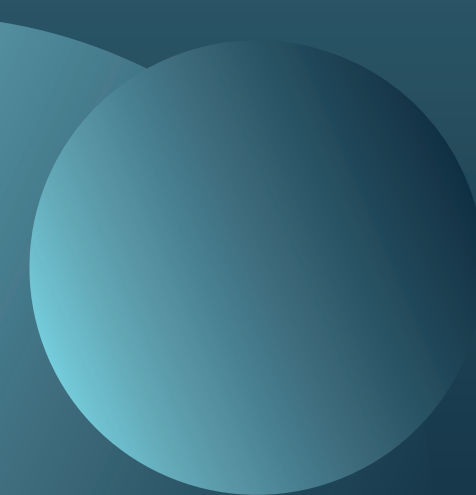


# ANNUAL REPORT

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Armenian  
Bioinformatics  
Institute

20  
21



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# Introduction

Genomic medicine, biotechnologies, ecosystem management are fields that offer a myriad of opportunities for a better life around the world. Leveraging these opportunities, however, requires relevant expertise that is currently lacking in Armenia.

With this in mind, the Armenian Bioinformatics Institute (ABI) was established in 2021 with the core mission to strengthen research capacity and excellence in bioinformatics and related fields, such as biomedicine, biotechnology and biodiversity preservation. While research is the main focus of ABI, it strongly supports educational activities to develop a capital of qualified young talents. ABI also engages in industrial partnerships, facilitating the economic impact of computational biology and biomedicine.

# Who we are

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The Armenian Bioinformatics Institute (ABI) is a nonprofit scientific-educational foundation established in February 2021. It aims at promoting data-driven studies in biomedicine and biotechnologies with international impact. ABI is envisioned as an interdisciplinary and cross-sectoral R&D center for building bioinformatics expertise and infrastructure. ABI focuses on three challenge areas: genomics for health, biotechnology, and biodiversity.

# Our mission

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- Promote scientific progress in bioinformatics
- Conduct basic and applied research in computational biology and life sciences
- Develop human capital in bioinformatics and life sciences
- Build international collaborative networks
- Provide services to the academia, the healthcare system, and the industry.

# Our vision

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**1<sup>st</sup>**  
year

**Mobilize talents around the idea**

**3<sup>d</sup>**  
year

**Reach a critical mass of people**

- 5 Independent labs

**5<sup>th</sup>**  
year

**Become an established place for cutting edge research with international impact**

**10<sup>th</sup>**  
year

**Drive developments in the biotech industry and precision medicine in Armenia and abroad**

# Highlights of 2021

February

## ■ Establishment of ABI

The Armenian Bioinformatics Institute (ABI) is officially registered as a nonprofit scientific educational foundation.

June  
-  
August

## ■ OMICS Summer School

In Summer 2021, ABI in collaboration with the Institute of Molecular Biology in Armenia had a Summer School in Genome Bioinformatics. The school, sponsored by Tashir Medica, offered undergraduate and graduate students, as well as young researchers, extensive training in molecular biology, statistics, programming, experimental methods in molecular biology, and genomic data analysis. The school concluded with projects related to SARS-CoV-2 genome analysis. Participants also got to know 38 speakers from 11 countries, heard their perspectives on the academic and industrial opportunities in bioinformatics. After OMICSS 2021, ten participants got involved with ABI Research School under the supervision of scientists from Armenia and abroad.

## ■ ARPA Scholarship to First ABI Student

After finishing his Bachelor's degree in Computer Science at AUA and defending his capstone on Telomeric Sequence Analysis in cell-free DNA under the supervision of Dr. Lilit Nersisyan (ABI) and Varderes Barsegyan (Freenome Holdings, Inc, USA), ABI Student Narek Shamamyan received a research scholarship from ARPA Institute to continue his studies for six more months at ABI.

September

## ■ Weekly Journal Clubs and Group Meetings

Journal Clubs (JC) and Group Meetings (GM) are hosted via Zoom every week. ABI researchers, guest speakers and students present and discuss published papers and their ongoing projects. 8GMs and 12JCs were conducted in 2021.

## ■ Machine Learning Group Led by ABI Student

Once a week, ABI Student Hripsime Gasoyan leads the meetings of the Machine Learning Group. Participants explore the fundamentals of linear algebra, statistics, artificial intelligence, and more.

