BIOGRAPHICAL SKETCH

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NAME: Andrew Lee Sugarman

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

POSITION TITLE: MD/PhD Student

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)*	Start Date MM/YYYY	Completion Date MM/YYYY	FIELD OF STUDY
Oberlin College	B.A.	08/2015	05/2019	Biochemistry with Honors
Pennsylvania State University	M.D.	06/2020	-	Medical School
Pennsylvania State University	P.h.D	06/2020	-	Bioinformatics and Genomics

A. Personal Statement

I am a medical student and a graduate student interested in imaging, statistics, and tumor heterogeneity. I completed an undergraduate degree in Biochemistry with Honors at Oberlin College, and I have extensive research experience in computational biochemistry with a focus in molecular dynamics simulations. My graduate research is focused on phase-contrast micro-CT of soft-tissue samples and the application of topological data analysis to the interpretation of 3D imaging. My long-term goal is to become a practicing physician-scientist whose work translates novel imaging technology and statistical methods to improve outcomes for cancer patients. Upon completion of MD/PhD training, I plan to pursue a research-track residency in either pathology or internal medicine. As I build towards this goal, I will develop my clinical skills while progressing towards independent academic research, running a primarily computational laboratory. I have multi-year experience of computational and wet-lab research ranging from organic synthesis to computational structural biology. My organic synthesis research culminated in an Honors thesis at Oberlin that I defended in 2019 and left me with bench skills that have enabled a seamless transition to histological sample preparation in the Cheng lab. Alongside this experience, I discovered a passion for molecular modeling while working in the lab of Dr. Duy Hua, which led me to pursue an internship in Dr. Blanton Tolbert's lab at Case Western (now at Penn).

During and after my BA at Oberlin, my time as a research assistant in the Tolbert lab at Case Western heavily influenced my graduate pursuits and cemented my desire to become a physician scientist. Engaging in this range of technical basic science research prior to graduate school has positioned me well to take on a project that applies developing imaging techniques and computational methods to a rapidly emerging problem in virtual histology. Diagnosis of human cancer relies on histology, a qualitative assessment with life-changing implications on treatment decisions. However, histology is limited by field of view and sample size, requiring destruction of the sample in the process. I have sought a co-mentorship between experts in 3D imaging and statistical methods to prepare myself to address these problems. 3-dimensional imaging of tumors at histological resolution will be invaluable to the proposed work, and the Cheng Lab has published custom micro-computed tomography technology that has achieved this field of view and resolution with model organisms (Yakovlev et. al 2022, Ding, et. al 2019). Analysis of these images requires segmentation of tissues

and cells of interest, often requiring the use of complex, black-box machine learning models such as neural networks (Yakovlev et. al 2023). The Silverman Lab is well versed in statistical methods that deal with uncertainty, which will be a crucial step in the deployment of these models to the quantification of cell morphology. Combining these unique technologies towards the study of human cancer will prepare me for a career in translational research. I look forward to how I can contribute to these projects as I train to become a well-rounded physician-scientist.

B. Positions, Scientific Appointments and Honors

2020 - 2021 NIH T32 Fellowship, Penn State College of Medicine Medical Scientist Training Program
2019 - 2020 Research Assistant, Tolbert Lab, Case Western Reserve University Department of Chemistry
2019 American Chemical Society Organic Division Undergraduate Award
2019 Sigma Xi Scientific Research Honor Society
2018 Summer Internship, Tolbert Lab, Case Western Reserve University Department of Chemistry
2015 - 2019 John F. Oberlin Scholarship

Leadership Positions:
2020-Present Treasurer of the Hematology/Oncology Interest Group, Penn State College of Medicine
2020-Present Secretary of the Exercise is Medicine Group, Penn State College of Medicine
2020-Present Treasurer of the Cycling Club, Penn State College of Medicine
2020-Present Student Government IT Chair, Penn State College of Medicine
2022-Present Social Chair, Penn State MSTP PSSA

C. Contributions to Science

Undergraduate Research in Organic Synthesis and Structural Biology: I began my research career in the lab of Dr. Albert Matlin, where I performed organic synthesis experiments testing enantioselective natural products synthesis. I enjoyed the daily opportunity to solve new problems, and after taking advanced organic chemistry courses in the spring of my sophomore year I pivoted to the lab of Dr. Duy (Zoey) Hua for the entirety of my junior year. I performed molecular dynamics simulations of human spleen tyrosine kinase, and developed a strong interest in structural biology and an inclination towards computational work. This motivated me to seek departmental funding to support a summer internship in the Tolbert lab where I continued conducting research after graduation. My final year of research at Oberlin College focused on chemical modifiers for self-polymerizing polydopamine reactions, which culminated in a successful honors thesis defense.

