Marc Vermulst

Assistant Professor

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Education

2009 — 2013	Post-doctoral Research Fellow, Department of Chemistry, University of North Carolina, Chapel Hill, USA
2008 — 2009	Post-doctoral Research Fellow Department of Biology, California Institute of Technology, Pasadena, CA, USA
2004 — 2008	Ph.D. Department of Pathology, University of Washington, Seattle, USA
2001 — 2002	Visiting Scholar, Institute of development Aging and Cancer, Tohoku University, Sendai, Japan
1997 — 2002	M.Sc. Department of Biology, University of Utrecht, Utrecht, the Netherlands

Professional Research and Teaching Positions

2018 — present
Assistant Professor
Leonard Davis School of Gerontology
Dornsife College of Letters, Arts and Sciences, Molecular and Cellular Biology
Keck School of Medicine, Molecular Medicine and Biochemistry

2013 — 2018
Assistant Professor
Center for Mitochondrial and Epigenomic Medicine
Children's Hospital of Philadelphia
University of Pennsylvania

2009 — 2013
Post-doctoral Research Fellow
The role of Transcription Errors in Cellular Aging and Disease
Advisor: Dr. Dorothy Erie
Department of Chemistry
University of North Carolina, Chapel Hill, USA

2008 — 2009
Post-doctoral Research Fellow
The Role of Mitochondrial Fusion and Fission in Mitochondrial Mutagenesis and the Tolerance of Cells to mtDNA mutations
Advisor: Dr. David Chang
Department of Biology
California Institute of Technology, Pasadena, CA, USA

2004 — 2008
Ph.D. Student
Mitochondrial Mutagenesis in Mammalian Longevity
Advisor: Dr. Lawrence A. Loeb
Department of Pathology
University of Washington, Seattle, WA, USA

Awards and Honors

2019 Hanson Thorell Family research Award (USC School of Gerontology)
2015 Mitochondrial Research Affinity Group Award (UPenn, CHOP)
2001 JYPE Scholarship, University of Utrecht - Tohoku University

Active Research Grants

2022 — 2027 R01 NIA AG075130
Temporal control of mitochondrial mutagenesis
Role: PI

2022 — 2023 SCEHSC pilot award Vermulst
Environmental mutagens promote amyloid diseases through transcriptional mutagenesis
Role: PI

2023 — 2024 NAVIGAGE pilot award Vermulst
Exploiting brainbow biology to study protein distribution
Role: PI

Expected Research Grants

2024 — 2029 R01 NIA AG075130
DNA damage induced transcription errors generate a constant stream of amyloid and prion-like proteins in human cells
Role: PI
Scored in 12th percentile

Completed Research Grants

2020 — 2022 NSF 2032784
Probing SARS-CoV-2 evolution and vulnerabilities through its mutation and fitness landscape
Role: PI

2019 — 2020 Hanson Thorell Family Award
Re-engineering "Brainbow-technology" to study mitochondrial biology in aging organisms.
Role: PI

2017 — 2022 R01 NIH GM124532
Exploiting the insulin signaling pathway to treat mtDNA disease
Role: PI

2017 — 2022 R01 NIA AG054641 NIA
Transcription errors in aging and disease
Role: PI

2016 — 2017 Center for excellence in environmental toxicology
Transcription errors: a new tool to study DNA damage, DNA repair and environmental exposure to mutagens
Role: PI

2015 — 2016 Mitochondrial Research Affinity Group

Using Multiple Fluorescence Markers to Study Mitochondria in Mice
Role: PI

2011 — 2015 K99 NIA AG041809
Non-genetic mutations in aging organisms
Role: PI

Selected Peer Reviewed Publications

Pending Publications:

Claire S. Chung*, Yi Kou*, Sarah J. Shemtov*, Bert M. Verheijen*, Ilse Flores, Kayla Love, Ashley Del Dosso, Max Thorwald, Yuchen Liu, Renaldo G. Toney, Lucy Carrillo, Megan Nguyen, Huang Biao, Yuxin Jin, Ashley Michelle Jauregui, Juan Diaz Quiroz, Darcie L. Moore, Stephen Simpson, Kelley Thomas, Marcelo P. Coba, Zhongwei Li, Bérénice A. Benayoun, Joshua Rosenthal, Scott Kennedy, Giorgia Quadrato, Jean-Francois Gout, Lin Chen, **Marc Vermulst**. Transcript errors generate a continuous stream of amyloid and prion-like proteins in human cells. Under revision at *Nature Communications* and now available on BioRxiv.

