

ANNUAL REPORT

ABI 

2022

**ARMENIAN
BIOINFORMATICS
INSTITUTE**

Scientific Educational Foundation

The Armenian Bioinformatics Institute (ABI) is a non-profit private foundation, launched in February of 2021 to support bioinformatics capacity building and the development of precision medicine and modern biotechnologies. This report summarizes the second year of our activities.

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31 December 2022

ARMENIAN BIOINFORMATICS INSTITUTE
Scientific Educational Foundation



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01

INTRODUCTION

BIOINFORMATICS: A CRUCIAL TOOL FOR ADVANCING PRECISION MEDICINE AND BIOTECHNOLOGY

Bioinformatics is a field that combines biology, data, and computer science to advance the fields of precision medicine, pharma, and biotechnology. It provides the tools and methods necessary for the analysis and interpretation of the large amounts of data generated by high-throughput technologies in the life sciences, allowing researchers to make more informed decisions.

In precision medicine, bioinformatics is used to identify genetic and molecular markers that can be used to predict an individual's response to a particular treatment, allowing doctors to tailor their treatment plans to each individual patient. In biotechnology, bioinformatics is used to design and optimize experiments, analyze and interpret the resulting data, and develop new products and therapies.

As the need for skilled bioinformaticians grows, the demand for bioinformatics training and education is also increasing. With a negative employment rate of more than 50%, bioinformatics is one of the most needed competencies of the 21st century. Hence, national/regional bioinformatics institutes and infrastructures have been established worldwide in the last 20 years. Their aim is to set up standards and capacity for genomic data collection, distribution, and analysis.

ARMENIAN BIOINFORMATICS INSTITUTE: MISSION AND GOALS

The Armenian Bioinformatics Institute (ABI) was founded in February 2021 with the core mission to strengthen research capacity and excellence in bioinformatics and related fields, such as precision medicine and modern biotechnologies. Our goal is to train the next generation of bioinformaticians, who will be instrumental in driving the continued growth and success of precision medicine and biotechnology.

While research is the main focus of ABI, we also have a strong commitment to developing the next generation of qualified young talents through educational activities. We also partner with industry to drive economic impact.

VISION

LAUNCH

Unite talents around the idea.

VISIBILITY

Critical mass of people

Established institute with international visibility

IMPACT

Demonstrate impact on the broader ecosystem

1st
year

3^d
year

5th
year

10th
year



WE ARE HERE

- 5 research labs
- 30 bioinformatics PhDs
- An idea-stage startup/spin-off from ABI

- Essential infrastructure for bioinformatics research in the region
- Human capital to attract modern biotech/precision medicine companies to Armenia
- Late-stage startups in modern biotech
- Precision medicine adapted in local hospitals & laboratories

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HIGHLIGHTS OF 2022

RESEARCH

- **Research team**

Research team expanded to 20 members.

- **Projects**

projects in cancer-omics, single-cell transcriptomics, microbiome & more

- **Mentor & Mentee program**

launch of second Mentor & Mentee program for postdoctoral researchers

- **Grants**

1. PMI Science & EIF grant to support microbiome research
2. Swedish Institute grant for networking in grapevine genomics
3. FAST ADVANCE grant for grapevine genomics research



EDUCATION

- **OMICSS-22**

the second genome bioinformatics summer school

- **OMICSS Guide 2022**

an amended guide to bioinformatics fundamentals for all

- **Advanced Molecular Biology course**

- **Seminars in single-cell and cancer omics**



INDUSTRY COLLABORATIONS

- **Agenus collaboration started**

A team at ABI conducts research in collaboration with Agenus, a US-based company focused on cancer immunotherapies.

- **Vivan Therapeutics team expanded**

ABI provides bioinformatics data analysis support to Vivan Therapeutics, a UK-based startup focused on precision medicine.



