



Applied Proteogenomics Organizational Learning and Outcomes (APOLLO)

APOLLO 10 Sarcoma





the **WHITE HOUSE**
PRESIDENT BARACK OBAMA

APOLLO 10

For Immediate Release

June 28, 2016

FACT SHEET: At Cancer Moonshot Summit, Vice President Biden Announces New Actions to Accelerate Progress Toward Ending Cancer As We Know It

Tri-Agency Coalition to Enhance Cancer Care - Applied Proteogenomics

Organizational Learning and Outcomes (APOLLO) Consortium: The Department of Defense (DoD), the Department of Veterans Affairs (VA), and the National Cancer Institute (NCI) are forming a new collaboration using state-of-the-art research methods in proteogenomics to more rapidly identify unique targets and pathways of cancer for detection and intervention. These methods will look at a patient's genes that may lead to cancer and the expression of these genes in the form of proteins, with potential impact on disease formation and treatment for cancer patients. Initial collaborative efforts will focus on a cohort of 8,000 lung cancer patients within the nation's two largest healthcare systems and will make data broadly available to the research community. Ultimately the effort will be expanded to additional cancer types to reach more cancer patients within the VA and DoD, providing knowledge scalable for physicians across the country treating the more than 1.6 million new patients diagnosed with cancer each year.



APOLLO Vision

Vision: A federal cancer alliance that through strong research collaborations and partnerships optimizes federal cancer resources, enhances cancer research and discoveries, decreases duplication, leverages technologies, enhances intellectual capital, and increases education and training opportunities. Using advanced methods in proteogenomics to characterize and compare tumors, the alliance develops a deeper understanding of cancer biology by identifying potential therapeutic targets and pathways for cancer prevention, detection, and intervention.





MARCH 17, 2022

Fact Sheet: White House Announces Initial Steps for Reignited Cancer Moonshot

- **The Department of Defense (DOD) is expanding a signature clinical research program to all DOD hospitals.** As part of the Cancer Moonshot in 2016, the DOD launched the Applied Proteogenomics OrganizationaL Learning and Outcomes (APOLLO) network as a collaboration between NCI, the DOD and the Department of Veterans Affairs (VA). The goal of this collaboration is to incorporate proteogenomics into patient care as a way of looking beyond the genome, to the activity and expression of the proteins that the genome encodes. To-date, this network includes thirteen DOD and VA hospitals which started with eight cancer-specific programs, including studies in lung, breast, prostate, ovarian, pancreatic, testicular, and brain cancers, and is now expanding to all cancer types. DOD, as part of the reignited Cancer Moonshot, will now ensure that the APOLLO trial network expands to include every DOD hospital.



APOLLO Projects

• APOLLO 1	Lung Cancer	Published
• APOLLO 2	Ovarian Cancer	Published
• APOLLO 3	Prostate Cancer	
• APOLLO 4	Breast Cancer	
• APOLLO 5	Prospective, Pan-Cancer	
• APOLLO 6	Pancreatic Cancer	
• APOLLO 7	Testicular Germ Cell Tumor	
• APOLLO 8	Glioblastoma	
• APOLLO 9	Krukenberg Tumor	
• <i>APOLLO 10</i>	<i>Sarcoma</i>	<i>Starting</i>
• <i>APOLLO 11</i>	<i>Melanoma</i>	<i>Starting</i>

