Allen W Zhang | Curriculum Vitae

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MD/PhD Candidate (final year) at the University of British Columbia, BC Cancer, and Centre for Molecular Medicine and Therapeutics (CMMT). Bioinformatics researcher and Vanier scholar with interests in cancer immunology, single cell transcriptomics, ovarian cancer, lymphomas, and machine learning.

Thesis: **Evolutionary dynamics of ovarian cancer microenvironments and tumour cells**

Previous Employment

- **Vancouver Coastal Health** — **Vancouver, Canada**
  Resident Physician — *July 2021–present*
  Starting Anatomical Pathology residency at UBC in July 2021!

- **Memorial Sloan Kettering Cancer Center** — **New York, USA**
  Graduate Research Assistant, Shah Lab — *September 2018–June 2019*
  I undertook a research exchange during my MD/PhD degree to acquire experience conducting clinical trials analysis in ovarian cancer immunotherapy, while continuing single cell RNA-seq work in ovarian cancer and follicular lymphoma.

- **BC Cancer** — **Vancouver, Canada**
  MD/PhD Student, Shah and Wasserman Labs — *May 2015–June 2021*
  I am working on projects in cancer immunology and genomics, primarily in the context of ovarian cancer and lymphomas, using whole-genome sequencing, single cell transcriptomics, histologic image analysis, TCR- and BCR-sequencing, immunohistochemistry, and mutation signature analysis.

- **Armstrong Lab** — **Vancouver, Canada**
  Work Learn Student — *September 2015–May 2016*
  I developed a genetics module on cancer exome analysis for UBC Medical School's curriculum renewal with Dr. Linlea Armstrong.

- **Centre for Molecular Medicine and Therapeutics** — **Vancouver, Canada**
  Bioinformatics Analyst, Wasserman Lab — *September 2012–August 2013*
  Developed software for transcription factor binding site prediction (MANTA) and the 2014 release of JASPAR, the largest freely-accessible database of high-quality transcription factor binding sites.

- **University of British Columbia** — **Vancouver, Canada**
  NSERC Summer Student, Wasserman Lab — *May 2012–August 2012*
  Developed fast computational methods for identification of transcription factor binding sites in whole-genome sequence data.

- **University of British Columbia** — **Vancouver, Canada**
  Work Learn Student, Centre for the Culture of Microorganisms — *May 2011–August 2011*
  Helped grow various single- and multicellular microorganisms for UBC Botany.

Education

Academic Qualifications

- **University of British Columbia** — **Vancouver, Canada**
  MD/PhD Candidate, Bioinformatics, GPA: 97% — *2014–2021*
- **University of British Columbia** — **Vancouver, Canada**
  MD Candidate — *2013–2014*
- **University of British Columbia** — **Vancouver, Canada**
  Combined Honours, Computer Science and Biology, GPA: 95.3% — *2010–2013*
- **University of British Columbia** — **Vancouver, Canada**
  Science One, GPA: 96%, Top Student — *2010–2011*
- **University Transition Program** — **Vancouver, Canada**
  GPA: 97%, Top Male Graduate — *2008–2010*

Notable Projects

- **MD/PhD Project:** *'CellAssign: Computational identification of known cell types in single cell transcriptome data using marker genes'*

  I am developing a Bayesian model for probabilistically assigning cells in single cell RNA-seq data to known cell types based on marker genes. CellAssign is available at `https://github.com/Irrationone/cellassign` and published in *Nature Methods*.

- **MD/PhD Project:** *'Interfaces of malignant and immunologic clonal dynamics in high-grade serous ovarian cancer'*

  I led a multi-national collaboration to establish the evolutionary interplay between lymphocytes and tumour cells in high-grade serous ovarian cancer by multimodal data analysis. Integrating whole-genome sequencing analysis of clonal composition, histologic imaging data, immunohistochemistry measurements, T- and B-cell receptor sequencing, and mutational signature analysis, we reported an evolutionary interplay between the immune microenvironment and tumour clones in *Cell* (senior authors: Dr. Sohrab Shah and Dr. Brad Nelson). I was responsible for co-ordinating the study and the majority of computational analysis.

