BIOGRAPHICAL SKETCH

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NAME: Mona Batish

eRA COMMONS USER NAME (credential, e.g., agency login): batishmo

POSITION TITLE: Assistant Professor

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
Panjab University, Chandigarh	BS	05/2003	Microbiology
Panjab University, Chandigarh	MS	11/2005	Microbiology and Molecular Biology
University of Medicine and Dentistry of New Jersey, Newark, New Jersey	PHD	10/2011	Cell Biology and Neurobiology
PHRI-UMDNJ, Newark, New Jersey	Postdoctoral Fellow	09/2012	Cell Biology

A. PERSONAL STATEMENT

I have a very interdisciplinary research background encompassing microbiology, biochemistry, molecular, cell and cancer biology. Working with single molecule florescent in situ hybridization method (smFISH) for 15 years, I have gained expertise in single molecule resolution imaging of RNAs in fixed cells. This contextual information helps in understanding perturbations in gene expression at the level of single cells instead of just analyzing whole cell populations where the subtle but significant changes get buffered. After finishing my PhD, I received a National Institutes of Health Director's Early Independence Award that enabled me to 'skip the post doc' and set up my own laboratory to develop new diagnostic assays for the detection of gene fusion transcripts that are leading causes of various cancers. We developed 'FusionFISH' method to image gene fusion transcripts at single molecule resolution. We recently developed a new method "circFISH" and showed its first application in imaging circular RNAs in mesenchymal tumors in collaboration with Dr. Pier Paolo Pandolfi (Harvard University). I am working on a Department of energy grant on utilizing quantum dots for live imaging of extracellular vesicles with Dr. Caplan (University of Delaware). We have already utilized our single molecule RNA imaging to understand the paracrine signaling in viral infections with Dr. Sealfon (Mount Sinai Medical center). Most recently, we utilized our probes to image the localization of viral RNA with stress granules in host cells at different time points following infection and identified the temporal regulation of stress granules afflicted by the viral infection. Apart from this, we have been collaborating with many different groups to understand the role of synthesis, processing, transport and localization of RNAs in various biological contexts as evident from our recent publications. One of the inherent interest in my lab is to understand the gene expression regulation in Ewing's sarcoma. We have been approaching this from multiple directions: by understating RNA-protein interactions, by identifying non genetic elements including novel non coding RNAs like circular RNAs and analyzing the extracellular vesicles cargo released by Ewing's Sarcoma cells.

B. POSITIONS AND HONORS

Positions and Employment

2004 - 2004 Internship in Forensic Biology, Central Forensic Science laboratory, Chandigarh
2005 - 2006 Programmer Analyst, Diaspark, Inc, Edison, NJ
2006 - 2006 Research Assistant, Public Health Research Institute, Newark, NJ

2011 - 2012	Internship in Patent and Technology Transfer, University of Medicine and Dentistry of New Jersey, Newark, NJ
2012 - 2013	Assistant Professor, University of Medicine and Dentistry of New Jersey, Newark, NJ
2013 - 2017	Assistant Professor, Rutgers University, Newark, NJ
2017-	Adjunct Assistant Professor, Rutgers University, Newark, NJ
2017-	Assistant Professor, University of Delaware, Newark, DE

Other Experience and Professional Memberships

2013 -	Grant reviewer, National Science Foundation
2014 -	Member, RNA Society
2014 -	Grant reviewer and study section member, National Institutes of health
2014 -	Reviewer for multiple peer reviewed manuscripts
2015 -	Member, Ewing Sarcoma Committee of the Children's Oncology Group
2015 -	Associate Member, Children's Oncology Group
2015 -	Associate member, Cancer Institute of New Jersey
2015 -	Member, American Association for Cancer Research
2019 -	Member, Tenure track faculty search committees at University of Delaware
2020-	Member, International society for Extracellular vesicles

