Stanford

Theodore Roth

Assistant Professor of Pathology

Bio

BIO

Theo Roth, MD PhD, was born in St. Louis, Missouri and grew up in Birmingham, Alabama before completing his undergraduate degree in Biology with Honors at Stanford University, along with a coterminal Master's degree in Biomedical Informatics. He completed his MD/PhD training in the Medical Scientist Training Program at the University of California, San Francisco. During his PhD work at UCSF with Dr. Alex Marson, he developed non-viral genome targeting, a new efficient method for large scale genetic engineering of diverse primary human immune cell types without the need for complex viral vectors. He further developed pooled knock-in screening, enabling rapid discovery of synthetic sequences to re-wire immune cell genomes and associate synthetic genotypes with high dimensional single cell phenotypes. Pooled screening of TCR and CAR T cell therapies has highlighted synthetic genetic perturbations with improved context dependent fitness profiles matched to specific solid tumor settings. After concluding his PhD, Theo co-founded ArsenalBio, and served as Arsenal's founding Chief Scientific Officer for a year before returning to UCSF to complete his MD and Stanford to complete his residency in Pathology. He is currently an Assistant Professor in Pathology at Stanford University, an Innovation Investigator at the Arc Institute, and a Senior Fellow at the Parker Institute for Cancer Immunotherapy.

ACADEMIC APPOINTMENTS

- Assistant Professor, Pathology
- Member, Bio-X
- Member, Stanford Cancer Institute

HONORS AND AWARDS

- NIH Director's New Innovator Award, NIH (2025)
- Innovation Investigator Award, Arc Institute (2025)
- Parker Institute Senior Fellows Award, PICI (2025)
- The Cancer League Research Award, The Cancer League (2025)
- Career Award for Medical Scientists, Burroughs Wellcome Fund (2024)
- K08 Mentored Clinical Scientist Development Award, NIH/NCI (2024)

PROFESSIONAL EDUCATION

- MD, University of California, San Francisco (2021)
- PhD, University of California, San Francisco , Biomedical Sciences (2019)
- MS, Stanford University , Biomedical Informatics (2014)
- BS, Stanford University , Biology, with Honors (2014)

LINKS

- Roth Lab Website: https://rothlab.com/
- Roth Lab X: https://x.com/Roth_Lab
- Google Scholar Profile: https://scholar.google.com/citations?hl=en&user=Ue3WxuYAAAAJ
- PICI Profile: https://www.parkerici.org/person/theodore-roth-md-phd/

Research & Scholarship

CURRENT RESEARCH AND SCHOLARLY INTERESTS

The Roth Lab develops, applies, and translates scalable genetic manipulation technologies in primary human cells and complex in vivo tissue environments. Working with students, trainees, and staff with backgrounds across bioengineering, genetics, immunology, oncology, and pathology, the lab has developed CRISPR-All, a unified genetic perturbation language able to arbitrarily and combinatorially examine genetic perturbations across perturbation type and scale in primary human cells. Ongoing applications of CRISPR-All in the lab have revealed surprising capacities to synthetically engineer human cells beyond evolved cellular states. These new capacities to perturb human cell's genetics beyond their evolved functionality drives ongoing work to understand the biology and therapeutic potential of synthetic cell state engineering - in essence learning how to build new human genes tailor made for a specific cell and specific environment to drive previously inaccessible therapeutic cellular functions.

Teaching

STANFORD ADVISEES

Med Scholar Project Advisor

Yuncong Mao

Doctoral Dissertation Reader (AC)

Thao Nguyen, Johnathon Soro, Pat Yan

Postdoctoral Faculty Sponsor

Jason Nideffer

Doctoral Dissertation Advisor (AC)

Keala Gapin

Doctoral Dissertation Co-Advisor (AC)

Austin Hartman

Postdoctoral Research Mentor

Meelad Amouzgar

Publications

PUBLICATIONS

- **High-throughput screening of chimeric RNA-binding proteins for improved CAR T cell function**
  Kernick, C., Takacsi-Nagy, O., Hartman, A., Wu, L., Chang, C., Satpathy, A., Roth, T.
  AMER ASSOC CANCER RESEARCH.2026
- **Ultra-large targeted DNA integrations in primary human cells.** *bioRxiv : the preprint server for biology*
  Kernick, C., Chow, L., Alejandro, M., Li, K., Foisey, M. G., Yang, X., Hilburger, C., Lu, J., Wu, L., McClellan, A., Takacsi-Nagy, O., Brajenovic, R., Theberath, et al