PEOPLE

- **ABI Board of Trustees welcomes**

Dr. Aram Adourian

Senior Scientific Advisor at Flagship Pioneering

- **ABI Advisory Board welcomes**

Rafi Baghdjian

Advisor to foundations, former Shell executive

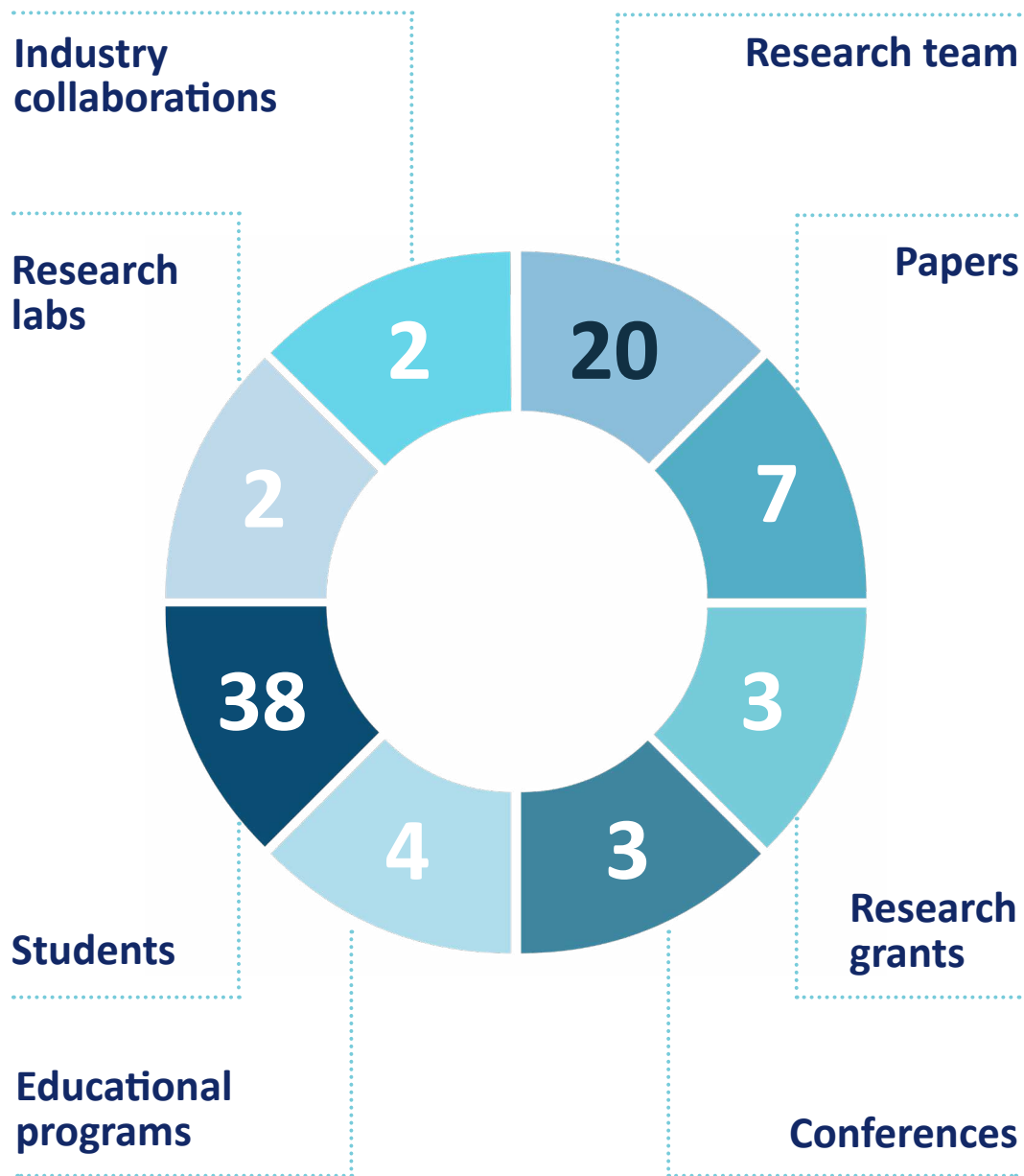
Eduard Avetisyan

IT team lead at EMBL, Hamburg



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2022 IN NUMBERS



04

EDUCATION

OMICSS-2022

The OMICSS-22 summer school in genome bioinformatics, organized by ABI and the Institute of Molecular Biology in Armenia and sponsored by Tashir MEDICA, took place from June 14 to August 25, 2022. This intensive program provided training in molecular biology, statistics, programming, and genomic data analysis to 22 students with diverse backgrounds. The organizing team included Maria Nikoghosyan as a mentor and manager, Siras Hakobyan as a mentor, Lilit Nersisyan as a coordinator, OMICSS-21 graduates as junior mentors, and Alisa Hovsepyan as an assistant. The summer school featured nearly 20 speakers from more than 10 countries, who participated in both online and offline seminars.