Honors

2003	National Scholarship Award for Postgraduate Students, Ministry of Human Resource Development of India
2008	Mentor Appreciation Award, Bergen Academy
2010	Best Oral Presentation Prize, 17th Annual Graduate Student Research Symposium, UMDNJ, Newark, New Jersey
2011	Executive Women of New Jersey Graduate Merit Award for an Outstanding Candidate pursuing an Advanced Degree in Science, technology, Engineering, Math or Environmental Science, Executive Women of New Jersey Organization
2011	Best Poster Prize, 24th Annual International RNA Symposium, Hunter College, City University of New York
2011	First Prize for Best Poster, 3rd Annual Postdoctoral Appreciation Week Symposium, Robert Wood Johnson Medical School, Rutgers University
2012	NIH Director's Early Independence Award
2012	Outstanding Student of the Year, New Jersey Medical School Faculty Organization, UMDNJ
2012	Stanley S. Bergen, Jr., M.D. Medal of Excellence for Academic Excellence and Leadership in the Graduate School of Biomedical Sciences, UMDNJ
2014	Feldstein Medical Foundation Award 2015
2015	Nominated for a David and Lucile Packard Fellowship in Science, Math and Engineering
2016	Selected to receive Free FDA approved compound library (worth $10,000) from Rutgers Translational Science through internal competition.
2017	Selected for full proposal for the Pershing Square Sohn Prize for young Investigators in Cancer Research
2019	Featured article " The Genetics of cancer" in UDaily and in biospace.com
2019	Featured article "Decoding Plant communication" in UDaily
2020	Nominated for the 2020 Excellence in Honors Mentoring Award at University of Delaware

C. CONTRIBUTIONS TO SCEINCE:

1. **Understanding RNA processing in cells:** During my graduate work, a novel technology, single-molecule fluorescence *in situ* hybridization (smFISH) was developed in our laboratory for single-molecule resolution

imaging of mRNAs. I optimized the use of smFISH in various biological systems, such as primary cells and *Drosophila* embryos. I used smFISH to explore the process of alternative splicing; and this study led to an appreciation of the previously underrated phenomenon of posttranscriptional splicing. My Thesis project aimed at understanding the transport of dendritically localized mRNAs in hippocampal neurons. RNA transport granules deliver translationally repressed mRNAs to synaptic sites in dendrites, where synaptic activity promotes their localized translation. Imaging nine different dendritically localized mRNA species with single-molecule sensitivity and sub-diffraction-limit resolution in cultured hippocampal neurons, I found that there is just one molecule of mRNA in each RNA granule. Even mRNA species that possess a common dendritic localization element, a sequence that is believed to mediate the incorporation of that mRNA into a transport granule, are segregated into separate granules. These results support a model in which mRNA molecules are transported to distal reaches of dendrites singly, and independent of other mRNAs, thereby enabling a finer control of mRNA content within synapses.

I. **Batish M**, Raj A, Tyagi S. Single molecule imaging of RNA *in situ*. (2011) Methods Mol Biol:714:3-13. PubMed PMID: 21431731.

II. Vargas DY, Shah K, **Batish M**, Levandoski M, Sinha S, et al. (2011) Single-molecule imaging of transcriptionally coupled and uncoupled splicing. Cell 147(5):1054-65. PubMed PMID: 22118462.

III. **Batish M**, van den Bogaard P, Kramer FR, Tyagi S. (2012) Neuronal mRNAs travel singly into dendrites. Proc Natl Acad Sci USA. 109(12):4645-50. PubMed PMID: 22392993.

2. **Development of Single molecule RNA Imaging methods:** I started my independent research group as an NIH director's Early Independence Awardee for 2012 to develop clinical applications of smFISH probes. I developed a new method called Fusion-FISH, for imaging fusion RNAs that are formed due to chromosomal rearrangements. We utilized Fusion-FISH for the detection of chronic myeloid leukemia (CML), and for Ewing's sarcoma (ES). We also optimized a method to perform smFISH simultaneously with immunofluorescence in various biological systems. Most recently, we developed circFISH for concurrent imaging of linear and circular isoforms originating from same genetic sequence.

I. Markey FB, Ruezinsky W, Tyagi S, **Batish M***. (2014) Fusion FISH imaging: single-molecule detection of gene fusion transcripts *in situ*. PLOS One 9(3):e93488. PubMed PMID: 24675777.

II. Bayer LV, **Batish M**, Formel SK, Bratu DP. (2015) Single-molecule RNA *in situ* hybridization (smFISH) and immunofluorescence (IF) in the *Drosophila* egg chamber. Methods Mol Biol 1328, 125-36. PubMed PMID:1326324434

III. **Batish M*** & Tyagi S (2019) Fluorescence in situ imaging of dendritic RNAs at single molecule resolution Current Protocols in Neurosciences Epub Doi.0rg/10.1002/cpn.79. PubMed PMID: 31532916

IV. Guarnerio J, Zhang Y, Cheloni G, Panella R, Mae Katon J, Simpson M, Matsumoto A, Papa A, Loretelli C, Petri A, Kauppinen S, Garbutt C, Petur Nielsen G, Deshpande V, Castillo-Martin M, Cordon-Cardo C, Dimitrios S, Clohessy JG, **Batish M** & Pandolfi PP. (2019) Intragenic antagonistic roles of protein and circRNA in tumorigenesis. **Cell Research**. (8):628-640. doi: 10.1038/s41422-019-0192-1. PubMed PMID:31209250.

