

ARUNAVA MANNA

EDUCATION

- Ph.D. in Chemistry, Carnegie Mellon University, Pittsburgh, PA** 2015
Thesis title: γ PNA Building Blocks: Methodology Development, Synthesis and Applications.
Thesis advisor: Professor Danith H. Ly
- M.Sc. in Organic Chemistry, Jadavpur University, Kolkata, India** 2009
Thesis title: Synthesis of pentasaccharide repeating unit of cell wall of Escherichia coli 051.
Thesis advisor: Professor Rina Ghosh
- B.Sc. in Chemistry, Jadavpur University, Kolkata, India** 2007

PROFESSIONAL EXPERIENCE

- Post-doctoral Fellow, Department of Chemistry, Emory University, Atlanta** 2017-2019
with Professor Jennifer Heemstra
- Post-doctoral Fellow, Department of Chemistry, University of Geneva, Switzerland** 2015-2017
with Professor Nicolas Winssinger
- Graduate Research Assistant, Department of Chemistry, Carnegie Mellon University** 2010-2015
with Professor Danith H. Ly
- Scientific Officer, Bhabha Atomic Research Centre (BARC), Kalpakkam, India.** 2009-2010

HONORS AND AWARDS

- Awarded the Travel Grant (2016) from Department of Chemistry, University of Geneva for Annual Retreat of NCCR Chemical Biology, 2016.
- Prof. Bidyut Kamal Bhattacharyya Memorial Silver Medal for securing 1st class 1st in the University in Organic Chemistry, Jadavpur University, Kolkata, India, 2009.
- Secured 1st class 1st position in the University in M.Sc. Part-I, Chemistry Department, Jadavpur University, Kolkata, India, 2008.
- Secured 1st class 3rd position in the University in B.Sc, Chemistry Department, Jadavpur University, Kolkata, India, 2007.
- Qualified National Eligibility Test (Ranked 115th) and Graduate Aptitude Test Examination (Ranked 103rd in All India Examination) for PhD scholarship in India, 2009-2010.
- Awarded National Merit Scholarship for securing top 1% position in the state from Government of West Bengal, India, 2004.

PUBLICATIONS

<https://scholar.google.ch/citations?user=s9GYkX8AAAAJ&hl=en>

1. Goldman, Johnathan M; Zhang, Li Ang; **Manna, Arunava**; Armitage, Bruce; Ly Danith H; Schneider, James W. High affinity PNA Sandwich Hybridization Assay for Rapid Detection of Short Nucleic Acid targets with Single Mismatch Discrimination. *Biomacromolecules*, **2013**, 14 (7), 253-2261.
2. **Manna, Arunava**; Rapireddy, Srinivas; Sureshkumar, Gopalsamy; Ly, Danith H. Synthesis of optically pure γ PNA monomers: A comparative study. *Tetrahedron*, **2015**, 71(21), 3507-3514.
3. Sacui, Iulia; Hsieh, Wei-Che; **Manna, Arunava**; Sahu, Bichismita; Ly, Danith H. Gamma Peptide Nucleic Acids: As Orthogonal Nucleic Acid Recognition Codes for Organizing Molecular Self-Assembly. *J. Am. Chem. Soc.*, **2015**, 137(26), 8603-8610.
4. **Manna, Arunava**; Hsieh, Wei-Che; Bhunia, Dinesh; Sureshkumar, Gopalsamy; Ly, Danith H. A general method for preparing optically pure (*R*)-and (*S*)-FmocMiniPEG- γ PNA monomers, (Manuscript to be submitted).
5. **Manna, Arunava**; Rapireddy, Srinivas; Bahal, Raman; Ly, Danith H. MiniPEG-gPNA. *Methods in Molecular Biology (New York, NY, United States)*, **2014**, 1050(Peptide Nucleic Acids), 1-12.
6. Bahal, Raman; McNeer, Nicole Ali; Elias Quijano, Yanfeng Liu; Parker, Sulkowski; Bhunia, Dinesh C.; **Manna, Arunava**; Griener, Dale L.; Brehm, Michael A.; Cheng, Christopher J.; Francesc, López-Giráldez; Beloor; Jagadish, Kumar Priti; Saltzman W. Mark; Ly, Danith H.; Glazer, Peter M. In vivo correction of anaemia in β -thalassemic mice by γ PNA-mediated gene editing with nanoparticle delivery. *Nature Communications*, **2016**, 7, 13304 doi: 10.1038/ncomms13304.
Article received considerable media attention: Tweeted by 68, Blogged by 1, Picked up by 6 news outlets (The Washington Post, Science Daily, etc.), 1 Reddit, 1 Wikipedia.
7. Bahal, Raman; **Manna, Arunava**; Hsieh, Wei-Che; Thadke SA, G Sureshkumar; Ly, Danith H. RNA-Templated Concatenation of Triplet Nucleic-Acid Probe. *Chem Bio Chem*, **2018**, 19 (7), 674-678.

