Interdisciplinary Science and Research Program

ANNUAL REPORT 2023-24

Collaborative for STEM Education and Outreach

Interdisciplinary Science & Research Program
Stratford STEM HS

Hillsboro High School
AGHS
Interdisciplinary Science and Research Program
1939

John Overton High School
Interdisciplinary Research Academy

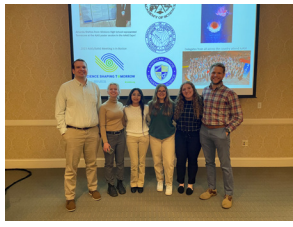
Interdisciplinary Science and Research Program Overview

The Interdisciplinary Science and Research (ISR) Program is a partnership between the Vanderbilt Collaborative for STEM Education and Outreach and Metropolitan Nashville Public Schools. The program aims to enhance students' understandings of STEM concepts and research principles while empowering teachers through scientific research.

ISR is currently available at three Metro Nashville high schools: Stratford STEM Magnet High School, Hillsboro High School, and John Overton High School. All ISR courses are **co-taught by a Metro Public schools teacher and a Vanderbilt scientist**, with a focus on providing individualized instruction to meet student needs. The ISR curriculum is designed to guide students from exploring science topics of interest to investigating how these scientific topics work. As students advance, ISR provides them with opportunities to share their ideas with broader scientific and community audiences.

ISR offers a collection of unique opportunities for students, such as dual enrollment with Tennessee Tech University and **multiple summer internship experiences**.

Since it began in 2010, **over 700 students** have participated from the ISR program. The Interdisciplinary Science and Research Program is elevating both the teaching and learning of STEM—preparing students to solve 21st century problems, and be critical thinkers and leaders.



2023-24 BY THE NUMBERS

225
STUDENTS

37
GRADUATES

32
STUDENTS
participated in summer internships, including the REHSS & SHIRE programs

94
INDUSTRY CERTIFICATES
completed by students

37
STUDENTS
earned dual enrollment credit through Tennessee Tech

50+
FIELD TRIPS & JOB SHADOWS

36
STUDENTS
recognized as Tennessee Ready Graduates

$28k+
GRANT FUNDING
awarded to teachers, fellows & students

29
STUDENTS
presented research at local science events with

10
AWARD WINNERS

Our ISR Team

VANDERBILT UNIVERSITY COLLABORATIVE FOR STEM EDUCATION AND OUTREACH

Angela Eeds, Ph.D.
Executive Director

Amanda Dixon, M. Ed.
Assistant Director

Nathaniel Freymeyer, Ph.D.
Program Manager
STEM Student Research

Nicolas Means, Ph.D.
ISR Scientist
Hillsboro High School

Natalie Wallace, Ph.D.
ISR Scientist
Stratford High School

Ryan Bowen, Ph.D.
ISR Scientist
John Overton High School

METRO NASHVILLE PUBLIC SCHOOLS

Jesi Seifert, M. Sci.
ISR Teacher
Stratford STEM Magnet School

Joshua Swartz, Ph.D.
ISR Teacher
Hillsboro High School

Gregory Smith, Ph.D.
ISR Teacher
John Overton High School

*Select headshots are provided courtesy of The Ayin Project

2023-24 School Highlights

First ISR Student Attends ISEF

Alex Zambrano became the first Overton student to win the Grand Prize award at the Middle Tennessee Science and Engineering Fair (MTSEF). In May, they traveled with their ISR Scientist, Dr. Nathaniel Freymeyer, to the International Science and Engineering Fair (ISEF) in Los Angeles. Their project was titled "Effect of Cyanobacteria on *Dugesia dorotocephala*" and was completely conducted within the ISR lab.

Additionally, Alex completed the REHSS program and submitted their project "Observing the Role of the p75 Neurotrophin Receptor on Cerebral Organoids", carried out with Dr. Bruce Carter and Dr. Hrishita Das, to the Regeneron Science Talent Search. Alex will attend the University of Oregon and double major in Marine Biology and Neuroscience.

Alex was also named the John Overton High School Student of the Year.