Weiyi Li , Stephan Baehr , Michelle Marasco , Lauren Reyes , Danielle Brister , Craig S. Pikaard , Jean-Francois Gout, **Marc Vermulst**, and Michael Lynch. A Narrow Range of Transcript-error Rates Across the Tree of Life". Submitted to *Nature Ecology and Evolution*. May 2023.

Marc Vermulst, Samantha Paskvan, Claire Chung, Jean-François Gout, Nigel Clegg, Jason H. Bielas, Simultaneous detection of mutations and DNA damage using a massively parallel sequencing approach. Under revision at *Nucleic Acids Research*.

Jori Symons, Claire Chung, Bert. M. Verheijen, Monique Nijhuis, **Marc Vermulst**, Jean-François Gout. Mutational and fitness landscapes of SARS-CoV-2 revealed through short-term evolution experiments. Under review at *Molecular Biology of Evolution (impact factor 10.7)*.

Frontiers in Genetics: Special Issue on “Molecular Mistakes”, to be edited by **Marc Vermulst**, Dorothy Erie and Michael Ibba.

Accepted and Published

Bert M. Verheijen, Claire Chung, Chao Qi, Yang Shi, Hyunjin Kim, Ben Thomson, Asa Nakahara, Jasper J. Anink, James D. Mills, Jeong H. Lee, Eleonora Aronica, Kiyomitsu Oyanagi, Akiyoshi Kakita, Sjors H.W. Scheres, Michel Goedert, Jean-Francois Gout, **Marc Vermulst**. Amyotrophic lateral sclerosis/parkinsonism–dementia complex of Guam (ALS/PDC): molecular analysis of post-mortem brain and spinal cord tissues supports an environmental etiologic hypothesis. Accepted at *Acta Neuropathologica Communications*.

Chao Qi, Bert M. Verheijen, Yasumasa Kokubo, Yang Shi, Stephan Tetter, Alexey G. Murzin, Asa Nakahara, Satoru Morimoto, **Marc Vermulst**, Ryogen Sasaki, Eleonora Aronica, Yoshifumi Hirokawa, Kiyomitsu Oyanagi, Akiyoshi Kakita, Benjamin Ryskeldi-Falcon, Mari Yoshida, Masato Hasegawa, Sjors H.W. Scheres, Michel Goedert. Tau Filaments from Amyotrophic Lateral Sclerosis/Parkinsonism-Dementia Complex (ALS/PDC) adopt the CTE Fold. Accepted at *PNAS*. November 2023.

Shanshan Wang1, Kyumin Kim, Nicolas Gelvez, Claire Chung, Jean-Francois Gout, **Marc Vermulst**, Xiaojiang Chen, Identification of RBM46 as a novel APOBEC1 cofactor for C-to-U RNA-editing activity. Accepted at *Journal of Molecular Biology*, December 2023

Chung C, Verheijen BM, Navapanich Z, McGann EG, Shemtov S, Lai GJ, Arora P, Towheed A, Haroon S, Holczbauer A, Chang S, Manojlovic Z, Simpson S, Thomas KW, Kaplan C, van Hasselt P, Timmers M, Erie D,

Chen L, Gout JF, **Vermulst M**. Evolutionary conservation of the fidelity of transcription. *Nat Commun*. 2023 Mar 20;14(1):1547. doi: 10.1038/s41467-023-36525-w. PMID: 36941254

Chung C, Verheijen BM, Zhang X, Huang B, Coakley A, McGann E, Wade E, Dinep-Schneider O, LaGosh J, Anagnostou ME, Simpson S, Thomas K, Ernst M, Rattray A, Lynch M, Kashlev M, Benayoun BA, Li Z, Strathern J, Gout JF, **Vermulst M**. The fidelity of transcription in human cells
Proc Natl Acad Sci U S A. 2023 Jan 31;120(5):e2210038120. doi: 10.1073/pnas.2210038120. Epub 2023 Jan 25. PMID: 36696440