PATENTS

1. Left-handed γ -peptide nucleic acids for use in nanostructures and in nucleic acid amplification; Ly, Danith H.; Hsieh, Wei-Che; Sacui, Iulia; **Manna, Arunava** ; **PCT Int. Appl., WO 2015172058 A1 20151112**. Type: Application, Filed: 2015
2. Divalent nucleobase compounds and their uses as genetic recognition reagent; Ly, Danith H.; Gopalsamy Suresh, Kumar; **Manna, Arunava**; **PCT Number 10370415**, Type: Grant, Filed: 2014, Date of Patent: 2019.
3. Template-directed γ PNA synthesis and γ PNA targeting compounds; Ly, Danith H.; Bahal, Raman; **Manna, Arunava**; Bhunia, Dinesh; Rapireddy, Srinivas; Cong, Yidan; **PCT Number 10221216**, Type: Grant, Filed: 2014, Date of Patent: 2019.

RESEARCH SEMINARS & POSTER PRESENTATIONS

2010: Participated in 244th ACS national meeting 2010 held at Denver, Colorado, USA.

2011: "Development of Modified Nucleobases for High salt B-DNA invasion". Manna Arunava, Ly Danith. Poster Session, Department of Chemistry, Carnegie Mellon University, USA.

2013: "γ-Modified peptide nucleic acid targeting the internal ribosome entry site of the hepatitis C viral RNA genome" Spitzer, Emily; Ly, Danith; Manna, Arunava; Yang, Yan; Lemon, Stanley; Mihailescu, Mihaela Rita. 245th ACS National Meeting, New Orleans, LA, USA.

2013: "Optically pure (*R*)- and (*S*)-FmocMiniPEG-γPNA monomers: Synthesis and Applications ". Manna Arunava, Bhunia Dinesh, Ly Danith. Poster Session, Nucleic Acid Symposium, Department of Chemistry, University of Pittsburgh, USA.

2014: "RNA Templated Assembly of γ-Modified PNA by Native Chemical Ligation". Manna Arunava, Bahal Raman, Cong Yidan, Ly Danith. Poster Session, CNAAT, Department of Chemistry, Carnegie Mellon University, USA.

2017: "γPNA-Development, Synthesis and Applications". Manna Arunava. Invited talk, Department of Chemistry, Jadavpur University, Kolkata, India.

2014: miR-122: An Antiviral Target against Hepatitis C Virus, Damian S McAninch, Valerie Schrott, Rebecca Barnard, Arunava Manna, Danith Ly, Rita Mihailescu, Biophysical Journal, 2013, 104, 2, 264a, Elsevier.

2014: Targeting the Hepatitis C Virus with PNAs, Damian S McAninch, Arunava Manna, Danith Ly, Rita Mihailescu, Biophysical Journal, 2014, 106, 2, 281a, Elsevier.