- **Wasserman Lab:** *'Cis-regulatory mechanisms of gene expression alterations in B cell lymphomas'*

  I developed and applied methods to predict the effect of *cis*-regulatory somatic variants in B-cell lymphomas on transcription factor binding sites. These predictions were used by Dr. Anthony Mathelier and Calvin Lefebvre to associate regulatory variants with alterations in gene expression. This work was published in *Genome Biology*.

- **Wasserman Lab (NSERC):** *'Computational identification of transcription factor binding sites from whole-genome sequence data'*

  I developed computational methods to predict the effect of *cis*-regulatory variants within transcription factor binding sites on transcription factor binding affinity. The optimizations I introduced sped up the algorithm by 4-5 orders of magnitude, allowing for a single whole genome to be processed in a few hours. This method was used to generate the predictions in the MANTA database and its successor MANTA2 (published in *Scientific Data*).

Honours and Awards

- **Antonio and Iolanda Giuseppina Minicucci Award ($1875)**: 2020
  3 awards for 3rd/4th year MD students for outstanding academic achievement with demonstrated service to the community
- **Dennis Harris Memorial Prize in Psychiatry ($250)**: 2020

Awarded to one 3rd year MD student who excels at Psychiatry

- **Anita Unruh Prize for Ovarian Cancer Research ($5,000)**: 2020
  One national prize awarded every 2 years for excellence in ovarian cancer research by a trainee
- **BC Cancer Research Excellence Prize — Lloyd Skarsgard Excellence Award ($500)**: 2020
  Annual prize awarded for research excellence by a graduating BC Cancer trainee
- **BC Cancer Outstanding Trainee Publication ($1,000)**: 2019
  Annual prize awarded for an outstanding research publication by a BC Cancer trainee
- **CGS — Michael Smith Foreign Study Supplement ($6,000)**: 2018-2019
  Competitive award for graduate students to pursue research internationally
- **Canadian Conference on Ovarian Cancer Research Oral Presentation Award ($200)**: 2018
  Oral presentation award for the CCOCR conference
- **Canadian Conference on Ovarian Cancer Research Travel Award ($500)**: 2018
  Travel award for the CCOCR conference, based on submitted abstracts
- **BIG Research Day Poster Presentation Award ($50)**: 2018
  Poster presentation award for the annual UBC Bioinformatics Research Day
- **CIHR Vanier Scholarship ($150,000)**: 2016-2019
  Prize of $50000/yr for the most competitive doctoral students in Canada
- **UBC Four Year Fellowship (4YF, $72,800)**: 2016-2020
  UBC Award for academic excellence among graduate students
- **Elwyn Gregg Memorial Fellowship ($5,000)**: 2015
  Awarded to the best graduate talent across faculties in UBC
- **Faculty of Science Graduate Award ($3,236)**: 2015
  Graduate award for the Faculty of Science at UBC
- **CIHR CGS-M Scholarship ($17,500)**: 2015-2016
  National award for the most competitive Masters' and first-year doctoral students in Canada
- **Faculty of Medicine Graduate Award ($4,072)**: 2014
  Graduate award for the Faculty of Medicine at UBC
- **Faculty of Science Graduate Award ($3,407)**: 2014
  Graduate award for the Faculty of Science at UBC
- **CFRI Summer Student Scholarship ($3,750)**: 2014
  Annual competition for students participating in research at BC Children's Hospital
- **Ward-Essof Scholarship ($965)**: 2013
  For undergraduate students in any Faculty at UBC
- **Pacific Blue Cross Medical Entrance Scholarship ($1,000)**: 2013
  Awarded to one student entering UBC Medicine on the basis of outstanding promise and personal qualities. Recommendation made by the Dean of Medicine and Selection Committee
- **BC Clinical Genomics Network Training Award ($3,750)**: 2013
  Awarded to an undergraduate student pursuing genomics research
- **Charles and Jane Banks Scholarship ($1,000)**: 2013
  UBC award based on academic achievement
- **UBC Trek Excellence Scholarship ($1,500)**: 2012
  Annually awarded UBC scholarship for the top 5% of domestic undergraduate students
- **NSERC Summer Studentship ($4,500)**: 2012
  National scholarship awarded to students based on academic record and research aptitude
- **UBC Trek Excellence Scholarship ($1,500)**: 2011
  Annually awarded UBC scholarship for the top 5% of domestic undergraduate students
- **Larry Roberts Science One Memorial Scholarship ($1,000)**: 2011