Of the 22 students who participated in the program, 14 successfully graduated, with 12 of these students participating in a week-long bootcamp

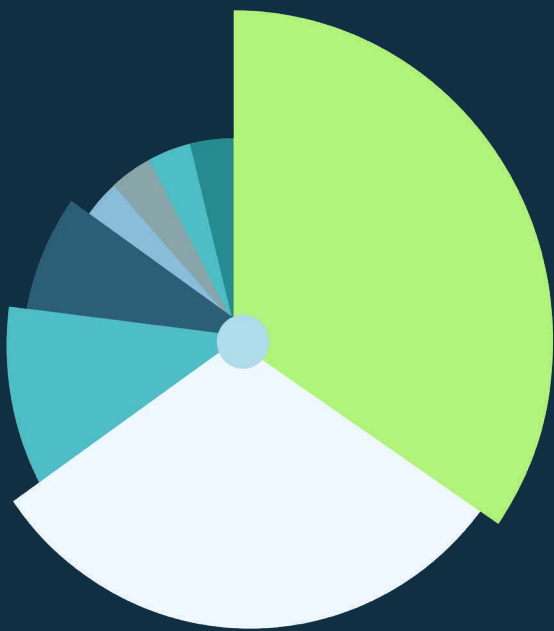
at Sevan, where they worked on seven research projects. Six of the graduates went on to join ABI research projects as interns.

This successful summer school was a great opportunity for students to gain valuable skills and knowledge in the field of genome bioinformatics, and we look forward to continuing to offer similar programs in the future.

<https://abi.am/education/omics-school-2022/>

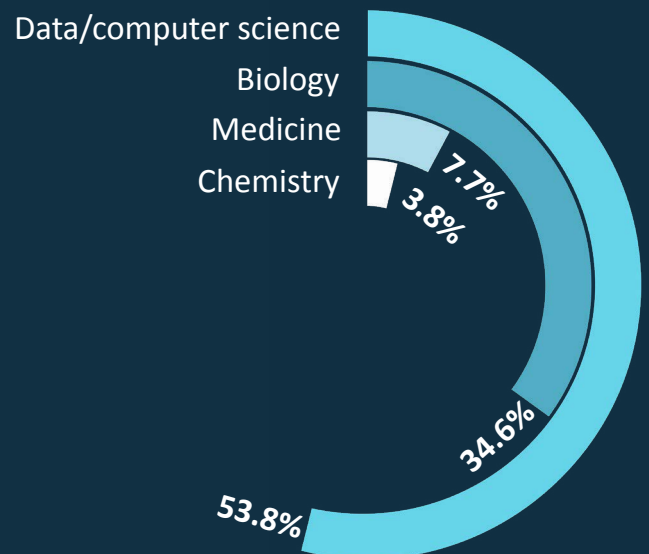
OMICSS-22 student backgrounds

Universities/Institutes



- American University of Armenia
- Yerevan State University
- Yerevan State Medical University
- Institute of Molecular Biology, NAS RA
- Yerevan State University/Göttingen University
- Shanghai Jiao Tong University
- Russian-Armenian University
- Arizona State University

Specialization



OMICSS GUIDE 2022

The OMICSS Guide 2022 is now available to help individuals interested in bioinformatics gain the fundamental knowledge and skills necessary to start their first bioinformatics project. This guide was used as the curriculum for the OMICS School 2022 and is suitable for individuals with a background in biology or data/computer science. The OMICSS Guide 2022 is a successor of the OMICSS Guide 2021 with considerable revisions, additions and amendments.

This comprehensive resource now covers a wide range of topics, including molecular biology, statistics, programming, and genomics data analysis. It is essential for anyone interested in this rapidly growing field, whether for beginners looking to enter the field of bioinformatics or for experienced researchers looking to refresh their knowledge.

<https://abi.am/education/omicss-guide-2022/>

ADVANCED MOLECULAR BIOLOGY COURSE

This year-long course covers the core concepts of molecular and cellular biology, genomes and genetic mechanisms, and much more. The course is open to everyone who wants to deepen their knowledge in molecular biology and is interactive, with weekly readings followed by discussions facilitated by the course instructor. In spring, the course was facilitated by Dr. Meri Hovsepyan (PhD in molecular biology, director for academic affairs at Ayb School, trained by the UCL Institute of Education), and starting from September - by Dr. Alexey Kurnosov (PhD in molecular biology, Advanced biology tutor at London Gates Education group).

