

# Curriculum Vitae

**Name-** Tirtha Das Banerjee  
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**Permanent Residency-** Singapore  
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**Google Scholar:** <https://scholar.google.com/citations?user=H2S5ROQAAAAJ&hl=en>  
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**GitHub:** <https://github.com/tdblab>  
**Website:** <https://tirthadasbanerjee.com>

**h-index:** 12  
**i10-index:** 12

## Current Positions

Senior Postdoctoral Research Fellow: Department of Biological Sciences, National University of Singapore.  
PI: Prof. Antónia Monteiro  
Joining Date: 3<sup>rd</sup> Jan 2025-Present

Research Associate: Institute of Digital Medicine, Yong Loo Lin School of Medicine, National University of Singapore.  
PI: Associate Prof. Ajay Sriram Mathuru  
Joining Date: 19<sup>th</sup> May 2025-Present

## PhD Thesis

Molecular Mechanisms Underlying Venation and Color Patterning in *Bicyclus anynana* Butterflies. (2020).  
<https://scholarbank.nus.edu.sg/handle/10635/186943>  
Supervisor: Prof. Antónia Monteiro

## Educational Qualification

	Degree	Year	Institute	CAP/%
1	Doctor of Philosophy (Biological Sciences)	2016-2021	National University of Singapore	4.06/5
2.	Bachelor of Technology (Biotechnology)	2011-2015	National Institute of Technology, Durgapur	8.7/10*
3.	12 <sup>th</sup> (CBSE Board)	2008-2010	Kendriya Vidyalaya, C.R.P.F., Durgapur, India	86.6%**
4.	10 <sup>th</sup> (CBSE Board)	2007-2008	Kendriya Vidyalaya, C.R.P.F., Durgapur, India	83.8%

\* First Class with Distinction.

\*\*School Topper in Science Stream.

## Publications

**Banerjee TD<sup>#</sup>, and Monteiro A<sup>#</sup>** (2023). Shared regulatory networks link vein positioning and eyespot ring formation in butterflies. *Communications Biology*. (<sup>#</sup>Co-corresponding author). doi: 10.1038/s42003-025-09356-2

