**Curriculum vitae** **January 2024**

**Jeremy Nathans**

**Current Position:**
Professor
Department of Molecular Biology and Genetics
Department of Neuroscience
Samuel Theobald Professor, Wilmer Eye Institute (Department of Ophthalmology)
Johns Hopkins University School of Medicine

Investigator
Howard Hughes Medical Institute

**Personal Data:**
Born July 31, 1958; New York City
Married to Thanh Huynh. Children: Riva (born 7/88) and Rosalie (born 3/94)

**Business Address:**
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**Education:**

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| Massachusetts Institute of Technology | |
| B.S., Life Sciences | 1979 |
| B.S., Chemistry | 1979 |
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| Stanford University School of Medicine | |
| Ph.D., Biochemistry (with David Hogness) | 1985 |
| M.D. | 1987 |
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| Postdoctoral fellow, Genentech | |
| (with Axel Ullrich) | 1987 |

**Professional Experience:**

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| Assistant Professor, Department of Molecular Biology and Genetics, | |
| Department of Neuroscience, Johns Hopkins University School of Medicine | |
| Assistant Investigator, Howard Hughes Medical Institute | 1988–1992 |
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| Associate Professor, Department of Molecular Biology and Genetics, | |
| Department of Neuroscience, Johns Hopkins University School of Medicine | |
| Associate Investigator, Howard Hughes Medical Institute | 1992-1996 |
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| Associate Professor, Department of Ophthalmology | |
| Johns Hopkins University School of Medicine | 1993-1996 |

Professor, Department of Molecular Biology and Genetics,
Department of Neuroscience, Department of Ophthalmology
Johns Hopkins University School of Medicine 1996-present
Investigator, Howard Hughes Medical Institute 1997-present

Interim Director, Department of Molecular Biology and Genetics 2019-2023

**Advisory and Grant Review Boards (past):**
Scientific Advisory Board, Zanvil Kreiger Mind–Brain Institute, JHU 1991-1992
Scientific Advisory Board, The Ruth and Milton Steinbach Fund 1997-2007
Intramural Program Review Committee, National Eye Institute, NIH 1997-1998
Review Board, McKnight Endowment Fund for Neuroscience 2000-2011
Scientific Advisory Board for Ophthalmology, Novartis 2005-2008
Visiting Committee, Division of Medical Sciences, Harvard Medical School 2006-2010
Review Board, HHMI International Scholars Program 2006, 2011
Scientific Advisory Committee, Machiah Foundation 2009-2011
Advisor, HHMI Janelia Farm Research Campus 2009-2015
Review Board, HHMI Professors Program 2010
Scientific Advisory Board, Merck Research Laboratories 1996-1999 and 2008-2013
Review Board, Beckman Initiative for Macular Research 2010-2014
Scientific Advisory Board, Cerevance 2017-2023
HHMI Investigator Council 2018-2020
Joint Steering Committee, Bayer-Wilmer Research Collaboration 2015-2022

**Advisory and Grant Review Boards (current):**
Scientific Advisory Board, The Foundation Fighting Blindness 1995-present
Review Board, Life Sciences Research Foundation 2005-present
Officer, Life Sciences Research Foundation 2020-present
Scientific Advisory Committee, Klingenstein-Simons Neuroscience Fellowship Awards 2013-present
Chair, Scientific Advisory Committee, Klingenstein-Simons Neuroscience Awards 2022-present
Scientific Advisory Board, Blue Cone Monochromacy Families Foundation 2014-present
Trustee, The Rockefeller University 2017-present
Review Board, Hanna H. Gray Fellows Program (HHMI) 2017-present
Scientific Advisory Board, RYR-1 Foundation 2018-present
Scientific Advisory Board, Atengen 2019-present
Founder, ScienceforthеWorld.org (web-based K-12 education) 2019-present
Scientific Advisory Board, EyeBiotech 2022-present
Review Panel, Schmidt Science Polymath Fellowship Award (Schmidt Futures) 2022-present
Scientific Advisory Board, Harrington Discovery Institute 2023-present

