Nirmala Arul Rayan

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Senior Scientist

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Scientist specializing in neuroscience and cellular and spatial genomics, with over 14 years of experience applying high-throughput methods to study brain biology across rodent, primate, and human models. Demonstrated record of collaborative research through contributions to the NIH BICAN consortium (neuroscience) and program management of A*STAR's SCISSOR flagship initiative (cancer spatial omics). Led molecular profiling studies investigating mechanisms of depression and antidepressant response in the brain. Experienced in developing and optimizing omics workflows, integrating experimental and computational approaches, and coordinating multi-institutional collaborations. Author of more than 25 peer-reviewed publications, including papers in leading journals (*Cell, Nature Genetics, Molecular Psychiatry, Genome Research, Nature Biotechnology*). Committed to using neurogenomic approaches to investigate the cellular and molecular basis of human brain biology and disease.

Core Expertise

- Single-cell and spatial omics: SlideTag, 10x Genomics (snRNA-seq, Multiome, Visium, Xenium)

- Epigenomic profiling: ChIP-seq, ATAC-seq, PairedTag, and chromatin conformation capture assays (3C, 4C)

- Neurobiology and neuroanatomy: post-mortem human brain, rodent and primate models

- High-throughput workflow optimization and benchmarking

- Computational analysis: Seurat, Scanpy, DESeq2, DESpace, NATMI, SpaceRanger,GSEA, custom R/Python pipelines

- Cross-consortia collaboration: NIH BICAN, A*STAR SCISSOR, Marmoset Genome Consortium, Human Cell Atlas Asia, Singapore Single Cell Network (SSCN)

- Team leadership, training, and mentorship

- Program management and strategic planning

Work Experience

Senior Scientist I   **Jul 2023–Oct 2025**
Center for Human Brain Variation (BICAN), Broad Institute of MIT and Harvard

- Designed and executed large-scale single-nucleus and spatial transcriptomics experiments across 150+ postmortem human brain donors and 28 neuroanatomical regions for consortium brain atlas projects.

- Developed standardized protocols for postmortem tissue dissection and nuclei isolation that improved RNA integrity scores and cell recovery rates across multi-site studies. Published protocols on protocols.io.

- Implemented quality control frameworks for data validation across experimental workflows.

- Implemented SlideTag (spatial) and PairedTag (epigenomic) workflows for multimodal profiling of human brain tissue.

- Contributed to data analysis, interpretation, and manuscript preparation for publications arising from consortium studies.

- Served on BICAN consortium adult atlas integrative analysis working group and thalamus annotation subgroup.

- Led panel discussions at BICAN consortium annual meetings and Human Cell Atlas nervous system working group meetings.

- Developed training programs and supervised 7 research associates and 8 graduate/undergraduate interns in 10x Genomics platforms, FANS/MACS sorting, and molecular profiling workflows.

Senior Program Manager, SCISSOR Program   Apr 2019–Jun 2023
Agency for Science, Technology and Research (A*STAR)
SCISSOR: Single-Cell In Situ Spatial Omics at Subcellular Resolution

- Coordinated multi-institutional spatial omics research across six A*STAR institutes and three industry partners, managing scientific deliverables, budgets, and project milestones.

- Developed and piloted protocols for Visium and Xenium-based spatial transcriptome profiling and PBMC single-cell isolation.

- Provided technical troubleshooting support to postdoctoral researchers across partner laboratories.

- Supported principal investigators in securing A*STAR Flagship TISHUMAP grant for AI-driven drug target discovery, including multi-million dollar industry in-kind contributions, through proposal writing and scientific presentations.

- Facilitated research agreements, technology disclosures, and grant submissions in partnership with program principal investigators.

Research Associate   Apr 2014 – Apr 2019
Genome Institute of Singapore (GIS), Systems Biology and Data Analytics

- Led the GIS–McGill–Lallemand collaboration on SSRI, non-SSRI, and probiotic effects in rodent and primate brain; directed experimental design and data analysis.