> "I enjoyed the outreach day because I got to share my opinions on scientific theories with other people from different categories, and seeing how science can truly unite people from all backgrounds, and then the pin exchange was pretty awesome as well because I got to meet all these people prior to judging which had an impact on how comfortable I felt while talking about my research."
>
> —Alex on ISEF

ISR will benefit from a $750,000 3-year gift to the CSEO to expand student research opportunities from Regeneron. This funding provided support for the inaugural year of the SHIRE program and for Dr. Freymeyer's attendance at the 2025 International Science and Engineering Fair (ISEF).

Collaborative Learning

- In the fall of 2023, ISR seniors from all three schools gathered at the Vanderbilt Collaborative for STEM Education and Outreach for the inaugural ISR Senior Collaboration Day. Together with their teachers and Vanderbilt teaching fellows, students discussed ideas for their final research projects, heard talks from recent ISR alumni, and provided constructive feedback on the ISR program.
- Hillsboro sophomores and juniors and Stratford juniors enjoyed a three-day trip to the Coon Creek Science Center in West Tennessee. They dug and preserved 76 million-year-old fossils with UT Martin paleontologists and learned about the evolution of life from Vanderbilt's Evolutionary Sciences Initiative. The highlight of the trip was astronomy where they observed the rings of Saturn and Jupiter's moons.
- Other opportunities for collaborative learning include the ISR Symposium, Tennessee Junior Academy of Sciences (TJAS) annual meeting, REHSS, and SHIRE.

Testimonials

"I would recommend ISR to other students because it helps teach valuable skills and provides amazing opportunities. The ISR program taught me writing skills, presentation skills, and how always to improve myself. The program did not only teach me academic lessons but also personal lessons. It provided me with a lot of meaningful relationships."

—Natalie, Class of 2023

"I have enjoyed that ISR has challenged me in ways that I didn't know possible, and it pushed me to be better in ways that I didn't know I could."

—Valary, Class of 2027

"ISR has been a great program, offering fun and challenging experiences as well as pre- paring me for the next level of education after high school. ISR has offered more ideas and opportunities than I was aware existed and opened up so many different fields of science."

—Jalen, Class of 2025

"ISR is a wonderful program that has given me opportunities to expand my research skills. Through presentations, research reports, collaborations, and independent projects I am now more equipped for my future in science. ISR led me to an internship opportunity at Vanderbilt (REHSS) that exposed me to real labs as well as gave me a stepping stone to get my research published. ISR is a one of kind experience that has allowed me to go beyond the normal high school scope of science."

—Gracie, Class of 2024

Community Partners

In addition to Vanderbilt University and Peabody College, many community partners and organizations contribute each year to the success of the ISR program by providing field trip sites, transportation, supplies, and additional support. ISR partners include:

Course Progression

	Content-Focused Courses	Research-Focused Courses
Explore **9th grade**	**Interdisciplinary Science I:** Students develop an understanding of the fundamental concepts essential to scientific inquiry.	
Investigate **10th grade**	**Interdisciplinary Science II:** In this accelerated, multidisciplinary course, students investigate real-world relevant research questions under major themes during each nine-week period.	**Research I:** Students develop an understanding of the fundamental concepts essential to scientific inquiry. Credit obtained through summer research internship.
Understand **11th grade**	**Interdisciplinary Science III* (ESS 1100: Introduction to Environmental Studies):** This course is a college-level introduction to the field of environmental studies requiring an understanding of diverse topics including biology, toxicology, sociology, and anthropology. Students will investigate environmental problems involving complex interconnections between people, ecosystems, and the biosphere.	**Research II* (ESS 1200: Environmental Research I):** In this introductory course, students are introduced to all aspects of research with particular emphasis on experimental design, statistics, ethics, writing and communication. Methodologies for observation, data collection, and analysis are explored in greater depth with a focus on cross-discipline application.
Communicate **12th grade**	**Interdisciplinary Science IV* (ESS 2200: Environmental Research II):** An intermediate-level course on conducting research in the environmental sciences and allied fields. Students will be paired with a research mentor and will conduct an undergraduate-level research project.	**Research III* (ESS 2300: Environmental Science Communication):** A course on developing oral and written scientific communication skills necessary to convey research findings in a variety of formats such as oral and poster presentations for conferences and manuscripts for scientific journals.

