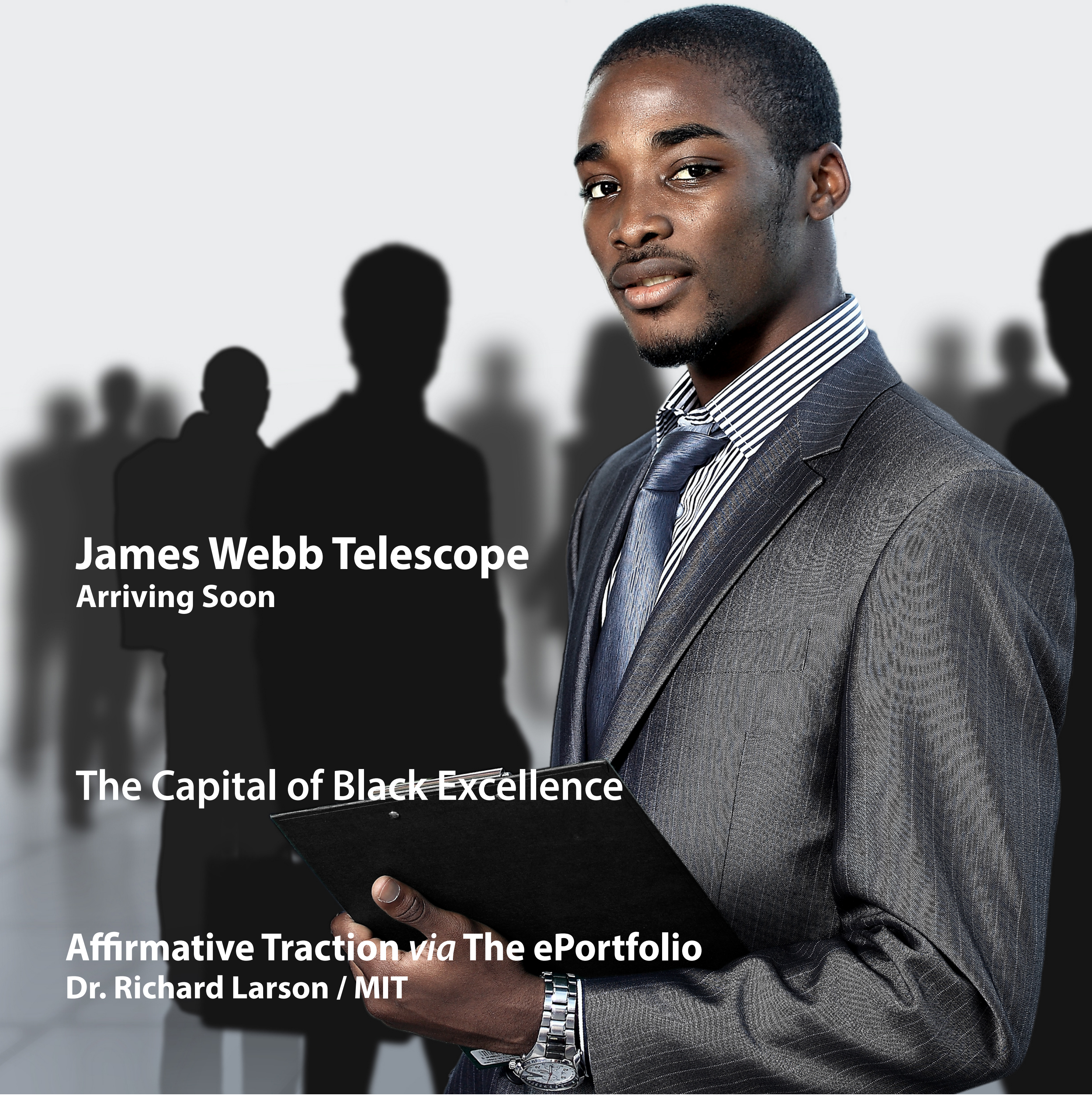
January 2022

GEORGIA PATHWAYS

M A G A Z I N E



James Webb Telescope
Arriving Soon

The Capital of Black Excellence

Affirmative Traction *via* The ePortfolio
Dr. Richard Larson / MIT

TAG
Technology Association of Georgia

TAG | TAG-Ed
Education Collaborative

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 2000. 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.