- Generated bulk ChIP-seq, RNA-seq, and single-cell datasets across 27 brain regions (300+ bulk libraries; 0.5M single cells).

- Performed differential expression and pathway analyses using DESeq2, GSEA, Seurat, and Space Ranger.

- Benchmarked single-cell workflows (Fluidigm, 10x Genomics, Wafergen, SMART-Seq) adopted by the GIS Single-Cell Omics Platform; certified 10x Genomics Service Provider.

- Research contributed to two *Molecular Psychiatry* and one *Biological Psychiatry* publication.

Postdoctoral Fellow   Jan 2012 – Mar 2014
Genome Institute of Singapore, Computational Systems Biology

- Investigated temporal and tissue-specific epigenomic regulation during embryonic development using low-input ChIP-seq.

- Developed and optimised low-input ChIP protocols; validated enhancer–promoter interactions with 3C/4C assays.

- Mentored eight MSc and four undergraduate trainees on experimental design and data interpretation.

- Contributed to three successful research grant proposals.

Senior Research Officer   Jul 2009 – Dec 2011
Genome Institute of Singapore, Regulatory Genomics Laboratory

- Contributed to the identification and characterization of a primate-specific non-coding neurodevelopmental enhancer *in vivo*.

- Established pipelines for reporter assays, histology, zebrafish embryo microinjection, and molecular cloning.

- Supported collaborative studies on enhancer evolution and regulatory sequence function.

Graduate Student / CSIR Research Fellow   Jan 2005 – Dec 2011
Bharathidasan University, India │ PhD research in collaboration with the Dept. of Anatomy, Yong Loo Lin School of Medicine, National University of Singapore

- Investigated the anti-inflammatory and neuroprotective effects of costunolide in rodent brain-injury models using *in vitro* and *in vivo* approaches.

- Awarded CSIR Research Fellowship for doctoral studies.

Lecturer   Jun 2003 – Dec 2004
DBT–BIF, Holy Cross College (Autonomous), India

- Designed and taught undergraduate and postgraduate Biotechnology courses.

- Supervised student research projects.

EDUCATION

Bioinformatics Graduate Certificate, *Harvard University, Division of Continuing Education, USA*   2024–Present
Ph.D. in Biotechnology *Bharathidasan University, India | Joint program with Department of Anatomy, Yong Loo Lin School of Medicine, National University of Singapore*   Jan 2012
Master of Science in Biotechnology, *Department of Biotechnology, Bharathidasan University, India*   Jun 2003
Bachelor of Science in Zoology, *Holy Cross College (Autonomous), India*   Jun 2001

Professional Development and Training
Visceral Mind: Functional Neuroanatomy Summer School, *Bangor University, Wales, UK*   Sept 2025
Neuroanatomical Dissection Course: Human Brain and Spinal Cord, *Marquette University, USA*   Aug 2024
Project Management Professional Certificate, *Google / Coursera*   2023

AWARDS AND ACTIVITIES

100 Women Leaders in STEM (Asian Scientist–Elsevier Foundation)   2022
Scientist Volunteer, Broad Discovery Center, Broad Institute   Aug 2023–Oct 2025
Core Team Member, Staff Scientist Development Committee (SSDC), Broad Institute   Sept 2023–Oct 2025
Editorial Board Member, *Frontiers in Molecular Neuroscience*   2021–2024
Co-Investigator, Epigenetic Modulation for Parkinson's Disease Therapeutics (A*P202D800019)   2019–2021
Co-founder, Singapore Single Cell Network (SSCN)   2020
Outstanding Partnership Award, Genome Institute of Singapore (A*STAR)   2019
Organising Member, Human Cell Atlas Asia Meeting   2018–2019
Best Innovative Idea, Young Entrepreneurship Scheme (YES) Global   2017
Rotary Youth Leadership Award (RYLA), India   2001

PUBLICATIONS

1. Ichihara K, Yoo O, Burger S, Nemesh J, Vanderburg C, Shakir K, Mello C, **Rayan NA**, et al. Inter-individual variation of the adult human striatum. *Manuscript in preparation*.