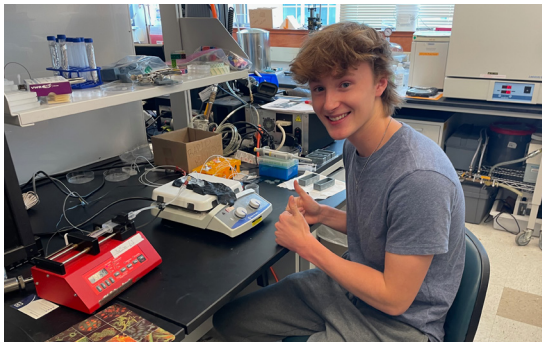
*These courses are eligible for dual-enrollment credit at Tennessee Tech University

Select Colleges & Universities

ISR Graduates Attend or Have Attended

Arizona State University · Austin Peay State University · Belmont University · BYU Brigham Young University · Columbia University in the City of New York · Dartmouth · DePaul · Jacksonville State University · Loyola University Chicago · Middle Tennessee State University · Mississippi State University · Purdue University · Sewanee The University of the South · Tennessee State University · Tennessee Tech · Towson University · Trevecca Nazarene University · UCLA · University of Colorado Boulder · University of Massachusetts Amherst · University of Oregon · The University of Tennessee Chattanooga · The University of Tennessee Knoxville · University of Virginia · Vanderbilt University





Summer Opportunities

Students in the ISR program have the opportunity to experience research-based internships during the summers leading into the junior and senior years. These programs offer MNPS course credit and allow the students to get additional experiences that cannot be offered in a traditional classroom setting.

SHIRE

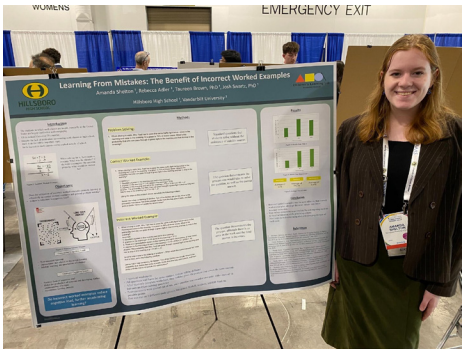
In Summer 2024, the Collaborative for STEM Education and Outreach launched the inaugural Summer High-school Internships in Research Experiences (SHIRE) program in partnership with The Ayin Project and the Nashville POWER Youth Summer Employment Initiative. The SHIRE program is a unique, paid internship to rising juniors and seniors within the ISR programs designed to engage students in invaluable hands-on research, enhance their skill development, and broaden their communication abilities. Additionally, our students successfully obtained either Research I or Career Based Learning MNPS credit. Our interns worked alongside scientists from Vanderbilt's Collaborative for STEM Education and Outreach and educators from their home ISR schools. In our inaugural year, our juniors from John Overton High School and Hillsboro High School dove into cancer biology and engineering principles, obtaining unique skillsets to analyze various problems and perform genetic engineering experiments with the CRISPR-Cas9 system. Our seniors focused on Water Quality Assessment for The Ayin Project and developed their ideas for individual research projects to continue during the fall semester at their home high schools.

REHSS

In Summer 2024, ISR celebrated the 12th anniversary of the Research Experience for High School Students (REHSS) program with a new cohort of students from all three ISR campuses. This summer, our students engaged in an intense, 6-week scientific internship at Vanderbilt University, fully immersing themselves in independent research projects. Under the mentorship of research faculty members, students conducted independent research projects. The REHSS students partnered with the School of Science and Math at Vanderbilt for an annual symposium, where they showcased their summer projects. In addition to this invaluable experience, these students earned Career Based Learning credit for their respective schools and had the opportunity to continue their research in the lab during the fall semester. Students are now preparing their work for the Regeneron Science Talent Search (STS).

Hillsboro High School

Hillsboro High School



"Overall, the ISR program was a wonderful opportunity that prepared me tremendously. Without ISR, I wouldn't have found my love for the research field, as well as how awesome it is to share your discoveries with others."

—Amanda

Hillsboro alumna presents at American Junior Academy of Science (AJAS)

Hillsboro High School alumna Amanda Shelton recently presented her research the 2024 AJAS meeting in Denver, Colorado. Amanda showcased her research, under the guidance of Dr. Bethany Rittle-Johnson at Vanderbilt University – Peabody College of Education.