President / CEO
Larry K. Williams

TAG-Ed Executive Director
Heather Maxfield

Publisher
Wayne Carley
wayne@tagonline.org

The Technology Association of Georgia (TAG) and
TAG Education Collaborative
4400 North Point Parkway
Suite 155
Alpharetta, Ga. 30022

http://www.tagedonline.org

Welcome to the January 2022 issue of Georgia Pathways Magazine.

The new-year career and workforce development initiatives from TAG-Ed and TAG are comprehensive and timely as our state workforce continues to be the focus of our calendared opportunities.

For decades, the percentage of entrepreneurial ventures has been on the decline nationally, but recent events these past few years have spurred new enthusiasm and interest in this approach.

As we honor Martin Luther King Jr. day, our Social Justice and Equity Task Force has set several impressive goals for 2022 and beyond. Having supported and encouraged the entrepreneurial mindset for decades, the first goal set by our Task Force is:

1. to ensure black technology entrepreneurs participate fully and equitably in Georgia's growth economy with unimpeded access to resources and opportunities equivalent to non-black entrepreneurs.

This should go without saying, but the struggles continue for many as TAG and TAG-Ed remain devoted to this important and essential component of Georgia's economy and workforce. The second goal of equal importance is:

2. to ensure our technology industries in Georgia reflect the overall available workforce, with proportionally representation of this demographic in all of Georgia's technology industries.

The third task force goal is:

3. to ensure that black technology professionals continue to advance into managerial and senior leadership positions, achieving representation in these ranks commensurate to their demographic representation.

The three initiatives mentioned are only part of the overall strategy for 2022 by TAG and TAG-Ed to promote entrepreneurial ventures that sustain our workforce and economy now and into the future. Of all U.S. states, Georgia has the 7th highest percentage of minority-owned startups, which is impressive, while placing 9th nationally for startups in general. As we continue to improve those numbers through innovative and supportive opportunities, it is encouraging to know that past initiatives are bearing some fruit and affirms we are set on a good path to further success.

Larry K. Williams
President
TAG / TAG-Ed

Larry K. Williams serves as the President and CEO of the Technology Association of Georgia (TAG) and President of the TAG Education Collaborative (TAG-Ed). 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.