RESEARCH EXPERIENCE

Post-doctoral Research Fellow, Emory University

2017-present

– **Develop a FACS based High Throughput Screening assay for the directed evolution of an enantioselective biocatalyst.**

- Enantioselective chemical synthesis of molecule, determination of % *ee*
- Enzymatic biotransformation reactions, whole cell vs isolated enzymes, % *ee*
- Structure Switching SELEX to develop an aptamer bio-sensor for an enantioselective molecule, PCR, Gel Purification, Fluorescence measurement.
- Enzyme evolution by Site-saturation mutagenesis (Transformation, Recombinant technology, protein expression and isolation).
- Microfluidics for droplet generations.

– **Develop an independent project on next generation cell-permeable Peptide Nucleic Acid.**

- Synthesis of modified nucleobases and PNA oligonucleotides
- Determining water solubility, binding affinity, cellular uptake of modified PNA.

Post-doctoral Research Fellow, University of Geneva, Switzerland

2015-2017

– **Develop a PNA Polychromophore encoded library for screening of drug molecules**

- Synthesis of fluorescent dye molecules
- Synthesis of modified PNA monomers with the fluorescent dye molecules.
- Study the photo-physical properties of the 4-mer PNA oligos.
- Create a library of PNA Polychromophores.

Graduate Research, Department of Chemistry, Carnegie Mellon University

2010-2015

– **Comparison of different methods for synthesis of optically pure γ PNA monomers**

- Synthesis of γ PNA monomers by different synthetic routes like Reductive amination, Swern, Parikh-Doering, Mitsunobu reactions.
- Determine the optical purity of the backbone, monomers by different synthetic routes by ^{19}F NMR spectroscopy.
- Find out the effect of the optical purity of the monomers on binding affinity, selectivity of γ PNA oligomers.

– **Synthesis of optically pure (*R*)- and (*S*)-Fmoc MiniPEG- γ PNA Monomers**

- Develop a synthetic scheme for the synthesis of (*R*)- and (*S*)-Fmoc MiniPEG- γ PNA Monomers in a cheap, simple, large scale way.
- Determine optical purity of the monomers synthesized by new synthetic route.
- Show the binding orthogonality of the RH, LH γ PNA and unmodified PNA to the complementary DNA, each other and thus developing a molecular self-assembly kit.

– **Development of γ PNA to improving the sequence specificity for anti-sense applications**

- Synthesis of LH γ PNA monomers
- Synthesis of PNA oligos with modified LH γ PNA monomers in the sequence.
- Determine the effect of a single/ multi substitution of these modified monomers on the binding affinity of γ PNA to complementary DNA.
- Study the effect of Mismatches on the binding affinity and selectivity in and around the point of substitution of the modified monomers.
- Study the effects of substitution on conformation as well by CD-Spectroscopy.

– **Development of modified nucleobases (Janus nucleobase) for higher binding affinity of γ PNA for anti-gene applications and targeting hairpin RNA**

- Design and Synthesis of two Janus Nucleobases among 16 for molecular recognition of ds DNA, hairpin RNA.
- Incomplete synthesis of modified Thymine modified nucleobase for higher binding affinity towards complementary DNA and invading ds B-DNA at high salt concentration.

– **Development of templated directed assembly of γ PNA via Native Chemical Ligation**

- Synthesis of cysteine and thioester modified γ PNA monomers.
- Synthesis of modified γ PNA oligomers, HPLC, MALDI.
- Proof-of-concept showing template directed concatenation of 3 mer γ PNA via NCL
- Targeting the Unstable Repeat Disorders like Muscular Dystrophy, etc. via this approach.

– **Involved in collaborative projects with Prof. Peter Glazer, Yale University** for in-vivo gene correction of anemia in β -thalassemic mouse by γ PNA. We synthesized the corresponding monomers.

– **Involved in collaborative projects with Prof. James Schneider, Carnegie Mellon University** for Rapid Detection of Short Nucleic Acid targets with Single Mismatch Discrimination using γ PNA.

PROFESSIONAL AFFILIATIONS

Member of the American Chemical Society since 2011.