**Honors and Awards:**
John Asinari Award for undergraduate research in the life sciences, M.I.T. 1978
Alpha Chi Sigma Award for excellence in chemistry, M.I.T. 1979
Newcomb–Cleveland Prize, American Association for the Advancement of Science 1986
Young Scientist Award, Passano Foundation 1987
Initiatives in Research Award, National Academy of Sciences, U.S.A. 1987
Rank Prize in Opto–Electronics, Rank Prize Fund (London) 1988
Wilson S. Stone Memorial Award, M.D. Anderson Cancer Center 1988
Distinguished Young Scientist Award, Maryland Academy of Sciences 1989
Golden Brain Award, Minerva Foundation 1989
Cogan Award, The Association for Research in Vision and Ophthalmology 1992
Alcon Research Institute Award for Vision Research, Alcon Laboratories 1992
Young Investigator Award, Society for Neuroscience 1995

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| Member, National Academy of Sciences, U.S.A. | 1996 |
| Member, American Academy of Arts and Sciences | 2000 |
| Teacher of the Year, Graduate Student Association, Johns Hopkins Medical School | 2003, 2010, 2016 |
| Professor's Award for Distinction in Teaching in the Basic Sciences, Johns Hopkins Medical School | 2004 |
| Golden Apple Award for Teaching Excellence, American Medical Student Association | 2004 |
| Champalimaud Award for Vision Research (shared with King-Wai Yau) | 2008 |
| Fellow, American Association for the Advancement of Science | 2009 |
| Edward Scolnick Prize in Neuroscience, McGovern Institute, MIT | 2009 |
| Member, National Academy of Medicine (formerly, Institute of Medicine), U.S.A. | 2011 |
| Albert Muse Prize, The Eye and Ear Foundation of Pittsburgh | 2012 |
| Gilman Scholar, Johns Hopkins University | 2013 |
| Arthur Kornberg and Paul Berg Lifetime Achievement Award in Biomedical Sciences, Stanford Medical School | 2013 |
| Member, American Association of Physicians | 2014 |
| Beckman-Argyros Award in Vision Research, Arnold and Mabel Beckman Foundation | 2016 |
| Helen Keller Prize in Vision Research (shared with King-Wai Yau), Helen Keller Foundation and BrightFocus Foundation | 2019 |
| Benjamin Franklin Medal in the Life Sciences, Franklin Institute | 2020 |
| Mechthild Esser Nemmers Prize in Medical Science, Northwestern University | 2022 |

**Editorial Positions:**

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| Associate Editor, Journal of Neuroscience | 1991-1996 |
| Editorial Board Member, Proceedings of the National Academy of Sciences, U.S.A. | 1999-present |
| Associate Editor, Proceedings of the National Academy of Sciences, U.S.A. | 2005-2006 |
| Board of Reviewing Editors, eLife | 2012-2019 |

**Award Juries (past):**

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| Newcomb Cleveland Prize, American Association for the Advancement of Science | 1997, 2018 |
| Molecular Biology Award, National Academy of Sciences, U.S.A. | 2004 |
| Pradel Research Award, National Academy of Sciences, U.S.A. | 2016-2018 |
| Chair, Scientific Advisory Board, Sanford and Susan Greenberg Prizes to End Blindness | 2019-2020 |

**Award Juries (current):**

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| Passano Award, Passano Foundation | 2004-present |
| Lasker Prizes, Albert and Mary Lasker Foundation | 2010-present |

**Named or Honorary Lectures:**

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| Juan March Lecture, Juan March Foundation, Madrid | 1991 |
| W.S. Stiles Lecture, University College, London | 1992 |
| Walter Sondheim Lecture, Columbus Center, Baltimore | 1996 |
| Jack Schultz Memorial Lecture, Fox Chase Cancer Center, Philadelphia | 1996 |
| Holiday Lectures (with A. J. Hudspeth), Howard Hughes Medical Institute | 1997 |
| Zacharias Dische Memorial Lecture, Columbia University | 2001 |
| Stephen M. Schuetze Memorial Lecture, Columbia University | 2002 |
| Keynote Lecture, FASEB Meeting – Biology and Chemistry of Vision | 2003 |
| Rachford Lecture, Cincinnati Children's Hospital Research Foundation | 2004 |
| Russell DeValois Memorial Lecture, University of California, Berkeley | 2007 |
| Laureate Lecture, University of Pittsburgh | 2008 |
| Edward Scolnick Prize Lecture in Neuroscience, McGovern Institute, MIT | 2009 |
| Gordon Guroff Memorial Lecture, NIH | 2009 |
| George Khoury Memorial Lecture, NIH | 2010 |