## ■ Launch of Mentor & Mentee Program

The new Mentor & Mentee program provides life science Postdoctoral fellows worldwide with a chance to expand their bioinformatics skills by getting mentorship for the data analysis aspects of their research while also mentoring an ABI student and engaging them in their research. The program kickstarted with the collaboration of Dr. Erik Aznauryan (postdoctoral fellow at Church lab, Wyss Institute, Harvard University) and Tatevik Jalatyan (Data Science student at the American University of Armenia).



October

### ■ Partnership with ARPA Institute

The newly-forged partnership between ABI and ARPA Institute, one of ABI's first supporters.

### ■ ARPA Scholarship to Second ABI Student

ABI research student Tatevik Jalatyan has been awarded a six-month research scholarship by ARPA Institute to conduct a research project in collaboration with Erik Aznauryan, as part of ABI's Mentor and Mentee program. The project is about discovering new viral vectors for gene delivery.



November

### ■ Opening of Binder Lab

The first international lab was opened and led by ABI Chairman Dr. Hans Binder, who regularly spends some time of the year in Armenia. Currently, three ABI students, two ABI mentors, and three mentors from the University of Leipzig are engaged in the lab's activities. The lab's central interests are understanding genomic regulation of complex age-related disorders, as well as exploring genomic diversity of Armenian grapevine varieties by developing and applying comprehensive analysis methods around machine learning kernels for large multidimensional omics data.

### ■ Applied Bioinformatics course by Hans Binder

The 14-week-long Applied Bioinformatics course by ABI Chairman Hans Binder covers the core concepts of molecular medicine, life and data sciences, as well as gives an insight into emerging and promising research areas and addresses disputed topics in Bioinformatics. It is open to everyone interested in learning more about Bioinformatics.

### ■ Advanced Molecular Biology course by Meri Hovsepyan

The full-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 of Molecular Biology and is interactive, with weekly readings followed by discussions facilitated by the course instructor.



December

### ■ Launch of OMICS Guide

The guide offers the possibility to gain the fundamental knowledge and skills one would need to start their first Bioinformatics project: from the basics of molecular biology and programming to bioinformatics analysis of genome sequences. Those who accomplish the exams may have an opportunity to get an internship at ABI.

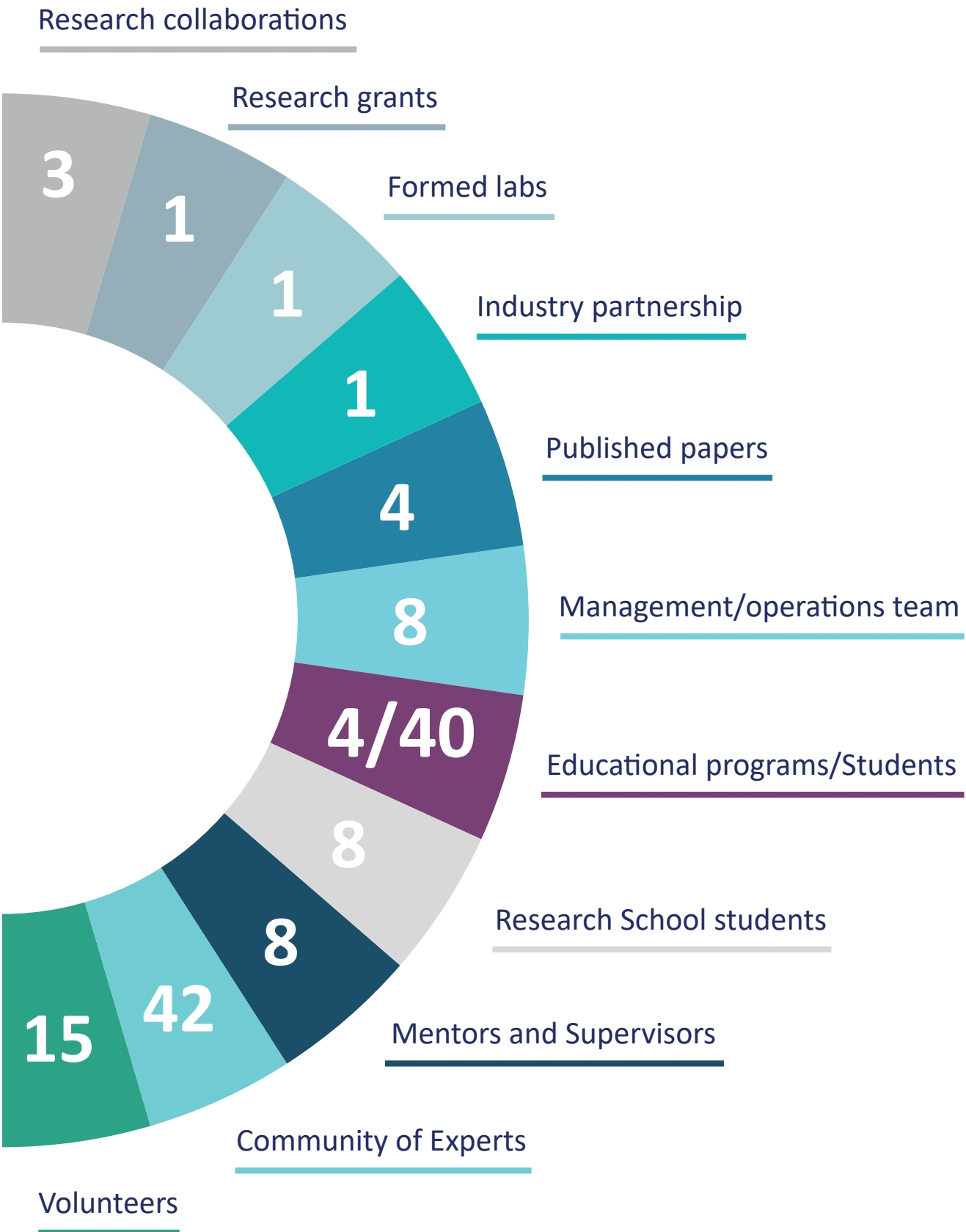
### ■ EIF and PMI Science Faculty Research Grant