2026

- **Universal T cell therapy screening library in preclinical models of CAR T cell therapy**
  Eapen, A., Wu, L., Moser, L., Quach, B., Gamal, W., Rodrigues, K., Tsui, K. C., Good, Z., Roth, T.
  AMER ASSOC CANCER RESEARCH.2026
- **Assessing donor heterogeneity in CAR-T cells with massively parallel mixed lymphocyte reactions**
  Wu, L., Mohamad, L., Mantilla, M., Lu, J., Satpathy, A. T., Roth, T.
  AMER ASSOC CANCER RESEARCH.2026
- **Molecular pixelation of the CAR T cell surface proteome.** *bioRxiv : the preprint server for biology*
  Cesnik, A., Takacsi-Nagy, O., Le, T., Roth, T. L., Satpathy, A. T., Lundberg, E.
  2026
- **Mitochondrial transfer from immune to tumor cells enables lymph node metastasis.** *Cell metabolism*
  Terasaki, A., Bhatnagar, K., Weiner, A. T., Tan, Y., Szeifert, V., Huang, H. L., Wiggers, L., Rodrigues, V., Rada, C. C., Shankar, V., Saito, S., Ankomah, P. O., Roth, et al
  2026
- **A unified genetic perturbation language for human cellular programming.** *bioRxiv : the preprint server for biology*
  Hartman, A., Takacsi-Nagy, O., Kernick, C., Theberath, N. E., Lu, J., Wu, L., Mantilla, M., Mittra, S., McClellan, A., Johnson, N., Mohamad, L., Castillo-Colin, L., Hoque, et al
  2025
- **Mitochondria redistribution organizes the immunosuppressive tumor ecosystem.** *bioRxiv : the preprint server for biology*
  Terasaki, A., Weiner, A. T., Tan, Y., Szeifert, V., Bhatnagar, K., Rada, C. C., Shankar, V., Kernick, C., Mahmood, M., Wiggers, L., Rodrigues, V. R., Gammage, P. A., Roth, et al
  2025
- **Site-specific DNA insertion into the human genome with engineered recombinases.** *Nature biotechnology*
  Fanton, A., Bartie, L. J., Martins, J. Q., Tran, V. Q., Goudy, L., Kernick, C., Durrant, M. G., Wei, J., Armour-Garb, Z., Pawluk, A., Konermann, S., Marson, A., Gilbert, et al
  2025
- **Scalable transcription factor mapping uncovers the regulatory dynamics of natural and synthetic transcription factors in human T cell states.** *bioRxiv : the preprint server for biology*
  Mullins, R. D., Zaretsky, J., Stoller, E., Moore, M., Takacsi-Nagy, O., Shpynov, O., Sampaleanu, R., Roth, T. L., Satpathy, A. T., Mitra, R. D., Puram, S. V.
  2025
- **Massively parallel immunopeptidome by DNA sequencing provides insights into cancer antigen presentation.** *Nature genetics*
  Shi, Q., Simon, E. P., Cimen Bozkus, C., Kaminska, A., Velazquez, L., Saxena, M., Zhang, Z., Belk, J. A., Wang, S., Yang, N., Zhang, Y., Kwong, A., Che, et al
  2025
- **Non-viral intron knock-ins for targeted gene integration into human T cells and for T-cell selection.** *Nature biomedical engineering*
  Roth, T. L., Lu, J., McClellan, A., Kernick, C., Takacsi-Nagy, O., Satpathy, A. T.
  2025
- **Immune composition of the mononuclear cell fraction of human umbilical cord blood.** *Frontiers in immunology*
  Kikuta, K., Lee, E., Menezes, T., Fung, H., Amorin, A., Agrawal, A., Roth, T. L., Porteus, M.
  2025; 16: 1614230
- **Latent human herpesvirus 6 is reactivated in CAR T cells.** *Nature*
  Lareau, C. A., Yin, Y., Maurer, K., Sandor, K. D., Daniel, B., Yagnik, G., Peña, J., Crawford, J. C., Spanjaart, A. M., Gutierrez, J. C., Haradhvala, N. J., Riberdy, J. M., Abay, et al
  2023
- **Modular pooled discovery of synthetic knockin sequences to program durable cell therapies.** *Cell*
  Blaeschke, F., Chen, Y. Y., Apathy, R., Daniel, B., Chen, A. Y., Chen, P. A., Sandor, K., Zhang, W., Li, Z., Mowery, C. T., Yamamoto, T. N., Nyberg, W. A., To, et al