The
VINE
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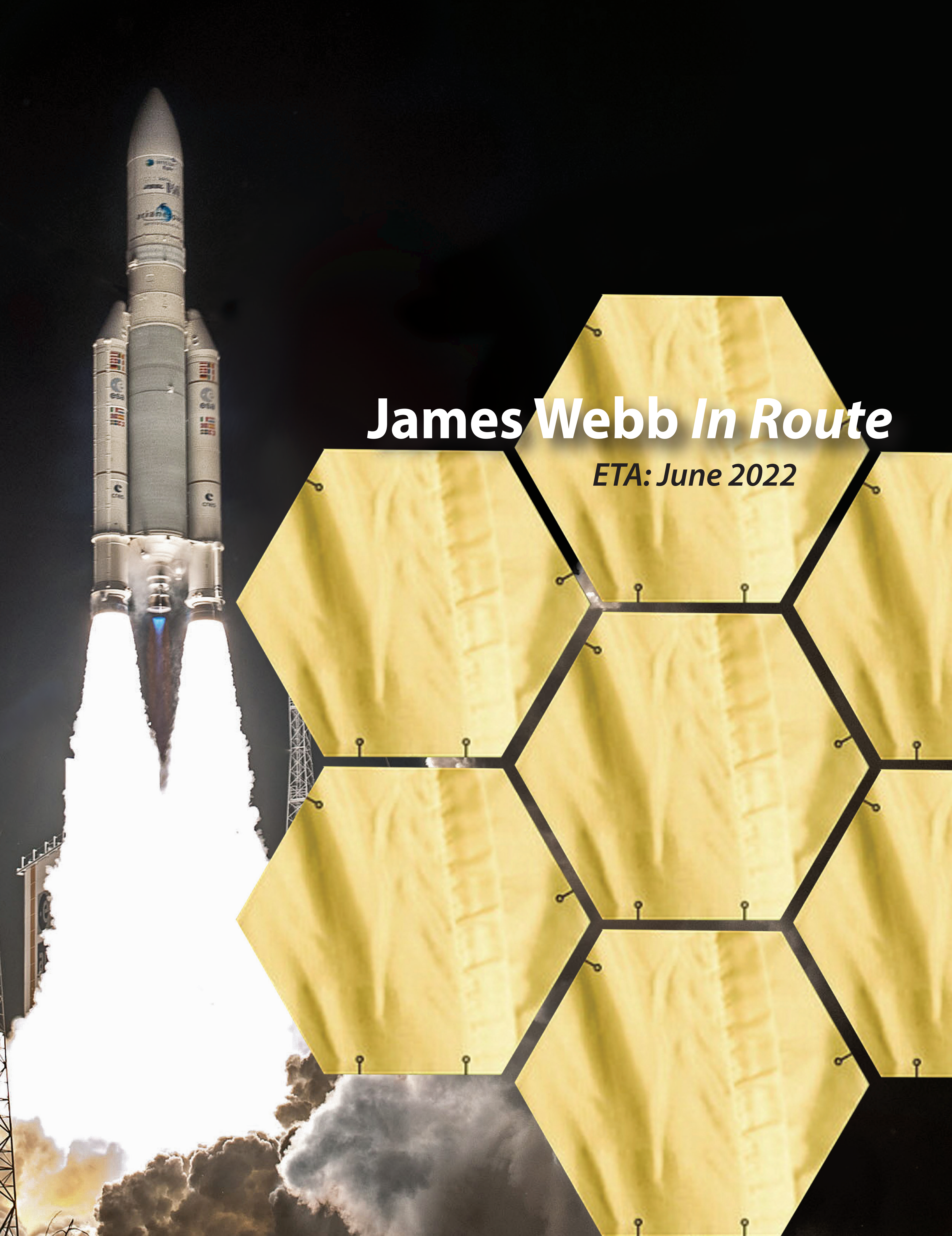
TAG | TAG-Ed Education Collaborative

James Webb *In Route*

ETA: June 2022



James Webb Space Telescope

"In Route - ETA for photos; 6 months"

After a multi-year delay, the $10 billion dollar James Webb telescope is finally on its way.

The "nail bitting" will continue for the international community as dozens of tasks must be completely successfully prior to our first images, deep into the Universe.

Last week, NASA achieved another engineering milestone decades in the making. While the journey is not complete, the Webb team is breathing a little easier and imagining the future breakthroughs bound to inspire the world. The James Webb Space Telescope is an unprecedented mission that is on the precipice of seeing the light from the first galaxies and discovering the mysteries of our universe.

Unfolding a telescope as large and complex as Webb is a risky maneuver and one that NASA has never tried before. As of January 8, 2022, the successful deployment of Webb was complete.

The JWST will offer never before seen resolution and sensitivity from long-wavelength (orange-red) visible light, through near-infrared to the mid-infrared (0.6 to 27 micrometers). While Hubble has a 7.9 foot mirror (light collector), the JWST features a larger and segmented (multi-part) 21 foot primary mirror.

This international collaboration of about 17 countries led by NASA, and with significant contributions from the European Space Agency and the Canadian Space Agency. It is named after James E. Webb, the second administrator of NASA, who played an integral role in the Apollo program.

JWST's capabilities will enable a broad range of investigations across the fields of astronomy and cosmology. One particular goal involves observing some of the most distant events and objects in the Universe, such as the formation of the first galaxies. These types of targets are beyond the reach of current ground and space-based instruments. Another goal is gaining a better theoretical understanding the formation of stars and planets.

