 small nucleolar RNA in rRNA processing. "The Ribosome". *Cold Spring Harbor Laboratory Symposium on Quantitative Biology*, p. 196.
2. **A.V. Borovjagin** and S.A. Gerbi (2002). An evolutionary intra-molecular swap in the preferred U3 small nucleolar RNA binding site on pre-ribosomal RNA. "RNA 2002"; *Seventh Annual meeting of the RNA Society, Madison, Wisconsin*.
3. Bruce F. Smith, D.T. Curiel, V.V. Ternovoi, **A.V. Borovjagin**, H.J. Baker, N.Cox, A.N. Smith, M.L. Higginbotham and G.P. Siegal. Administration of an Osteosarcoma-Targeted Canine Oncolytic Adenovirus in Normal and Tumor-Affected dogs. *American Society of Gene Therapy 10th Annual Meeting, 2007 Seattle, WA Abstract # 727*.
4. **A.V. Borovjagin**, M. Icyuz, J. Li, R. Alvarez and D. T. Curiel. A New Infectivity-Enhanced "delta24" Oncolytic Adenovirus with Capsid-Incorporated Imaging Modality Reporter for a Dynamic Fluorographic and SPECT/PET-Based Imaging. *American Society of Gene Therapy 10th Annual Meeting, 2007 Seattle, WA. Abstract # 44*.
5. H. Ugai, **A.V. Borovjagin**, L.P. Le, M. Wang, D.T. Curiel. Characterization of the Minor Core Protein V Gene-Deleted Adenoviral Vector with High Packaging Capacity Potential. *American Society of Gene Therapy 10th Annual Meeting, 2007 Seattle, WA. Abstract # 880*
6. L.R. McNally, **A. Borovjagin**, K.R. Zinn. Spectral Imaging for separation of mCherry-labeled Adenovirus from autofluorescence *in vitro* and *in vivo*. *World Molecular Imaging Congress. Sept 10-13, 2008 (France)*.
7. D.B. Lehman, L.R. McNally, M.Yamamoto, M.J. MacDougall, K.R. Zinn, V. Krasnykh and **A.V. Borovjagin**. A capsid-labeled oncolytic adenovirus, targeted to tumor-specific marker Her-2/neu; *The 38th Annual Meeting of AADR, Miami FL, April 1-4, 2009; Abstract # 2241*.
8. K. J. Kimball, A. A. Rivera, Z. B. Zhu, M.Wang, K.R. Zinn, D.T. Curiel, R.D. Alvarez and **A.V. Borovjagin**. A Novel Infectivity Enhanced Oncolytic Adenovirus with a Capsid Incorporated Dual Imaging Moiety for Monitoring Virotherapy in Ovarian Cancer. *The 40th Annual Meeting of the Society of Gynecologic Oncologists, San Antonio TX. Feb 2009*.
9. **A.V. Borovjagin**, C. Ren, P. DeVilliers, L. R. McNally and M.J. MacDougal. Evaluation of Modified Adenoviral Vectors for Treatment of Odontogenic tumors; *The 39th Annual AADR meeting. Washington DC, March 3-6, 2010; Abstract # 623*
10. Warram JM, **Borovjagin A**, Zinn KR. Localized imaging and blood-based detection of breast cancer. World Molecular Imaging Congress, *World Molecular Imaging Congress 2010, Sept 8-11; Kyoto, Japan*.
11. Warram JM, **Borovjagin A**, Zinn KR. Systemic delivery of adenovirus (Ad) with cancer targeted microbubbles. *World Molecular Imaging Congress 2010, Sept 8-11; Kyoto Japan*.

