Muhammad Elsadany

Iowa City, IA • E-mail • LinkedIn • GitHub • Portfolio • ORCiD

EXPERIENCE

UNIVERSITY OF IOWA, DEPARTMENT OF PSYCHIATRY, MICHAELSON LAB Iowa City, IA

Graduate Research Assistant JUN 2022 - PRESENT

- **Drug Discovery & Pharmacogenomics:** Engineered a computational framework to predict psychiatric drug response and neurological side effects by integrating genetic data (GWAS, eQTL), gene expression, and drug perturbation profiles.
- **Multi-Modal Data Fusion:** Architected and implemented scalable data processing pipelines for diverse datasets, including genetic variants (SNP-array), multi-modal neuroimaging (sMRI, fMRI, DWI), behavioral surveys, audio recordings, and clinical interviews.
- **Single-Cell Multi-Omics Analysis:** Developed a novel analytical pipeline for single-nuclei multi-omics (RNA+ATAC) data, implementing a bootstrapped pseudo-bulk strategy and mixed-effects models (lmmSeq) to identify cell-type-specific transcriptional responses to human brain stimulation, validated via cross-species comparison (RRHO).
- **Leadership & Mentorship:** Supervised and trained 9 undergraduate interns and graduate students in computational biology methods, statistical analysis, and research best practices.

REGENERON, INC., REGENERON GENETICS CENTER (RGC) Tarrytown, NY

Ph.D. Intern JUN 2025 – AUG 2025

- **Genetic Target Discovery:** Applied structural equation modeling (SEM) to decompose the shared genetic architecture between depression, anxiety, and body composition, defining novel latent factors.
- **Multivariate Genomics:** Conducted multivariate GWAS and GWAS-by-subtraction to identify genetic loci specific to shared and unique latent factors, to identify and prioritize potential therapeutic targets.
- *Supervisor: Frank Wendt, Ph.D.*

UNIVERSITY OF IOWA, GRADUATE COLLEGE Iowa City, IA

Graduate Teaching Assistant 2024

- **BIOL:3212 (Bioinformatics):** Instructed senior undergraduate and graduate students (n=30) on core bioinformatics concepts and led hands-on computational workshops.
- **GENE:6200 (Seminar):** Facilitated discussion groups and managed course logistics for a PhD-level seminar course (n=37).

EDUCATION

UNIVERSITY OF IOWA Iowa City, IA

Ph.D. – Interdisciplinary Graduate Program in Genetics AUG 2021 – PRESENT (ANTICIPATED 2026)

- Advisor: Jacob Michaelson, Ph.D.
- Relevant Coursework: Computational Genomics, Human Genetics & Genomics, Regression & ANOVA, Data Visualization

ZEWAIL CITY FOR SCIENCE AND TECHNOLOGY (ZC-UST) *ABET-accredited.* Giza, Egypt

B.S., Biomedical Sciences (Computational Biology and Genomics), Cum Laude SEP 2017 - JUN 2021

- A premier institution dedicated to educating Egypt's top-performing STEM students.
- Thesis: "Comparative Transcriptome Analysis of Alzheimer's, Huntington's, and Parkinson's Diseases"

TECHNICAL SKILLS

- **Programming & Statistical Languages:** R, Python, UNIX Shell, MATLAB
- **Statistical & Machine Learning Modeling:**
  - *Statistical Analysis:* Linear/Mixed Effects Models, Logistic/Poisson Regression, SEM, Mediation Analysis, Hypothesis Testing
  - *Machine Learning:* Dimensionality Reduction (PCA, sPLS, CCA), Cluster Analysis, TensorFlow
- **Genomics & Multi-Omics Analysis:**
  - *Genetics:* GWAS, Polygenic Scores (PGS), Genomic SEM, eQTL Analysis, TWAS
  - *Transcriptomics:* Bulk, Single-Cell, & Spatial RNA-Seq, ATAC-Seq, Differential Expression, Cell Communication

- **Neuroimaging & Multimodal Data:** Structural/Functional/Diffusion MRI (sMRI/fMRI/DWI) Analysis, Audio Analysis, Facial Landmarking, NLP
- **Software & Platforms:** R Shiny, Git, High-Performance Computing (HPC), AWS Cloud, RedCap, Qualtrics, Seurat, RRHO2, lmmSeq, plotly, ggplot

RESEARCH PROJECTS

COMPUTATIONAL DRUG DISCOVERY & PHARMACOGENOMICS

Polygenic Drug Response Signatures for Psychiatric Disorders | University of Iowa, Michaelson Lab

- Developed a computational tool integrating genetic data (GWAS, eQTL, RNA-Seq) to generate personalized treatment recommendations for psychiatric disorders, with a focus on ADHD.
- Scaled the application to cohorts with 88,000+ participants (SPARK, ABCD) and validated predictions against behavioral scales (CBCL, BPM) and neuroimaging (fMRI) data.
- **Poster:** *Biological Psychiatry* (DOI: 10.1016/j.biopsych.2023.02.769)

Mapping Brain-Wide Drug Effects using Deep Learning | University of Iowa, Michaelson Lab

- Built a deep learning model that integrates brain-wide gene expression (Allen Institute) and fMRI trait maps with drug perturbation signatures (CMAP, LINCS) to predict functional brain activity changes for 838 compounds.
- Delivered insights through an interactive R Shiny application featuring 3D brain visualizations, linking compounds to phenotypic effects via Neurosynth and Neuromaps.

