April 2026

GEORGIA PATHWAYS

MAGAZINE

ORION

Successful Artemis II Mission

Strandbeest's

Mechanics / Art / Creation

The Pharmacist's Role

High Flux Isotope Reactor

Sumner Brown Gibbs / Oak Ridge National Laboratory

The Technology Association of Georgia Education Collaborative (TAG-Ed) strengthens the future workforce by providing students with relevant, hands-on STEM learning opportunities and connecting them to Technology Association of Georgia (TAG) resources.

Formerly the TAG Foundation, TAG-Ed is a 501(C)(3) non-profit organization formed by TAG in 2002. Later, the organization's name was re-branded to TAG Education Collaborative to facilitate our role as the leaders for K-12 STEM education in Georgia.

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Welcome to the April 2026 edition of Georgia Pathways Magazine, your monthly guide to the innovation, exploration, and talent shaping Georgia's STEM-driven future.

This issue highlights how ideas move from imagination to real-world impact. From space exploration to advanced research labs, innovation is not only about discovery, but also about the discipline and persistence required to bring concepts to life. As industries evolve, preparing students for these opportunities means fostering both technical expertise and the ability to carry ideas through to execution.

We begin with a look at the Orion space capsule, developed by Lockheed Martin, and the cutting-edge technology enabling new missions to the moon and beyond. Innovation also takes creative forms in our feature on Strandbeasts, where engineering, mathematics, and artistic vision come together to demonstrate the unexpected possibilities of STEM.

In the healthcare space, our spotlight on pharmacy technicians explores a critical and growing career pathway, including the essential role of vaccines in protecting public health. Meanwhile, advances in physics are on display through the Department of Energy's Isotope Reactor, where precision and safety drive breakthroughs that expand our understanding of science and its applications.

Finally, "From Bench to Breakthrough" emphasizes a key truth behind every advancement. Discovery alone is not enough. Progress depends on the commitment to refine, test, and implement ideas in ways that create lasting value.

As Georgia's innovation economy continues to grow, TAG Education Collaborative remains dedicated to building pathways that connect learning with opportunity. The next IBM SkillsBuild Certificate Program orientation will be held on April 27 from 6-7 PM, offering leaners a chance to gain in-demand skills at no cost. Learn more by visiting https://tagedonline.org/ibm-skill-share-certificates/. Together, we are preparing the next generation to imagine boldly, execute thoughtfully, and lead with purpose.

Larry K. Williams
President
TAG / TAG-Ed

Larry K. Williams serves as the President and CEO of the TAG and the TAG Education Collaborative. TAG-Ed's mission is to strengthen Georgia's future workforce by providing students with relevant, hands-on STEM learning opportunities by connecting Technology Association of Georgia (TAG) resources with leading STEM education initiatives.

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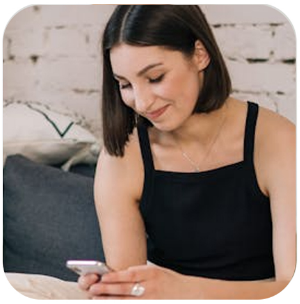

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To understand STEM...

...you must DEFINE STEM. You cannot define an acronym without defining each of the words the letters stand for.

Universities and organizations around the world continue to debate what a STEM career is, but there is no doubt that "every career" uses STEM skills and this observation remains the focus of STEM Magazine.

Science: "The systematic accumulation of knowledge" (all subjects and careers fields)

Technology: "The practical application of science" (all subjects and careers)

Engineering: "The engineering method: a step by step process of solving problems and making decisions" (every subject and career)

Math: "The science of numbers and their operations, interrelations, combinations, generalizations, and abstractions" (every career will use some form[s])

For a moment, set aside any preconceived notions of what you think a STEM career is and use the above dictionary definitions to determine the skills used in any career field you choose.

These definitions are the "real" meaning of STEM and STEM careers.

ARTEMIS

ORION

The next steps in manned space flight to the Moon and Mars is here - in the capable and incredible arms of NASA, Lockheed Martin and Orion. This was a great mission.

Orion is NASA's spacecraft that will take humans deep into space. No other spacecraft in development has the technology needed for the extremes of deep space, such as life support, navigation, communications, radiation shielding and the world's largest heat shield that will protect astronauts and help return them safely home.

Lockheed Martin is the prime contractor building Orion. We are in the production phase and have finalized a contract for six Orion spacecraft missions and the ability to order up to 12 in total. The first spacecraft delivered on this contract, Artemis III, will carry the first woman and the next man to the surface of the Moon. Orion is a critical part of the agency's Artemis program to build a sustainable presence on the lunar surface and to prepare us to move on to Mars.

What puts Orion in a class all its own? The technology our engineers use to build the only exploration class spacecraft to take humans deeper into space than ever before. Orion is the only human-rated spacecraft designed to carry astronauts into deep space and safely bring them home. On Artemis II, that capability becomes reality, as Orion carries a crew of four beyond the Moon for the first time in more than 50 years, paving the way for a sustained lunar presence and future missions to Mars.

ORION

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REACTION CONTROL SYSTEM
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A deep space flight requires a broad attention to detail for the crews safety, health, comfort and effectiveness. A variety of concerns will be addressed.

- A compact flywheel exercise machine is used for aerobic and strength workouts, and works similar to a rowing machine. All four astronauts have to exercise every day (except launch and landing days) to keep from losing bone mass. In order to exercise comfortably and efficiently, the machine will be placed on a 45 degree angle.

- Orion is designed to accommodate 99% of the human population, which is a larger range than every other NASA or Department of Defense project. The spacecraft can accommodate astronauts as small as a 4'10" and as tall as a 6'5".

- Orion has room for supplies and consumables to safely sustain a crew of four for up to 21 days. It can function unattended for six months in orbit when docked to the Gateway at the Moon. Orion has also been evaluated to support a 1,000 day mission to Mars when equipped with additional propulsion, habitats and supplies as part of a larger Mars transport system.

- Orion's main computers provides significantly faster computing speed over other human spaceflight vehicles. The computing speed of each computer is about 25 times faster than the International Space Station's computers, 400 times faster than the space shuttle's and have four independent computers running in parallel for redundancy. Orion computers are 20,000x faster than Apollo's

- Artemis II won't just build on the success of Artemis I, it will fly with parts that have already been to deep space and back. Ten components from the Artemis I Orion spacecraft are being reused on Artemis II, including nine avionics units that have already flown beyond the Moon. These include three inertial measurement units, one GPS receiver, four phased-array antennas, and one vision processing unit. Even one of the crew seats flying on Artemis II has already been to lunar distance and safely returned, giving the first crewed Orion mission an added layer of confidence from flight-proven hardware.