- Banerjee TD<sup>#</sup>**, Murugesan SN, Connahs H, and Monteiro A<sup>#</sup> (2023). Spatial and temporal regulation of Wnt signaling pathway members in the development of butterfly wing patterns. **Science Advances**. (<sup>#</sup>Co-corresponding author). Featured in the cover of 28<sup>th</sup> July 2023 issue. doi: 10.1126/sciadv.adg3877.
- Tian, S, Lee, B, **Banerjee, TD**, Murugesan, SN, and Monteiro, A. (2025). A novel Hox gene promoter fuels the evolution of adaptive phenotypic plasticity Shen. **Nature Ecology and Evolution**. doi: 10.1038/s41559-025-02891-5
- Raine, J., Kibat, C., **Banerjee, TD**, Mathuru, A. S. and Biology, C. (2025). *chrna3* modulates biphasic response to alcohol. **Journal of Neuroscience**. doi: 10.1523/JNEUROSCI.0304-25.2025
- Banerjee, TD<sup>#</sup>**, Raine, J, Mathuru, A. S. and Chen, K. H., Monteiro A<sup>#</sup> (2025). Spatial mRNA profiling using Rapid Amplified Multiplexed-FISH (RAM-FISH). (<sup>#</sup>Co-corresponding author) **bioRxiv**. doi: 10.1101/2024.12.06.627193
- Banerjee, TD<sup>#</sup>**, Zhang, L<sup>\*</sup>. and Monteiro, A<sup>#</sup>. (2025). Mapping Gene Expression in Whole Larval Brains of *Bicyclus anynana* Butterflies. **Methods Protoc.** 8, 2. (<sup>\*</sup>Co-first author and <sup>#</sup>Co-corresponding author). Doi: 10.3390/mps8020031. Featured in the cover of Volume 8, Issue 2.
- Tian, S., Asano, Y., **Banerjee, TD**, Komata, S., Liang, J., Wee, Q., Lamb, A., Wang, Y., Murugesan, S. N., Fujiwara, H., et al. (2024). A microRNA is the effector gene of a classic evolutionary hotspot locus. **Science** (1141). 1141, 1135–1141. doi: 10.1126/science.adp7899
- Goel, T., Raine, J., Kibat, C., Collado, JW., **Banerjee, TD**, Ajay, S. (2025). Role of *chrna5* in multi-substance preference and phenotypes comorbid with the development of substance dependence. **bioRxiv**. doi: 10.1101/2025.07.10.663858
- Banerjee TD<sup>#</sup>**, Finet C<sup>#</sup>, Seah KS, and Monteiro A<sup>#</sup> (2024). *Optix* regulates nanomorphology of butterfly scales primarily via its effects on pigmentation. (Special issue on structural colors in **Frontiers in Ecology and Evolution**; <sup>\*</sup>Co-first author and <sup>#</sup>Co-corresponding author). doi: 10.3389/fevo.2024.1392050
- Prakash A., Dion E., **Banerjee TD**, and Monteiro A (2024). The molecular basis of scale development highlighted by a single-cell atlas of *Bicyclus anynana* butterfly pupal forewings. **Cell Reports**. doi: 10.1016/j.celrep.2022.111052
- Banerjee TD<sup>#</sup>** and Monteiro A<sup>#</sup>, Reuse of a wing venation gene-regulatory subnetwork in patterning the eyespot rings of butterflies. **bioRxiv** (2023). (<sup>#</sup>Co-corresponding author) doi: 10.1101/2021.05.22.445259.
- How S<sup>\*</sup>, **Banerjee TD<sup>#</sup>**, and Monteiro A<sup>#</sup> (2023). *vermilion* and *cinnabar* are involved in ommochrome pigment biosynthesis in eyes but not wings of *Bicyclus anynana* butterflies. **Scientific Reports**, 1–12. (<sup>\*</sup>Co-first author and <sup>#</sup>Co-corresponding author). doi: 10.1038/s41598-023-36491-9
- Prakash A, Finet C, **Banerjee, TD**, Saranathan V and Monteiro A. *Antennapedia* and *optix* regulate metallic silver wing scale development and cell shape in *Bicyclus anynana* butterflies Graphical. **Cell Reports**. (2022), doi: 10.1016/j.celrep.2022.111052.
- Banerjee, TD<sup>#</sup>**, Tian, S., and Monteiro, A<sup>#</sup>. (2022). Laser Microdissection-Mediated Isolation of Butterfly Wing Tissue for Spatial Transcriptomics. **Methods Protocol**. (<sup>#</sup>Co-corresponding author). doi: 10.3390/mps5040067
- Wee J.L.Q., **Banerjee TD.**, Prakash A., Seah K.S. and Monteiro A (2022). Distal-Less and Spalt Are Distal Organisers of Pierid Wing Patterns. **EvoDevo**, 13, 1–14, doi:10.1186/s13227-022-00197-2.
- Banerjee TD<sup>#</sup>** and Monteiro A<sup>#</sup> (2020). Molecular mechanisms underlying simplification of venation patterns in holometabolous insects. **Development**. (<sup>#</sup>Co-corresponding author). doi:10.1242/dev.196394.

**Banerjee TD<sup>#</sup>**, Ramos D and Monteiro A<sup>#</sup> (2020) Expression of Multiple *engrailed* Family Genes in Eyespots of *Bicyclus anynana* Butterflies Does Not Implicate the Duplication Events in the Evolution of This Morphological Novelty. **Frontiers in Ecology and Evolution** 8:227. (<sup>#</sup>Co-corresponding author). doi: 10.3389/fevo.2020.00227.