SINGLE-CELL AND CANCER-OMICS

Since October 2022, ABI has been collaborating with the University of Leipzig to offer project- and seminar-based learning on various topics in single-cell transcriptomic and cancer *-omics* data analysis. The seminars are prepared and led by ABI students and mentors.

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RESEARCH

BINDER LAB

PI: Hans Binder, PhD

The Binder lab focuses on a diverse array of topics, including the mechanisms of cancer heterogeneity and treatment resistance at the single-cell level, the molecular mechanisms of human aging and the creation of a genome atlas of vine accessions in the Caucasus region. The lab uses machine learning and single-cell *-omics* analysis with the goal of extracting insights from large and complex datasets to study genomic diversity and function. These approaches are part of the lab's efforts to understand and describe genomic regulation and its effects on health and disease and to use this understanding to improve healthcare and preserve biodiversity.

The Binder lab is supervised remotely by Dr. Hans Binder who spends several months each year in Armenia to oversee the lab's operations. The lab is co-led by Maria Nikoghosyan, who is responsible for the grapevine project and is mentored by Dr. Maria Schmidt and Dr. Henry Löffler-Wirth from the University of Leipzig on the single-cell transcriptomics project.

Funding & collaborations

The lab has received funding from the Swedish Institute for a collaboration with the Swedish University of Agricultural Sciences and Iakob Gogebashvili Telavi State University in Georgia and the Institute of Molecular Biology (IMB) in Armenia on the genomic aspects of production of grapes in a changing climate.

From the next year it will also rely on the Foundation for Armenian Science and Technology (FAST) ADVANCE Grant to Hans Binder to carry on the grapevine genomics research project at ABI in collaboration with IMB.

The lab collaborates with the University of Leipzig in Germany, and the Institute of Molecular Biology NAS in Armenia.

Projects

Grapevine genomics

- Population & functional genomics
- Armenian grapevines
- ML & *-omics* integration

Maria Nikoghosyan, PhD student
Tomas Konecny, Postdoctoral researcher
Anush Baloyan, BSc student
Hripsime Gasoyan, MSc student
Emma Hovhannisyan, intern
Levon Galstyan, intern
Kristina Margaryan, PhD (Collaborator, IMB)

Human fibroblast atlas

- Single-cell transcriptomics
- ML & systems biology

Susanna Avagyan, MSc student
Melina Tamazyan, intern
Arpine Grigoryan, intern
Maria Schmidt (Uni Leipzig), mentor
Henry Löffler-Wirth(Uni Leipzig), mentor

Biomarkers of aging

- Population genomics & epigenomics
- Leipzig health atlas

Vardan Saroyan, MD

NERSISYAN LAB

PI: Lilit Nersisyan, PhD

The aim of the Nersisyan lab is to facilitate research in the field of genomics through the development of algorithms and software solutions.

The team is currently focused on various areas, including telomere biology, microbiome research, mRNA degradome analysis, gene therapies, single-cell transcriptomics, and liquid biopsies.

Through the development of computational tools, the Nersisyan lab aims to support biologists in their efforts to advance our understanding of genomics and its role in health and disease.

Funding & collaborations

In 2022, the lab received a Faculty research grant from EIF & PMI Science for microbiome research and partial funding for genetic engineering research from the ARPA institute.

The lab collaborates with the Institute of Molecular Biology NAS and Yerevan State University in Armenia, the Karolinska Institute in Sweden, and the Wyss Institute at Harvard University in the US.

Projects

Microbiome

- Metagenomics, metatranscriptomics & metatranslatomics
- Interactions of microbiota with drugs and other molecules

Nelli Vardazaryan, MSc student

Gene therapy

- Computational tools used in the development of adeno-associated viral vectors
- Algorithm and software development

Tatevik Jalatyan, MSc student
Valeri Vardanyan, Postdoctoral researcher (remote)
Erik Aznauryan (Wyss Institute), mentor

Single-cell transcriptomics

- Development of a new method for RNA velocity estimation
- Single-cell transcriptomics & systems biology
- Software development

Tatevik Jalatyan, MSc student
Lilit Galstyan, intern
Lusine Adunts, intern

Liquid biopsies

- Identification of biomarkers in freely circulating DNA in the blood
- Non-invasive disease diagnostics
- Analysis of repetitive genomic regions

Daria Laricheva, BSc student (remote)
Jakub Wudarski, Postdoctoral researcher (remote)
Emil Harutyunyan, intern
Samvel Yerznkyan, intern

MENTOR & MENTEE PROGRAM

The ABI Mentor & Mentee program is a global initiative that connects life science Postdoctoral fellows with junior researchers at ABI, providing mentorship and support for data analysis in their research projects. In this program, the junior researcher shares their skills and knowledge in bioinformatics, and data analysis, while the postdoc provides guidance in their field of expertise.