- Advanced manufacturing is transforming how Orion is built. The spacecraft includes more than 150 3D-printed parts on Artemis II—up from just four on Orion's first test flight in 2014. Engineers also use augmented reality during assembly, reducing training time by up to 85%.

Thruster Technology

Orion uses 12 MR-104G catalytic thrusters manufactured by Aerojet Rocketdyne. The thrusters are part of the MR-104 family that provided in-space propulsion for a number of projects including Voyager and Landsat.

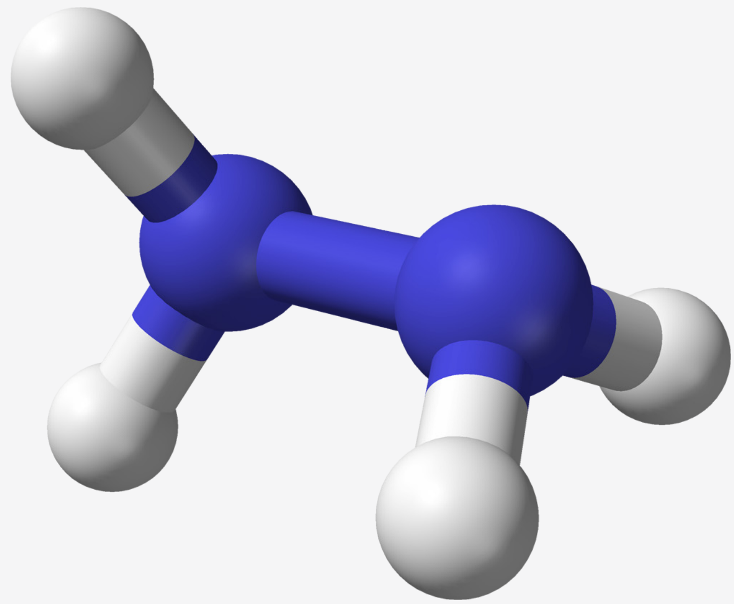
The twelve engines are arranged in four single-engine pods and four dual engine pods to provide redundant control in yaw, pitch and roll.

The MR-104G thrusters each deliver 712 Newtons (160 pounds) of thrust using catalytic decomposition of hydrazine over a heated metallic catalyst bed. The 104G version includes a number of improved design features that include a newly developed 120-Volt redundant propellant valve, a 120V/40W catalyst bed heater, new chamber pressure transducers and an integral thruster mount configuration.

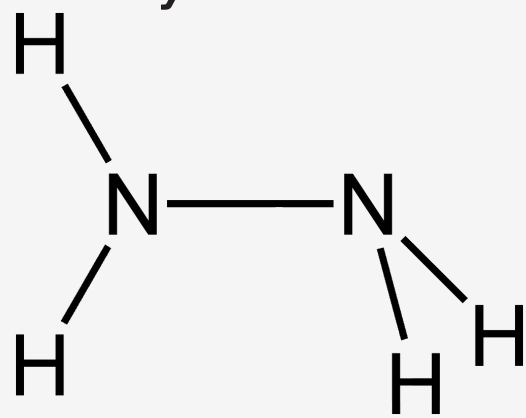
The pressure-fed thrusters are capable of operating in a wide range of conditions in terms of supplied propellant pressure.

Role: The MR-104G thrusters are used for maneuvering the Crew Module after it separates from the Service Module.

MR-104 Thruster – Aerojet Rocketdyne



Hydrazine



Configuration: The 12 engines are arranged in four single-engine pods and four dual-engine pods.

Fuel: They use hydrazine propellant, which decomposes across a catalyst bed, providing essential attitude control. Hydrazine (\(N_{2}H_{4}\)) is a highly toxic, colorless liquid used extensively as a high-performance monopropellant for satellite maneuvering, spacecraft thrusters, and emergency power units.

It decomposes over a catalyst into hot gases (ammonia, nitrogen, hydrogen), providing efficient thrust. Powerful, but extreme toxicity and carcinogenicity require stringent safety protocols.

Hydrazine is an inorganic compound with the chemical formula N2H4 (also written H2NNH2), archaically called diamidogen. A simple pnictogen hydride, it is a colorless flammable liquid with an ammonia-like odour.

Hydrazine is highly toxic and dangerously unstable unless handled in solution.

Reid Wiseman

"It's all I think about," Wiseman said, noting the thrill of going beyond low Earth orbit. He has spoken openly about the difficulty of being a single parent to his children while training for space flight following his wife's death from cancer in 2020.

G. Reid Wiseman served as commander of the Artemis II mission. Wiseman's first trip to space was on Expedition 40/41 to the International Space Station in 2014.

Victor Glover

Victor emphasizes that his work is focused on "duty and responsibility" to advance space exploration for future generations, rather than seeking personal spotlight. Glover has stated that while representation is important, his mission was about "human history" rather than solely Black history.

Astronaut Victor Glover made his second flight to space as the pilot of the Artemis II mission. Glover previously served as pilot on NASA's SpaceX Crew-1, which landed May 2, 2021, after 168 days in space.

Christina Koch

Koch has expressed excitement for the Artemis missions, noting that they are crucial for applying technologies for deep space exploration and answering philosophical questions about humanity's place in the universe.