V. Huang K, Demirci F, **Batish M,** Treible W, Meyers BC, Caplan JL. (2020). Quantitative, super-resolution localization of small RNAs with sRNA-PAINT. **Nucleic Acids Res.** 18;48(16):e96. doi: 10.1093/nar/gkaa623.PubMed PMID: 32716042.

3. **Understanding cancer progression at transcriptional level:** Our technique for single-molecule imaging enables us to explore gene expression changes in a mouse model of chronic lymphocytic leukemia (CLL) and to understand the tumor progression in Ewing's Sarcoma (ES). We utilized smFISH to profile changes in expression of critical mRNAs at the level of individual cells. This analysis helped us to determine the therapeutic role of the microRNA encoded by the Dleu2 gene, as well as to understand the role of miRNA15a/16 in early B cell development. In ES, we imaged EWSFLI1 dependent changes in alternative splicing of ARID1A (a component of chromatin remodeling complex) as a mechanism of tumor progression

in ES.

I. Kasar S, Underbayev C, Yuan Y, Hanlon M, Aly S, Khan H, Chang V, **Batish M*,** Gavrilova T, Badiane F, Degheidy H, Marti G & Raveche E* (2013) Therapeutic Implications of Activation of the Host Gene (Dleu2) Promoter for miR-15a/16-1 in Chronic Lymphocytic Leukemia. **Oncogene**. 1–9 PubMed PMID: 23995789

II. Kasar S, Underbayev C, Hassan M, Ilev I, Degheidy H, Bauer S, Gerald M, Lutz C, Raveche E & **Batish M***. (2016). Alterations in the mir-15a/16-1 Loci Impairs its Processing and Augments B-1 Expansion in De Novo Mouse Model of Chronic Lymphocytic Leukemia (CLL). **PLOS One**. DOI: 10.1371/journal.pone.0149331. PubMed PMID: 6959643

III. Selvanathan S, Graham G, Grego A, Baker T, Hogg J, Simpson M, **Batish M**, Crompton B, Stegmaier K, Tomazou E, Kovar H, Üren A & Toretsky J. (2019). EWS-FLI1 modulated alternative splicing of ARID1A reveals oncogenic function through the BAF complex. **Nucleic Acids Research**. pii: gkz699. doi: 10.1093/nar/gkz699. PubMed PMID: 31392992

4. **Elucidating roles of non-coding RNAs in cancer:** The functions of non coding RNAs is largely dictated by their localization in the cell. By employing Single molecule RNA imaging and its modifications, we have been contributing to the understanding the role of the different types of non coding RNAs like microRNAs, long non coding RNAs and circular RNAs in various physiological conditions. We have collaborated with different groups for functional characterization of non coding RNA repertoire.

I. Underbayev C, Kasar S, Ruezinsky W, Degheidy H, Schneider JS, Marti G, Bauer S, Fraidenraich D, Lightfoote M, Parashar V, Raveche E, **Batish M*** (2016). Role of mir-15a/16-1 in early B cell development in a mouse model of chronic lymphocytic leukemia. Oncotarget. DOI: 10.18632/oncotarget.11290. PubMed PMID: 27533467

II. Zhang Y, Cieslik M, Pitchiaya S, Niknafs Y, Tien J, Hosono Y, Iyer M, Yazdani S, Subramanyiam S, Shukla S, Jiang X, Wang L, Liu T, Uhl M, Gawronski A, Qiao Y, Dhanasekaran S, Kunju L, Cao X, Patel U, **Batish M**, Jiang H, Mehra R, Backofen R, Sahinalp C, Guo S, Feng F, Malik R & Chinnaiyan A, (2018) Analysis of the androgen receptor-regulated lncRNA landscape identifies a role of ARLNC1 In prostate cancer progression. **Nature Genetics** 50(6): 814-824. Doi: 10.1038/s41588-018-0120-1. PubMed PMID: 29808028

III. Lee B, Sahoo A, Marchica J, Holzhauser E, Chen X, Li JL, Seki T, Govindarajan S, Markey F, **Batish M**, Lokhande ST, Zhang S, Ray A, & Perera R. (2017) LncRNA SPRIGHTLY acts as an intra-nuclear organizing hub for pre-mRNA necessary for melanoma development. **Science Advances.** 3;3(5):e1602505. doi: 10.1126/sciadv.1602505. PubMed PMID: 28508063

5. **Exploring the role and distribution of RNA in diverse biological systems:** We have extensively collaborated with various groups to understand the role of RNA localization in various biological contexts. We profiled the effect of viral infection on signaling from first responder cells at the transcriptional level. We also combined our imaging techniques in three dimensional biomaterial niches to predict stem cell fates. And we employed our probes for imaging in frozen tissue sections of rat brains, in order to demonstrate the ability of our probes to work in tissue sections.