2023; 186 (19): 4216-4234.e33

- **High-yield genome engineering in primary cells using a hybrid ssDNA repair template and small-molecule cocktails** *NATURE BIOTECHNOLOGY*
  Shy, B. R., Vykunta, V. S., Ha, A., Talbot, A., Roth, T. L., Nguyen, D. N., Pfeifer, W. G., Chen, Y., Blaeschke, F., Shifrut, E., Vedova, S., Mamedov, M. R., Chung, et al
  2023; 41 (4): 521-+

- **RASA2 ablation in T cells boosts antigen sensitivity and long-term function.** *Nature*
  Carnevale, J., Shifrut, E., Kale, N., Nyberg, W. A., Blaeschke, F., Chen, Y. Y., Li, Z., Bapat, S. P., Diolaiti, M. E., O'Leary, P., Vedova, S., Belk, J., Daniel, et al
  2022

- **A functional map of HIV-host interactions in primary human T cells** *NATURE COMMUNICATIONS*
  Hiatt, J., Hultquist, J. F., McGregor, M. J., Bouhaddou, M., Leenay, R. T., Simons, L. M., Young, J. M., Haas, P., Roth, T. L., Tobin, V., Wojcechowskyj, J. A., Woo, J. M., Rathore, et al
  2022; 13 (1): 1752

- **Robust T cell activation requires an eIF3-driven burst in T cell receptor translation** *ELIFE*
  De Silva, D., Ferguson, L., Chin, G. H., Smith, B. E., Apathy, R. A., Roth, T. L., Blaeschke, F., Kudla, M., Marson, A., Ingolia, N. T., Cate, J. H. D.
  2021; 10

- **Efficient generation of isogenic primary human myeloid cells using CRISPR-Cas9 ribonucleoproteins** *CELL REPORTS*
  Hiatt, J., Cavero, D. A., McGregor, M. J., Zheng, W., Budzik, J. M., Roth, T. L., Haas, K. M., Wu, D., Rathore, U., Meyer-Franke, A., Bouzidi, M. S., Shifrut, E., Lee, et al
  2021; 35 (6): 109105

- **The CD28-Transmembrane Domain Mediates Chimeric Antigen Receptor Heterodimerization With CD28** *FRONTIERS IN IMMUNOLOGY*
  Muller, Y. D., Nguyen, D. P., Ferreira, L. M. R., Ho, P., Raffin, C., Valencia, R., Congrave-Wilson, Z., Roth, T. L., Eyquem, J., Van Gool, F., Marson, A., Perez, L., Wells, et al
  2021; 12: 639818

- **TCF-1 regulates HIV-specific CD8+ T cell expansion capacity.** *JCI insight*
  Rutishauser, R. L., Deguit, C. D., Hiatt, J., Blaeschke, F., Roth, T. L., Wang, L., Raymond, K. A., Starke, C. E., Mudd, J. C., Chen, W., Smullin, C., Matus-Nicodemos, R., Hoh, et al
  2021; 6 (3)

- **XYZeq: Spatially resolved single-cell RNA sequencing reveals expression heterogeneity in the tumor microenvironment.** *Science advances*
  Lee, Y., Bogdanoff, D., Wang, Y., Hartoularos, G. C., Woo, J. M., Mowery, C. T., Nisonoff, H. M., Lee, D. S., Sun, Y., Lee, J., Mehdizadeh, S., Cantlon, J., Shifrut, et al
  2021; 7 (17)