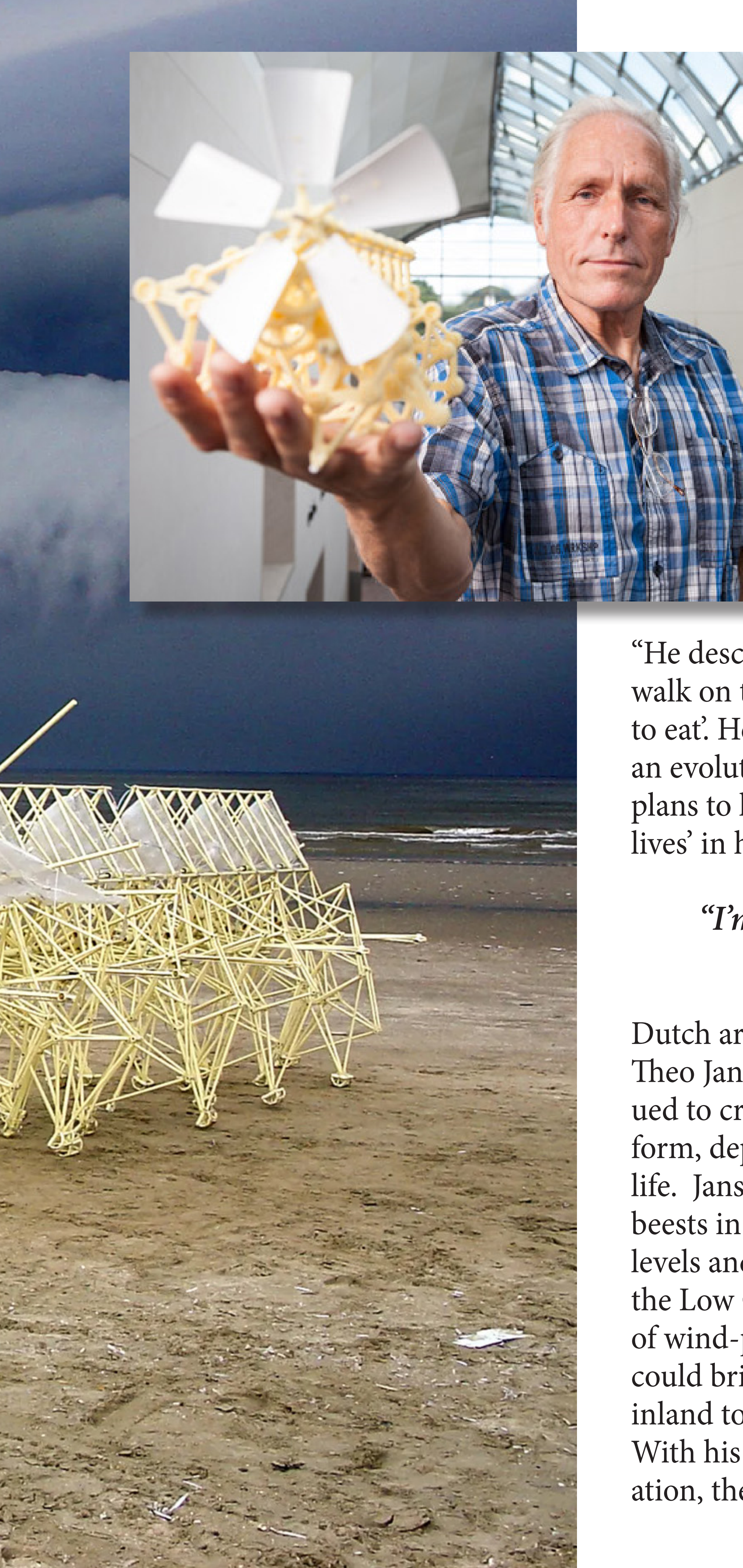
This was Christina Hammock Kochs second flight to space on the Artemis II, serving as a mission specialist. Koch served as flight engineer aboard the space station for Expedition 59, 60, and 61, setting a record for the longest single spaceflight by a woman with a total of 328 days in space.

Jeremy Hansen

He has expressed that the most interesting part of the mission was seeing Earth from the Moon's perspective. He views Artemis II as a testament to what can be achieved with big goals and teamwork. Hansen has been open about the inherent dangers, recounting a conversation with his parents - he remained "relaxed and confident" for the mission.

Jeremy Hansen served as a mission specialist on the Artemis II mission.


STRANDBEEST'S



Theo Jansen

"He describes them as 'skeletons that walk on the wind, so they don't have to eat'. He compares their creation to an evolution of 'new forms of life', and plans to leave them to 'live their own lives' in herds on beaches."

"I'm Theo Jansen and I'm a kinetic sculptor."

Dutch artist, physicist and engineer Theo Jansen has for 20 years, continued to create a fascinating artificial life form, depending on your definition of life. Jansen began building the Strandbeests in 1990. Mindful of rising sea levels and what that might mean for the Low Countries, he imagined a race of wind-powered beach creatures that could bring sand from the water's edge inland to build a never-ending barrier. With his hopeless task of dune creation, the Strandbeest was born.

Strandbeests are dramatically mathematical in concept, engineering marvels in structure, technological wonders in materials applications, and very scientific in their evolution (the systematic accumulation of knowledge), thus the perfect STEM life form.

Although they are still basic, the Strandbeests are now more self-sufficient. "They've found better ways to protect themselves against storms, they have sensors that feel the water and feel the hardness of the sand. They've become better and better at surviving on the beaches." One development means they can now walk on soft as well as hard sand. "It's easy to walk on hard sand because they're pushed by the wind, but on soft sand they need a special drive system which is driven by pressed air.

"Now the animals have a way of storing the wind," says Jansen. "There are wings which go up and down in the wind, and there are pumps connected to those wings which pump air into bottles at high pressure. The pressed air can drive muscles – ski poles that lift the animal and help push it over the soft sand."

Jansen often strays into the language of the engineer, and it's easy to forget that his creatures are also beautiful. "I don't want to make 'nice' animals, I just want to make surviving animals," he says. "They can be very nasty; my relationship with the beasts is different from what it is with people or animals. They are so low in their evolutionary development I still see them as machines."

Jansen elaborated, "In the middle the beests have this sort of spine. The spine makes a circular movement, and that circular movement is transformed by a number of tubes to a walking movement by the shoe which is under there. And this particular movement is to do with the proportion of the lengths of the tubes which are in-between the spine and the shoe. The proportions are based on thirteen numbers. And this particular proportion takes care that the animal stays on the same level while walking. And that's the special thing of Strandbeests, because normal animals always toss up and down as they walk, but the Strandbeests stay on the same level. You could see this proportion of thirteen numbers as the DNA code of the Strandbeests.

I published this DNA code on my website. Since then, thousands of students around the world are building Strandbeests. And all these students, they think they're having a good time. They think they're happy. But in fact they're being used for Strandbeest reproduction! So the Strandbeests abuse students for their reproduction.

And there's a new kind of Strandbeest that doesn't survive on beaches. They have found a protection against wind. They can survive in student rooms and bookshelves. This is in fact a better environment than on the beach. Now in all corners of the world you see appearing these small beests, and this Strandbeest reproduction went into an acceleration a few years ago. Two guys came to my studio, and they put something on my table: a walking Strandbeest. And this Strandbeest turned out not to be assembled but to be born. It was born in a 3D printer.

Nowadays you have specialized 3D printers which can make moving parts and moving things which you don't have to assemble. They come born in one piece. You can imagine what happened next. You can put a series of zero's and one's in a software program– the DNA code – and everywhere around the world you can print out these beests."

Kinetic art is art from any medium that contains movement perceivable by the viewer or depends on motion for its effect. Canvas paintings that extend the viewer's perspective of the artwork and incorporate multidimensional movement are the earliest examples of kinetic art.