ABI has received a research grant from the Enterprise Incubator Foundation (EIF). With the provided support, ABI's founding director Lilit Nersisyan and three ABI students will study the effect of cigarettes and e-cigarettes on the human microbiome.

### ■ Industry partnership with Vivan Therapeutics

Vivan Therapeutics, a London-based biotechnology company, has initiated a partnership with ABI. ABI Research Student Susanna Avagyan is engaged in their research projects under the supervision of ABI Chairman Dr. Hans Binder and the support of ABI mentors.

# 2021 in numbers



# Research

Research projects at ABI are organized within programs of different formats:

- Research labs
  - Binder lab
- Research school
  - Student project supervision by bioinformatics researchers
  - Mentor & Mentee program led by life science postdocs

## Research labs

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### *Binder lab*

The Binder lab has its focus on omic bioinformatics and systems biology in different areas of life sciences and biomedicine. It brings together scientists and students from ABI and Leipzig University, where Hans Binder is a principal investigator.

The lab currently hosts three ABI students - Vardan Saroyan, Hripsime Gasoyan, and Susie Avagyan - who work on projects related to the molecular mechanisms of human aging, genomic evolution of COVID-19, the origin of vine cultures in Armenia, as well as personalized genomic diagnostics of cancer.

## Research school

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### *Student project supervision by bioinformatics researchers*

ABI Research School provides an opportunity for students to learn bioinformatics by engaging them in research projects supervised by researchers from Armenia or abroad. The projects serve as an entry to a junior researcher's position, or as a capstone for a bachelor's or master's thesis, and can eventually lead to a publication.



## Mentor and Mentee Program

The ABI Mentor & Mentee program supports life science postdoctoral fellows around the world to get mentorship for the data analysis aspects of their research while mentoring an ABI student and engaging them in their projects. The students share their knowledge and skills with the postdoc, while the postdoc shares the details of their study.