**Banerjee TD<sup>#</sup>** and Monteiro A<sup>#</sup> (2020) Dissection of Larval and Pupal Wings of *Bicyclus anynana* Butterflies. **Methods & Protocol** 3, 5. (<sup>#</sup>Co-corresponding author). doi: 10.3390/mps3010005.

Connahs H, Tlili S, van Creijl J, Loo TYJ, **Banerjee TD**, Saunders TE and Monteiro A (2019) Activation of butterfly eyespots by Distal-less is consistent with a reaction-diffusion process. **Development**, 146, 1–12. doi: 10.1242/dev.169367

**Banerjee TD<sup>#</sup>** and Monteiro A<sup>#</sup> (2018) CRISPR-Cas9 Mediated Genome Editing in *Bicyclus anynana* Butterflies. **Methods & Protocol**. doi: 10.3390/mps1020016. (<sup>#</sup>Co-corresponding author)

Pal S, Kundu A, **Banerjee TD**, Mohapatra B, Roy A, Manna R, Sar P and Kazy SK (2017). Genome analysis of crude oil degrading *Franconibacter pulveris* strain DJ34 revealed its genetic basis for hydrocarbon degradation and survival in oil contaminated environment. **Genomics** 109, 374–382. doi: 10.1016/j.ygeno.2017.06.002

Pal S, **Banerjee TD**, Roy A, Sar P and Kazy SK (2015) Genome Sequence of Hydrocarbon-Degrading *Cronobacter* sp. Strain DJ34 Isolated from Crude Oil-Containing Sludge from the Duliajan. **Genome Announcement** ,3, 2011– 2012. doi: 10.1128/genomeA.01321-15

Paul D, Kazy SK, **Banerjee TD**, Gupta AK, Pal T and Sar P (2015) Arsenic biotransformation and release by bacteria indigenous to arsenic contaminated groundwater. **Bioresource Technology** 188, 14–23. doi: 10.1016/j.biortech.2015.02.039

Project: 1) Development and implementation of next generation multiplex-FISH systems for applied zebrafish brain research.

2) Development of smart AI powered feeding systems for aging model systems (Killifish).

### **Technologies developed**

**RAM-FISH**: Spatial mRNA profiling technology that allows multiplexing (~30 genes) in complex biological systems such as whole mount organs of butterflies and zebrafish.

### **Technologies currently under development**

**NanoPulse**: A nanolitre scale microinjection system for CRISPR-Cas9 and embryonic research application. Developing in collaboration with students from Raffels institution, Singapore.

**Corn\_AI**: A computer vision and AI powered system for smart crop system for maximum yield.

**Multiplex\_AI**: An AI pipeline to process multiplex-FISH data to detect signal quality, non-specific signals, and signals in abnormal tissue types.

**AquaSentinel\_AI**: AI and computer vision powered closed loop hardware system for neurobehavioral assays.

### **Awards and Scholarships**

Inspiring Research Mentor Award, 2025. Awarded by NUS High School of Math and Science.

Young Researcher Award, Asia Evo-Devo-2021. Awarded by Asia Evo-devo 2021.

Yale-NUS scholarship (2016-2020). Awarded by Yale University and NUS.

### **Grants Awarded**

Integrating Reaction-Diffusion and Positional-Information in patterning the wing veins of *Bicyclus anynana* butterflies. (MOE Tier 1, primarily written, PI: Ant3nia Monteiro).

Investigating a transcriptional role of primary cilia in striatal neural computation mediating cognitive flexibility. (MOE Tier 2, as collaborator, PI: Siew Cheng Phua).

The evolution of novel complex traits from preexisting traits: Identifying shared cellular identities and gene regulation across traits. (MOE Tier 2, co-written with Antónia Monteiro and Suriya Narayanan Murugesan).

### **Reviewed papers in the following journals**

PloS genetics, eLife, BMC Biology, Cells, Journal of Insect Physiology, Insect sciences, Biology, and Molecules.

### **Past Positions**

#### **Industrial**

Orchid Chemicals and Pharmaceuticals Ltd., R&D Center, Sholingnallur, Chennai, India (acquired by Pfizer).