More pertinently speaking, kinetic art is a term that today most often refers to three-dimensional sculptures and figures such as mobiles that move naturally or are machine operated The moving parts are generally powered by wind, a motor or the observer. Kinetic art encompasses a wide variety of overlapping techniques and styles.

There is also a portion of kinetic art that includes virtual movement, or rather movement perceived from only certain angles or sections of the work. This term also clashes frequently with the term "apparent movement", which many people use when referring to an artwork whose movement is created by motors, machines, or electrically powered systems.

The Mechanism


Download mechanism dimensions here

The Pharmacist's Role in Mitigating the Impact of Declining MMR Vaccination

By Norin Khandaker, Touro College of Pharmacy, Class of 2026 and Irene Cokro, PharmD / Edited by: Anastasiya Shor, PharmD, BCPS

MMR is a combination vaccine that protects against measles, mumps, and rubella. It provides immunity for individuals and the broader community.[1] It is usually given to children on a two-dose schedule administered at 12–15 months and again at 4–6 years of age.[2] MMR vaccination is important for children as well as adults who do not have evidence of immunity.

Public confidence in the MMR vaccine became greatly diminished due to a now-retracted paper in the British Medical Journal The Lancet authored by Dr. Andrew Wakefield et al[3] which falsely implied a link between the MMR vaccine and autism. The study was later discredited due to serious methodological flaws and unreliable data, and the author lost his medical license for "serious professional misconduct".

Since then, multiple large, well-designed epidemiologic studies have consistently showed no association between the MMR vaccination and autism. Despite this strong evidence, misconceptions persist in public opinion and threaten our vaccination rate.[3]

The MMR vaccination rate declined after the 2020 pandemic. Since then, there have been serious outbreaks in the U.S. Kindergarten vaccination rates in the U.S. fell to 92.7% in 2023-2024, which is below the threshold for herd immunity.[4] When more than 95% of the community are vaccinated, most people will be protected. However, in 2025, there were 2,144 confirmed measles cases reported in 45 jurisdictions in the U.S., with 93% of cases occurring in individuals who were unvaccinated or of unknown vaccination status. Of these cases, 240 hospitalizations and three deaths occurred.[4]

Measles infection may lead to complications such as pneumonia and encephalitis, or death.[5] Although endemic measles transmission was declared eliminated in the U.S. in 2000 following adoption of the 2-dose vaccination schedule, global decline in routine immunization has increased the risk of outbreaks worldwide.[5] While achieving herd immunity has led to a dramatic reduction in measles, mumps, and rubella cases, the decline in vaccination threatens this milestone.

As highly accessible healthcare professionals, pharmacists can play a significant role in increasing vaccination rates and preventing outbreaks in the community.

Measles

Measles is a highly contagious viral illness caused by the measles virus. Transmission occurs primarily through respiratory droplets when an infected individual coughs or sneezes. The clinical symptoms typically manifest 7 to 14 days following exposure to the virus. Initial symptoms often include high fever, cough, coryza (runny nose), and conjunctivitis (watery, red eyes). Fever is generally the first presenting sign, followed by the onset of a maculopapular rash approximately 2 to 4 days later.

This characteristic rash usually begins on the face and neck before progressing caudally to involve the trunk and extremities. Currently, there is no specific antiviral treatment for measles; management is primarily supportive, focusing on hydration, antipyretics, and monitoring for complications.[6]

Mumps

Mumps is a viral illness characterized by non-specific symptoms such as fever, headache, myalgia, fatigue, and loss of appetite. The hallmark clinical feature is painful swelling of the salivary glands, typically located below and in front of the ears. While mumps

is often self-limiting, it can result in serious complications, including sensorineural hearing loss, meningitis or encephalitis (inflammation of the brain or its surrounding tissues), painful testicular swelling, ovarian inflammation, and, in rare cases, death.[6]

Rubella

Rubella causes fever, sore throat, rash, headache, and eye irritation. It can cause arthritis in up to half of teenage and adult women. If a woman gets rubella while she is pregnant, she could have a miscarriage, or the baby could be born with serious birth defects.[6]

Reasons for Declining MMR Vaccination

Public misconceptions and fear of autism caused by MMR vaccines have led to vaccination gaps despite the proven safety and efficacy of the MMR vaccine. Many people no longer perceive measles, mumps, or rubella as serious threats, leading to disease outbreak. Access issues, particularly in low-resource or conflict-affected areas, also limit vaccination. The COVID-19 pandemic further disrupted routine immunizations. Additionally, cultural and religious beliefs contribute to resistance in some communities.[1]

Importance of MMR Vaccine

Vaccination remains the most effective public health intervention for the prevention of highly infectious diseases like measles, mumps, and rubella. Prior to its implementation in 1963, the United States reported nearly four million measles cases annually, resulting in approximately 400–500 deaths, 48,000 hospitalizations, and 1,000 cases of measles-related encephalitis.[6] To sustain herd immunity and prevent outbreaks, the CDC recommends maintaining ≥95% immunization coverage, with a two-dose schedule administered at 12–15 months and again at 4–6 years of age.[7,8]

The Pharmacist's Role in Increasing MMR Vaccination

Pharmacists can play an important role in increasing MMR vaccination. Educating parents about the importance of MMR, addressing misconceptions about autism, and improving access to vaccines are some of the ways pharmacists can improve MMR vaccination rates. Pharmacists can also identify eligible individuals, ensure proper vaccine storage, handling, and participate in public health campaigns. Their accessibility in communities makes them extremely important in combating disinformation, increasing immunization rates, and supporting disease prevention.[1,9]