The first M&M program was launched in 2021, with Dr. Erik Aznauryan from the Wyss Institute at Harvard University and Tatevik Jalatyan, a junior researcher at ABI, working under the supervision of Dr. Lilit Nersisyan to analyze ade-no-associated viral vectors for gene delivery applications.

Starting in May 2022, our second M&M program was successfully launched with Dr. Jakub Wudarski, a Specially Appointed Assistant Professor at the National Institute for Basic Biology in Japan, and Daria Laricheva, a remote junior researcher at ABI. Supervised by Dr. Lilit Nersisyan, this project is aimed at using liquid biopsies, a term referring to DNA freely floating in the blood, to identify new biomarkers for non-invasive disease diagnostics.

INDUSTRY COLLABORATION: VIVAN THERAPEUTICS

Vivan Therapeutics is a UK-based biotech company that focuses on the development of decision platforms for personalized cancer therapeutics. In 2022, we entered into a service provision agreement with Vivan Therapeutics and have been collaborating with them since.

This year, our team at ABI has expanded to include MSc students Susanna Avagyan and Daniil Igumnov, who are supervised by Dr. Hans Binder and work closely with the Vivan team. The project involves the collection, management, integration, and analysis of vast amounts of genomics and clinical data, utilizing a range of techniques including machine learning, classification, statistics, and systems biology approaches.

This collaboration is part of our longer term vision to build the R&D ecosystem in Armenia and we are looking forward to continuing our work in the field of personalized cancer therapeutics with Vivan.



INDUSTRY COLLABORATION: AGENUS

ABI has had a successful year collaborating with Agenus, a US-based biotech company specializing in the development of cancer immunotherapies. Under a sponsored research agreement, we have recruited and trained a team of three students and two interns who are working under the supervision of Dr. Hans Binder, Dr. Lilit Nersisyan, and Dr. Arsen Arakelyan, in close collaboration with the Agenus team. The team performs basic research relevant to Agenus, focusing on cancer heterogeneity, tumor microenvironment, and the genomic and epigenomic determinants of treatment response with the applications of machine learning, systems biology, and *-omics* data integration techniques.

We are looking forward to continuing this collaboration with the ultimate goal of building expertise to bring advances in precision medicine to Armenia.

The logo for AGENUS features the word "agenus" in a lowercase, sans-serif font. The letter "a" is colored red, while the remaining letters "genus" are in a dark grey color.

PUBLICATIONS IN 2022

- Binder H, Schmidt M, Hopp L, Davitavyan S, Arakelyan A, Loeffler-Wirth H. **Integrated Multi-Omics Maps of Lower-Grade Gliomas.** *Cancers* 2022, Vol 14, Page 2797. 2022;14: 2797. doi:10.3390/CANCERS14112797
- Loeffler-Wirth H, Hopp L, Schmidt M, Zakharyan R, Arakelyan A, Binder H. **The Transcriptome and Methylome of the Developing and Aging Brain and Their Relations to Gliomas and Psychological Disorders.** *Cells* 2022, Vol 11, Page 362. 2022;11: 362. doi:10.3390/CELLS11030362
- Nikoghosyan M, Loeffler-Wirth H, Davitavyan S, Binder H, Arakelyan A. **Projection of High-Dimensional Genome-Wide Expression on SOM Transcriptome Landscapes.** *BioMedInformatics* 2022, Vol 2, Pages 62-76. 2022;2: 62–76. doi:10.3390/BIOMEDINFORMATICS2010004
- Nersisyan S, Gorbonos A, Makhonin A, Zhiyanov A, Shkurnikov M, Tonevitsky A. **isomiR-Tar: a comprehensive portal of pan-cancer 50-isomiR targeting.** *PeerJ.* 2022;10: e14205. doi:10.7717/PEERJ.14205/SUPP-3
- Goukassian D, Arakelyan A, Brojakowska A, Bisserier M, Hakobyan S, Hadri L, et al. **Space flight associated changes in astronauts' plasma-derived small extracellular vesicle microRNA: Biomarker identification.** *Clin Transl Med.* 2022;12: e845. doi:10.1002/CTM2.845
- Nersisyan S, Zhiyanov A, Zakharova M, Ishina I, Kurbatskaia I, Mamedov A, et al. **Alterations in SARS-CoV-2 Omicron and Delta peptides presentation by HLA molecules.** *PeerJ.* 2022;10: e13354. doi:10.7717/PEERJ.13354
- Loeffler-Wirth H, Rade M, Arakelyan A, Kreuz M, Loeffler M, Koehl U, Reiche K, Binder H. **Transcriptional states of CAR-T infusion relate to neurotoxicity – lessons from high-resolution single-cell SOM expression portraying.** *Front Immunol.* 2022;13: 5395. doi:10.3389/FIMMU.2022.994885/BIBTEX