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| Friedman Lecture, Mount Sinai Medical School | 2012 |
| Muse Prize Lecture, University of Pittsburgh | 2012 |
| Marvin Sears Lecture, Yale University | 2012 |
| Edward R. and Anne G. Leffler Lecture, Harvard Medical School | 2013 |
| Dialogues of Discovery Lecture, Janelia Research Campus, HHMI | 2014 |
| The C.H. Li Memorial Lectures, University of California, Berkeley | 2014 |
| Randy Chipperfield Memorial Lecture, M.I.T. | 2015 |
| Eric Shooter Lecture, Stanford Medical School | 2015 |
| Harvey Lecture, The Harvey Society | 2016 |
| Samuel J. Kimura Lecture, University of California at San Francisco | 2017 |
| Richard Hoover Lecture, Greater Baltimore Medical Center | 2017 |
| Martin Meyerson Lecture, Monell Chemical Senses Center | 2018 |
| Samir Deeb Memorial Lecture, University of Washington | 2020 |
| Ulf von Euler Lecture, Karolinska Institute | 2021 |
| Alexander Rich Memorial Lecture, MIT | 2023 |

**Web materials:**

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| Holiday Lectures (with A. J. Hudspeth), Howard Hughes Medical Institute | 1997 |
| The Vertebrate Retina (four lectures), iBioSeminars, ASCB/HHMI | 2008 |
| Creativity in Science, iBioMagazine, ASCB/HHMI | 2011 |
| One Amazing Second in the Life of Your Brain (lecture), iBiology, ASCB/HHMI | 2011 |
| Advice for Young Scientists, Lasker Lessons in Leadership, NIH | 2016 |
| The Physics of Basketball, ScienceforthеWorld.org | 2020 |

**Patents:**

1. United States Patents Nos. 5,693,775 (issued 12/2/97) and 5,872,226 (issued 2/16/99). Fibroblast growth factor homologous factor-1 (FHF-1) and methods of use. Inventors: Nathans, J., Smallwood, P.M., and Macke, J.P.

2. United States Patent No. 5,876,967 (issued 3/2/99). Fibroblast growth factor homologous factor-2 (FHF-2) and methods of use. Inventors: Nathans, J., Smallwood, P.M., and Macke, J.P.

3. United States Patent No. 6,020,189 (issued 2/1/00) Fibroblast growth factor homologous factors (FHFs) and methods of use. Inventors: Nathans, J. and Smallwood, P.M.

4. United States Patent No. 6,635,744 (issued 10/21/03) Fibroblast growth factor homologous factor-4 (FHF-4). Inventors: Nathans, J. and Smallwood, P.M.

5. United States Patents Nos. 6,713,300 (issued 3/30/04) and 7,141,420 (issued 11/28/06). Nucleic acid and amino acid sequences for ATP-binding cassette transporter and methods of screening for agents that modify ATP-binding cassette transporter. Inventors: Allikmets, R., Singh, N., Sun, H., Shroyer, N.F., Hutchinson, A, Chidambaram, A., Gerrard, B., Baird, l., Stauffer, D., Peiffer, A., Rattner, A., Smallwood, P., Li, Y., Anderson, K.L., Lewis, R.A., Nathans, J., Leppert, M., Dean, M. and Lupski, J.R.

6. United States Patents No. 8129353 (issued 3/6/12). Methods of gene therapy using nucleic acid sequences for ATP-binding cassette transporter. Inventors: Allikmets, R., Anderson, K.L., Dean, M., Leppert, M., Lewis, R.A., Li, Y., Lupski, J.R., Nathans, J., Rattner, A., Shroyer, N., Singh, N., Smallwood, P., and Sun, H.

**Publications:**
**Research Publications:**

1. Wang, A., Nathans, J., Van Der Marel, G., Van Boom, J.H., and Rich, A. (1978) Molecular structure of a double helical DNA fragment intercalator complex between deoxy CpG and a terpyridine platinum compound. Nature 276: 471–474.

2. Kronenberg, H.M., McDevitt, B.E., Majzoub, J.A., Nathans, J., Sharp, P., Potts, J.T., and Rich, A. (1979) Cloning and nucleotide sequence of DNA coding for bovine preproparathyroid hormone. Proceedings of the National Academy of Sciences USA 76: 4981–4986.