Award made on the recommendation of the Science One Faculty and Director, based on academic excellence and an inquisitive mind

- **Janusz J. Klawe Memorial Science One Scholarship ($900)**: 2010
  Awarded to a student entering Science One, made on recommendation of the Science One Director
- **J. Fred Muir Memorial Scholarship in Science ($1,000)**: 2010
  Offered to students in the UBC Faculty of Science based on academic performance
- **President's Entrance Scholarship ($2,500)**: 2010
  BC provincial university entrance scholarship
- **British Columbia Government Scholarship ($1,000)**: 2010
  BC provincial scholarship for performance on Provincial Exams
- **Passport to Education ($500)**: 2010
  BC provincial scholarship for secondary school performance
- **3rd place in BC, Euclid Mathematics Contest ($1,000)**: 2010
  Monetary award for top performance on the national Euclid Mathematics Competition (Grade 12)
- **1st place, BC's Brightest Minds Physics Competition ($1,500)**: 2010
  Monetary award for winning 1st place in the BC's Brightest Minds Physics Competition
- **1st place in BC, Michael Smith Science Challenge ($100)**: 2010
  Monetary award for winning 1st place in BC in the national Michael Smith Science Challenge
- **Genome BC Award ($50)**: 2009
  Regional award for genetics research at the Greater Vancouver Science Fair

Publications

*: co-first author

2021: Sohrab Salehi, Farhia Kabeer, Nicholas Ceglia, Mirela Andronescu, Marc Williams, Kieran Campbell et al. Single cell fitness landscapes induced by genetic and pharmacologic perturbations in cancer. *Nature (in press)*, page 2020.05.08.081349, may 2021.

2021: Saket Navlakha, Sejal Morjaria, Rocio Perez-Johnston, **Allen Zhang** and Ying Taur. Projecting COVID-19 disease severity in cancer patients using purposefully-designed machine learning. *BMC Infectious Diseases*, 21:391, 2021.

2020: **A.W. Zhang** and K.R. Campbell. Computational modelling in single-cell cancer genomics: Methods and future directions. *Physical Biology*, 17(6), 2020.

2020: Sejal Morjaria, **Allen W. Zhang**, Sohn Kim, Jonathan U. Peled, Simone Becattini, Eric R. Littmann et al. Monocyte reconstitution and gut microbiota composition after hematopoietic stem cell transplantation. *Clinical Hematology International*, pages 1–9, sep 2020.

2020: Daisuke Ennishi, Shannon Healy, Ali Bashashati, Saeed Saberi, Christoffer Hother, Anja Mottok et al. TMEM30A loss-of-function mutations drive lymphomagenesis and confer therapeutically exploitable vulnerability in B-cell lymphoma. *Nature Medicine*, pages 1–12, feb 2020.

2020: Helen H. Chung, Sejal Morjaria, John Frame, Michael Riley, **Allen W. Zhang**, Steven C. Martin et al. Rethinking the need for a platelet transfusion threshold of 50 $\times$ 109/L for lumbar puncture in cancer patients. *Transfusion*, 60(10):2243–2249, 2020.

2019: **Allen W. Zhang**, Ciara O'Flanagan, Elizabeth A. Chavez, Jamie L. P. Lim, Nicholas Ceglia, Andrew McPherson et al. Probabilistic cell-type assignment of single-cell RNA-seq for tumor microenvironment profiling. *Nature Methods*, pages 1–9, sep 2019.