I. Patil S, Fribourg M, Ge Y, **Batish M**, Tyagi S, Hayot F, Sealfon SC. (2015). Single-cell analysis shows that paracrine signaling by first responder cells shapes the interferon-ß response to viral infection. **Science signaling.** 8(363):ra16. PubMed PMID: 25670204.

II. Dhaliwal A, Brenner M, Wolujewicz P, Zhang Z, Mao Y, **Batish M**, Kohn J, Moghe P. (2016). Profiling stem cell states in three-dimensional biomaterial niches using high content image informatics. **Acta Biomaterialia.** pii: S1742-7061(16)30457-3. doi: 10.1016/j.actbio.2016.08.052. [Epub ahead of print] PubMed PMID: 27590870.

III. Barnum C, Saai S, Patel, S, Cheng C, Deepti Anand D, Xu, X , Dash S, Siddam A, Glazewski L, Paglione E, Polson S, Chuma S, Mason R, Wei S, **Batish M**, Fowler, V , Lachke S. **(2020)** The Tudor-domain Protein TDRD7, Mutated in Congenital Cataract, Controls the Heat Shock Protein HSPB1 (HSP27) and Lens Fiber Cell Morphology. **Human Molecular Genetics**. doi: 10.1093/hmg/ddaa096. Online ahead of print. PubMed PMID: 32420594.

IV. Harkess A, Huang K, Hulst R, Tissen B, Caplan J, Koppula A, **Batish M**, Meyers B, Leebens-Mack J **(2020)** Sex Determination by Two Y-Linked Genes in Garden Asparagus. **The Plant Cell** 32(6):1790-1796. doi: 10.1105/tpc.19.00859. Epub 2020 Mar 27.PubMed PMID: 32220850.

V. Musah A, Brown T, Jeffries M, Shang Q, Hashimoto H, Evangelou A, Kowalski A, **Batish M**, Macklin W, Wood T. **(2020)** Mechanistic Target of Rapamycin Regulates the Oligodendrocyte Cytoskeleton During Myelination. **J of Neuroscience** 40(15):2993-3007. doi: 10.1523/JNEUROSCI.1434-18.2020. Epub 2020 Mar 5. PubMed PMID: 32139584.

Complete List of Published Work
https://pubmed.ncbi.nlm.nih.gov/?term=mona+batish&sort=date

D. ADDITIONAL INFORMATION: RESEARCH SUPPORT AND/OR SCHOLASTIC PERFORMANCE

Ongoing Research Support

DE-SC0020348 Jefferey Caplan (PI) 09/15/2019 – 09/14/2022
Funding Agency: Department of Energy/USDA
Title: Live-cell, quantum dot-based tracking of plant & microbial extracellular vesicles.
Description: The proposed research aims to answer some of the most challenging questions in the new field of plant EVs by developing new Quantum Dot (QD)-enabled technologies for tracking EVs carrying specific small RNA cargo. These new approaches will take advantage of the superior fluorescence characteristics of QDs, including their brightness, photostability, size-tunable emission, and their detectability by both magnetic resonance imaging and electron microscopy. Specific small RNA cargo in EVs will be detected and tracked using QD molecular beacons that can be easily multiplexed to detect different small RNA classes.

Completed Research Support

5 DP5 OD012160-01 Batish (PI) 09/01/2012 – 08/31/2019
Funding Agency: NIH (Early Independence Award 2012)
Title: Detection of chromosomal translocations by single-molecule RNA imaging
Description: This proposal aimed at developing single molecule imaging method for imaging of gene fusion products (mRNAs) in tumors caused by gene fusions.

UDRF-SI Batish (PI) 11/01/201-12/31/2020
Funding Agency: University of Delaware Research Foundation-Strategic Initiatives
Title: Functional Characterization of post-transcriptional regulation in congenital cataract.
Description: This proposed work aims to understand the mechanism of action of RNA binding protein (RBP)-based post- transcriptional regulation of gene expression in maintenance of lens transparency and how its disruption results in the eye disease cataract.

Busch grant Vijay Parashar (PI) 07/01/2016 – 06/31/2018
Funding Agency: Charles & Johanna Busch Biomedical Grants (Rutgers University)
Title: Development of novel antibiotic adjuvants targeting cyclic-di-AMP metabolism in Gram-positive bacteria.
Description: This proposal aimed to develop novel fluorescence based assays to screen inhibitors of the cyclic-di-AMP degrading enzymes that can then be used as antibiotic adjuvants.