3. Nathans, J. and Hogness, D.S. (1983) Isolation, sequence analysis, and intron–exon arrangement of the gene encoding bovine rhodopsin. Cell 34: 807–814.

4. Nathans, J. and Hogness, D.S. (1984) Isolation and nucleotide sequence of the gene encoding human rhodopsin. Proceedings of the National Academy of Sciences USA 81: 4851-4855.

5. Nathans, J., Thomas, D., and Hogness, D.S. (1986) Molecular genetics of human color vision: the genes encoding blue, green, and red pigments. Science 232: 193–202.

6. Nathans, J., Piantanida, T.P., Eddy, R.L., Shows, T.B., and Hogness, D.S. (1986) Molecular genetics of inherited variation in human color vision. Science 232: 203–210.

7. Vollrath, D., Nathans, J., and Davis, R.W. (1988) Tandem array of human visual pigment genes at Xq28. Science 240: 1669–1671.

8. Nathans, J., Weitz, C.J., Agarwal, N., Nir, I., and Papermaster, D.S. (1989) Production of bovine rhodopsin by mammalian cell lines expressing cloned cDNA: spectrophotometry and subcellular localization. Vision Research 29: 907–914.

9. Nathans, J., Davenport, C.M., Maumenee, I.H., Lewis, R.A., Hejtmancik, J.F., Litt, M., Lovrien, E., Weleber, R., Bachynski, B., Zwas, F., Klingaman, R., and Fishman, G. (1989) Molecular genetics of human blue cone monochromacy. Science 245: 831–838.

10. Nathans, J. (1990) Determinants of visual pigment absorbance: the role of charged amino acids in the putative transmembrane segments. Biochemistry 29: 937–942.

11. Nathans, J. (1990) Determinants of visual pigment absorbance: identification of the retinylidene Schiff's base counterion in bovine rhodopsin. Biochemistry 29: 9746–9752.

12. Zack, D.J., Bennett, J., Wang, Y., Davenport, C., Klaunberg, B., Gearhart, J., and Nathans, J. (1991) Unusual topography of bovine rhodopsin promoter–lacZ fusion gene expression in transgenic mouse retinas. Neuron 6: 187–199.

13. Sung, C.–H., Davenport, C.M., Hennessey, J.C., Maumenee, I.H., Jacobson, S.G., Heckenlively, J.R., Nowakowski, R., Fishman, G., Gouras, P., and Nathans, J. (1991) Rhodopsin mutations in autosomal dominant retinitis pigmentosa. Proceedings of the National Academy of Sciences USA 88: 6481–6485.

14. Sung, C.–H., Schneider, B.G., Agarwal, N. Papermaster, D.S., and Nathans, J. (1991) Functional heterogeneity of mutant rhodopsins responsible for autosomal dominant retinitis pigmentosa. Proceedings of the National Academy of Sciences USA 88: 8840–8844.

15. Jacobson, S.G., Kemp, C.M., Sung, C.–H., and Nathans, J. (1991) Retinal function and rhodopsin levels in autosomal dominant retinitis pigmentosa with rhodopsin mutations. American Journal of Ophthalmology 112: 256–271.

16. Weitz, C.J., Miyake, Y., Shinzato, K., Montag, E., Zrenner, E., Went, L.N., and Nathans, J. (1992) Human tritanopia associated with two amino acid substitutions in the blue–sensitive opsin. American Journal of Human Genetics 50: 498-507.

17. Kemp, C.M., Jacobson, S.G., Roman, A.J., Sung, C.–H., and Nathans, J. (1992) Abnormal rod dark adaptation in autosomal dominant retinitis pigmentosa with proline–23–histidine rhodopsin mutation. American Journal of Ophthalmology 113: 165-174.

18. Merbs, S.L., and Nathans, J. (1992) Absorption spectra of human cone pigments. Nature 356: 433-435.

19. Weitz, C.J., and Nathans, J. (1992) Histidine residues regulate the transition of photoexcited rhodopsin to its active conformation, metarhodopsin II. Neuron 8: 465-472.

20. Wang, S.-Z., Adler, R., and Nathans, J. (1992) A visual pigment from chicken that resembles rhodopsin: amino acid sequence, gene structure, and functional expression. Biochemistry 31: 3309-3315.