Fritsch C, Gout JF, Haroon S, Towheed A, Chung C, LaGosh J, McGann E, Zhang X, Song Y, Simpson S, Danthi PS, Benayoun BA, Wallace D, Thomas K, Lynch M, **Vermulst M**. Genome-wide surveillance of transcription errors in response to genotoxic stress. *Proc Natl Acad Sci* U S A. 2021 Jan 5;118(1):e2004077118. doi: 10.1073/pnas.2004077118. Epub 2020 Dec 21. PMID: 33443141.

Alexander-Floyd J, Haroon S, Ying M, Entezari AA, Jaeger C, **Vermulst M**, Gidalevitz T. Unexpected cell type-dependent effects of autophagy on polyglutamine aggregation revealed by natural genetic variation in C. elegans. *BMC Biol.* 2020 Feb 24;18(1):18. doi: 10.1186/s12915-020-0750-5. PMID: 32093691

Kim MJ, Haroon S, Chen GD, Ding D, Wanagat J, Liu L, Zhang Y, White K, Park HJ, Han C, Boyd K, Caicedo I, Evans K, Linser PJ, Tanokura M, Prolla T, Salvi R, **Vermulst M**, Someya S. Increased burden of mitochondrial DNA deletions and point mutations in early-onset age-related hearing loss in mitochondrial mutator mice. *Exp Gerontol*. 2019 Oct 1;125:110675. doi: 10.1016/j.exger.2019.110675. Epub 2019 Jul 22. PMID: 31344454 Free PMC article.

Haroon S, **Vermulst M**. Oxygen Consumption Measurements in Caenorhabditis elegans Using the Seahorse XF24. Bio Protoc. 2019 Jul 5;9(13):e3288. doi: 10.21769/BioProtoc.3288. eCollection 2019 Jul 5. PMID: 33654802.

Fritsch C, Gout JP, **Vermulst M**. Genome-wide Surveillance of Transcription Errors in Eukaryotic Organisms J Vis Exp. 2018 Sep 13;(139):57731. doi: 10.3791/57731. PMID: 30272673

McManus MJ, Picard M, Chen HW, De Haas HJ, Potluri P, Leipzig J, Towheed A, Angelin A, Sengupta P, Morrow RM, Kauffman BA, **Vermulst M**, Narula J, Wallace DC. Mitochondrial DNA Variation Dictates Expressivity and Progression of Nuclear DNA Mutations Causing Cardiomyopathy. *Cell Metab*. 2019 Jan 8;29(1):78-90.e5. doi: 10.1016/j.cmet.2018.08.002. Epub 2018 Aug 30. PMID: 30174309

Verheijen BM, **Vermulst M**, van Leeuwen FW. Somatic mutations in neurons during aging and neurodegeneration Acta Neuropathol. 2018 Jun;135(6):811-826. doi: 10.1007/s00401-018-1850-y. Epub 2018 Apr 28. PMID: 29705908

Haroon S, Li A, Weinert JL, Fritsch C, Ericson NG, Alexander-Floyd J, Braeckman BP, Haynes CM, Bielas JH, Gidalevitz T, **Vermulst M**. Multiple Molecular Mechanisms Rescue mtDNA Disease in C. elegans. *Cell Rep*. 2018 Mar 20;22(12):3115-3125. doi: 10.1016/j.celrep.2018.02.099. PMID: 29562168

Gout JF, Li W, Fritsch C, Li A, Haroon S, Singh L, Hua D, Fazelinia H, Smith Z, Seeholzer S, Thomas K, Lynch M, **Vermulst M**. The landscape of transcription errors in eukaryotic cells. *Sci Adv*. 2017 Oct 20;3(10):e1701484. doi: 10.1126/sciadv.1701484. eCollection 2017 Oct. PMID: 29062891

Someya S, Kujoth GC, Kim MJ, Hacker TA, **Vermulst M**, Weindruch R, Prolla TA. Effects of calorie restriction on the lifespan and healthspan of POLG mitochondrial mutator mice. *PLoS One*. 2017 Feb 3;12(2):e0171159. doi: 10.1371/journal.pone.0171159. eCollection 2017. PMID: 28158260

Haroon S, **Vermulst M**. Linking mitochondrial dynamics to mitochondrial protein quality control. *Curr Opin Genet Dev*. 2016 Jun;38:68-74. doi: 10.1016/j.gde.2016.04.004. Epub 2016 May 25.
PMID: 27235806 Review.