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CONFERENCES & EVENTS

- Dr. Lilit Nersisyan presented the study on “Telomere maintenance pathway activity analysis” as an invited speaker at the virtual conference “**Telomeres and Cancer Biology**” organized by the German Cancer Research Center (DKFZ), Germany. The work was published in collaboration with the IMB Bioinformatics Group and the University of Leipzig.
- **ELIXIR All Hands 2022.** Dr.Lilit Nersisyan participated in the annual gathering of national bioinformatics nodes of the European network ELIXIR as a guest in June 2022 and presented the state of the Armenian bioinformatics ecosystem.
- **Starmus VI.** ABI participated at the Starmus Science Camp, presenting our activities and opportunities to join ABI. In the framework of Science Camp Dr. Arsen Arakelyan had a public talk about the importance of bioinformatics in modern medicine.
- **Science and Technology Convergence Conference (STCC).** Dr. Hans Binder, Dr. Arsen Arakelyan, Dr. Jonathan Schug and Dr. Lilit Nersisyan had a panel discussion about the role of bioinformatics in life sciences. The students also presented their projects with four posters.
- **BioJapan exhibition.** The Armenian Bioinformatics Ecosystem including the Institute of Molecular Biology NAS RA, Russian-Armenian University and ABI were presented by Dr. Arsen Arakelyan.
- **FAST Global Innovation Forum (GIF22).** In the framework of the GIF22s panel on “Future of Precision Medicine”, Dr. Hans Binder participated as a speaker and discussed the role of bioinformatics, genomics and AI in precision medicine.
- **Drylands, Deserts and Desertification Conference.** Dr. Tomas Konecny, a postdoctoral researcher at Binder lab participated in the 8th international conference of Drylands, Deserts and Desertification (Nov. 27-Dec.1) in Israel. During the poster session he presented his project about a Self-Organizing Maps-based machine learning method that boosts the study of (epi-)genetics of the vine *Vitis Vinifera*.
- **BioML EVN Meetings.** On November 24 during the Bioml EVN meeting Dr. Hans Binder and Hripsime Gasoyan, an MSc student at Binder lab, did a presentation on the topic of Innovative Vine-bioinformatics in Armenia.
- **Bioinformatics training program in SLU.** Anush Baloyan, a research student at Binder lab, has participated in a two-month Bioinformatics training program at the Swedish University of Agricultural Sciences (SLU) in the city of Uppsala. The training was part of our joint grant program with SLU and Iakob Gogebashvili Telavi State University on the topic of Production of Grapes in a Changing Climate (ProGriCC) funded by the Swedish Institute.

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PEOPLE

DIRECTOR

Lilit Nersisyan, PhD

BOARD OF TRUSTEES

1. Hans Binder, PhD, Chairman
ABI, University of Leipzig, Germany
2. Arsen Arakelyan, PhD, Board member
Institute of Molecular Biology NAS, Armenia
3. Aram Adourian, PhD, Board Member
Flagship Pioneering, USA

OPERATIONS TEAM

1. Karine Shahgaldyan, HR Administrative Assistant
2. Mariam Hovsepyan, Legal expert
3. Sona Melikjanyan, Graphic Designer
4. Khachatur Ashotyan, System Administrator
5. Volodya Poghosyan, Full-Stack Developer

ADVISORY BOARD

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K.A.K. Doo, Macedonia
6. Rafi Baghjian,
Centre for Scientific Innovation and
Education Foundation in Armenia
7. Eduard Avetisyan,
European Molecular Biology Laboratory,
Germany