### Research School Projects



**Design and analysis of AAV vectors for gene editing applications (part of Mentor and Mentee Program)**

*Life Science Postdoc*

Dr. Erik Aznauryan, Church Lab,  
Wyss Institute, Harvard University, USA



Supervisor: Dr. Lilit Nersisyan, ABI



*Bioinformatics Student*

Tatevik Jalatyan, Data Science BSc at AUA



**Developmental neuroscience and single cell transcriptomics**

Supervisor: Dr. Araks Martirosyan,  
KU Leuven, Belgium



Student: Arabo Apresyan,  
Resident at YSMU



**Molecular mechanisms of aging**

Supervisor: Prof. Hans Binder,  
Leipzig University, Germany & ABI



Student: Vardan Saroyan,  
Resident at YSMU



**Oncogenic pathway alterations across large scale cancer studies**

Supervisor: Anna Hakobyan, PhD  
student at Max Perutz Labs, Austria



Student: Nelly Vardazaryan, MSc  
student in Molecular and Cell  
Biology at ISEC NAS RA



**Evaluation of genetic risk factors for complex human disorders**

Supervisors: Dr. Arsen Arakelyan, ABI and Maria  
Nikoghosyan, PhD student at Institute  
of Molecular Biology NAS RA



Student: Anush Baloyan,  
Data Science BSc at AUA



**Analysis of SARS-CoV-2 Variants**

Supervisor: Prof. Hans Binder, Leipzig  
University, Germany & ABI



Student: Hripsime Gasoyan,  
BSc in Applied Math from YSU



**Finding telomere-related cancer biomarkers in cell free DNA (completed)**

Supervisor: Dr. Lilit Nersisyan, ABI



Student: Narek Shamamyan,  
BSc in Computer Science from AUA



**Signaling pathways states in health and disease with integrative genomics**

Supervisors: Dr. Arsen Arakelyan, ABI and  
Siras Hakobyan, PhD Student, Institute of  
Molecular Biology NAS RA



Student: Mher Kurghinyan,  
Student at YSMU



# Collaborative research projects

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ABI is collaborating with a few labs from Armenia and abroad. Below are a couple of stories from these cooperations resulting in joint publications in 2021.

## ***On the SARS-CoV-2 genomic variations***

A cooperative project between ABI and Leipzig University studied the diversity and evolution of SARS-CoV-2 using machine learning. The approach portrayed the genomic patterns and explored the impact of mutations in different SARS-CoV-2 lineages.

Another project led by Dr. Arsen Arakelyan at the Institute of Molecular Biology (IMB) in Armenia and the Russian-Armenian University, performed genomic surveillance of SARS-CoV-2 lineages in Armenia using whole genome sequencing.

## ***Machine learning for genomics research***

In collaboration with the Institute of Molecular Biology and the University of Leipzig, two complementary approaches for transfer learning have been developed to enable integration and analysis of multiple genomic datasets in the context of genome medicine.

## ***Glioma***

In an extensive study, Leipzig and Yerevan deciphered the diversity and molecular mechanisms of brain tumors based on their transcriptomes and methylomes. It revealed a complex multi-omic landscape with an impact for prognosis and personalized diagnostics.

# Publications

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## **2022**

- Nikoghosyan, M., Loeffler-Wirth, H., Davidavyan, S., Binder, H. & Arakelyan, A. Projection of High-Dimensional Genome-Wide Expression on SOM Transcriptome Landscapes. *BioMedInformatics 2022, Vol. 2, Pages 62-76* **2**, 62–76 (2022).
- Loeffler-Wirth, H. et al. The Transcriptome and Methylome of the Developing and Aging Brain and Their Relations to Gliomas and Psychological Disorders. *Cells 2022, Vol. 11, Page 362* **11**, 362 (2022).

## **2021**

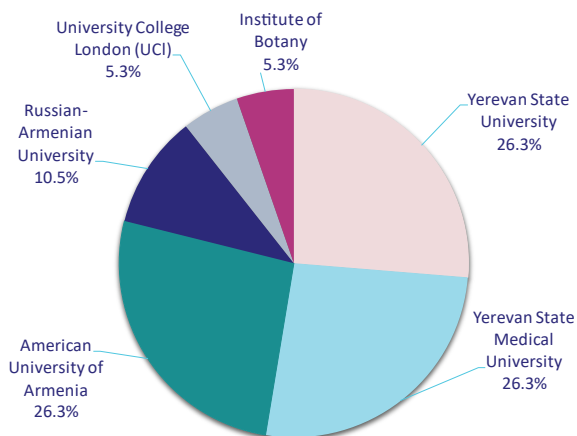
- Avetyan, D. et al. Molecular Genetic Analysis of SARS-CoV-2 Lineages in Armenia. *medRxiv 2021.06.19.21259172* (2021).
- Schmidt, M. et al. The Evolving Faces of the SARS-CoV-2 Genome. *Viruses 2021, Vol. 13, Page 1764* **13**, 1764 (2021).
- Willscher, E. et al. High-Resolution Cartography of the Transcriptome and Methylome Landscapes of Diffuse Gliomas. *Cancers 2021, Vol. 13, Page 3198* **13**, 3198 (2021).
- Al-Sanea, M. M. et al. Identification of Novel Potential VEGFR-2 Inhibitors Using a Combination of Computational Methods for Drug Discovery. *Life 2021, Vol. 11, Page 1070* **11**, 1070 (2021).