Vermulst M, Denney AS, Lang MJ, Hung CW, Moore S, Moseley MA, Thompson JW, Madden V, Gauer J, Wolfe KJ, Summers DW, Schleit J, Sutphin GL, Haroon S, Holczbauer A, Caine J, Jorgenson J, Cyr D, Kaeberlein M, Strathern JN, Duncan MC, Erie DA. Transcription errors induce proteotoxic stress and shorten cellular lifespan. *Nat Commun*. 2015 Aug 25;6:8065. doi: 10.1038/ncomms9065. PMID: 26304740

Ericson NG, Kulawiec M, **Vermulst M**, Sheahan K, O'Sullivan J, Salk JJ, Bielas JH. Decreased mitochondrial DNA mutagenesis in human colorectal cancer. *PLoS Genet*. 2012;8(6):e1002689. doi: 10.1371/journal.pgen.1002689. Epub 2012 Jun 7. PMID: 22685414

Chen H*, **Vermulst M***, Wang YE, Chomyn A, Prolla TA, McCaffery JM, Chan DC. * Equal contributors. Mitochondrial fusion is required for mtDNA stability in skeletal muscle and tolerance of mtDNA mutations. *Cell.* 2010 Apr 16;141(2):280-9. doi: 10.1016/j.cell.2010.02.026. PMID: 20403324

Vermulst M, Wanagat J, Loeb LA. On mitochondria, mutations, and methodology. *Cell Metab*. 2009 Dec;10(6):437. doi: 10.1016/j.cmet.2009.11.001. PMID: 19945399

Dai DF, Santana LF, **Vermulst M**, Tomazela DM, Emond MJ, MacCoss MJ, Gollahon K, Martin GM, Loeb LA, Ladiges WC, Rabinovitch PS. Overexpression of catalase targeted to mitochondria attenuates murine cardiac aging *Circulation*. 2009 Jun 2;119(21):2789-97. doi: 10.1161/CIRCULATIONAHA.108.822403. Epub 2009 May 18. PMID: 19451351

Vermulst M, Bielas JH, Loeb LA. Quantification of random mutations in the mitochondrial genome. *Methods.* 2008 Dec;46(4):263-8. doi: 10.1016/j.ymeth.2008.10.008. Epub 2008 Oct 21.
PMID: 18948200

Vermulst M, Wanagat J, Kujoth GC, Bielas JH, Rabinovitch PS, Prolla TA, Loeb LA. DNA deletions and clonal mutations drive premature aging in mitochondrial mutator mice. *Nat Genet*. 2008 Apr;40(4):392-4. doi: 10.1038/ng.95. Epub 2008 Mar 2. PMID: 18311139

Vermulst M, Bielas JH, Kujoth GC, Ladiges WC, Rabinovitch PS, Prolla TA, Loeb LA. Mitochondrial point mutations do not limit the natural lifespan of mice. *Nat Genet*. 2007 Apr;39(4):540-3. doi: 10.1038/ng1988. Epub 2007 Mar 4. PMID: 17334366

Professional Activities

Editorial Boards

2019 — present	Frontiers in Genetics
2015 — present	Mutation Research

Academic Service and Administration

2022 — present	USC Leonard Davis School of Gerontology Faculty Council
2022 — present	USC Leonard Davis School of Gerontology Facilities and Safety Committee
2019 — 2022	Institutional Animal Care and Use Committee
2020 — present	PhD in Biology of Aging program, Advisor
2018 — present	Personnel