Former members

6. Alisa Hovsepyan, Administrative Assistant
7. Mariam Simonyan, Communications Manager

RESEARCH TEAM

1. Hans Binder, PhD, PI
2. Lilit Nersisyan, PhD, PI
3. Arsen Arakelyan, PhD, PI
4. Siras Hakobyan, PhD Student
5. Maria Nikoghosyan, PhD Student
6. Tomas Konecny, Postdoc
7. Erik Aznauryan, Postdoc *
8. Valeri Vardanyan, Postdoc *
9. Jakub Wudarski, Postdoc *
10. Stepan Nersisyan, Postdoc
11. Tatevik Jalatyan, MSc student
12. Nelli Vardazaryan, MSc student
13. Susanna Avagyan, MSc student
14. Hripsime Gasoyan, MSc student
15. Anush Baloyan, BSc student
16. Anna Kudryavtseva, MSc student
17. Ohanes Ashekyan, MSc student
18. Daniil Igumnov, MSc student
19. Nerses Shahbazyan, MD student
20. Vardan Saroyan, MD
21. Daria Laricheva, BSc student
22. Lilit Galstyan, MSc student, intern
23. Yeva Bareghamyan, MSc student, intern
24. Emil Harutyunyan, BSc student, intern
25. Emma Hovhannisyan, BSc student, intern
26. Lusine Adunts, BSc student, intern
27. Melina Tamazyan, BSc student, intern
28. Arpine Grigoryan, BSc student, intern
29. Levon Galstyan, BSc student, intern

ALUMNI

1. Narek Shamamyan - MSc student of Educational technology at Saarland University
2. Arabo Apresyan - PhD student at the University of Bonn, Germany
3. Mher Kurghinyan - Student at Yerevan State Medical University

** Some of the researchers have contributed part time, remotely and/or in-kind*

OMICSS-22 SPEAKERS

1. Stepan Nersisyan, Thomas Jefferson University, USA
2. Davit Sargsyan, Janssen PRD (J&J), USA
3. Hans Binder, ABI, Leipzig University, Germany
4. Arsen Arakelyan, ABI, Institute of Molecular Biology NAS, Armenia
5. Lilit Nersisyan, ABI, Armenia
6. Meri Hovsepyan, Ayb School, Armenia
7. Vardges Tserunyan, University of Southern California, USA
8. Anna Hakobyan, Max Perutz labs, Austria
9. Roza Selimyan, Johns Hopkins Bloomberg School of Public Health, USA
10. Gegham Jivanyan, Scimagine, Armenia
11. Aram Adourian, ABI, Flagship Pioneering, USA
12. Haig Eskandarian, UCSF, USA
13. Ashot Margaryan, University of Copenhagen, Denmark
14. Aram Minasian, Agilent Technologies, USA
15. Maria Nikoghosyan, ABI, Institute of Molecular Biology NAS, Armenia
16. Jonathan Schug, University of Pennsylvania, USA
17. Narek Dshkhunyan, 10x Genomics, USA
18. Araks Martirosyan, KU Leuven, Belgium
19. Chrats Melkonian, Wageningen University and Research, The Netherlands
20. Sandrine Da Cruz, KU Leuven, Belgium
21. Lilit Grigoryan, Stanford University, USA
22. Siras Hakobyan, ABI, Institute of Molecular Biology NAS, Armenia