# Education

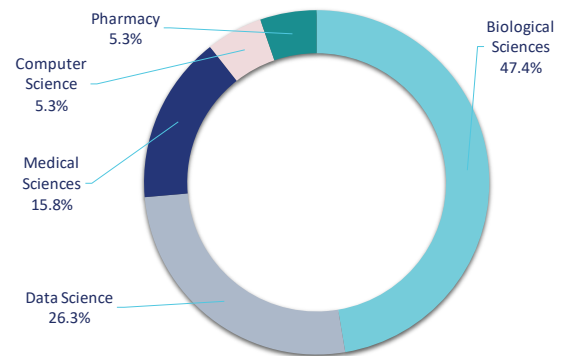
## OMICS School

In Summer 2021, ABI in collaboration with the Institute of Molecular Biology NAS RA had a Summer School in Genome Bioinformatics. The school was sponsored by Tashir Medica, mentored by PhD students Maria Nikoghosyan and Siras Hakobyan, and coordinated by Dr. Lilit Nersisyan. It offered undergraduate and graduate students, as well as young researchers, extensive training in molecular biology, statistics, programming, experimental methods in molecular biology, and genomic data analysis. The school concluded with projects related to SARS-CoV-2 genome analysis. The participants also got to know the 38 speakers from 11 countries, heard their perspectives on the academic and industrial opportunities in bioinformatics. After OMICSS 2021, some of the participants got involved with ABI Research School under the supervision of scientists from Armenia and abroad.

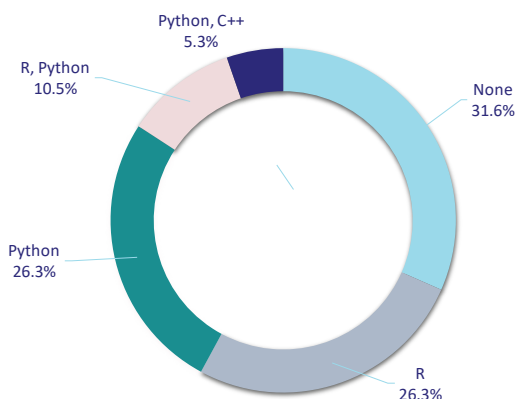
*Universities*



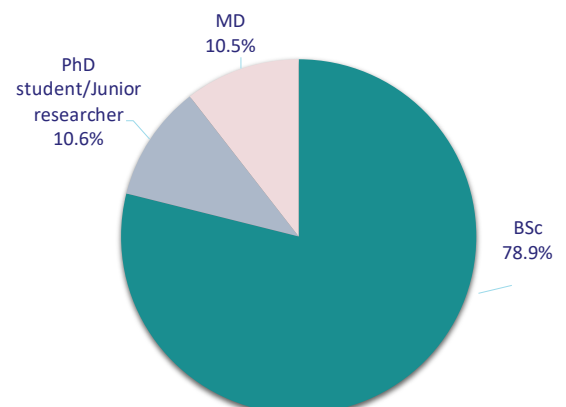
*Specialization*



*Programming languages*



*Degrees Pursued*



# Courses

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## ***Applied Bioinformatics course by Hans Binder***

The 14-week-long Applied Bioinformatics course by ABI Chairman Hans Binder covers the core concepts of molecular medicine, life data sciences, as well as gives an insight into emerging and promising research areas and addresses disputed topics in Bioinformatics. It is open to everyone interested in learning more about Bioinformatics.

## ***Advanced Molecular Biology course by Meri Hovsepyan***

The full-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 of Molecular Biology and is interactive, with weekly readings followed by discussions facilitated by the course instructor.