2019: Ciara H. O'Flanagan*, Kieran R. Campbell*, **Allen W. Zhang***, Farhia Kabeer*, Jamie L. P. Lim, Justina Biele et al. Dissociation of solid tumor tissues with cold active protease for single-cell RNA-seq minimizes conserved collagenase-associated stress responses. *Genome Biology*, 20(1):210, dec 2019.

2019: Sejal Morjaria, **Allen W. Zhang**, Sohn Kim, Jonathan U. Peled, Simone Becattini, Eric R. Littmann et al. Monocyte reconstitution and gut microbiota composition after hematopoietic stem cell transplantation. *bioRxiv*, 2:156–164, 2019.

2019: Alex Miranda, Phineas T. Hamilton, **Allen W. Zhang**, Swetansu Pattnaik, Etienne Becht, Artur Mezheyeuski et al. Cancer stemness, intratumoral heterogeneity, and immune response across cancers. *Proceedings of the National Academy of Sciences*, page 201818210, apr 2019.

2019: Tyler Funnell, **Allen W. Zhang**, Diljot Grewal, Steven McKinney, Ali Bashashati, Yi Kan Wang et al. Integrated structural variation and point mutation signatures in cancer genomes using correlated topic models. *PLOS Computational Biology*, 15(2):e1006799, 2019.

2019: Tomohiro Aoki, Lauren C Chong, Katsuyoshi Takata, Katy Milne, Monirath Hav, Anthony Colombo et al. Single cell transcriptome analysis reveals disease-defining T cell subsets in the tumor microenvironment of classic Hodgkin lymphoma. *Cancer discovery*, dec 2019.

2018: **Allen W. Zhang**, Andrew McPherson, Katy Milne, David R. Kroeger, Phineas T. Hamilton, Alex Miranda et al. Interfaces of Malignant and Immunologic Clonal Dynamics in Ovarian Cancer. *Cell*, 173(7):1755–1769.e22, jun 2018.

2018: Rebecca A.G. De Souza, Natalia Kosior, Sarah B. Thomson, Anthony Mathelier, **Allen W. Zhang**, Kristina Bečanović et al. Computational Analysis of Transcriptional Regulation Sites at the HTT Gene Locus. *Journal of Huntington's Disease*, 7(3):223–237, jul 2018.

2017: Yi Kan Wang, Ali Bashashati, Michael S Anglesio, Dawn R Cochrane, Diljot S Grewal, Gavin Ha et al. Genomic consequences of aberrant DNA repair mechanisms stratify ovarian cancer histotypes. *Nature Genetics*, apr 2017.

2017: Puya Seid-Karbasi, Xin C. Ye, **Allen W. Zhang**, Nicole Gladish, Suzanne Y. S. Cheng, Katharina Rothe et al. CuboCube: Student creation of a cancer genetics e-textbook using open-access software for social learning. *PLOS Biology*, 15(3):e2001192, mar 2017.

2016: Andrew McPherson, Andrew Roth, Emma Laks, Tehmina Masud, Ali Bashashati, **Allen W Zhang** et al. Divergent modes of clonal spread and intraperitoneal mixing in high-grade serous ovarian cancer. *Nature Genetics*, 48(7):758–767, may 2016.

2016: A. Mathelier, O. Fornes, D.J. Arenillas, C.-Y. Chen, G. Denay, J. Lee et al. JASPAR 2016: A major expansion and update of the open-access database of transcription factor binding profiles. *Nucleic Acids Research*, 44(D1), 2016.

2015: A. Mathelier, C. Lefebvre, **A.W. Zhang**, D.J. Arenillas, J. Ding, W.W. Wasserman et al. Cis-regulatory somatic mutations and gene-expression alteration in B-cell lymphomas. *Genome Biology*, 16(1), 2015.