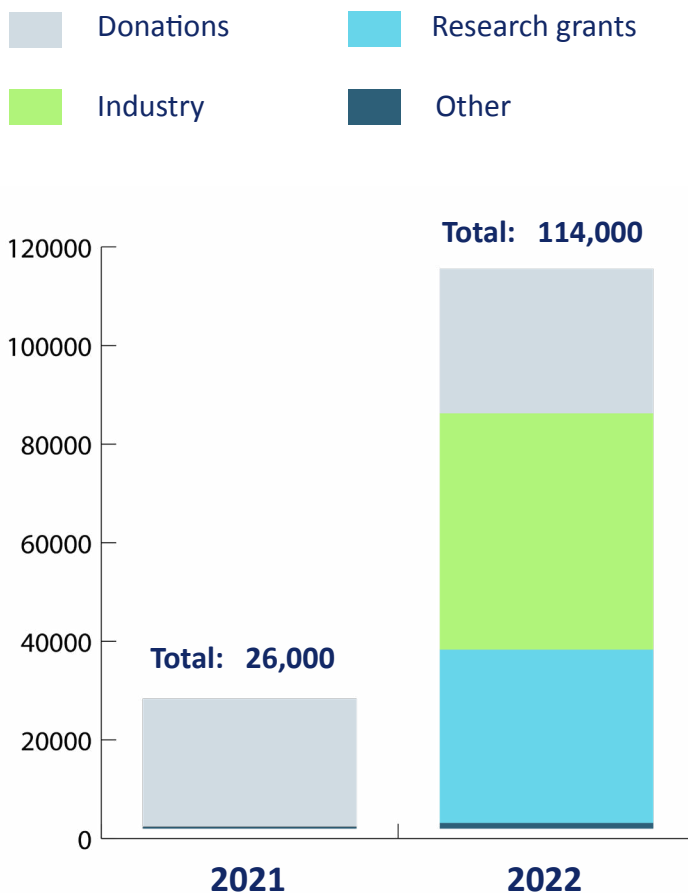
08

FUNDING

ANNUAL CASH FLOWS

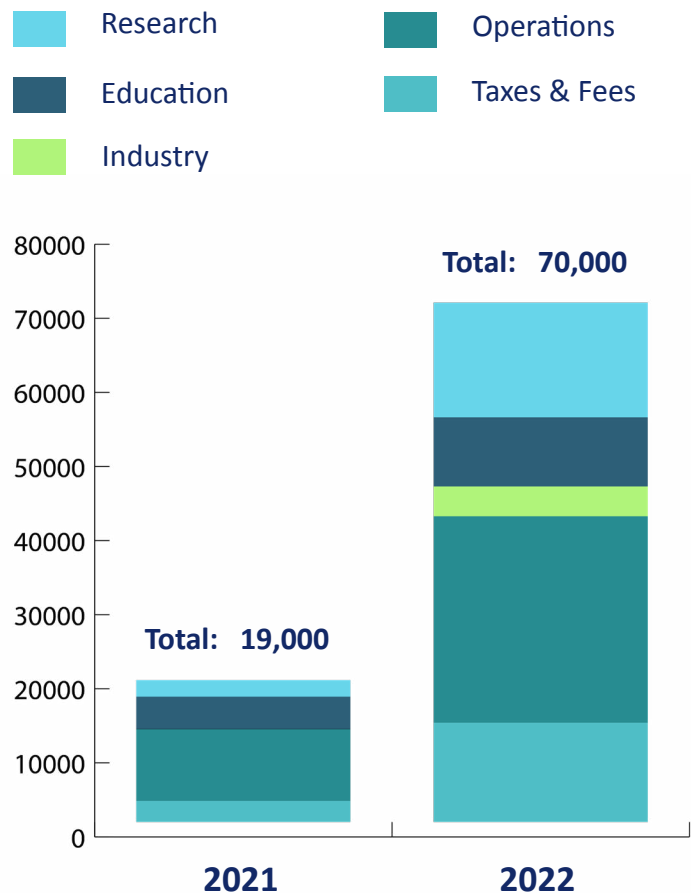
In 2022, both sources of income and expenses more than tripled compared to the previous year. In the first year, we relied solely on donations to fund the development of our human resources and prepare for other sources of funding. Consequently, in 2022, in addition to donations, industry collaborations and research grants became major sources of income for our organization.

Income, USD



Many researchers also made in-kind contributions by dedicating their valuable time to our projects, which is not reflected in our expense charts. Thanks to these efforts, we have secured the necessary funds to expand our team in 2023 and continue our ongoing activities. We will continue with fundraising activities to enable further growth and the realization of additional projects.

Expense, USD



* We have changed the way we consider fund distribution between 2021 & 2022 in comparison to the report of 2021.

DONORS

We are grateful to the private donors and organizations that trusted us and supported our mission. Their contributions have had a significant impact on our organization, including the expansion of our research team and economic growth.

- 100+ Individual Donors
- Tashir MEDICA
- ARPA institute
- SmartClick
- SOFT PAPYRUS
- Health Fund for Children of Armenia

Donation Matching Organizations On Benevity

- Adobe Armenia
- AMD
- Synopsis
- Spotify

INDUSTRY COLLABORATIONS

- Agenus
- Vivan Therapeutics

FUNDRAISING CAMPAIGNS

ReArmenia campaign: ABI has launched a fundraising campaign on the reArmenia platform to raise funds for the establishment of a genome bioinformatics computing infrastructure for researchers and students at ABI and other institutions in Armenia.

RESEARCH GRANTS

- Philip Morris International (PMI) and Enterprise Incubator Foundation (EIF)
- Swedish Institute

DONATE



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Website: <https://abi.am>