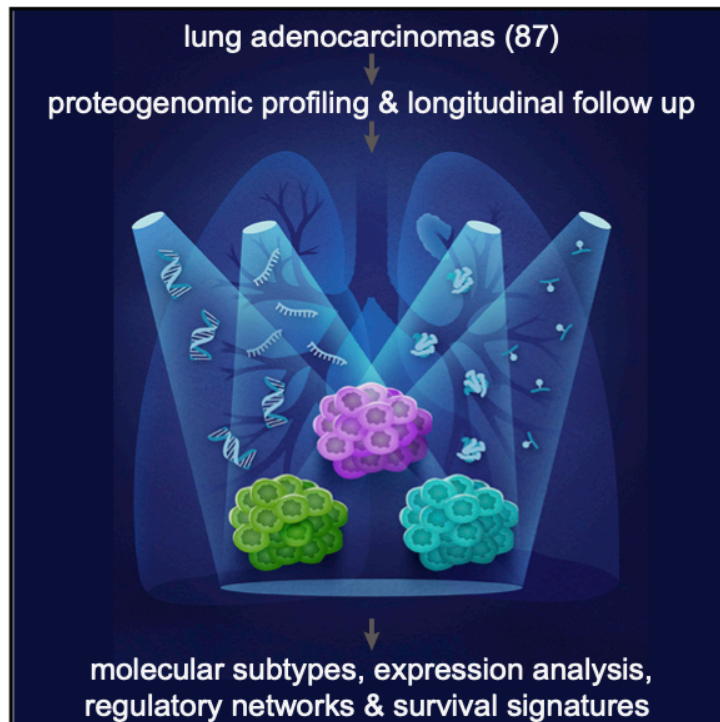
APOLLO 1: Lung Cancer

Cell Reports
Medicine

Article

Proteogenomic analysis of lung adenocarcinoma reveals tumor heterogeneity, survival determinants, and therapeutically relevant pathways

Graphical abstract



Authors

Anthony R. Soltis, Nicholas W. Bateman, Jianfang Liu, ..., Christopher A. Moskaluk, Robert F. Browning, Jr., Matthew D. Wilkerson

- N=87
- Integrated **whole-genome sequencing**, **transcriptome sequencing**, **proteomics** and **phosphoproteomics** (mass spectrometry), and **reverse-phase protein arrays**
- Identified 3 subtypes by somatic genome alterations
- Identified protein and RNA signatures predictive of survival
- Used phosphoproteomic networks to identify potential therapeutic vulnerabilities between subtypes

Soltis et al, *Cell Reports Medicine* 2022

APOLLO 2: Ovarian Cancer

npj | precision oncology

Published in partnership with The Hormel Institute, University of Minnesota

Article

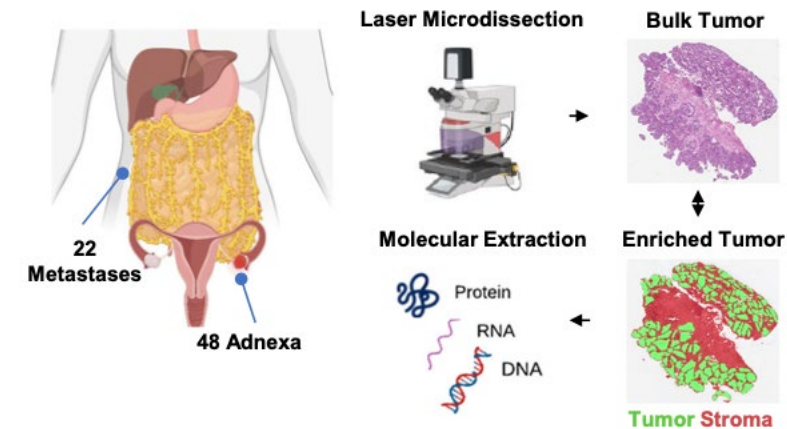


<https://doi.org/10.1038/s41698-024-00519-8>

Proteogenomic analysis of enriched HGSOc tumor epithelium identifies prognostic signatures and therapeutic vulnerabilities