2014: A. Mathelier, X. Zhao, **A.W. Zhang**, F. Parcy, R. Worsley-Hunt, D.J. Arenillas et al. JASPAR 2014: An extensively expanded and updated open-access database of transcription factor binding profiles. *Nucleic Acids Research*, 42(D1), 2014.

News Releases

- **"Arms race" between cancer and immune system revealed** **Vancouver, Canada**
  BC Cancer & UBC Medicine *May 2018*
  `https://www.med.ubc.ca/ubc-scientists-uncover-evolutionary-arms-race-between-cancer-and-immune-system/`, `https://bccancerfoundation.com/about-us/news/scientists-uncover-%E2%80%9Cevolutionary-arms-race%E2%80%9D-between-cancer-and-immune-system`
- **An injection of youth** **Vancouver, Canada**
  UBC Medicine *September 2014*
  `https://www.med.ubc.ca/an-injection-of-youth/`

Presentations

- **Virtual Canadian Conference for Ovarian Cancer Research 2021** — **Virtual**
  Oral presentation (invited) — *May 2021*
  Interfaces of malignant and immunologic clonal dynamics in ovarian cancer

- **11th Annual AACR/JCA Joint Conference on Breakthroughs in Cancer Research** — **Maui, USA**
  Poster presentation — *February 2019*
  Probabilistic cell type assignment of single-cell transcriptomic data reveals temporal microenvironment dynamics in follicular lymphoma

- **NY Genome & MSKCC FFF Cancer Genomics Seminar Series** — **New York, USA**
  Oral presentation (invited) — *January 2019*
  Evaluating spatiotemporal dynamics in human cancers using CellAssign

- **Systems Genetics of Cancer 2018** — **Portland, USA**
  Oral presentation (chalk talk) — *June 2018*
  Interfaces of malignant and immunologic clonal dynamics in ovarian cancer

- **Canadian Conference for Ovarian Cancer Research 2018** — **Edmonton, Canada**
  Oral presentation (3rd place) — *May 2018*
  The Evolutionary Interplay Between Lymphocytes and Cancer Cells in High-Grade Serous Ovarian Cancer

- **BIG Research Day 2018** — **Vancouver, Canada**
  Poster presentation (3rd place) — *March 2018*
  The evolutionary interplay between lymphocytes and cancer cells in high-grade serous ovarian cancer

- **Friesen Award Laureate Institutional Visit** — **Vancouver, Canada**
  Oral presentation (invited) — *January 2018*
  The malignant-immune interface in high-grade serous ovarian cancer

- **Canadian Cancer Research Conference 2017** — **Vancouver, Canada**
  Oral presentation — *November 2017*
  Spatiotemporal dynamics of tumour-infiltrating lymphocytes, mutational scars, and cancer clones in high-grade serous ovarian cancer

- **BC Tech Summit 2017** — **Vancouver, Canada**
  Oral and poster presentation (invited) — *March 2017*
  Profiling clonal diversity at the single-cell level & the effect of immune cells on tumour evolution in high-grade serous ovarian cancer

- **16th Annual Bellairs Workshop: Cancer and the Immune System** — **Holetown, Barbados**
  Oral presentation (invited) — *January 2017*
  Tumour infiltrating lymphocytes and clonal evolution in high-grade serous ovarian cancer

- **AACR Annual General Meeting 2016** — **New Orleans, USA**
  Poster presentation — *April 2016*
  Properties of the immune microenvironment associated with clonal diversity in high-grade serous ovarian cancer

- **Clinician-Investigator Trainee Association of Canada AGM 2015** — **Toronto, Canada**
  Poster presentation — *November 2015*
  Co-evolution of tumour-infiltrating lymphocytes and cancer clones in high-grade serous ovarian cancer

- **BC Children's Hospital Research Poster Day** — **Vancouver, Canada**
  Poster presentation — *July 2014*

- **BC Children's Hospital Research Poster Day** — **Vancouver, Canada**
  Poster presentation — *July 2013*
- **BC Children's Hospital Research Poster Day** — **Vancouver, Canada**
  Poster presentation — *July 2012*