Investigation of RNA 3D Structure and RNA-drug Interactions with Molecular Dynamics Simulations: After graduating Oberlin I joined the lab of Dr. Blanton Tolbert in the Department of Chemistry at Case Western Reserve University. I primarily performed molecular dynamics simulations, integrating NMR and Small Angle X-ray Scattering (SAXS) data to solve the structures of RNA, RNA-drug, RNA-protein, and RNA-drug-protein interactions. Our work culminated in the analysis of a small molecule that selectively binds to a stem loop region of the ribosomal entry site in enterovirus-71 (1) and solution structures of HIV-1 RNA structural elements.

1. Davila-Calderon J, Patwardhan NN, Chiu LY, **Sugarman A**, Cai Z, Penutmutchu SR, Li ML, Brewer G, Hargrove AE, Tolbert BS. IRES-targeting small molecule inhibits enterovirus 71 replication via allosteric stabilization of a ternary complex. Nat Commun. 2020 Sep 22;11(1):4775. doi: 10.1038/s41467-020-18594-3. PMID: 32963221; PMCID: PMC7508794.
2. Chiu LY, Emery A, Jain N, **Sugarman A**, Kendrick N, Luo L, Ford W, Swanstrom R, Tolbert BS. Encoded Conformational Dynamics of the HIV Splice Site A3 Regulatory Locus: Implications for Differential Binding of hnRNP Splicing Auxiliary Factors. J Mol Biol. 2022 Sep 30;434(18):167728. doi: 10.1016/j.jmb.2022.167728. Epub 2022 Jul 21. PMID: 35870649; PMCID: PMC9945881.
3. Luo L, Chiu LY, **Sugarman A**, Gupta P, Rouskin S, Tolbert BS. HnRNP A1/A2 Proteins Assemble onto 7SK snRNA via Context Dependent Interactions. J Mol Biol.

2021 Apr 30;433(9):166885. doi: 10.1016/j.jmb.2021.166885. Epub 2021 Mar 5. PMID: 33684393; PMCID: PMC8091503.

4. Donlic A, Swanson EG, Chiu LY, Wicks SL, Juru AU, Cai Z, Kassam K, Laudeman C, Sanaba BG, **Sugarman A**, Han E, Tolbert BS, Hargrove AE. R-BIND 2.0: An Updated Database of Bioactive RNA-Targeting Small Molecules and Associated RNA Secondary Structures. ACS Chem Biol. 2022 Jun 17;17(6):1556-1566. doi: 10.1021/acschembio.2c00224. Epub 2022 May 20. PMID: 35594415; PMCID: PMC9343015.

Graduate Research in Micro-CT and Statistics: Under the co-mentorship of Dr. Justin Silverman and Dr. Keith Cheng I have contributed to the acquisition and analysis of high-resolution micro-computed tomography images of soft tissue samples. For example, in recent work led by Maksim Yakovlev in Elife I performed statistical analysis on 3-dimensional segmentation masks of Zebrafish red blood cells. This work aims to build a framework for Zebrafish researchers to quantitatively compare phenotypes within models of disease.

5. Yakovlev Maksim A., Liang Ke, Zaino Carolyn R., Vanselow Daniel J., **Sugarman Andrew L.**, Lin Alex Y., La Riviere Patrick J., Zheng Yuxi, Silverman Justin D., Leichty John C., Huang Sharon X., Cheng Keith C. (2023) Quantitative Geometric Modeling of Blood Cells from X-ray Histotomograms of Whole Zebrafish Larvae eLife 12:RP89432. https://doi.org/10.7554/eLife.89432.1
6. Ngu, Mee S., Daniel J. Vanselow, Rachelle A. Saint-Fort, **Andrew L. Sugarman**, Carolyn R. Zaino, Maksim A. Yakovlev, Keith C. Cheng, and Khai C. Ang. “Staining and Resin Embedding of Whole Daphnia Magna Samples for Micro-CT Imaging Enabling 3D Visualization of Cells, Tissues, and Organs of Various Thicknesses.” bioRxiv, January 1, 2024, 2023.05.21.541654. https://doi.org/10.1101/2023.05.21.541654.