 Check for updates

Nicholas W. Bateman^{1,2,3,32}✉, Tamara Abulez^{1,2}, Anthony R. Soltis⁴, Andrew McPherson⁵, Seongmin Choi⁵, Dale W. Garsed^{6,7}, Ahwan Pandey⁸, Chungqiao Tian^{1,2}, Brian L. Hood^{1,2}, Kelly A. Conrads^{1,2}, Pang-ning Teng^{1,2}, Julie Oliver^{1,2}, Glenn Gist^{1,2}, Dave Mitchell^{1,2}, Tracy J. Litz^{1,2}, Christopher M. Tamey¹, Barbara A. Crothers⁸, Paulette Mhawech-Fauceglia⁹, Clifton L. Dalgard⁴, Matthew D. Wilkerson⁴, Mariaelena Pierobon¹⁰, Emanuel F. Petricoin¹⁰, Chunhua Yan¹¹, Daoud Meerzaman¹¹, Clara Bodelon¹², Nicolas Wentzensen¹², Jerry S. H. Lee¹³, The APOLLO Research Network*, David G. Huntsman¹⁴, Sohrab Shah⁵, Craig D. Shriver³, Neil T. Phippen¹, Kathleen M. Darcy^{1,2,3}, David D. L. Bowtell^{6,7}, Thomas P. Conrads^{1,3,15,32}✉ & G. Larry Maxwell^{1,3,15,32}✉



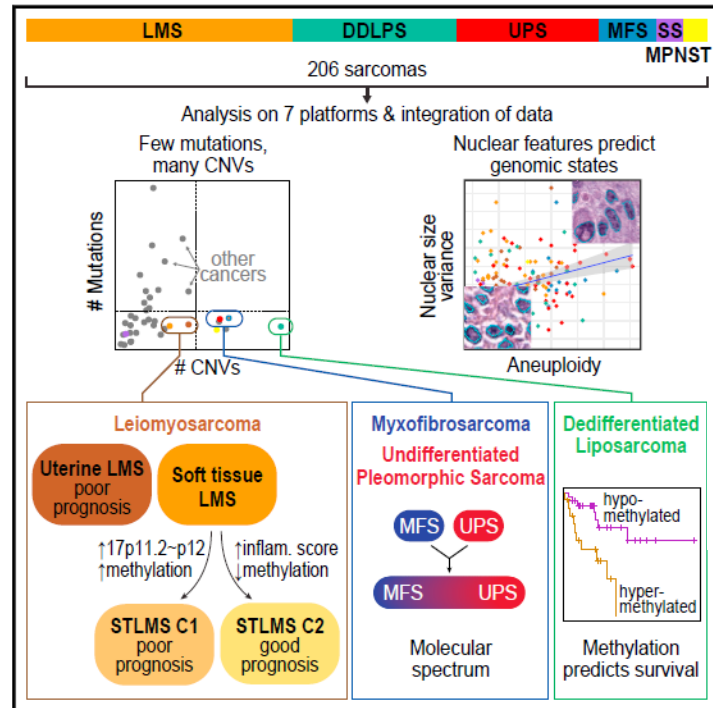
- N=70
- Increased immune-related signatures associated with longer PFS
- Elevated polycomb complex protein BMI-1 correlated with poor OS in homologous recombination proficient (HRP) high-grade serous ovarian cancer (HGSOc)
- HRP HGSOc cells sensitive to BMI-inhibition

Sarcoma Multi-omics Literature

Cell

Comprehensive and Integrated Genomic Characterization of Adult Soft Tissue Sarcomas

Graphical Abstract



Authors

The Cancer Genome Atlas Research Network

nature communications



Article


<https://doi.org/10.1038/s41467-023-39486-2>

The proteomic landscape of soft tissue sarcomas

Received: 11 August 2022

Accepted: 15 June 2023

Published online: 29 June 2023

 Check for updates

Jessica Burns¹, Christopher P. Wilding¹, Lukas Krasny¹, Xixuan Zhu², Madhumeeta Chadha¹, Yuen Bun Tam¹, Hari PS¹, Aswanth H. Mahalingam¹, Alexander T. J. Lee¹, Amani Arthur¹, Nafia Guljar¹, Emma Perkins^{1,3}, Valeriya Pankova¹, Andrew Jonks¹, Vanessa Djabatey¹, Comelia Szecsei¹, Frank McCarthy¹, Chanthirika Ragulan¹, Martina Milighetti¹, I. Roumeliotis⁴, Stephen Crosier⁵, Martina Finetti⁶, Shoudhary⁴, Ian Judson⁵, Cyril Fisher⁷, Eugene F. Schuster^{8,9}, Sadanandam¹, Tom W. Chen^{10,11}, Daniel Williamson⁵, Khin Thway^{1,3}, Jones^{2,3}, Maggie C. U. Cheang² & Paul H. Huang¹✉

nature communications

Article


<https://doi.org/10.1038/s41467-024-45306-y>

Proteomic characterization identifies clinically relevant subgroups of soft tissue sarcoma