21. Dhallan, R.S., Macke, J., Eddy, R.L., Shows, T.B., Reed, R.R., Yau, K.-W., and Nathans, J. (1992) Human rod photoreceptor cGMP-gated channel: amino acid sequence, gene structure, and functional expression. Journal of Neuroscience 12: 3248-3256.

22. Weitz, C.J., Went, L.N., and Nathans, J. (1992) Human tritanopia associated with a third amino acid substitution in the blue sensitive visual pigment gene. American Journal of Human Genetics 51: 444-446.

23. Merbs, S.L., and Nathans, J. (1992) Photobleaching difference absorption spectra of human cone pigments: quantitative analysis and comparison to other methods. Photochemistry and Photobiology 56: 869-881.

24. Wang, Y., Macke, J. P., Merbs, S. L., Klaunberg, B., Bennett, J., Zack, D., Gearhart, J., and Nathans, J. (1992) A locus control region adjacent to the human red and green pigment genes. Neuron 9: 429-440.

25. Merbs, S.L., and Nathans, J. (1992) Absorption spectra of the hybrid pigments responsible for anomalous color vision. Science 258: 464-466.

26. Borjigin, J., and Nathans, J. (1993) Bovine pancreatic trypsin inhibitor (BPTI) - trypsin complex as a detection system for recombinant proteins. Proceedings of the National Academy of Sciences USA 90: 337-341.

27. Johnson, R.L., Grant, K.B., Zankel, T.C., Boehm, M.F., Merbs, S.L., Nathans, J., and Nakanishi, K. (1993) Cloning and expression of goldfish opsin sequences. Biochemistry 32: 208-214.

28. Macke, J.P., Davenport, C.M., Jacobson, S.G., Hennessey, J.C., Gonzalez-Fernandez, F., Conway, B.P., Heckenlively, J., Palmer, R., Maumenee, I.H., Sieving, P., Gouras, P., Good, W., and Nathans, J. (1993) Identification of novel rhodopsin mutations responsible for retinitis pigmentosa: implications for the structure and function of rhodopsin. American Journal of Human Genetics 53: 80-89.

29. Macke, J. P., Hu, N., Hu, S., Bailey, M., King, V.L., Brown, T., Hamer, D., and Nathans, J. (1993) Sequence variation in the androgen receptor gene is not a common determinant of male sexual orientation. American Journal of Human Genetics 53: 844-852.

30. Merbs, S. L., and Nathans, J. (1993) Role of hydroxyl-bearing amino acids in differentially tuning the absorption spectra of the human red and green cone pigments. Photochemistry and Photobiology 58: 706-710.

31. Nathans, J., Maumenee, I.H., Zrenner, E., Sadowski, B., Sharpe, L.T., Lewis, R.A., Hansen, E., Rosenberg, T., Schwartz, M., Heckenlively, J.R., Traboulsi, E., Klingaman, R., Bech-Hansen, N.T., LaRoche, G.R., Pagon, R.A., Murphey, W.H., and Weleber, R.G. (1993) Genetic heterogeneity among blue cone monochromats. American Journal of Human Genetics 53: 987-1000.

32. Xiang, M., Zhou, L., Peng, Y.-W., Eddy, R.L., Shows, T.B., and Nathans, J. (1993) Brn-3b: a POU-domain protein expressed in a subset of retinal ganglion cells. Neuron 11: 689-701.

33. Sung, C.-H., Davenport, C. M., and Nathans, J. (1993) Rhodopsin mutations responsible for autosomal dominant retinitis pigmentosa: clustering of functional classes along the polypeptide chain. Journal of Biological Chemistry 268: 26645-26649.

34. Weitz, C., and Nathans, J. (1993) Rhodopsin activation: the effects on the metarhodopsin I - metarhodopsin II equilibrium of neutralization or introduction of charged amino acids within putative transmembrane segments. Biochemistry 32: 14176-14182.

35. Portera-Cailliau, C., Sung, C.-H., Nathans, J., and Adler, R. (1994) Apoptotic photoreceptor cell death in mouse models of retinitis pigmentosa. Proceedings of the National Academy of Sciences USA 91: 974-978.

36. Jacobson, S.G., Kemp, C.M., Cideciyan, A.V., Macke, J.P., Sung, C.-H., and Nathans, J. (1994) Phenotypes of stop codon and splice site rhodopsin mutations causing retinitis pigmentosa. Investigative Ophthalmology and Visual Science 35: 2521-2534.