I aim to build upon this work and apply similar methods to the quantitative analysis of tumor biopsies. My current project focuses on the phase-contrast based imaging of tumor tissue blocks, from which our group aims to extract measurements of microanatomical features, measure 3D spatial variation in key diagnostic elements such as prostate glands, and build methods to better quantify tumor heterogeneity in multiple tissue types. My thesis work will also focus on the computational methods required to refine, analyze, and distribute the findings from these imaging experiments. I will focus on the use of methods from topological data analysis in the analysis of 3D data, which will sharpen my skills in programming and statistics, preparing me to contribute to a wide range of computational problems. I look forward to improving my knowledge of the basic and clinical sciences as I prepare for a career as an independent investigator.

D. Scholastic Performance

YEAR	COURSE TITLE	GRADE
2023	BMS 591: Biomedical Research Ethics	A
2023	STAT 555: Statistical Genomics	A
2023	MCIBS: 554 Bioinformatics 1	A
2023	BIOL 428: Population Genetics	A
2023	BGEN 600: Thesis Research	A
2023	BGEN 590: Colloquium	A
2022	BMMB 852: Applied Bioinformatics	A
2022	BGEN 551: Genomics	A
2022	BGEN 597: Special Topics Bioinformatics and Genomics Core	A-
2022	MICRO 581: Immunology A	A-
2021	NBS 723: Neural and Behavioral Sciences	P
2021	SHS 721: Health Systems	P
2021	NBS 723: Neuroanatomy	P
2021	MEP 721: Med Ethics Prof	P
2021	HMN 723: Communications	P

2021	GI 723: GI	P
2021	FPCC 723: Foundations of Patient Centered Care - 3	P
2021	ENREP 721: Endo and Repro	P
2021	BMS 506A: Human Health and Disease A	P
2021	REN 713: Renal Med	P
2021	HMN 715: Critical Thinking	P
2021	FPCC 714: Foundations of Patient Centered Care - 2	P
2021	FORM 713: Form and Function	P
2021	BMS 506B: Human Health and Disease B	P
2020	CARES 713: CardioResp Med	P
2020	HMN 714: Mind-Body	P
2020	HDHR 711: Host Defense Host Response	P
2020	HMN 713: Medical Humanities	P
2020	FPCC 713: Foundations of Patient Centered Care - 1	P
2020	SPM 711: Scientific Principles of Medicine	P
2020	SHS 711: Health Systems	P
2020	TRANS 711: Transitions to Medical School	P
2019	CHEM 405: Topics in Organic Chemistry	B
2019	PHIL 201: Reason and Argument	A-
2019	CHEM 339: Quantum Chemistry and Kinetics	B-
2019	CHEM 526F Research - Full	P
2019	CHEM WT002: Honors Research	Full
2018	CHEM 327: Synthesis Laboratory	B
2018	CHEM 374: Biochemistry	B
2018	CHEM 525: Research - Half	P
2018	STAT 114: Introduction to Biostatistics	B+
2018	BIOL 213: Mol Biol, Cell Biol, & Biochem	B
2018	CHEM 213: Inorganic Chemistry	B
2018	CHEM 526F: Research - Full	P
2018	ENGL 140: Arthurian Fictions	B+
2018	CHEM WT002: Computational Structural Bio	Full
2017	PSYC 100: Intro to Psychological Sciences	A
2017	HIST 101: Medieval and Early Modrn Eur Hist	A
2017	CHEM 525F: Research - Full	P
2017	CHEM 211: Analytical Chemistry	B
2017	PHYS104: Elementary Physics II	B+
2017	CHEM 525H: Research - Half	P
2017	CHEM 325: Organic Mechanisms and Synthesis	A
2017	CHEM 254: Bioorganic Chemistry	A
2017	CHEM WT001: Organic Chemistry Research	Full
2016	RELG 153: Intro to Relg: Purity and Pollution	A-
2016	PHYS 110: Mechanics and Relativity	B
2016	PHIL 126: Problems of Philosophy	A-
2016	CHEM 205: Principles of Organic Chemistry	B+
2016	GEOL 122: Natural Hazards	A-
2016	ECON 101: Principles of Economics	A
2016	CHEM 102: Chemical Principles	B+
2016	BIOL 100: Organismal Biology	B+

2016	WT004: Shadowing of Trauma Surgeon	Full
2015	MATH 134: Calculus II	B
2015	PYSP 034: Values of Higher Education	B
2015	CHEM 101: Structure and Reactivity	A-
2015	ATHL 159: Ind. Baseball Skills Training	P
2015	ANTH 102: Human Origins	B

* The first two years of medical school coursework at Penn State College of Medicine are graded pass(“P”)/fail only