Received: 29 April 2023

Accepted: 18 January 2024

Published online: 15 February 2024

 Check for updates

Shaoshuai Tang^{1,6}, Yunzhi Wang^{1,6}, Rongkui Luo^{2,6}, Rundong Fang^{1,6}, Yufeng Liu^{2,6}, Hang Xiang¹, Peng Ran¹, Yexin Tong¹, Mingjun Sun¹, Subei Tan¹, Wen Huang², Jie Huang², Jiacheng Lv¹, Ning Xu¹, Zhenmei Yao¹, Qiao Zhang¹, Ziyang Xu¹, Xueting Yue¹, Zixiang Yu², Sujie Akesu², Yuqin Ding^{2,3}, Chen Xu^{2,3}, Weiqi Lu⁴, Yuhong Zhou⁵, Yingyong Hou^{2,3} & Chen Ding¹✉

microenvironment to inform clinical trials of checkpoint inhibitors.

nature communications



Article


<https://doi.org/10.1038/s41467-025-58678-6>

Genomic, transcriptomic, and immunogenomic landscape of over 1300 sarcomas of diverse histology subtypes

Received: 7 May 2024

Accepted: 24 March 2025

Published online: 06 May 2025

 Check for updates

Alex Soupir^{1,2,3}, Oscar E. Espina^{1,2,3}, Oliver Hampton², Michelle Churchman², Michael Radmacher², Dale Hedges², David McKean², Phaedra Agius², Saman Zeeshan³, Nathan D. Seligson⁴, Raphael Pollock⁵, David Liebner⁶, James L. Chen⁶, Gabriel Tinoco⁶, Bodour Sathia⁷, Martin McCarter⁸, Breelyn A. Wilky⁸, Benjamin J. Miller⁹, Michael J. Cavar¹⁰, John S. Groundland¹¹, Bryan P. Schneider¹², Gregory Riedinger¹³, Stephen B. Edge¹⁴, Christopher A. Moskaluk¹⁵, Kenneth Cardona¹⁶, Abdul Rafef Naqash¹⁷, Ricardo J. Gonzalez¹⁸, John E. Mullinax¹⁸, David M. Joyce¹⁹, Odion Binitie¹⁹, G. Douglas Letson¹⁹, Arash O. Naghavi¹⁹, Mihaela Druta¹⁹, Damon R. Reed²⁰, Erin M. Siegel²¹, Jamie K. Teer¹, Brooke L. Fridley^{1,2,22} & Andrew S. Brohl¹⁸✉



Specimens

- Freshly obtained tissue (lesional and non-lesional control)
 - Frozen embedded in OCT (optimal cutting temperature compound)
 - Snap frozen
 - Formalin-fixed paraffin-embedded (FFPE)
- Liquid specimens
 - Blood (serum, plasma, RBC component, clot)
 - Urine
 - Other body fluids as appropriate





Data

- EPIDEMIOLOGY QUESTIONNAIRE – Page 8
- ## 7.0 FAMILY CANCER HISTORY
1. Has anyone in your family (blood relatives only) ever been diagnosed with any of the following types of cancer?
- ☐ No ☐ Yes → If yes, indicate type of cancer for each family member in the chart below.
- | | Lymphoma | Colon/Rectum | Lung | Mouth/Pharynx | Breast | Urinary Bladder | Leukemia | Prostate | Ovary | Thyroid | Melanoma | Other (specify if female) |
|-----------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|---------------------------|
| Mother | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Father | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Sister | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Sister (2) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Brother | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Brother (2) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Son | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Son (2) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Daughter | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Daughter (2) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Grandfather (P) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Grandmother (P) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Grandfather (M) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Grandmother (M) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
- Other:
- ---