Field of research: Large scale bacteria-based enzyme production and recombinant DNA technology.

Date: August 2015-June 2016

#### **Academic**

Research Scholar: Department of Civil Engineering, Curtin University, Perth, Western Australia.

Project: Development of self-healing concrete using cyanobacteria.

Date: January 2016-July 2016

Postdoctoral research Fellow: Department of Biological Sciences, National University of Singapore. PI: Prof. Antónia Monteiro

Projects: 1) Evolution and Development of novel complex traits.

2) Development and application of spatial transcriptomics technologies (in collaboration with GIS-Singapore).

Date: November 2020-June 2024

Senior Postdoctoral research Fellow: Department of Biological Sciences, National University of Singapore. PI: Prof. Antónia Monteiro

Project: Development and application of next generation spatial transcriptomics technologies.

Date: June 2024-October 2024

Senior Postdoctoral research Fellow: Center for Life Sciences, National University of Singapore.

Project: *chrna3* modulates alcohol response in zebrafish. PI: Associate Prof. Ajay Sriram Mathuru.

Date: October 2024- January 2025

### **Conferences**

14th Zebrafish conference, Singapore, 2025. Spatially resolved mRNA profiling using Rapid Amplified Multiplexed-FISH (AAA-FISH)

Spatial Biology Congress, 2024, Singapore. Spatially resolved mRNA profiling using Automated Accelerated Amplification based multiplex-FISH (AAA-FISH).

Biology of Butterflies 2023, Prague, Czech Republic. Presentation. **Banerjee TD**, Murugesan SN, Connahs H, and Monteiro A. Spatial and temporal regulation of Wnt signaling pathway members in the development of butterfly wing patterns.

Euro-evo-devo 2022, Naples, Italy. Poster: **Banerjee TD** and Monteiro A: Reuse of a Wing Venation Gene-Regulatory Network in Patterning the Eyespot Rings of Butterflies.

2<sup>nd</sup> Asia Evo-Devo 2021, Japan. Presentation: **Banerjee TD** and Monteiro A. Molecular mechanism underlying wing venation is reused to pattern the eyespot rings in *Bicyclus anynana* butterflies.

GYSS 2021, Singapore. Video presentation: **Banerjee TD** and Monteiro A. Molecular mechanisms underlying simplification of venation patterns in holometabolous insects.

Biology of Butterflies 2018, Bangalore. Poster: **Banerjee TD** and Monteiro A. Differential expression of *engrailed* paralogs elucidates gene duplication events in butterflies.

### **Skills and expertise**

Spatial biology, Laser Capture Microdissection, Multiplex-FISH, Single cell and bulk RNA-Seq, CRISPR-Cas9, immunohistochemistry, qPCR, gene cloning, western blotting, microbial gene and protein expression, and advanced bioinformatics.

### **Programming language**

C++, html, and Python

### **Apps**

[https://tdblab.github.io/hcrprobedesigner/hcr\\_22.1.html](https://tdblab.github.io/hcrprobedesigner/hcr_22.1.html)

[https://tdblab.github.io/rgbhcr/rgb\\_2.html](https://tdblab.github.io/rgbhcr/rgb_2.html)

Merge: A python based tool to create composite 2D images of z-slices or maximum projection of in-situ data for multiplex-FISH applications. Github: <https://github.com/tdblab/RAMFISH>

### **Teaching and mentorship**

#### **Current students**

Research Assistant: Mr. Jeriel Lee Cheng Hock

Project: Investigating the spatial-temporal expression of leg gap genes during the embryonic and larval wing development of *Bicyclus anynana* butterflies.

FYP: Mr. Javen Tan Yih Ruay

Project: Modeling reaction-diffusion based mechanisms patterning the wing veins of *Bicyclus anynana*.

Raffles Institution. JayaVardhan Harihar Prasad and Chan Sum Ngai Jeff. Project: Design and implementation of nanolitre scale microinjector for CRISPR-Cas9 injection on embryos. Project under MOE.