12. **Borovjagin A.V.**, Mamaeva O, Dong J., Passineau M, Ren C, Lamani E., Murakami M. Keyser E, Chen S and MacDougall M. Adenovirus Gene Transfer for Amelogenesis Imperfecta Ameloblast-like Cells. *The 40th Annual AADR meeting, San Diego CA, March 16-19, 2011*
13. Warram JM, Sorace AG, Saini R, **Borovjagin A**, Zinn KR. Targeted delivery of a cancer-specific adenovirus using microbubbles. *World Molecular Imaging Congress 2011, San Diego, CA. Sept. 2011*

Patents and inventions:

- *US Patent # US6913889/US20030203378*; AU: **Anton Borovjagin**, Susan Gerbi, Thilo Sascha Lange; Brown University Research Foundation; “*Methods to screen for antibiotic agents and their use in treatment of opportunistic infections*” (WO 2002001953 A1); publication date: Jan 10, 2002; filing date: June 28, 2001

STRENGTHS

- Talent for making scientific observations;
- Years of experience in collaborative teamwork;
- Great communication skills;
- Ability to mentor, train and supervise people and lead a research team.
- Inventive and highly motivated researcher, friendly personality.
- Hand-on experience in large number of molecular biology techniques.

EXPERIMENTAL SKILLS

Molecular Cloning (DNA work):

Genomic and plasmid **DNA isolation** from cells and clinical samples, restriction analysis; Kunkel and **PCR-based DNA mutagenesis** protocols; degenerate PCR, Nested PCR, RACE, Real Time quantitative PCR (with Taqman and CyberGreen probes) techniques; **gene cloning, restriction analysis and mapping**; manual sequencing (Sanger) protocol; cDNA synthesis; **real time quantitative PCR**; PCR-based colony screen, Southern hybridization technique. Adenoviral vector design/construction; homologous recombination in *E.coli* BJ-5183 strain; adenovirus rescue, propagation and CsCl gradient purification.

Molecular Biology/Biochemistry of RNA:

Total RNA and poly-A RNA isolation from animal and plant tissues (Trizol extraction), cell culture and clinical tissue samples; T7-, SP6- or T3- *in vitro* transcription (radioactive and non-radioactive RNA synthesis), Incorporation of various ribonucleotide analogs into RNA transcripts (4-Thio-UTP, Biotin-UTP, Fluorescein-UTP etc), RNA-RNA and RNA-protein UV cross-linking including photoactivated nucleotide analogs (4-Thio-U). **Northern blot hybridization; RNase protection assay (RPA)**; Reverse transcription (**RT**) for **PCR and primer extension** analyses; chemical and enzymatic probing of RNA and enzymatic RNA sequencing. RNA or RNP structure analysis by chemical probing of RNA (RNP under protein binding conditions); RNA secondary structure and natural RNA modification (2’O-Me and Pseudouridine) analyses (CMCT-OH⁻ and hydrazine-anilin treatment protocols). RNA secondary structure modeling by using RNA FOLD software. Toeprinting technique (reverse transcriptase-based analysis of RNA-bound protein complexes in cell lysates). Sucrose gradient centrifugation and RNP complex analysis. RNase H-mediated cleavage of RNA *in vitro* and *in vivo*. Biotinylated RNA/RNP **pull down** assay with streptavidin coated beads. **Reverse genetics** approach in studying RNA function. **Anti-sense technology: in vivo RNA** (mRNA, snRNA, snoRNA) **knockdown** in *Xenopus* oocytes by anti-sense DNA oligo or 2’O-Me-RNA oligo microinjection. *In vitro* gene silencing using siRNA and shRNA technologies.

Cell Biology:

Propagation and passaging of ascites cells in mice. **Microinjection techniques:** microinjection of *Xenopus* oocytes and fly (*Drosophila* and *Sciara*) embryos; dissection of *Xenopus* oocytes and manual isolation of nuclei; *in vivo* labeling of *Xenopus* oocytes; pulse-chase labeling of nucleic acids. Expression and Northern blot analysis of tagged pre-rRNA in *Xenopus* oocyte nucleoli. **Microscopy techniques:** light microscopy of cells, confocal microscopy, detection of fluorescein-labeled small RNAs (snRNA, snoRNA) in *Xenopus* oocyte nucleoli by fluorescent microscopy. Immunohistochemistry (IHC): staining of cultured cells and tissue slices. Fluorescent microscopy of IHC-stained slides (culture cells and tissues) using Alexa Fluor 488-, Texas Red-, Cy5-conjugated antibodies. Fluorescence imaging of adenoviral vectors expressing fluorescent imaging reporters (EGFP, mRFP1, mCherry, Neptune D, iRFP, IFP1.4) and capsid-labeled (genetic pIX-fusions) viral particles. **Fluorescence-activated cell sorting (FACS) analysis (Flow cytometry)** of cell surface molecule/marker/receptor expression. FlowJo software data plotting and analysis. **Electron microscopy (EM) analysis of viruses** by negative staining (uranyl acetate, PTA) on grids and in thin sections.