SINGLE-CELL MULTI-OMICS & CROSS-SPECIES VALIDATION

Gene Expression Signature of Human Brain Stimulation | University of Iowa, Michaelson Lab

- Engineered an end-to-end computational pipeline for single-nuclei multi-omics (RNA+ATAC) data, implementing a bootstrapped pseudo-bulk strategy and mixed-effects models (lmmSeq) to identify cell-type-specific responses to electrical stimulation.
- Validated translational relevance through cross-species comparison (RRHO) with mouse models, identifying conserved gene sets.
- **Status:** Manuscript in Review (DOI: 10.1101/2023.09.21.558812)

NEUROeSTIMator: A Deep Learning Model for Neuronal Activation | University of Iowa, Michaelson Lab

- Contributed to the development of a deep learning model (NEUROeSTIMator) that estimates neuronal activation from transcriptomic data (scRNA-seq, spatial).
- Demonstrated model robustness by associating outputs with patch-seq electrophysiology and across species and cell types.
- **Publication:** *Nature Communications* (DOI: 10.1038/s41467-023-44503-5)

MULTIMODAL PHENOTYPING & DIGITAL BIOMARKERS

Exceptional Ability: A Multimodal Cognitive Study | University of Iowa, Michaelson Lab

- Designed and implemented a multimodal analysis pipeline integrating NIH-Toolbox/IQ scores, a custom language task, acoustic feature extraction (audio), interview transcription (Whisper AI), facial landmarking (computer vision), and structural/functional/diffusion MRI.
- Developed a 10-minute language task that effectively captures cognitive performance, demonstrating potential as an efficient digital biomarker.

Linguistic Signatures of Bipolar Disorder from Social Media | University of Iowa, Michaelson Lab

- Applied NLP (topic modeling, sentiment analysis) and GPT-4 embeddings to Reddit comments to identify language patterns and temporal mood cycles in users with bipolar disorder.
- Extracted behavioral features such as sleep patterns and comment frequency to track disease-relevant trends.

Transcriptional Analysis in Neurodegeneration | Zewail City, Center for Genomics

- Conducted a meta-analysis of nuclear-encoded mitochondrial genes across 8 neurodegenerative diseases (Alzheimer's, Parkinson's, Huntington's, etc.) using RNA-seq data (DESeq2, Limma).
- Identified common transcriptional pathways and potential therapeutic targets, with a focus on Friedreich's ataxia.
- **Publication:** *Frontiers in Genetics* (DOI: 10.3389/fgene.2021.749792)

ADDITIONAL INFORMATION

- **Selected Presentations**
  - **International Society for Autism Research (INSAR) Annual Meeting** (2025) | *Oral Presentation*
  - **Society of Biological Psychiatry Annual Conference** (2023) | *Poster Presentation*
  - **HawkIDDRC Program Retreat** (2024) | *Data Blitz Presentation* (100+ attendees)
  - **Computational Psychiatry Symposium** (2022, 2023, 2024) | *Poster Presentations (3)*
  - **Intel International Science and Engineering Fair (ISEF)** (2015) | *Poster Presentation* | *National Finalist*
- **Works**
  - Chatterjee, S., **Elsadany, M.**, *et al.* (2025). The gene expression signature of electrical stimulation in the human brain. bioRxiv, 2023.2009.2021.558812.
    - DOI: 10.1101/2023.09.21.558812
  - Bliese, S.R., Basu, B., Beyer, S.E., **Elsadany, M.**, *et al.* (2025). Single-cell resolution spatial transcriptomic signature of the retrosplenial cortex during memory consolidation. *Molecular Psychiatry*.
    - DOI: 10.1038/s41380-025-03331-3
  - Bahl, E., Chatterjee, S., Mukherjee, U., **Elsadany, M.**, *et al.* (2024). Using deep learning to quantify neuronal activation from single-cell and spatial transcriptomic data. *Nature Communications*, 15, 779.
    - DOI: 10.1038/s41467-023-44503-5
  - Casten, L. G., Koomar, T., **Elsadany, M.**, *et al.* (2024). Lingo: an automated, web-based deep phenotyping platform for language ability. *medRxiv*.
    - DOI: 10.1101/2024.03.29.24305034
  - **Elsadany, M.**, Thomas, T. T., Michaelson, J. J. (2023). 529. Polygenic Drug Response Signatures and Their Associated Behavioral Patterns. *Biological Psychiatry*, 93(9), S308.
    - DOI: 10.1016/j.biopsych.2023.02.769
  - **Elsadany, M.**, Elghaish, R. A., Khalil, A. S., *et al.* (2021). Transcriptional Analysis of Nuclear-Encoded Mitochondrial Genes in Eight Neurodegenerative Disorders. *Frontiers in Genetics*, 12, 749792.
    - DOI: 10.3389/fgene.2021.749792
- **Honors, Awards & Grants**
  - **Zewail City Scholarship** for Undergraduate Studies (2017-2021) | *Awarded based on academic excellence*
  - **Misr El-khair Scholarship** for Undergraduate Studies (2017-2021) | *Awarded based on high school excellence*
  - **ITAC & ITIDIA Grant** for Undergraduate Thesis Project (2020-2021) | *10k EGP*
  - **National Finalist**, Intel International Science and Engineering Fair (ISEF) (2015)
- **Languages:** English (Professional Proficiency), Arabic (Native)