APOLLO Core Facilities

USU's The American Genome Center

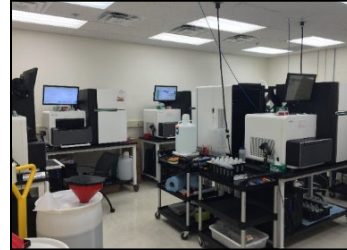
Robotic Liquid
Handling Platform



LIMS-enabled
Clustering Stations



HiSeq X Ten System



CSSIMM at Windber Biorepository

Liquid Nitrogen Storage



Minus 80 degree Celsius freezers

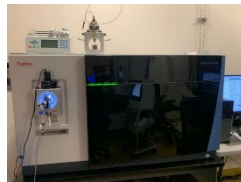


Laser micro-dissection (LMD)



APOLLO Clinical Proteomics Platform

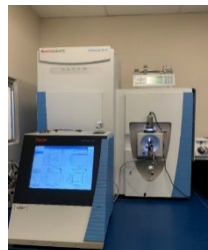
2 Lumos Fusion Orbitraps



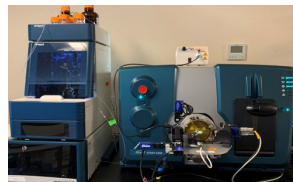
1 Exploris 480 Orbitrap



5 Q-Exactive HF-Xs

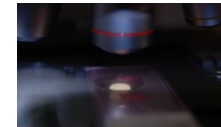
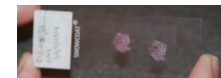


2 Q-Trap 6500 Triple Quadrupoles



APOLLO Research Pathology Center

Cellular Harvest by Laser Microdissection





Study

Multi-omics approach characterizing
molecular signatures in adults with soft
tissue and bone sarcoma, including
pretreated patients

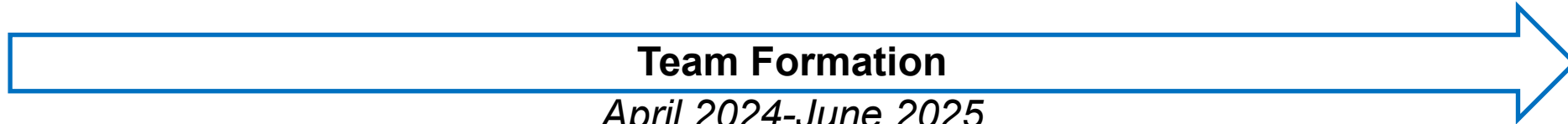


APOLLO 10: Project Timeline



Project Initiation

March 2024



Proposal Submission to Budget Finalization

January 2025-May 2025





Formation of APOLLO 10 Team

- TAGC
 - Drs. Wilkerson, Dalgard *et al*
- APOLLO LCMD/proteomics team
 - Drs. Conrads, Petricoin, Bateman *et al*
- MCCRP/APOLLO informatics and operational teams
 - Drs. Hu, Kvetcher *et al*



Formation of APOLLO 10 Team

- Subject matter experts
 - Chandrajit Raut, MD, MSc
 - Ashley Anderson, MD
 - Jason Sicklick, MD
 - Suzanne George, MD
 - David Shulman, MD
 - *Emily Keung, MD*
 - *John Mullinax, MD*
- Pathology core
 - Aaron Auerbach, MD
 - Christian Curcio, MD
 - Jason Hornick, MD, PhD
 - Oluwole Fadare, MD
- External computation working group
 - Ludmil Alexandrov, PhD
 - Vineet Bafna, PhD
 - Hannah Carter, PhD
 - Trey Ideker, PhD
 - Rob Knight, PhD
 - Jill Mesirov, PhD
- Project manager/CRC
 - Catherine Pellegrini
 - Kodey Silknitter, PhD
 - Maggie Connolly