Sonal Kumar

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RESEARCH INTERESTS

My interests lie at the intersection of **neurodegeneration**, **genetics**, and **computational biology**. I want to combine my background in **bioinformatics** with applied experimental approaches to better understand **Alzheimer's disease** pathophysiology in support of improved **translational outcomes**.

EDUCATION

Doctor of Philosophy in Neuroscience September 2022 – Present
Tufts University Graduate School of Biomedical Sciences (GSBS), Boston, MA, in collaboration with the Jackson Laboratory, Bar Harbor, ME, USA
GPA: 4.0/4.0

Master of Science in Biotechnology and Bioinformatics August 2020 – July 2022
Institute of Bioinformatics and Applied Biotechnology (IBAB), Bengaluru, India
GPA: 8.87/10, equivalent to 4.0/4.0 (Rank 1 of 39)

Bachelor of Science in Biotechnology June 2017 – September 2020
St. Xavier's College (Autonomous), Ahmedabad, India
GPA: 8.38/10, equivalent to 4.0/4.0 (Rank 1 of 42)

RESEARCH EXPERIENCE

Doctoral Research, the Jackson Laboratory June 2023 – Present
Advisor: Prof. Gregory W. Carter
Thesis Advisory Committee: Dr. Giuseppina Tesco (Chair), Dr. Mary Teena Joy, Dr. Vivek Kumar

Dissecting potentially heritable biomarkers of neurodegeneration in a marmoset model of Alzheimer's disease
Leveraging high-performance computing environments and statistical modeling to analyze data collected longitudinally across phenotypic modalities spanning multiomics, neuroimaging, biomarker measures, and a battery of behavioral and cognitive tests for the common marmoset. Utilizing both wild-type and genetically engineered animals modeling AD genetic variants for mining genome-wide associations driven by correlations between disease biomarkers in addition to gene and protein expression.

Rotation Student, the Jackson Laboratory March 2023 – May 2023
Advisor: Dr. Mary Teena Joy

Analyzed mice microglial RNA sequencing data for differential gene expression and carried out differential splicing analysis for different cases and controls for models of ischemic stroke.

Rotation Student, the Jackson Laboratory January 2023 – March 2023
Advisor: Prof. Martin Pera

Managed and maintained various human iPSC lines. Investigated the commitment and differentiation to the RPE cell lineage for a hIPSC line expressing inducible *NGN-2*.

Graduate Thesis, Institute of Bioinformatics and Applied Biotechnology November 2021 – July 2022
Advisor: Prof. Bibha Choudhary

Analyzing the sex-dependent transcriptional landscape of the Alzheimer's disease brain

Examined human RNA sequencing data for different brain regions in controls and AD patients to develop sex-dependent transcriptional profiles. Analyzed whole-genome sequencing (WGS) data to look at variants for heat shock proteins implicated in ESR2 signaling. Used homology modeling and molecular dynamics to understand the effect of a potentially deleterious variant in HSPB7 on high-performance computing environments. Established mouse primary neuron cultures and studied the relationship between *ESR* and *HSPB7* expression post estradiol valerate treatment using qPCR.

Undergraduate Thesis, St. Xavier's College November 2019 – May 2020
Advisor: Dr. Shital Doshi

Studying the effect of HSP16.2 overexpression on β-amyloid protein aggregation in transgenic Caenorhabditis elegans CL2006
Maintained wild and transgenic *C. elegans* using *E. coli* OP50 as feed. Synthesized cDNA from total isolated RNA using custom primers for *HSP16.2*. Gene amplification and vector propagation were underway but interrupted by the COVID-19 pandemic. The hypothesis that HSP16.2 overexpression would result in decreased muscle paralysis due to β-amyloid disaggregation when subjected to heat shock could not be validated due to a nationwide lockdown.

INTERNSHIPS

Laboratory Intern, Dept. of Microbiology, Civil Hospital, Ahmedabad, India May 2018

Learned lab management and safety principles, undergoing rotations in Bacteriology, Serology, Virology, and HIV labs in one of the largest public hospitals in the country. Performed slide preparation, microscopic evaluation, plating and culturing, and learned about broader treatment implications of findings. Observed biochemical, ELISA and agglutination-based test procedures, as well as clinical protocols and patient counseling following HIV confirmation.