37. Chiu, M.I., and Nathans, J. (1994) Blue cones and cone bipolar cells share transcriptional specificity as determined by expression of human blue visual pigment-derived transgenes. Journal of Neuroscience 14: 3426-3436.

38. Chiu, M.I., and Nathans, J. (1994) A sequence upstream of the mouse blue visual pigment gene directs blue cone-specific transgene expression in mouse retinas. Visual Neuroscience 11: 773-780.

39. Rosas, D.J., Roman, A.J., Weissbrod, P., Macke, J.P., and Nathans, J. (1994) Autosomal dominant retinitis pigmentosa in a large family: a clinical and molecular genetic study. Investigative Ophthalmology and Visual Science 35: 3134-3144.

40. Borjigin, J., and Nathans, J. (1994) Insertional mutagenesis as a probe of rhodopsin's topography, stability, and activity. Journal of Biological Chemistry 269: 14715-14722.

41. Chiu, M.I., Zack, D.J., Wang, Y. and Nathans, J. (1994) Murine and bovine blue pigment genes: cloning and characterization of two new members of the S family of visual pigments. Genomics 21: 440-443.

42. Sung, C.-H., Makino, C., Baylor, D., and Nathans, J. (1994) A rhodopsin gene mutation responsible for autosomal dominant retinitis pigmentosa results in a protein that is defective in localization to the photoreceptor outer segment. Journal of Neuroscience 14: 5818-5833.

43. Macke, J.P., Hennessey, J.C., and Nathans, J. (1995) Rhodopsin mutation proline347-to-alanine in a family with autosomal dominant retinitis pigmentosa indicates an important role for proline at position 347. Human Molecular Genetics 4: 775-776.

44. Xiang, M., Zhou, L., Macke, J.P., Yoshioka, T., Hendry, S.H.C., Eddy, R.L., Shows, T.B., and Nathans, J. (1995) The Brn-3 family of POU-domain factors: primary structure, binding specificity, and expression in subsets of retinal ganglion cells and somatosensory neurons. Journal of Neuroscience 15: 4762-4785.

45. Wang, Y., Macke, J.P., Abella, B.S., Andreasson, K., Worley, P., Gilbert, D.J., Copeland, N.G., Jenkins, N.A., and Nathans, J. (1996) A large family of putative transmembrane receptors homologous to the product of the Drosophila tissue polarity gene frizzled. Journal of Biological Chemistry 271: 4468-4476.

46. Zhou, H., Yoshioka, T., and Nathans, J. (1996) RPF-1: a complex POU-domain gene implicated in the development of retinal ganglion and amacrine cells. Journal of Neuroscience 16: 2261-2274.

47. Gan, L., Xiang, M., Zhou, L.,Wagner, D.S., Klein, W.H., and Nathans, J. (1996) The POU domain factor Brn-3b is required for the development of a large set of retinal ganglion cells. Proceedings of the National Academy of Sciences USA 93: 3920-3925.

48. Xiang, M., Zhou, L., and Nathans, J. (1996) Similarities and differences among inner retinal neurons revealed by the expression of reporter transgenes under the control of Brn-3a, Brn-3b, and Brn-3c promotor sequences. Visual Neuroscience 13: 955-962.

49. Bhanot, P., Brink, M., Harryman Samos, C., Hsieh, J.-C., Wang, Y., Macke, J.P., Andrew, D., Nathans, J., and Nusse, R. (1996) A new member of the frizzled family from Drosophila functions as a Wingless receptor. Nature 382: 225-230.

50. Smallwood, P.M., Munoz-Sanjuan, I., Tong, P., Macke, J.P., Hendry, S.H.C., Gilbert, D.J., Copeland, N.G., Jenkins, N.A., and Nathans, J. (1996) Fibroblast growth factor homologous factors (FHFs): new members of the FGF family implicated in nervous system development. Proceedings of the National Academy of Sciences USA 93: 9850-9857.

51. Xiang, M., Gan, L., Zhou, L., Klein, W.H., and Nathans, J. (1996) Targeted deletion of the mouse POU domain gene Brn-3a causes a selective loss of neurons in the brainstem and trigeminal ganglion, uncoordinated limb movement, and impaired suckling. Proceedings of the National Academy of Sciences USA 93: 11950-11955.