2. Kraft A, Lee M, **Rayan NA**, et al. Molecular zonation of the human striatum across cell types and people. *Manuscript in preparation*.

3. Kock KH, et al., **Rayan NA** et al., Park WY, Prabhakar S. Asian diversity in human immune cells. ***Cell***. 2025 Apr;188(8):2288–2306.e24.

4. **Rayan NA**, Aow J, Lim MGL, Arcego DM, et al. Shared and unique transcriptomic signatures of antidepressant and probiotic action in the mammalian brain. ***Molecular Psychiatry***. 2024;29(11):3653–3668.

5. Honardoost MA, Adinatha A, Ranjan B, et al., **Rayan NA**, Prabhakar S. Systematic immune cell dysregulation and molecular subtypes revealed by single-cell RNA-seq of subjects with type 1 diabetes. ***Genome Medicine***. 2024;16(1):45.

6. Arcego DM, Buschdorf JP, Fitzgerald E, et al., **Rayan NA**, Meaney MJ. A glucocorticoid-sensitive hippocampal gene network moderates the impact of early-life adversity on mental health outcomes. ***Biological Psychiatry***. 2024;95(1):48–61.

7. Fitzgerald E, Arcego DM, Buschdorf JP, et al., **Rayan NA**, Prabhakar S, Meaney MJ. Sex- and cell-specific gene expression in corticolimbic brain regions associated with psychiatric disorders revealed by bulk and single-nucleus RNA sequencing. ***EBioMedicine***. 2023;95:104745.

8. Krishnan V, Schmidt F, Ranjan B, et al., **Rayan NA** et al., Prabhakar S. A single-cell atlas identifies pretreatment features of primary imatinib resistance in chronic myeloid leukemia. ***Blood***. 2024;141(22):2738–2755.

9. **Rayan NA**, Kumar V, Aow J, Rastegar N, Meaney MJ, Prabhakar S. Integrative multi-omics landscape of fluoxetine action across 27 brain regions reveals global increase in energy metabolism and region-specific chromatin remodelling. ***Molecular Psychiatry***. 2022;27(11):4510–4525.

10. Del Rosario RCH, Poschmann J, Lim C, et al., **Rayan NA**, Singhal A, Prabhakar S. Histone acetylome-wide associations in immune cells from individuals with active *Mycobacterium tuberculosis* infection. ***Nature Microbiology***. 2022;7(2):312–326.

11. Ranjan B, Sun W, Park J, et al., **Rayan NA**, Prabhakar S. DUBStepR: a scalable correlation-based feature selection method for accurately clustering single-cell data. ***Nature Communications***. 2021;12(1):5849.

12. Schmidt F, Ranjan B, Lin QXX, et al., **Rayan NA**, Prabhakar S. RCA2: a scalable supervised clustering algorithm that reduces batch effects in scRNA-seq data. ***Nucleic Acids Research***. 2021;49(15):8505–8519.

13. Ranjan B, Schmidt F, Sun W, et al., **Rayan NA**, Prabhakar S. scConsensus: combining supervised and unsupervised clustering for cell type identification in single-cell RNA sequencing data. ***BMC Bioinformatics***. 2021;22(1):186.

14. Utz SG, See P, Mildenberger W, **Rayan NA**, Greter M. Early fate defines microglia and non-parenchymal brain macrophage development. ***Cell***. 2020;181(3):557–573.e18.

15. Arcego DM, O'Toole N, Buschdorf JP, et al., **Rayan NA**, Meaney MJ. Cross-species glucocorticoid-sensitive posterior dentate gyrus gene network. *Journal of the Endocrine Society*. 2020;4(Suppl 1):MON-722.