## ***Machine learning course***

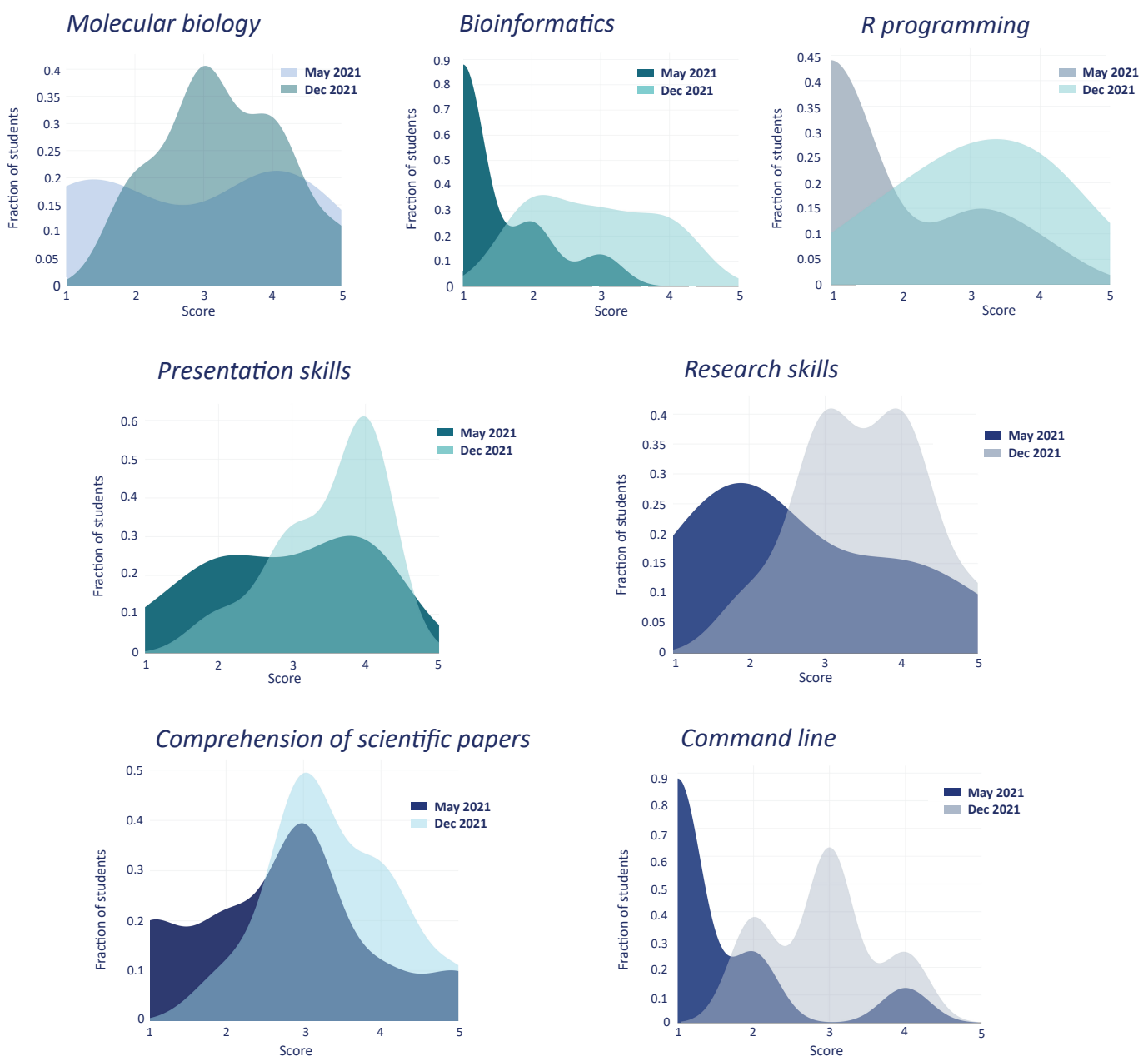
Once a week, ABI Student Hripsime Gasoyan leads the Machine Learning Group. The participants explore the fundamentals of linear algebra, statistics, artificial intelligence, and more.



# Outcomes of Research School and OMICSS-2021

As a result of the OMICS School-2021, 10 students have joined ABI to continue their journey in bioinformatics at the Research School, participating in research projects, educational activities, and weekly meetings with the ABI international community.