- **Epithelial miR-141 regulates IL-13-induced airway mucus production.** *JCI insight*
  Siddiqui, S., Johansson, K., Joo, A., Bonser, L. R., Koh, K. D., Le Tonqueze, O., Bolourchi, S., Bautista, R. A., Zlock, L., Roth, T. L., Marson, A., Bhakta, N. R., Ansel, et al
  2021; 6 (5)

- **Genetic Disease and Therapy.** *Annual review of pathology*
  Roth, T. L., Marson, A.
  2021; 16: 145-166

- **Comparative host-coronavirus protein interaction networks reveal pan-viral disease mechanisms** *SCIENCE*
  Gordon, D. E., Hiatt, J., Bouhaddou, M., Rezelj, V. V., Ulferts, S., Braberg, H., Jureka, A. S., Obernier, K., Guo, J. Z., Batra, J., Kaake, R. M., Weckstein, A. R., Owens, et al
  2020; 370 (6521): 1181-+

- **Polymer-stabilized Cas9 nanoparticles and modified repair templates increase genome editing efficiency.** *Nature biotechnology*
  Nguyen, D. N., Roth, T. L., Li, P. J., Chen, P. A., Apathy, R., Mamedov, M. R., Vo, L. T., Tobin, V. R., Goodman, D., Shifrut, E., Bluestone, J. A., Puck, J. M., Szoka, et al
  2020; 38 (1): 44-49

- **Editing of Endogenous Genes in Cellular Immunotherapies.** *Current hematologic malignancy reports*
  Roth, T. L.
  2020; 15 (4): 235-240

- **Functional CRISPR dissection of gene networks controlling human regulatory T cell identity.** *Nature immunology*
  Schumann, K., Raju, S. S., Lauber, M., Kolb, S., Shifrut, E., Cortez, J. T., Skartsis, N., Nguyen, V. Q., Woo, J. M., Roth, T. L., Yu, R., Nguyen, M. L., Simeonov, et al
  2020; 21 (11): 1456-1466

- **A SARS-CoV-2 protein interaction map reveals targets for drug repurposing.** *Nature*
  Gordon, D. E., Jang, G. M., Bouhaddou, M., Xu, J., Obernier, K., White, K. M., O'Meara, M. J., Rezelj, V. V., Guo, J. Z., Swaney, D. L., Tummino, T. A., Hüttenhain, R., Kaake, et al
  2020; 583 (7816): 459-468

- **CRISPR screen in regulatory T cells reveals modulators of Foxp3.** *Nature*
  Cortez, J. T., Montauti, E., Shifrut, E., Gatchalian, J., Zhang, Y., Shaked, O., Xu, Y., Roth, T. L., Simeonov, D. R., Zhang, Y., Chen, S., Li, Z., Woo, et al
  2020; 582 (7812): 416-420

- **Pooled Knockin Targeting for Genome Engineering of Cellular Immunotherapies.** *Cell*
  Roth, T. L., Li, P. J., Blaeschke, F., Nies, J. F., Apathy, R., Mowery, C., Yu, R., Nguyen, M. L., Lee, Y., Truong, A., Hiatt, J., Wu, D., Nguyen, et al
  2020; 181 (3): 728-744.e21

- **Large dataset enables prediction of repair after CRISPR-Cas9 editing in primary T cells.** *Nature biotechnology*
  Leenay, R. T., Aghazadeh, A., Hiatt, J., Tse, D., Roth, T. L., Apathy, R., Shifrut, E., Hultquist, J. F., Krogan, N., Wu, Z., Cirolia, G., Canaj, H., Leonetti, et al
  2019

- **A large CRISPR-induced bystander mutation causes immune dysregulation.** *Communications biology*
  Simeonov, D. R., Brandt, A. J., Chan, A. Y., Cortez, J. T., Li, Z., Woo, J. M., Lee, Y., Carvalho, C. M., Indart, A. C., Roth, T. L., Zou, J., May, A. P., Lupski, et al
  2019; 2: 70

- **Helios enhances the preferential differentiation of human fetal CD4+ naïve T cells into regulatory T cells.** *Science immunology*
  Ng, M. S., Roth, T. L., Mendoza, V. F., Marson, A., Burt, T. D.
  2019; 4 (41)