16. Ohka F, Shinjo K, Deguchi S, et al., **Rayan NA**, Kondo Y. Pathogenic epigenetic consequences of genetic alterations in IDH-wild-type diffuse astrocytic gliomas. *Cancer Research*. 2019;79(19):4814–4827.

17. Bardile CF, Garcia-Miralles M, Caron NS, et al., **Rayan NA**, Pouladi MA. Intrinsic mutant HTT-mediated defects in oligodendroglia cause myelination deficits and behavioural abnormalities in Huntington disease. *PNAS*. 2019;116(19):9622–9627.

18. **Rayan NA**, Del Rosario RCH, Prabhakar S. Massive contribution of transposable elements to mammalian regulatory sequences. *Seminars in Cell and Developmental Biology*. 2016;57:51–56.

19. Kumar V, **Rayan NA**, Muratani M, Lim S, Ng HH, Prabhakar S. Comprehensive benchmarking reveals H2BK20 acetylation as a distinctive signature of cell-state-specific enhancers and promoters. *Genome Research*. 2016;26(5):612–623.

20. del Rosario RCH*, **Rayan NA***, Prabhakar S. Noncoding origins of anthropoid traits and a new null model of transposon functionalization. *Genome Research*. 2014;24(9):1469–1484.

21. Marmoset Genome Sequencing and Analysis Consortium, including **Rayan NA**. The common marmoset genome provides insight into primate biology and evolution. *Nature Genetics*. 2014;46(8):850–857.

22. Kumar V, Muratani M*, **Rayan NA***, Kraus P, Lufkin T, Ng HH, Prabhakar S. Uniform, optimal signal processing of mapped deep-sequencing data. *Nature Biotechnology*. 2013;31(7):615–622.

23. **Rayan NA**, Baby N, Pitchai D, Indraswari F, Ling EA, Lu J, Dheen T. Costunolide inhibits pro-inflammatory cytokines and iNOS in activated murine BV2 microglia. *Frontiers in Bioscience*. 2011;16:1234–1245.

24. **Rayan NA**, James E, Rajalakshmi M, Priya CE, Daisy P. Effect of hexane extract of *Cassia fistula* bark on blood glucose and lipid profiles in streptozotocin-diabetic rats. *International Journal of Pharmacology*. 2008;4(4):292–296.

25. Daisy P, **Rayan NA**, Modilal DR. Hypoglycemic and related effects of *Elephantopus scaber* extracts on alloxan-induced diabetic rats. *Journal of Biological Sciences*. 2007;7(2):433–437.

26. Eliza PJ, Priya CE, **Rayan NA**. Anti-diabetic properties of *Tinospora cordifolia* stem extracts on streptozotocin-induced diabetic rats. *African Journal of Pharmacy and Pharmacology*. 2009;3(5):171–180.

27. **Rayan NA**, Rangasamy S, James E, Pitchai D. A database for medicinal plants used in the treatment of diabetes and its secondary complications. *Bioinformation*. 2007;2(1):22–24.

References

Contact information and reference letters available upon request.

- Prof. Steve McCarroll - Principal Investigator, Center for Human Brain Variation, Broad Institute of MIT and Harvard

- Dr. Shyam Prabhakar - Associate Director and Senior Group Leader, Genome Institute of Singapore (A*STAR)

- Prof. Michael Meaney - Professor, McGill University, and Director of Translational Neuroscience, Singapore Institute for Clinical Sciences (A*STAR)

- Dr. Evan Macosko - Principal Investigator, Center for Human Brain Variation, Broad Institute of MIT and Harvard

- Prof. Thameem Dheen - Professor of Anatomy, National University of Singapore

- Sylvie Binda - Vice President Research Development at Lallemand Health Solutions, Paris

- Dr. Andreas Wilm - Vice President, Computational Biology, ImmunoScape