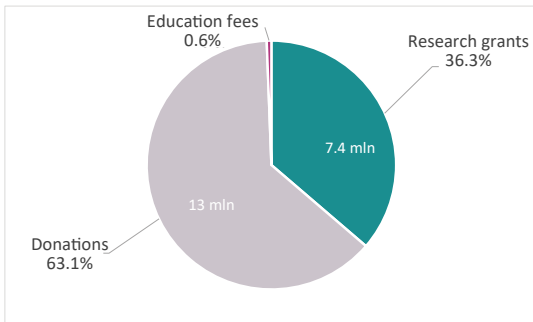
To assess the outcomes of these activities, we have conducted a survey to measure the progress in research and soft skills through the months May-December 2021, as self-assessed by the students. Below are some graphs highlighting the main outcomes on a scale of one to five.



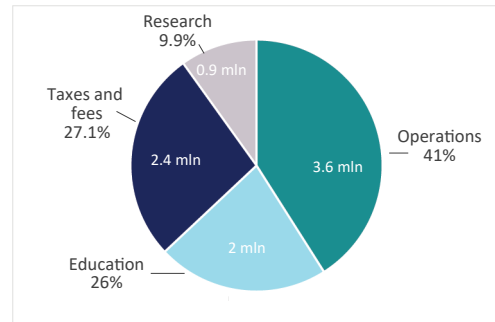
# Funding

We are grateful for the continued and much appreciated support of our community members, individual donors, and funding organizations, which in 2021 helped us conduct research in life sciences and lead bright students toward academic achievements.

Sources of funding in AMD (total: 20.4 mln)



Expenditures in AMD (total: 8.9 mln)



## Donors

### Organizations



### Individuals

over 1000\$	3 people
over 500\$	4 people

over 100\$	5 people
up to 100\$	31 people

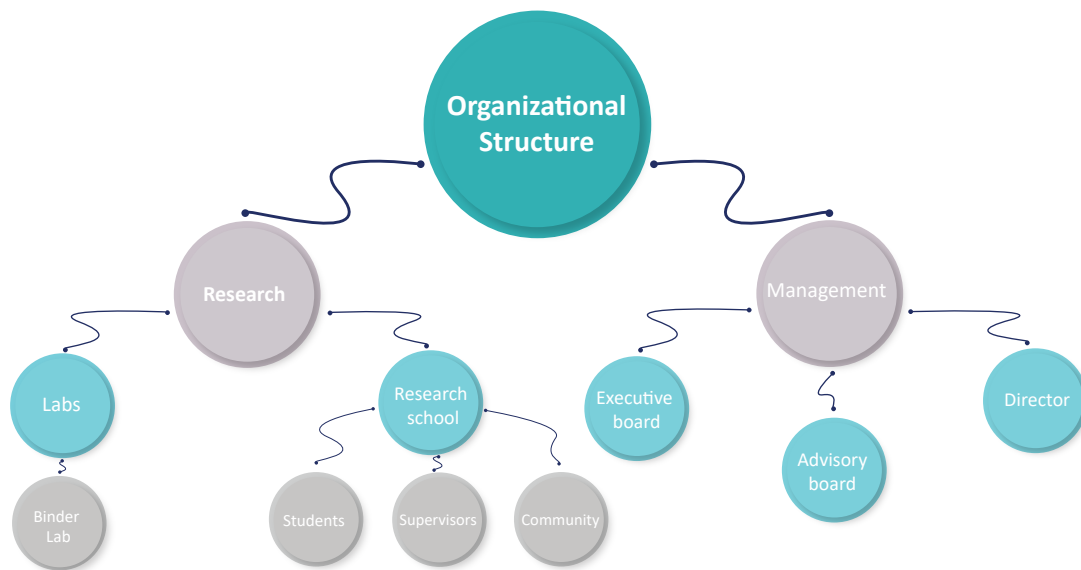
## Research grants



PMI SCIENCE  
PHILIP MORRIS INTERNATIONAL



# Organizational structure



## Our team

### Director

Lilit Nersisyan

### Executive Board

1. Hans Binder, *Chairman*
2. Arsen Arakelyan, *Board member*
3. Narek Dshkhunyan, *Board Member*

### Advisory Board

1. Jonathan Schug, *University of Pennsylvania, USA*
2. Aram Adourian, *Flagship Pioneering, USA*
3. Peter Stadler, *University of Leipzig, Germany*
4. Ogsen Gabrielyan, *Boehringer Ingelheim, Germany*
5. Hovhannes Harutyunyan, *Wayfair, Germany*
6. Hripsime Hovakimyan Kuzevska, *K.A.K. Doo, Macedonia*