Grants – Tennessee Valley Authority

The junior class of Hillsboro developed a compelling proposal for the Tennessee Valley Authority grant competition, securing $5,000 to bring their ideas to reality. With these funds, they organized outreach events at local middle and elementary schools for the upcoming fall semester, with the goal to inspire younger students through interactive STEM activities related to environmental hazards, such as plastic pollution. Additionally, their idea to Adopt the Richland Creek steam was successfully implemented this past summer during the SHIRE program, offering hands-on environmental educational opportunites with their peers.

Collaborations, Projects, and Field Trips

- *NanoDay* at Vanderbilt Institute of Nanoscale Science and Engineering (VINSE)
- Metro Water Tours
- Richland Creek
- Overnight camping experience at Coon Creek
- VINSE clean room
- Country Music Hall of Fame tour at the RCA studio B.

Hillsboro High School

ISR Teacher and Fellow Accomplishments

- Dr. Swartz was the 2023 recipient and 2024 finalist for Academy Innovator of the Year through the Academies of Nashville.
- Dr. Swartz attended the 2024 Research Teachers Conference sponsored by Regeneron in Washington D.C. as a session leader.
- Dr. Swartz attended the Samsung Solve for Tomorrow winners conference in Denver, Colorado during summer of 2023.
- Dr. Nicolas Means started at Hillsboro High School full-time in January 2024.

Student Accomplishments and Presentations

DELANEY FLEMING, CLASS OF 2024

"Investigating the impact of electrolyte content and carbohydrate content on the transfer of microplastics from disposable plastic bottles into drinks" **– TJAS presentation, Runner up**

Attending University of Virginia in Fall 2024

BRUNO BORGER-GILLIGAN, CLASS OF 2024

"Developing and evaluating Nutrient rich Breakfast Bars using molecular gastronomy" **– TJAS presentation, Runner up**

Attending University of Massachusetts at Amherst in Fall 2024

CHELSEA CLARK, CLASS OF 2024

"Manufacturing an Inexpensive and Student-Friendly 'Mock Mars Rover" **– Hillsboro Expo Presentation**

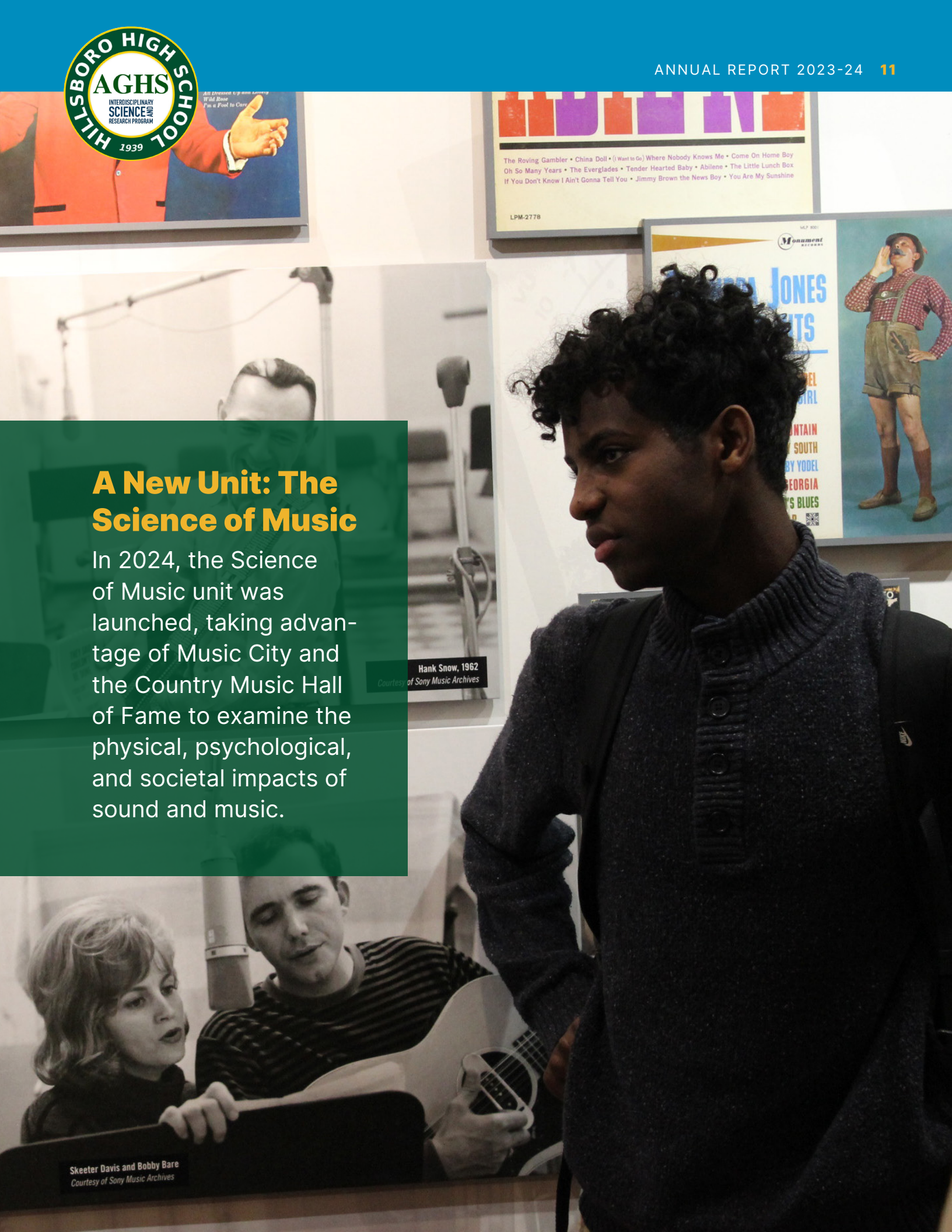
Attending Middle Tennessee State University in Fall 2024