Professional Service

2018 — present	AFAR Post-doctoral fellowship review panel
2016	TriMAD Research Meeting Co-Organizer, Presenter and Discussion Leader

Teaching and Mentoring Experience

2023	GESM141, GERO508, GERO600, BIOC518
2022	GERO 508, GESM141, GERO600
2021	GERO 508, GESM141

2020	GERO508, GESM141, GERO600
2019	GERO508, GESM141, GERO600
2017	CAMB6050
2016	CAMB6050
2015	CAMB6050

Trainees Supervised

Current Trainees	Previous Institution	Position in lab	Years Supervised
Sarah Shemtov	University of Florida	PhD Student	2019 — present
Yingwo Sun	Rockefeller University	PhD student	2023 — present
Gauri Velloor	USC	M.Sc. student	2023 — present
Daniel Cano	USC	Undergraduate Researcher	2022 — present
Karen Lee	USC	Undergraduate Researcher	2023 — present
Herbert Anson	USC	Undergraduate Researcher	2023 — present
Sam Lee	USC	M.Sc. student Researcher	2023 — present
Alex Park	USC	Undergraduate Researcher	2022 — 2023
Andrew Euredjian	USC	Undergraduate Researcher	2022 — 2023

Alumni	Position in lab	Years supervised	Next position
Bert M. Verheijen	Post-doc	2020-2023	Harvard, post-doc
Maria-Eleni Anagnostou	Post-doc	2019-2021	Started own company
Eric McGann	Ph.D. Student	2021-2022	Left for medical reasons
Guan-Ju Lai	M.Sc. Student	2020-2022	Ph.D. student Stony Brook
Renaldo Toney	University of Cambridge	M.Sc. Student	Applying for PhD programs
Zoe Navapanich	Undergraduate Researcher	2019-2021	Industry
Suraiya Haroon	Post-doc	2014-2018	Research professor UPenn
Agnes Holczbauer	Post-doc	2014-2016	Senior researcher Mayo Clinic
Jaye Weinert	Ph.D. Student	2016-2018	Senior researcher GSK
Clark Fritsch	Ph.D. Student	2016-2018	Graduating now from PhD program at UPenn

Selected invited Oral Presentations

2023 University of Washington, Seattle: “Transcription errors as a continuous source of amyloid and prion-like proteins in human cells”

2022 USC, Molecular Medicine: “Transcription errors as a continuous source of amyloid and prion-like proteins”

2020 University of Utrecht, Netherlands: “Genetic and epigenetic mutations in aging and disease”

Big Data in Aging Research Symposium: “Transcription errors in aging and disease”

2019 USC, Molecular and Computational Biology: “Transcription errors, a novel link between DNA damage, DNA repair and protein misfolding diseases in aging organisms”

2018 University of Pittsburgh: “Transcription errors in aging and disease”

University of Texas, MD Anderson: “Genome-wide surveillance of DNA damage, DNA repair and transcription errors in eukaryotic cells”

Buck Institute on Aging: “Transcription errors, a novel link between DNA damage, DNA repair and proteostasis in aging organisms”

2017	European Institute on Biology of Aging, Netherlands: “Transcription errors as a source of protein aggregation in eukaryotic cells”
	University of Texas, San Antonio: “Genome-wide surveillance of DNA damage, DNA repair and transcription errors in eukaryotic cells”
	University of Florida: “Biological fidelity in aging organisms
2016	TriMAD, Phildelphia: “Exploiting the IGF-1 pathway to ameliorate mtDNA disease”
	NCI, Frederick, “The landscape of transcription errors in aging cells”
2015	Fred Hutchinson Cancer Research Center: “Transcription errors, linking aging to age-related diseases”
2012	University of California, Berkeley: “Mitochondrial mutations in human aging and disease”
	Duke University: “Understanding the role of non-genetic mutations in aging organisms”
	University of Michigan: “Towards a new understanding of biological fidelity in aging organisms”
2011	United Mitochondrial Disease Fund: “Understanding the relationship between mitochondrial dynamics and mitochondrial DNA”
	NCI Frederick: “Uncovering a role for non-genetic mutations in aging organisms”