SKILLS

Programming languages and tools:
R, Shell scripting, SLURM, Java, Python, HTML, MySQL, C, C++, PHP

Computational Biology and Bioinformatics:
Transcriptome analysis, variant calling, genome-wide association studies (GWAS), differential splicing analysis, sequence and phylogenetic analysis, 16S rRNA metagenomic and whole metagenome analysis, whole genome assembly, ChIP-seq analysis, gene prediction, molecular dynamics simulation, homology modeling, docking

Experimental Techniques:
- *Molecular biology*: Nucleic acid and protein isolation, plasmid preps, quantification and quality analyses, electrophoretic techniques (AGE, FAGE, SDS-PAGE)
- *Biochemistry*: Biomolecule quantification, enzyme assays
- *Microscopy and slide preparation*: Inverted microscope, fluorescence microscope, immunofluorescence staining, microtomy and histology slide preparation (H&E staining), karyotyping, polytene chromosome preparation
- *Recombinant DNA technology*: Vector cloning, PCR, qPCR, cDNA synthesis, primer design, Gibson assembly
- *Plant tissue culture*: Media preparation, inoculation, subculture
- *Cell culture*: Passaging, transfection, viability testing, PBLC, experience with human iPS cell lines, mouse primary neuron culture
- *Immunology*: Immunofluorescence, western blotting, rocket immunoelectrophoresis, single and double immunodiffusion, agglutination tests, various types of ELISAs
- *Microbiology*: Isolation of bacterial species, various plating techniques, subculture, characterisation of unknown species, bacterial growth curve studies, antibiotic assays

PUBLICATIONS

Sonal Kumar, Annat Haber, Catrina Spruce, Duc Duong, Nicholas T Seyfried, Takeshi Murai, Laura Schultz, Hasi Huhe, Sang-Ho Choi, Julia Kofler, David Schaeffer, Stephanie Hachem, Yongshan Mou, Seung-Kwon Ha, Jung Eun Park, Peter L Strick, Gregg E Homanics, Stacey J Sukoff Rizzo, Afonso Silva, Gregory W Carter. (2024) Multi-omic analysis of fibroblasts from marmosets carrying early-onset Alzheimer's disease mutations in *PSEN1*. [In preparation].

ORAL PRESENTATIONS

Sonal Kumar, Catrina Spruce, Annat Haber, Laura Schultz, Hasi Huhe, Takeshi Murai, Sang-Ho Choi, Stephanie Hachem, Yongshan Mou, Seung-Kwon Ha, Jung Eun Park, Lauren Bailey, Lauren Mongeau, Andrew DeSana, Brianne Stein, Lauren K Hayrynen Schaeffer, Gregg E Homanics, Afonso C Silva, Stacey J Sukoff Rizzo, Gregory W Carter. (February 2025) "Potentially heritable biomarkers of neurodegeneration in a marmoset model of Alzheimer's disease," IEEE Women in Bioinformatics Workshop (WIBI) 2025, New Haven, CT, USA.

POSTER PRESENTATIONS

1. **Sonal Kumar**, Annat Haber, Catrina Spruce, Laura Schultz, Hasi Huhe, Takeshi Murai, Sang-Ho Choi, Stephanie Hachem, Yongshan Mou, Seung-Kwon Ha, Jung Eun Park, Lauren Bailey, Lauren Mongeau, Andrew DeSana, Brianne Stein, Lauren K Hayrynen Schaeffer, Gregg E Homanics, Afonso C Silva, Stacey J Sukoff Rizzo, Gregory W Carter. (July 2025) "Genetic associations of plasma biomarkers of neurodegeneration in a population of laboratory marmosets," Alzheimer's Association International Conference (AAIC) 2025, Toronto, Canada.
2. **Sonal Kumar**, Catrina Spruce, Annat Haber, Laura Schultz, Hasi Huhe, Takeshi Murai, Sang-Ho Choi, Stephanie Hachem, Yongshan Mou, Seung-Kwon Ha, Jung Eun Park, Lauren Bailey, Lauren Mongeau, Andrew DeSana, Brianne Stein, Lauren K Hayrynen Schaeffer, Gregg E Homanics, Afonso C Silva, Stacey J Sukoff Rizzo, Gregory W Carter. (July 2024) "Potentially heritable biomarkers of neurodegeneration in a marmoset model of Alzheimer's disease," Alzheimer's Association International Conference (AAIC) 2024, Philadelphia, PA, USA.
3. **Sonal Kumar**, Bibha Choudhary. (July 2022) "Investigating the role of the noncanonical human small heat shock protein HSPB7 in Alzheimer's disease", IBAB Graduate Research Poster Symposium, IBAB, Bengaluru, India.
4. Pavan Matani, **Sonal Kumar**, Akshit Jain, Lavanya Lulla, Shital Doshi. (January 2020) "Studying the effect of HSP16.2 overexpression on β-amyloid protein aggregation in transgenic *Caenorhabditis elegans* CL2006", Present-Day Biology: Impact of Research at Molecular and Cellular Level.
   National conference, Ahmedabad, India. Presented under the theme 'Diseases and Health'.
5. **Sonal Kumar**, Payal Varandani, Lavanya Lulla. (January 2019) "Biofortified Crops as a Possible Solution to Vitamin-A Deficiency in Developing Nations", Present-Day Biology: A Bastion for Social and Sustainable Development.
   International conference, Ahmedabad, India. Presented under the theme 'Interventions in Nutrition and Agriculture'.