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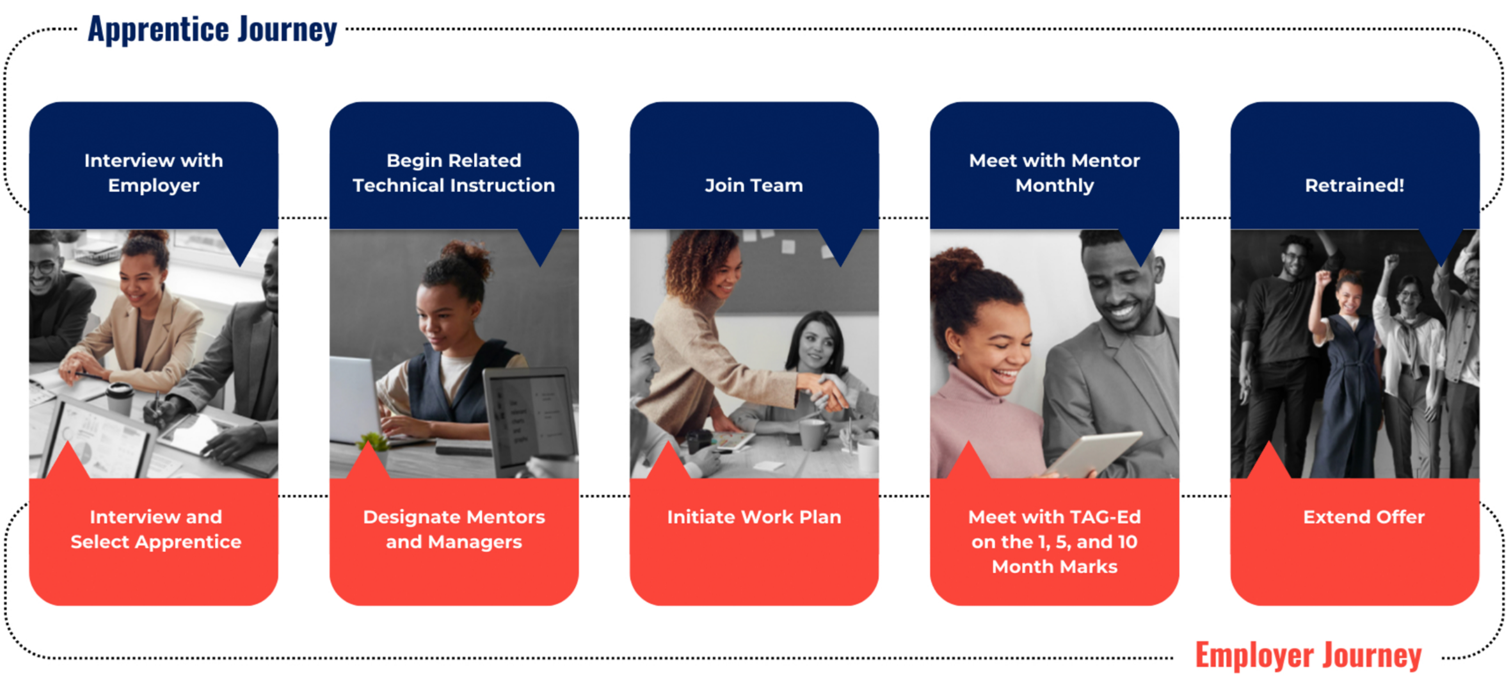

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Oak Ridge National Laboratory

High Flux Isotope Reactor: Forged by safety, fueled by discovery

By Sumner Brown Gibbs / ORNL

As night descends on the Department of Energy's Oak Ridge National Laboratory, the High Flux Isotope Reactor (HFIR) bursts with activity. A rigorous 24-day fuel cycle concludes and neutron production pauses at the lab's research reactor where neutrons help unravel the secrets of materials and energy. The reactor bay comes alive with the men and women who guard the frontiers of scientific research and discovery at HFIR — all night and all day for about the next two weeks during this typical refueling and maintenance outage.

With surgical precision, reactor operators work from a motorized bridge with 30-foot hand tools designed to navigate intricate spaces on the submerged reactor core. The entire pool area, about the size of an Olympic swimming pool and 17 feet deep, glows bright sapphire blue from the Cherenkov radiation effect. This phenomenon happens when charged particles from radioactive decay travel faster than light in water. The water in the pool serves the essential functions of cooling and radiation shielding.

Credit: Genevieve Martin/ORNL, U.S. Dept. of Energy

During a maintenance outage, HFIR crews move with the synchronicity of an operating room, each entering the bay at the precise time a certain skillset is needed. Operators, radiological control technicians and quality assurance specialists collaborate to dismantle, rebuild, refuel and prepare the reactor for restart.

They handle irradiated materials, add new experiment samples to HFIR's core and package radiological materials for transport. They load radiological packages in everything from small protective casings the size of a short pencil that ride 100 feet to the Radiochemical Engineering Development Center for isotope production to giant dog-bone-shaped casks that ride hundreds of miles on semitruck beds for offsite storage.

Two weeks later, at the end of the outage, the operating cycle begins again. HFIR's reactor operators restart the reactor, fine-tuning reactivity, testing water chemistry, checking valves throughout the facility and keeping a constant pulse on the reactor's safety systems — day and night. Operations supervisors play a central role, managing activities, directing critical tasks and training the next generation of reactor operators, most of whom graduated from the U.S. Navy's nuclear program.

The Navy's rigorous 18-month accelerated program in math, physics and engineering produces highly skilled, trusted operators who typically move on to ensuring safe operations for nuclear-powered submarines and aircraft carriers. Then they come to HFIR, bringing their culture of discipline and safety to bear on the operation of this invaluable U.S. resource.

Core of safety at HFIR

With equally rigorous standards, safety at HFIR involves multiple roles. Key players in safety at HFIR, known as radiological control technicians (RCTs), interact at all levels, working hand-in-hand with reactor operators

Lee Sugiyama and Cam Campbell discuss control room operations. Reactor control rooms provide a centralized location for monitoring, communicating and managing complex reactor operations. Carlos Jones/ORNL, U.S. Dept. of Energy

Operator using long hand tool over pool and five operators working on rigging.

Photo credits: Genevieve Martin/ORNL, U.S. Dept. of Energy

and reporting safe conditions to management while ensuring safe practices in daily operations. RCTs assess potential hazards and establish radiological conditions, communicating with staff throughout the days and nights by way of map postings and briefings.

Nuclear safety analysts at HFIR continually assess hazards, evaluating processes and equipment to prevent incidents and prepare for necessary responses. ORNL's Research Reactors Division ensures that experimental samples loaded into the core pose no risks to the safety of the reactor or personnel through stringent processes and procedures, securing competitive science and innovation for the nation. Roughly the size of a 30-gallon drum with enough energy to power a small city for several days, HFIR's 85-megawatt core, fueled with uranium-235, is one of two reactor-based neutron sources in the world that can produce such a high flux, or continual flow, of neutrons.

HFIR's core assembly design includes an 8-foot diameter pressure vessel submerged in the reactor pool, which helps provide radiation shielding and cooling. Nearly 16,000 gallons of water per minute flow through the pool from an independent primary coolant system, accomplishing the majority of the cooling work. The core's design also includes a beryllium reflector that helps maintain reactor criticality by reflecting stray neutrons back to the core. Redundant safety mechanisms include control plates that can independently shut down the reactor, if needed.

Although the control room appears similar to the way it did when HFIR first operated, continual updates and maintenance throughout the years keep monitoring and control performance at a high level so that personnel can ensure the reliability and safety of the facility.