Microbiology:

Basic microbiology; bacterial transformation with plasmid vectors (chemical and electroporation protocols); cell plating, antibiotic selection, isolation of transformants and colony screening techniques by PCR-based approach and Southern hybridization technique; bacterial culture propagation, advanced bacterial genetics.

Mammalian tissue culture:

Years of experience with mammalian tissue culture cells. Adenoviral vector rescue and propagation in HEK 293, HEK 293-F28, 911 helper cell lines. DNA transfection techniques using lipofectamine 2000, LTX, PolyJet etc, nucleofection (electroporation) technique. Infection with viral vectors (Adenovirus, EMCV, lentivirus); handling various human and non-human cancer cell lines: breast cancer, bladder, melanoma, prostate, ovarian HNSCC and many others; non-cancer cell lines: mouse embryonic fibroblast (3T3) cell line, human kidney cell line (HK2); isolation and culturing mammalian primary cells: proximal tubule epithelial cells from mouse kidneys. Stem cell biology; maintaining/passaging of human iPSCs. *In vitro* differentiation of human iPSCs into cardiomyocytes using small molecules (CHIR, IWR1 etc). Nucleofection of iPSCs. Gene knockout techniques using a CRISPR/Cas9 technology. iPSC clone selection and screening for mutations.

Animal models:

- ***Xenopus* (*X. laevis*, *X. borealis*):** expertise in *Xenopus* survival surgery, dissection of ovary, preparation, microinjection and dissection of *Xenopus* oocytes.
- **Mouse (*mus musculus*):** Xenograft tumor models, intraperitoneal, intramuscular and intratumoral injections; euthanasia and non-survival surgery of mice. Collection of blood, kidneys, spleen, liver and other organs from mice. Bioluminescence, fluorescence and fluorescence spectral imaging of mice (whole animal) and dissected tumors/organs. Ultrasound-assisted delivery of expression vectors (Cre-recombinase) into mouse kidneys following systemic delivery in mixture with Optison microbubbles (Ultrasound contrast agents) via tail vein injection. Mouse urine collection (24 hr) using metabolic cages.
- **Porcine and mouse models of myocardial infarction**

Protein biochemistry:

Tagged **protein expression** in bacteria and eukaryotic cells; Ni-NTA purification of expressed proteins. ***In vitro* translation** systems; preparation of cell free (S30) extracts and optimization of *in vitro* translation systems from ascites carcinoma cells and Reticulocyte Lysates (RRL); PAGE analysis of ³⁵S-Met labeled proteins. **Protein analyses:** two-dimensional gel electrophoresis; SDS-PAGE, electro focusing of proteins. Various protein staining methods: Coomassie, silver, Gelcode blue etc. Radioactive labeling of

proteins by [¹²⁵I] Bolton-Hunter reagent (N-succinimidyl-3[4-hydroxyphenyl]propionate) or ³⁵S-Methionine incorporation (by *in vitro* translation). Protein sequencing by Edman degradation method. Familiar with protein and peptide analysis by **HPLC**. Ammonium sulfate fractionation of proteins; DEAE-and Phosphocellulose **chromatography; gel filtration; Western blot analysis. Protein quantification** assays: UV absorption spectrophotometry, (“Nanodrop”); colorimetric assays: Lowry (DC assay by Bio-Rad), Bradford assays. **Ultracentrifugation**: sucrose and CsCl gradient centrifugation. Isolation of eukaryotic RNA-protein complexes and ribosomes (ribosomal subunits). Preparation of ribosome salt-wash; isolation of translation factors; *in vitro* formation (in the presence of non-hydrolysable GTP analogs GMPpNp or GMPpCp) and isolation of translation pre-initiation (48S) complexes.