### ABI Mentors and Supervisors

1. Hans Binder, *ABI, Leipzig University, Germany*
2. Lilit Nersisyan, *Karolinska Institutet, Sweden*
3. Anna Hakobyan, *Max Perutz labs, Austria*
4. Siras Hakobyan, *Institute of Molecular Biology NAS, Armenia*
5. Araks Martirosyan, *KU Leuven, Belgium*
6. Maria Nikoghosyan, *Institute of Molecular Biology NAS, Armenia*
7. Erik Aznauryan, *Harvard University, USA*
8. Arsen Arakelyan, *ABI, BIG IMB NAS RA, Armenia*

### Operations Team

1. Nane Khachikyan, *Marketing Specialist*
2. Alisa Hovsepyan, *Administrative Assistant*
3. Sona Melikjanyan, *Graphic Designer*
4. Mariam Hovsepyan, *Legal Expert*

### Research Students

1. Tatevik Jalatyan
2. Nelly Vardazaryan
3. Arabo Apresyan
4. Hripsime Gasoyan
5. Vardan Saroyan
6. Mher Kurghinyan
7. Anush Baloyan
8. Susanna Avagyan

## Guest speakers of OMICSS-2021

1. Meri Hovsepyan, *Ayb School, Armenia*
2. Vahe Momjyan, *Webb Fontaine, Armenia*
3. Roza Selimyan, *University of Maryland, USA*
4. Anna Hakobyan, *Max Perutz labs, Austria*
5. Hans Binder, *ABI, Leipzig University, Germany*
6. Vardges Tserunyan, *University of Southern California , USA*
7. Anahit Galstyan, *University of Cologne, Germany*
8. Martun Karapetyan, *Software Engineer, Armenia*
9. Lilit Grigoryan, *Stanford University, USA*
10. Shushan Sargsian, *NYU School of Medicine, USA*
11. Davit Sargsyan, *Janssen PRD (J&J), USA*
12. Volha Tryputsen, *Janssen R&D (J&J), USA*
13. Javier Cabrera, *Rutgers University, USA*
14. Diana Avetyan, *Institute of Molecular Biology, Armenia*
15. Vardan Andriasyan, *University of Zurich, Switzerland*
16. Stepan Nersisyan, *Higher School of Economics, Russia*
17. Hasmik Yepiskoposyan, *PMI R&D, Switzerland*
18. Arsen Arakelyan, *ABI, BIG IMB NAS RA, Armenia*
19. Araks Martirosyan, *KU Leuven, Belgium*
20. Ashot Margaryan, *University of Copenhagen, Denmark*
21. Lilit Atanesyan, *MRC Holland, Netherlands*
22. Haig Eskandarian, *UCSF, USA*
23. Alexandria Papa, *Inari, USA*
24. Ara Abramyan, *Schrödinger, USA*
25. Erik Aznauryan, *Harvard University, USA*
26. Aram Adourian, *Flagship Pioneering, US*
27. Ruzanna Leemann-Zakaryan, *Innovation Park, EPFL, Switzerland*
28. Arsen Gasparyan, *Masis Vardanyan, Tashir MEDICA, Russia*
29. Hrant Hovhannisyan, *Barcelona Supercomputing, Center Spain*
30. Lilit Nersisyan, *Karolinska Institutet, Sweden*
31. Jonathan Schug, *University of Pennsylvania, USA*
32. Sargis Sedrakyan, *University of Southern, California USA*
33. Ogsen Gabrielyan, *Boehringer Ingelheim, Germany*
34. Vrouyr Bilemjian, *Surflay Nanotec GmbH, Germany*

## Alumni

Narek Shamamyán



# How to support us

## Join us!



<https://abi.am/community/>

- Join the student community
- Participate in our weekly meetings
- Become a project supervisor
- Become a life science postdocs in the M&M program

## Donate!



<https://donate.abi.am/>

- Card payments
- Bank transfer
- Tax deductible donations

# ABI media presence

## ABI in media



<https://abi.am/abi-media-presence/>

- Public talks and interviews
- Seminars and forums
- Media articles