VISIBL 2024, CLASS OF 2027

Six freshmen, including Valary Adedire, Clara Dehority, Gwendolyn Gaskins, Gideon Raines, Hiya Sharma, and Tommy Tran, were nominated and accepted into the VISIBL program at Belmont this summer, where they focused on making billions of microscopic organisms visible to the eye.

A New Unit: The Science of Music

In 2024, the Science of Music unit was launched, taking advantage of Music City and the Country Music Hall of Fame to examine the physical, psychological, and societal impacts of sound and music.

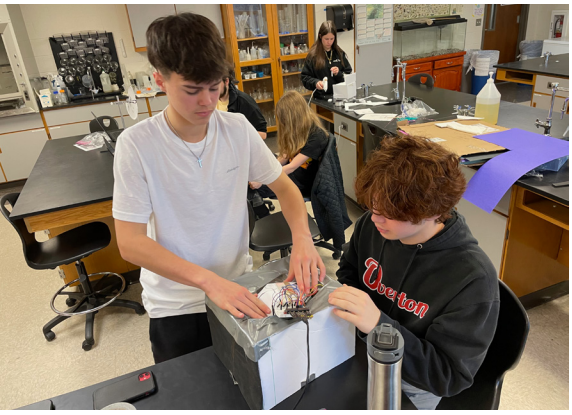


John Overton High School

John Overton High School

ISR Students Collaborate with Day of Discovery at the Zoo

ISR continued our partnership with Day of Discovery at the Zoo. In the fall, the DOD students came to Overton and performed a fecal float lab and learned about cladograms through candy. In the spring, ISR students traveled to the Zoo and visited the vet center to learn about how darting is used to give animals drugs and vaccines. In addition to building their own practice dart, students received a tour of the vet hospital and saw where surgery is performed on animals.



Grants

ISR Overton received a $5,000 grant from the Tennessee Valley Authority, in partnership with Bicentennial Volunteers, Inc., a TVA retiree organization. New microbit controllers, brain models, concussion goggles, and neuroprosthetic kits were purchased for use in the neuroscience unit. These supplies allowed the students to build and test brain protection devices to see how they prevented damage to the model brain. This unit also included a visit from the Vanderbilt Brain Institute's Neuroscience Student Organization to dissect sheep brains.