Immunology methods:

Immuno-Precipitation (IP) of proteins and RNP complexes, ELISA.

Virology (vectorology):

Infection of cells with animal (EMCV, Adeno) and plant (TMV) viruses and phages; passage, isolation, purification of virions; titration, isolation of viral genomic RNA; PCR-based **diagnostics of viruses** in animal and human cells. Years of hand-on experience with **adenoviruses as gene therapy vectors**: vector construction by homologous recombination in E.coli (BJ-5183 strain) and analysis, AdEASY-1 vector system; adenovirus rescue in mammalian helper cell lines (293, 911 and 293F28), virus propagation and analysis. Adenoviral gene transfer (quantitative luciferase reporter assay) **Adenoviral targeting**: tropism modification of adenoviral vectors by genetic modification of capsid proteins (fiber, pIX) by small (RGD4C, pK, 6His) and large ligands (single chain antibody, affibody); fiber modification by “serotype chimerism” approach to **infectivity enhance** and **re-target Ad vectors. Virotherapy approach**: design and construction of Conditionally Replicative Adenoviruses (**CRAds**) and their validation: gene transfer (luciferase) assay; RCA detection by PCR; quantitative *in vitro* cytotoxicity assays (XTT/MTS), Crystal Violet assay; cell binding/blocking assay. Fluorescence imaging of labeled Adenoviral vectors *in vitro* and *in vivo*. Progeny production assay. Lentiviral vectors: generation of lentivirus by plasmid vector co-transfection. Harvesting and concentration of lentivirus using Lenti-X Concentrator solution. Generation of stable cell lines using lentiviral vectors for gene delivery/integration.

Computer skills:

MS Office: Word, Excel, PowerPoint.

Desktop publishing: Adobe Photoshop, Adobe Illustrator, Canvas, MacDraw.

Image/data statistical analysis: GelDoc Software (Bio Rad) and Phosphoimager Software “Image Gauge” (Fuji), NIH Image.

DNA sequence analysis software: DNASTAR, Vector NTI; Clone Manager. RNA secondary structure analysis software (mfold); database searching applications: BLAST search. Spectral Imaging Software: Nuance 2.4.2, Imaging Signal Quantification. FlowJo - flow cytometry data analysis software.

Research Interests and fields of study.

- Basic mechanisms of eukaryotic translation and ribosome function;
- Molecular mechanism of internal initiation of eukaryotic translation; The role of picornaviral IRES elements (Encephalomyocarditis virus RNA model) in internal ribosome binding; The role of cellular factors.
- Translational control of eukaryotic gene expression;
- Structure of small nuclear (sn) and small nucleolar (sno) RNAs and their role in ribosomal RNA biogenesis in higher eukaryotes (The *Xenopus* model).
- Biology of human adenovirus. Replication-competent and non-replicative adenoviral vector construction. Oncolytic adenoviral vectors for virotherapy applications. Construction of adenoviral vectors “armed” with therapeutic genes for cancer therapy applications. Construction of capsid-labeled (mRFP, mCherry, Neptune D, iRFP etc) adenoviruses for *in vivo* imaging applications.

- Adenovirus-based delivery and therapeutic application of anti-cancer therapeutics: MMP14 shRNA, MDA7, PNP, MDA7 and tumor suppressor KISS1 for treatment of brain metastases. The biology of KISS1 and its role in metastatic tumor progression.
- Regulatory role of calreticulin (CRT) in the mechanism of extracellular matrix (ECM) induction during endoplasmic reticulum (ER) stress and in fibrotic disease.
- Stem cells in cardiovascular research and cardiovascular tissue engineering. CRISPR/Cas9 based gene targeting technology in cardiovascular tissue engineering. Development, generation and characterization of large cardiac tissue patches from human iPSC-differentiated cardiac tissues for myocardial infarction therapy applications.