- **Orthotopic replacement of T-cell receptor α- and β-chains with preservation of near-physiological T-cell function.** *Nature biomedical engineering*
  Schober, K., Müller, T. R., Gökmen, F., Grassmann, S., Effenberger, M., Poltorak, M., Stemberger, C., Schumann, K., Roth, T. L., Marson, A., Busch, D. H.
  2019; 3 (12): 974-984

- **CRISPR-Cas9 genome engineering of primary CD4+ T cells for the interrogation of HIV-host factor interactions.** *Nature protocols*
  Hultquist, J. F., Hiatt, J., Schumann, K., McGregor, M. J., Roth, T. L., Haas, P., Doudna, J. A., Marson, A., Krogan, N. J.
  2019; 14 (1): 1-27

- **Reprogramming human T cell function and specificity with non-viral genome targeting** *NATURE*
  Roth, T. L., Puig-Saus, C., Yu, R., Shifrut, E., Carnevale, J., Li, P., Hiatt, J., Saco, J., Krystofinski, P., Li, H., Tobin, V., Nguyen, D. N., Lee, et al
  2018; 559 (7714): 405-+

- **Genetic engineering in primary human B cells with CRISPR-Cas9 ribonucleoproteins.** *Journal of immunological methods*
  Wu, C. M., Roth, T. L., Baglaenko, Y., Ferri, D. M., Brauer, P., Zuniga-Pflucker, J. C., Rosbe, K. W., Wither, J. E., Marson, A., Allen, C. D.
  2018; 457: 33-40

- **Genome-wide CRISPR Screens in Primary Human T Cells Reveal Key Regulators of Immune Function.** *Cell*
  Shifrut, E., Carnevale, J., Tobin, V., Roth, T. L., Woo, J. M., Bui, C. T., Li, P. J., Diolaiti, M. E., Ashworth, A., Marson, A.
  2018; 175 (7): 1958-1971.e15

- **Enhanced Genome Editing with Cas9 Ribonucleoprotein in Diverse Cells and Organisms.** *Journal of visualized experiments : JoVE*
  Farboud, B., Jarvis, E., Roth, T. L., Shin, J., Corn, J. E., Marson, A., Meyer, B. J., Patel, N. H., Hochstrasser, M. L.

2018

- **Light-activated cell identification and sorting (LACIS) for selection of edited clones on a nanofluidic device.** *Communications biology*
  Mocciaro, A., Roth, T. L., Bennett, H. M., Soumillon, M., Shah, A., Hiatt, J., Chapman, K., Marson, A., Lavieu, G.
  2018; 1: 41

- **Discovery of stimulation-responsive immune enhancers with CRISPR activation.** *Nature*
  Simeonov, D. R., Gowen, B. G., Boontanrart, M. n., Roth, T. L., Gagnon, J. D., Mumbach, M. R., Satpathy, A. T., Lee, Y. n., Bray, N. L., Chan, A. Y., Lituiev, D. S., Nguyen, M. L., Gate, et al
  2017

- **Migratory and adhesive cues controlling innate-like lymphocyte surveillance of the pathogen-exposed surface of the lymph node.** *eLife*
  Zhang, Y., Roth, T. L., Gray, E. E., Chen, H., Rodda, L. B., Liang, Y., Ventura, P., Villeda, S., Crocker, P. R., Cyster, J. G.
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  Corps, K. N., Roth, T. L., McGavern, D. B.
  2015; 72 (3): 355-62

- **A Rapid and Simple Method for DNA Engineering Using Cycled Ligation Assembly** *PLOS ONE*
  Roth, T. L., Milenkovic, L., Scott, M. P.
  2014; 9 (9)

- **Microglia development and function.** *Annual review of immunology*
  Nayak, D., Roth, T. L., McGavern, D. B.
  2014; 32: 367-402

- **Transcranial amelioration of inflammation and cell death after brain injury.** *Nature*
  Roth, T. L., Nayak, D., Atanasijevic, T., Koretsky, A. P., Latour, L. L., McGavern, D. B.
  2014; 505 (7482): 223-8

- **Type I interferon programs innate myeloid dynamics and gene expression in the virally infected nervous system.** *PLoS pathogens*
  Nayak, D., Johnson, K. R., Heydari, S., Roth, T. L., Zinselmeyer, B. H., McGavern, D. B.
  2013; 9 (5): e1003395