Collaborations, Projects, and Field Trips

- Seniors in ISR volunteered for the spring homeschool program at Andrew Jackson's Hermitage. They taught visiting families about natural insect repellents, how to plant and grow seeds, the water quality of a nearby stream, and they even helped man a station with pelts of local mammals brought by the Tennessee Wildlife Resources Association.
- Other field trips this year included: Vanderbilt Institute of Nanoscale Science and Engineering, The Hermitage, Vanderbilt Center for Addiction Research, Long Hunter State Park, Metro Water Treatment Plants, Tennessee Aquarium, and Nashville Zoo

John Overton High School

ISR Teacher and Fellow Accomplishments

- Regeneron STEM Teaching Fellowship—Dr. Gregory Smith
- Academies of Nashville Student Choice Teacher of the Year Awardee —Dr. Gregory Smith
- Academies of Nashville Partner Choice Academy Champion Nominee —Dr. Gregory Smith
- After 4 years with the ISR program, Dr. Nathaniel Freymeyer has been promoted to Program Manager of STEM Student Research with the CSEO

Academies of Nashville awards 2024

Student Accomplishments and Presentations

GRACIE BIXLER

- Named Academy of Interdisciplinary Research Student of the Year
- Published her REHSS research in *Young Scientist* Journal: Bixler, G.M., Turk, K., & Darroch, S.A.F. (2024). Observing Internal Enigmatic Rock Structures from the Terminal Ediacaran of Namibia.
- Paper selected for presentation at TJAS
- Earned 2nd place in Biochemistry and 1st place American Chemical Society Nashville Branch Awards at MTSEF: "Observing the Impact of Acephate and Neem Oil on Zebrafish (*Danio rerio*)" with Greg Konar and the Patton lab

MOREEN HABIB

- Presented her REHSS research at VINSE's NanoDay: "Investigation of Optical Trapping in Comparison Between Glass and ITO Chips" with Ikjun Hongand Dr. Justus Ndukaife
- Submitted to the Regeneron Science Talent Search
- Paper selected for presentation at TJAS
- 1st Place Plant Science/Botany at MTSEF and Association for Women Geoscientists Award: "Effects of Carbon Dioxide Sequestration Capabilities on Varying Tree Populations Soil Samples" with Dr. Jennifer Gentry

RYAN SPRADLING—1st Place Earth & Planetary Science at MTSEF and U.S. Stockholm Junior Water Prize Regional Winner: "Assessment of Fecal Coliform Bacteria Contamination in Tennessee Water Sources"

ALWALEED MAHMOUD—1st Place Engineering: Electrical and Mechanical at MTSEF: "Optimizing Drone Recognition to Aid in Natural Disasters"

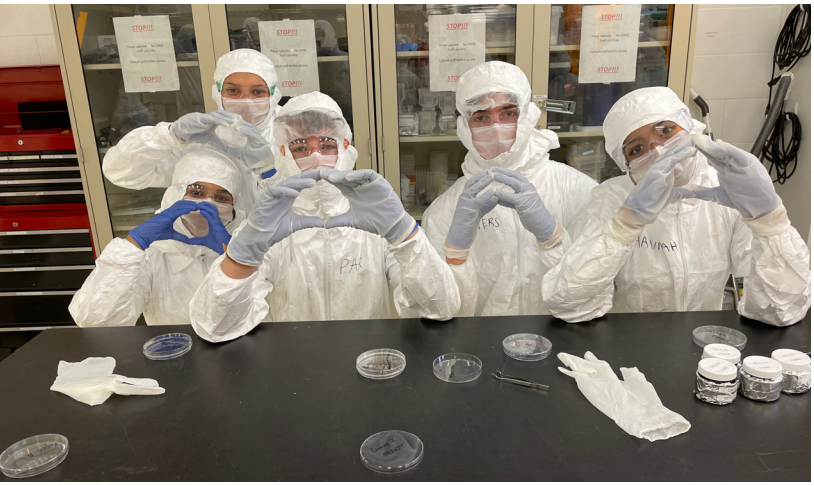
BETHANY ANDERSON—3rd Place Behavioral & Social Sciences at MTSEF: "The Influence of Plate Color on Food Preference among High School Students"

KATIE HUTCHINSON—1st place Animal Science/Zoology at MTSEF, Tennessee Academy of Sciences- Best Biological Sciences, and United States Air Force Award, TJAS Presenter: "Assessing the Relationship Between KardiaMobile ECG Readings and Clinically Diagnosed Abnormalities in *Pan paniscus*"

NATE JOSEPH—2nd Place Behavioral & Social Sciences at MTSEF and United States Air Force Award: "Assessing The Correlation between the Frequency and Intensity of Social Media Use and Psychological Well-being"

XIMENA PACHECO-GALLEGOS—TJAS Presenter: "Impacts of *Ginkgo biloba* and Sugar on PTEN and Wild Type *Drosophila melanogaster* Oogenesis" with Dr. Dara Ruiz-Whalen and the eClose Institute

John Overton High School



ISR Overton enjoys a robust partnership with Vanderbilt Institute of Nanoscale Science and Engineering (VINSE) – including multiple field trips and supply donations to build blackberry solar cells.