#### **Past students**

UROPS: Ms. Gianella Pacho

Project: Exploring FGF signaling in biological patterning using *Bicyclus anynana*.

Master Student: Ms. Emily Zhang Linwan.

Project: Spatial transcriptomics of developing *Bicyclus anynana* brain.

UROPS: Ms. Lara Chal

Project: Co-localization of multiple eyespot centre-specific mRNA and protein targets in larval wings of *Bicyclus Anynana*.

FYP: Ms. Dorothy Lau Shi Min

Project: Involvement of EGFR signaling in biological patterning of butterfly wings.

FYP: Mr. Jeff Winxin Collado

Project: Implementation of automated fluidics system for in-situ hybridization experiments in the larval and adult brains of *Danio rerio*.

FYP: Ms. Teesha Basak

Project: Designing an optimized autofeeder for behavioral experimentation in Zebrafish.

Master Student: Ms. Zhang Yu.

Project: Spatial interaction of *frizzled* receptors in patterning butterfly wing tissues.

Amgen and UROPS summer student: Mr. Jeriel Lee Cheng Hock.

Project: i) Functional role of *optix* and *spalt* CREs in the development of venation and eyespot color patterns.

ii) Spatial-temporal expression of leg gap genes during the embryonic and larval wing development of *Bicyclus anynana* butterflies.

URPOS student: Mr. How Hong Chuen Shaun

Project: Regulatory Interactions of *engrailed*, *optix* and Ommochrome Genes in *Bicyclus anynana* butterflies.

Summer Intern: Ms. Tirunagari Praveenya

Report: The role of Homothorax (Hth) and Dachshund (Dac) in the eyespot center formation in *Bicyclus anynana* butterflies.

High School students: 1) NUS High School. Lim Jun Hui Solomon and Isaac Sim Jing Xiang. Project: Reaction diffusion modeling on wing patterns of butterflies.

Teaching Assistant duties: Five semesters at Department of Biological Sciences, NUS. Worked with Prof. Ant3nia Monteiro; Assoc. Prof. Ryan Chisholm; Asst. Prof. Roman Carrasco; Assoc. Prof. Li Diaqin; and Asst. Prof. Nalini Puniamoorthy.

### **Area of Interest**

Developmental Biology, Evolutionary Biology, Artificial Intelligence, Robotics, Molecular Biology, and Spatial Biology.

### **Hobbies**

Microelectronics, aquarium, cycling, computer hardware, guitar, gym, running, tennis, badminton, and photography.

### **Other Research/Industry Experience and Projects Undertaken**

Summer Intern at the Lab of Microbiology, East India Pharmaceuticals Works Ltd., Durgapur Plant. Worked on detection and analysis of *S. abony*, *E. coli*, *P. aeruginosa*, and *S. aureus* in water samples.

Winter Research Intern 2013, Department of Biotechnology, Indian Institute of Technology – Kharagpur (2013-14). ‘Utilization of Petroleum Hydrocarbon and Oxidation of As(III) by Bacterial Strains Isolated from Arsenic Contaminated Sites in West Bengal (India)’.

Summer Research Intern 2014, Department of Biological Sciences, National University of Singapore. Project title ‘A Study on Expression of *engrailed* and *spalt* in Developing Wings of African Butterfly *Bicyclus anynana*’.

### **Other Participations and awards**

Genomics, Metagenomics and Metabolic Engineering: Workshop organized by Indian Institute of Technology – Kharagpur, India’; December 2014.

EduHeal Foundation Interactive Olympiad (National Biotechnology Olympiad) 2009 and secured National Rank-389.

Advance Functional Material at CSIR-CMERI, Durgapur on 24<sup>th</sup> Jan 2013.

Won numerous awards in academics during school days.

### **Carrier Goal**

Gain knowledge and apply it for the wellbeing of humanity.

**Last updated on 5<sup>th</sup> Jan 2026**