Neutrons: A discovery powerhouse

Once the operators refuel the reactor and the next fuel cycle begins, hundreds of top scientists and researchers from around the world come to HFIR to gain knowledge no other research techniques provide. As the most powerful reactor-based source of neutrons in the Western hemisphere, HFIR helps the U.S. remain competitive with other nations in neutron science research.

The high flux, or flow, of neutrons, needed to produce isotopes, continues to achieve the facility's original mission, which began in 1965 with HFIR's first criticality. At the time, HFIR fulfilled a national need for producing "heavy" elements such as plutonium and californium for research, industrial and medical applications.

UWindsor's Omotayo Gbadamosi observes a sample natural chemical compound that attacks cancer cells. Neutron scattering experiments at HFIR cover a diverse range of scientific disciplines, including quantum, nuclear, energy and more. Credit: Genvieve Martin/ORNL, U.S. Dept. of Energy

However, discovery research at HFIR also plays landmark roles in a range of science and technology. One of two neutron scattering facilities in North America, HFIR allows scientists to unlock mysteries of matter not accessible any other way. Combined with ORNL's Spallation Neutron Source (SNS), the two facilities form a discovery powerhouse that continually recharges America's global leadership in discovery science year after year, decade after decade. Plans for a third neutron source at ORNL, the Second Target Station, are underway.

Today, HFIR has four major missions: neutron scattering research using its suite of 12 state-of-the-art instruments; production of medical, industrial and research isotopes, many of which can be made nowhere else in the world; materials irradiation testing; and neutron activation analysis to examine trace elements.

Its primary mission, neutron scattering, provides researchers with a technique to explore atomic-scale dynamics in experimental samples as small as magnetic moments in quantum materials and big as jet engines. The 12 scientific instruments connected to HFIR's powerful core allow users to experiment with materials at the atomic scale, resulting in breakthrough discoveries and paving the way for life-changing technologies.

Because of neutrons' unique properties — deeply penetrating, nondestructive, and able to "see" light elements such as hydrogen and lithium — they provide insights no other research technique can. Discoveries made possible using neutrons help unravel the secrets of materials and energy, leading to the development and improvements of everyday products like hard drives, medicines and infrastructure such as bridges and cables. Scientists use the neutrons produced by HFIR to study physics, chemistry, materials science, engineering and biology, resulting in advances in many areas that improve daily life.

Discoveries at HFIR continue to make impacts for NASA space missions, the detection of dangerous materials, cancer treatment centers, medical advancements for Alzheimer's and other neurodegenerative diseases, industrial and agricultural processes, advanced 3D printing applications, pharmaceutical and geochemistry studies and consumer technologies.

Examples of discovery science at HFIR:

- Biochemist David Baker, a 2024 recipient of the Nobel Prize for Chemistry, turned to HFIR for information he couldn't get anywhere else.

- Neutron research at HFIR revealed the cause of the Arecibo telescope collapse in Puerto Rico.

- A researcher from The University of Oklahoma College of Dentistry used neutron scattering at HFIR to invent a more durable, antibacterial dental resin.

- A group of scientists used neutron scattering techniques to investigate a relatively new functional material called a Weyl semimetal, which could allow electricity to flow more efficiently in future electronic devices.

- Researchers designed and accurately characterized a novel polymer that is as effective as natural proteins in transporting protons through a membrane. This discovery could help make batteries and water purification systems more efficient.

- NASA scientist Andrew Needham used a neutron imaging capability at HFIR to study moon rock samples brought back from the Apollo missions.

Planning is underway to extend the Cold Guide Hall, the location of eight of HFIR's 12 neutron scattering instruments. Once the extension is complete, the guide hall will have an additional 5,600 square feet to provide space for new cold neutron instruments and to develop new capabilities.

Isotopes at HFIR

Today, still operating based on its original mission, HFIR produces 70% of the world's supply of californium-252. Among other critical uses, this isotope provides the power needed to start nuclear reactors. Isotopes from HFIR help a range of industries around the world identify potential deposits of oil and gas, provide cancer therapy and detect pollutants in the environment, explosives in luggage and illicit materials in cargo for port security.

The impacts of science from HFIR include the development of medical isotopes and elements for the periodic table, fuels and materials for advanced reactors and other energy security technologies, new medicines and biosecurity, 3D printing, forensic science and space exploration.

Likewise, ORNL-produced plutonium-238 helped power Perseverance on Mars. HFIR also leads America's efforts to establish secure domestic production of enriched uranium to help develop advanced materials and additive manufacturing capabilities for national security uses, such as advanced welding methods for the steel used in building U.S. nuclear submarines.

HFIR's bright future: Projects and upgrades

In 2014, the American Nuclear Society designated HFIR as a Nuclear Historic Landmark in recognition of its vital role in the history of the nuclear age and its continued importance to the U.S. for neutron scattering research, isotope production and national security. In 2017, the International Atomic Energy Agency (IAEA) designated

Instrument scientists discuss experimental data from the BIO-SANS instrument. In 2025, BIO-SANS was upgraded with a robotic arm to assist with experiments, allowing instrument scientists and users to remotely adjust samples during measurements. Credit: Sumner Brown Gibbs/ORNL, U.S. Dept. of Energy

ORNL as an International R&D Hub because of HFIR's continued importance for post-irradiation testing of materials, neutron scattering and processing of radioisotopes. The IAEA designation made the U.S. one of only four countries identified for unique capabilities and excellence in nuclear research.

Looking forward, to ensure operations to the end of the century, including a return to operating at the reactor's designed power of 100 megawatts, plans are underway to replace HFIR's beryllium reflector and pressure vessel. The beryllium reflector sends most stray neutrons back into the core during reactor operation, but due to the intensity of the flux, the reflector must be replaced about every 20 years.

In the 1980s, engineers found HFIR's carbon steel pressure vessel, or core container, more brittle than anticipated as an effect of the intense neutron environment. At that time, they reduced the reactor's operating power from 100 megawatts to 85 megawatts to slow the embrittlement and increase the reactor's operating lifetime. The long-term effects of continual bombardment cause embrittlement of the pressure vessel, requiring its replacement before its estimated end of life. However, plans are to replace the vessel well before then.

Given HFIR's importance in a myriad of critical applications, the beryllium reflector replacement and pressure vessel replacement project will ensure long-term availability of this vital national resource.

HFIR embodies the spirit of innovation. HFIR's operational excellence, living commitment to safety and dedication to neutron scattering and isotope production make it a beacon for discovery science. Its historic scientific impacts for the nation and the world set the standard for vital national resources that can adapt to new challenges and meet demands for solving difficult problems. Its legacy of impactful research and remarkable discoveries prove that HFIR will undoubtedly play a critical role in future science. The best is yet to come.