52. Margolis, R.L., Stine, O.C., McInnes, M.G., Ranen, N.G., Rubinsztein, D.C., Leggo, J., Brando, L.V.J., Kidwai, A.S., Loev, S.J., Breschel, T.S., Callahan, C, Simpson, S.G., DePaulo, J.R., McMahon, F.J., Jain, S., Paykel, E.S., Walsh, C., DeLisi, L.E., Crow, T.J., Torrey, E.F., Ashworth, R.G., Macke, J.P., Nathans, J., and Ross, C.A. (1996) cDNA cloning of a human homologue of the Caenorhabditis elegans cell fate-determining gene mab-21: expression, chromosomal localization and analysis of a highly polymorphic (CAG)n trinucleotide repeat. Human Molecular Genetics 5: 607-616.

53. Allikmets, R., Singh, N., Sun, H., Shroyer, N.F., Hutchinson, A, Chidambaram, A., Gerrard, B., Baird, l., Stauffer, D., Peiffer, A., Rattner, A., Smallwood, P., Li, Y., Anderson, K.L., Lewis, R.A., Nathans, J., Leppert, M., Dean, M. and Lupski, J.R. (1997) A photoreceptor cell-specific ATP-binding transporter gene (ABCR) is mutated in recessive Strargardt's macular dystrophy. Nature Genetics 15: 236-246.

54. He, X., Saint-Jeannet, J.-P., Wang, Y., Nathans, J., Dawid, I., and Varmus, R. (1997) A member of the Frizzled protein family mediating axis induction by Wnt-5A. Science 275: 1652-1654.

55. Rattner, A.,Hsieh, J.-C., Smallwood, P.M., Debra J. Gilbert, D.J., Copeland, N.G., Jenkins, N.A., and Nathans, J. (1997) A family of secreted proteins containing homology to the cysteine-rich ligand-binding domain of frizzled receptors. Proceedings of the National Academy of Sciences USA 94: 2859-2863.

56. Macke, J.P. and Nathans, J. (1997) Individual variation in the size of the human red and green pigment gene array. Investigative Ophthalmology and Visual Science 38: 1040-1043.

57. Sun, H., Macke, J.P., and Nathans, J. (1997) Mechanisms of spectral tuning in the mouse green cone pigment. Proceedings of the National Academy of Sciences USA 94: 8860-8865.

58. Xiang, M., Gan, L., Li, D., Chen, Z.-Y., Zhou, L., O'Malley, B.W., Klein, W., and Nathans, J. (1997) Essential role of POU-domain factor Brn-3c in auditory and vestibular hair cell development. Proceedings of the National Academy of Sciences USA 94: 9445-9450.

59. Sun, H., and Nathans, J. (1997) Stargardt's ABCR is localized to the disc membrane of retinal rod outer segments. Nature Genetics 17: 15-16.

60. Sun, H., Gilbert, D.J., Copeland, N.G., Jenkins, N.A., and Nathans, J. (1997) Peropsin, a novel visual pigment-like protein located in the apical microvilli of the retinal pigment epithelium. Proceedings of the National Academy of Sciences USA 94: 9893-9898.

61. Sherman, P.M., Sun, H., Macke, J.P., Williams, J., Smallwood, P.M., and Nathans, J. (1997) Identification and characterization of a conserved family of protein serine/threonine phosphatases homologous to Drosophila retinal degeneration C (rdgC). Proceedings of the National Academy of Sciences USA 94: 11639-11644.

62. Allikmets, R., Wasserman, W.W., Hutchinson, A., Smallwood, P., Nathans, J., Rogan, P., Schneider, T.D., and Dean, M. (1998) Organization of the ABCR gene: analysis of promotor and splice junction sequences. Gene 215: 111-122.

63. Soucy, E. Wang, Y., Nirenberg, S., Nathans, J., and Meister, M. (1998) A novel signaling pathway from rod photoreceptors to ganglion cells in mammalian retina. Neuron 21: 481-493.

64. Sharpe, L.T., Stockman, A., Jagle, H., Knau, H., Klausen, G., Reitner, A., and Nathans, J. (1998) Red, green, and red-green hybrid pigments in the human retina: correlations between deduced protein sequences and psychophysically-measured spectral sensitivities. Journal of Neuroscience 18: 10053-10069.

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