Extra-curricular activity

- **Violinist** — **Vancouver, Canada**
  Performer's ARCT level (w/ Grade 10 theory requirements) — *Ongoing*
  I have played the violin for 10+ years. I enjoy playing classical music (orchestral pieces and unaccompanied Bach) and trained under Amy Paster Levinson. I was a member of the **Sizzlers Fiddle Group**; during my time with the group we recorded 2 CDs, went on tours to Canada's East Coast (Halifax, Charlottetown, Fredericton), Victoria, and Seattle, and performed at the Vancouver Fringe Festival.

- **Genetics in Medicine Club** — **Vancouver, Canada**
  Executive, Co-founder — *May 2015–December 2017*
  I helped develop the Genetics in Medicine seminar series. The goal of our seminar series was to enrich genetics education for medical students by inviting speakers that apply principles classical genetics and modern genomics in their everyday clinical practice or research.

- **Skin Cancer Awareness Network (SCAN)** — **Vancouver, Canada**
  Co-founder, Events Co-ordinator — *May 2014–September 2015*
  I helped organize public events in Vancouver and presentations at secondary schools and community centres around the Lower Mainland to highlight skin care promotion and skin cancer awareness. I also trained undergraduate student volunteers and undergraduate student leaders (USLs) for presentations at secondary schools. I helped apply for and secure **UBC Teaching and Learning Enhancement Funding** (TLEF) as part of an initiative to create an open-access e-book to provide access to clinically relevant dermatology knowledge for medical students.

- **Adams Lab (UBC)** — **Vancouver, Canada**
  Research Student — *June 2013–August 2013*
  I devised algorithms for analyzing *cis*-regulatory alterations in *Arabidopsis thaliana* with Dr. Keith Adams. The focus of this research was to study regulatory element evolution following genomic duplication events.

- **Imagine UBC** — **Vancouver, Canada**
  Science Squad Manager — *January 2013–September 2013*
  I worked closely with a Science Squad Leader to train 8 Imagine UBC MUG Leaders for Imagine Day in September 2013. Worked with MUG Leaders to develop icebreaker activities, and led workshops on conflict resolution, teamwork, and campus tours. Each MUG Leader was responsible for supervising a group of 8-10 incoming UBC students.

- **The Fair Haven United Church Homes** — **Vancouver, Canada**
  Graphics Designer — *July 2012–May 2013*
  I re-designed the resident booklet for senior home visitors and residents as a volunteer.

- **Richmond General Hospital** — **Richmond, Canada**
  Emergency Department Volunteer — *July 2012–May 2013*
  I delivered meals and blankets to patients, interacted with patients and visitors in the waiting room, and assisted with wayfinding.

- **UBC Math Circle** — **Vancouver, Canada**
  Volunteer Leader — *January 2012–April 2014*

I served as an undergraduate leader for the UBC Math Circle, a group of mathematically-talented high school students selected by UBC professor Dr. George Bluman based on performance in national math competitions. I had participated in this group as a high school student (2010), and was nominated as a Leader in 2012 by Dr. Joel Feldman based on performance in MATH 226 (Honours Multivariable Calculus). I helped develop problem sets, led students through problems, and arranged for faculty speakers.

- **Gordon Lab** **Vancouver, Canada**
  Undergraduate Volunteer *April 2011–December 2011*
  I helped cross and propagate *Drosophila melanogaster* lines for neurobiological studies in Dr. Mike Gordon's lab at the Life Sciences Institute.

- **Mathematics and Physics Tutoring** **Vancouver, Canada**
  Private Tutor *June 2010–April 2014*
  I tutored 2 students in Mathematics and Physics 11 and 12, along with AP Calculus BC.

- **Amati String Studio** **Vancouver, Canada**
  Website Designer *June 2007–August 2013*
  I designed and maintained the websites `www.amatistringstudio.ca` and `www.sizzlersfiddlegroup.org`.