HFIR is a DOE Office of Science user facility. UT-Battelle manages ORNL for DOE's Office of Science, the single largest supporter of basic research in the physical sciences in the United States. The Office of Science is working to address some of the most pressing challenges of our time. For more information, **visit energy.gov/science**

From Bench to *Breakthrough*:
Why STEM Needs a Translational Mindset

By Shelly A. Muñoz

"STEM has no shortage of innovation. What it lacks is follow-through."

Every year, researchers, educators, and engineers generate promising ideas: new technologies, instructional models, tools, and systems designed to solve real problems. Yet too often, these breakthroughs stall before they ever reach a classroom, a community, or a career pathway. In medicine, this gap has a name. More importantly, it has a solution.

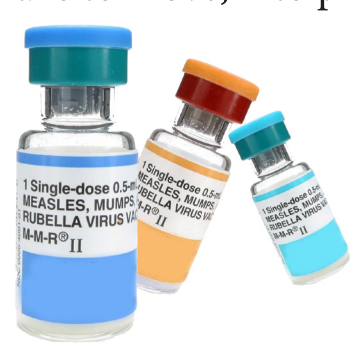
Translational Medicine

Translational medicine emerged from a hard truth in healthcare: scientific discovery alone does not improve patient outcomes. For decades, life-saving research remained trapped in laboratories, disconnected from clinical practice. Translational medicine was created to close that gap. Often described as "bench to bedside," translational medicine is not a single step. It is a continuous, bidirectional process.

Discoveries move from basic research to clinical testing, into real-world practice, and back again. Clinicians provide feedback, researchers refine interventions, and evidence guides each iteration.

Modern translational medicine is often described in phases. Early research is translated into clinical applications. Those applications are tested and validated in real settings. Proven practices are then implemented broadly and sustainably. Finally, population-level outcomes and equity are measured.

At every stage, the guiding question remains the same: Does this work in real conditions, for real people, and does it improve outcomes? This mindset has transformed healthcare by prioritizing collaboration, implementation science, and impact over novelty alone. It also offers a powerful framework for rethinking how STEM innovation moves, or fails to move, into practice.



The STEM Translation Gap

STEM faces a challenge strikingly similar to the one medicine confronted. We see it when research-informed practices never reach classrooms, when educational technologies are developed without practitioner input, when initiatives are rolled out without regard for context or capacity, and when promising pilots fade because implementation was an afterthought.

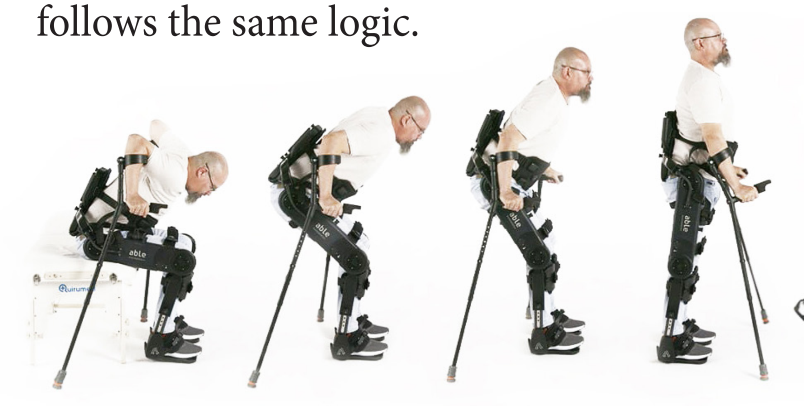
As Shelly A. Muñoz, STEM educator and consultant, notes:

"STEM doesn't struggle because we lack ideas. It struggles because we don't build systems that help good ideas survive real classrooms, real constraints, and real communities."

Like medicine before translation, STEM does not suffer from a lack of innovation. It suffers from a lack of systems designed to move ideas into impact.

Translational STEM: Applying the Model

A translational approach to STEM shifts the focus from invention alone to implementation, learning, and outcomes. It borrows directly from medicine's playbook. In translational medicine, clinicians are not passive recipients of research. They are active contributors to it. Translational STEM follows the same logic.



Teachers, students, engineers, industry partners, and communities become co-designers rather than end users. Classroom experiences, learner data, and local constraints inform research and development, creating feedback loops that strengthen innovation over time. STEM solutions become grounded, adaptable, and relevant.

STEM as a Living System

Medical interventions are never considered finished. They are continually tested, refined, and improved based on evidence. Translational STEM embraces the same approach. Pilot programs replace polished rollouts while a new iteration replaces one-time implementation. Learning replaces compliance and innovation becomes a process, not a product. Interdisciplinary collaboration by design allows translational medicine to thrive using interdisciplinary teams that include scientists, clinicians, data analysts, ethicists, and patients.

STEM faces equally complex challenges, from climate change to health disparities, sustainability, cybersecurity, and artificial intelligence. Translational STEM breaks down silos between science, engineering, education, industry, and community knowledge, recognizing that the most effective solutions emerge at these intersections.

Evidence That Guides Action

In medicine, data exists to improve outcomes, not to sit untouched in journals. Translational STEM treats evidence the same way as research, assessment, and analytics are used to inform decisions, identify what truly scales, improve access and equity, and retire approaches that do not work. Evidence becomes a tool for action, not just validation.

AI as a Catalyst for Translational STEM

Artificial intelligence is already reshaping translational medicine by accelerating discovery, implementation, and evaluation. Its greatest value lies not in automation, but in its ability to shorten the distance between insight and action.

In STEM, AI can serve a similar role. When used responsibly, AI can help synthesize research and practice-based data, identify patterns across classrooms and communities, and support faster cycles of testing and refinement. It can reduce the lag between innovation and impact, allowing educators, researchers, and industry partners to respond to evidence in near real time.

Importantly, AI in a translational STEM framework is not the decision-maker as humans must remain responsible for context, ethics, and judgment. AI becomes a tool that supports learning systems rather than replacing them, ensuring that innovation remains grounded in real-world needs and outcomes.

Equity as an Outcome, Not an Add-On

Modern translational medicine increasingly centers equity by asking who benefits, who is excluded, and why. Translational STEM adopts this lens from the start meaning designing STEM pathways that reflect diverse cultures and ways of knowing, remove systemic barriers to participation, prepare learners for real-world opportunities, and serve communities rather than just technologies. Success is measured not only by innovation, but by reach and impact.