AWARDS AND ACHIEVEMENTS

The Chief Minister's Scholarship for Best Female Student, M.Sc. Biotechnology and Bioinformatics Class of 2022, IBAB, Bengaluru (₹25,000) 2023
1st rank, M.Sc. Biotechnology and Bioinformatics Class of 2022, IBAB, Bengaluru 2022
National qualifier, Graduate Aptitude Test in Engineering (GATE), in Biotechnology and Life Sciences 2022
1st rank, B.Sc. Biotechnology Class of 2020, St. Xavier's College, Ahmedabad 2020
All India rank 333 (top 5% nationwide), IIT M.Sc. Joint Admission Test in Biotechnology 2020
National qualifier, Joint Graduate Entrance Examination in Biology and Interdisciplinary Life Sciences 2020
2nd place in state-level quiz competition, BioCalyx Science Meet 2020

2nd place statewide, Gujarat Science Academy Minaxi-Lalit Science Award in Biotechnology (₹500) 2019
1st place in state-level quiz competition**,** 30th Gujarat Integrated Bio Network Science Meet (₹2,000) 2019

PROFESSIONAL DEVELOPMENT AND CONTINUING EDUCATION

Gene Expression Quantitative Trait Locus (eQTL) Mapping, The Jackson Laboratory, Bar Harbor, ME 2024
Systems and Computational Neuroscience, Tufts University Graduate School of Biomedical Sciences (GSBS), virtual attendance 2024
Spatial Transcriptomics, The Jackson Laboratory, Bar Harbor, ME 2024
Computational Interspecies Translation of Omics Signatures in Alzheimer's Disease, The Jackson Laboratory for Genomic Medicine, Farmington, CT 2023
Introduction to Single-Cell RNA-Seq Time Series and Trajectory Analysis, Tufts University Data Intensive Studies Center (DISC), virtual attendance 2023

SELECT LEADERSHIP EXPERIENCE

Vice President, Tufts GSBS Computational Biology Club February 2024 – Present
Help organize workshops, open-coding, and plan special sessions with external speakers. Assist fellow graduate students with computational challenges.

Blog Editor, Social Media Team, Inst. of Bioinformatics and Applied Biotechnology August 2020 – July 2022
Managed "IBAB Insider", my graduate institute's public blog. Authored features, edited community-contributed content, designed layouts, and published posts.

Co-Lead, Departmental Movie Club, St. Xavier's College June 2019 – November 2019
Organized programming and coordinated logistics for biweekly screenings of scientific documentaries and movies. Facilitated peer discussions post-screening.

Logistics Team, International Biosciences Conference, St Xavier's College November 2018 – January 2019
Boosted participation by coordinating phone outreach to ~50 institutions. Led preparation of information packets for 250+ attendees. Managed student registration and backstage logistics.

VOLUNTEER EXPERIENCE

Workshop Facilitator, Computational Interspecies Translation of Omics Signatures in Alzheimer's Disease, Preconference workshop for the Alzheimer's Association International Conference (AAIC), 2024. 2024

PROFESSIONAL MEMBERSHIP

International Society to Advance Alzheimer's Research and Treatment (ISTAART) 2023 – Present
Alzheimer's Association