Stratford STEM Magnet School

Stratford STEM Magnet School

Two beehives donated by Honeybee Tennessee unveiled at Stratford

The hives will demonstrate ecological processes in conjunction with the largest pollinator garden in Tennessee, also located at Stratford. The Spartan Beehives will serve as educational and research tools for use in the ISR classroom. Eventually, honey from the hives will also be used for fundraising, outreach, and educational purposes.

Grants

Helping to fund the Spartan Beehives and other ISR initiatives, Stratford ISR received over $15,000 in grant awards this year, including:

Awarding Agency	Purpose	Grant
TN Stormwater Association Urban Runoff 5k Grant	Funds for Shelby water quality project	$1,000
Pets in the Classroom	Maintenance grant	$50
Honeybee Tennessee	Hives, tools, bees, & suits	$5,000
Centennial Park Conservancy Nashville Earth Day Environmental Grants	Funds for bee infrastructure	$3,400
Tennessee Valley Authority/ Bicentennial Volunteers, Inc.	Funds for Shelby water quality project and bee maintenance	$5,000
Inglewood Neighborhood Association Grant	Funds for Adopt-A-Tree Program	$500
Inglewood Neighborhood Association Grant	Funds for 3 digital scales	$500

Collaborations, Projects, and Field Trips

- Shelby Park Nature Center: Stratford ISR students are engaging in a longitudinal water quality study with Nashville Metro Water services to investigate the connection between pet waste and fecal bacteria in the waterways. Numerous field trips for field work take place throughout the year to sample and take measurements.
- Other field trips this year included: Coon Creek, Sevier Lake, Raccoon Mountain, Cheatham Lock and Dam, Fort Negley, and the Tennessee State University Wetlands.

Stratford STEM Magnet School

ISR Teacher and Fellow Accomplishments

- Cumberland River Compact Teacher Fellowship—Ms. Jesi Seifert
- Academies of Nashville Student Choice Teacher of the Year Nominee —Ms. Jesi Seifert
- Academies of Nashville Partner Choice Academy Champion —Ms. Jesi Seifert

Student Accomplishments and Presentations

SHANYA MIRZA

Shanya was the 2024 Stratford Valedictorian and will attend Vanderbilt in fall 2024 on a full ride Questbridge Scholarship.

JAMARRIAN (JJ) JACKSON

JJ was accepted to the Cancer Research Education Program for Rising Juniors organized by the Meharry-Vanderbilt-TSU Cancer Partnership.

ANDRE ESKRIDGE

Andre Eskridge will attend Belmont University in fall 2024 on a full ride Bell Tower Scholarship.

COREAS RUFFIN

"The complexity of Cologne Manufacture and its Effects on Olfactory Perception" **– TJAS presentation**

Attending Vol State Community College Fall 2024 with the HOPE Scholarship

EMILY WAGNER

"Maximizing Microbiological Growth Prevention in Cosmetics through Optimal Utilization of Preservatives" **– TJAS presentation**

Attending University of Tennessee Fall 2024 with the Flagship Scholarship

Cosmetic chemistry is an innovative unit at Stratford where students develop signature lines of skin care and fragrance products and compete in a *Shark Tank*-style event!

CONNECT WITH US

EMAIL
vandyisr@vanderbilt.edu

WEBSITE
vu.edu/isr

vandyisr

JOHS: overtonisr
SHS: stratfordstemisr
HHS: hillsboroisr

ISR Alumni LinkedIn Group:
linkedin.com/groups/13069539

Vanderbilt CSEO Facebook:
facebook.com/STEMEdOutreach

The ISR program is made possible by the contributions of Metro Nashville Public Schools, Vanderbilt Peabody College, and generous donors to the Collaborative for STEM Education and Outreach. To donate, please visit:

vanderbilt.edu/cseo/donate-to-the-cseo