Why This Matters Now

STEM innovation is accelerating at an unprecedented pace, but trust, access, and outcomes remain uneven. A translational mindset ensures that STEM does not advance around classrooms and communities, but with them. It reframes the central question from "Is this innovative?" to "Does this improve real outcomes, in real contexts, for real people?" That question, borrowed directly from medicine, may be exactly what STEM needs most.

A Call to Action

It is time for STEM leaders, educators, researchers, and industry partners to adopt a translational mindset. This means designing STEM innovations with implementation in mind, building feedback loops between research and practice, and measuring success by real-world impact rather than novelty. The future of STEM will not be defined by what we invent, but by what we effectively translate into classrooms, communities, and careers.

Shelly A. Muñoz is a STEM educator and instructional leader dedicated to advancing innovative teaching practices in K–12 classrooms. With experience designing and implementing project-based learning, coding, robotics, and 3D design initiatives, she helps teachers integrate research-based strategies that promote critical thinking, collaboration, and real-world problem solving.

Shelly also works closely with administrators and instructional coaches to support evidence-based professional development and coaching cycles, ensuring that STEM education is engaging, equitable, and impactful for all students.

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AI Skills: The New Currency in Today's Job Market

The AI revolution is here. Ever since ChatGPT arrived on the scene in late 2022, artificial intelligence has been reshaping the way we live and work. What does that mean for tech professionals looking to compete in a changing labor market?

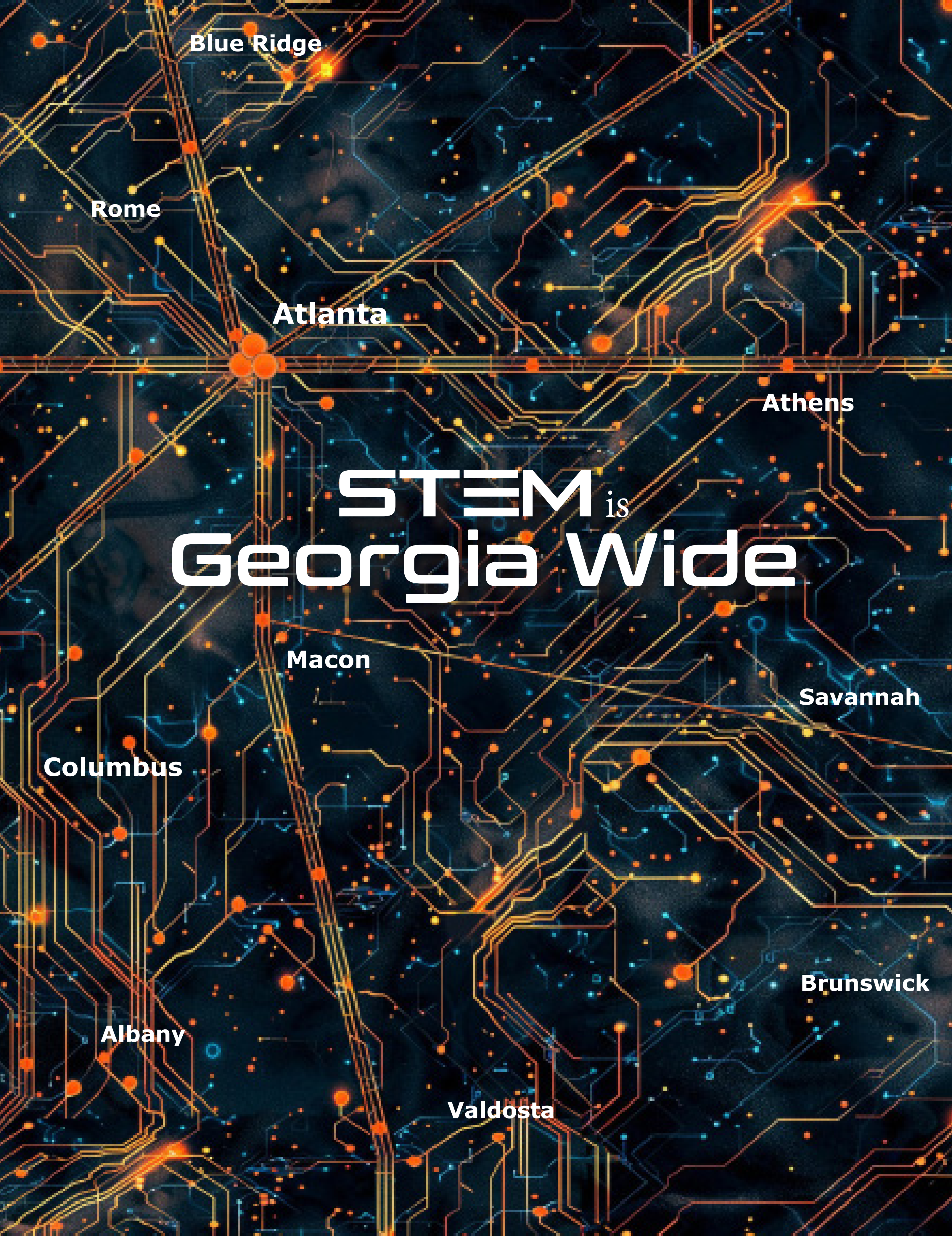
TV pundits and talking heads love to get riled up about whether robots are coming for our jobs — but the truth is that AI will probably create more jobs than it eliminates. And one thing's for sure: understanding how AI works, and mastering AI skills, will be the key to success in tomorrow's ever-changing world of work.

New research shows that a growing number of companies are asking for AI skills in job descriptions — including non-tech roles. And a survey of HR professionals released last month shows that job candidates with AI skills ask for more money during the interview process — and tend to get it once they're hired. Simply put, AI is going to be underpinning nearly every job out there. That's why staying ahead of the latest in AI development is so important.

Building AI skills doesn't just mean learning how to engineer prompts for ChatGPT. It's everything from programming to data modeling and analysis to mastering concepts like machine learning and natural language processing. And if there's anything certain in our fast-paced economy, it's that building AI fundamentals today will translate to career opportunities tomorrow and beyond.

That's where SkillStorm comes in. In partnership with TAG, we offer Microsoft Azure AI courses that are instructor-led, career-aligned tech certification courses and will help you build the AI skills that employers need. From the basics of AI and machine learning to a comprehensive understanding of how to design, deploy, and maintain AI solutions, you'll learn everything you need to accelerate a career in the economy's hottest fields.

It won't be long before all kinds of jobs, all across the economy, require AI skills. And starting now is the best way to accelerate your ascent up the career ladder. Build those skills today and you'll lay the foundation for opportunity for years to come — and set yourself up for success in an AI-driven future of work. Register today to get started with a career in tech.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