The fuel capacity is designed for a ten year mission, hopefully, compared to over 25 years so far for the Hubble Telescope. The Hubble cost was about 2.5 Billion dollars where as the James Webb has cost 10 Billion dollars.

Webb will also undergo a third mid-course correction burn – one of three planned to place the telescope precisely in orbit around the second Lagrange point, commonly known as L2, nearly 1 million miles from Earth.

This will be Webb's final orbital position, where its sunshield will protect it from light from the Sun, Earth, and Moon that could interfere with observations of infrared light. Webb is designed to peer back over 13.5 billion years to capture infrared light from celestial objects, with much higher resolution than ever before, and to study our own solar system as well as distant worlds.

"The successful completion of all of the Webb Space Telescope's deployments is historic," said Gregory L. Robinson, Webb program director at NASA Headquarters. "This is the first time a NASA-led mission has ever attempted to complete a complex sequence to unfold an observatory in space – a remarkable feat for our team, NASA, and the world."

STEM Magazine will keep you posted on continued developments in the journey of James Webb.

The Capital of Black Excellence

By Wayne Carley

Few industries are more entrepreneurial than the music industry, which is certainly filled with technological applications and has long flowed through the veins of Atlanta and Georgia in general.

Science, tech, engineering and math are deeply woven into every aspect of music with special emphasis on mathematics. Algebraic formulas are the bones of any musical creation, wrapped with creative imagination, rooted in inspiration and experience, then launched into existence by the voice, instruments, a mixture of these two and fine tuned by the ear of the studio engineer.

Though this process occurs from coast to coast, the greater Atlanta area is seeing renewed growth for musicians, the film industry and a variety of technology industries that are re-discovering the excitement of the entrepreneur mindset. Georgia's economy is making it possible to attract talent from Silicon Valley to New York as many are calling Atlanta the black tech capital of the U.S., and with good reason.

One in four tech workers in the greater Atlanta area are African-American, far exceeding cities like San Jose and San Francisco who have a long history of tech innovation. The diversity enjoyed by Georgia is certainly attracting strong talent from regions across America who may not reflect this aspect of socialization and the states' economy is a strong source of influence for those seeking to raise their standard of living while enjoying a better balance of ethnic diversity, opportunity and encouragement in tech.

the Silicon Valley of the South.

Opportunity distribution and equity continues to be a struggle, even in Georgia, but statistically, the tech numbers are looking better here than most cities and are on the rise. Venture capital dollars to support this growing volume of entrepreneurs remains a struggle, but a shift in focus may be in sight as investors continue to see the value, success and potential of plugging into Georgia's tech markets.

Start-up funding as you would expect is in short supply, but enthusiasm is abundant among those hoping to pitch their

"The best way to predict the future is to create it."

\- Peter Drucker (influential thinker)

Collaboration within the black and tech communities in Atlanta is exciting and growing as the migration to Georgia continues. A variety of active groups regularly gather in the city to discuss tech, innovation, social causes, opportunities and strategy.

As for Atlanta, some have said that there may be no better place in our country for black entrepreneur's to flourish in tech. Putting your tech roots down in Georgia is a win, win for the states' economy as well as its workforce. Tech companies nation-wide continue to pour money into increasing the diversity of their work forces, while African-Americans remain seriously underrepresented in many tech jobs nationally, except for Atlanta, dubbed

tech dreams to the venture capitalists.

The variety of tech companies in Silicon Valley are all looking for that edge, both in funding and talent, that will propel them upward and outward. Perhaps Atlanta will provide what is lacking in California. An example of a rare commodity such as "powerful influencers", seem to be in abundance in greater Atlanta across multiple ethnicities and industries.

"Keep away from people who try to belittle your ambitions. Small people always do that, but the really great make you feel that you, too, can become great."

- Mark Twain

The music and film industries certainly fall into that category, but it extends far beyond those to include finance, cybersecurity, medical tech, logistics, aerospace, agriculture and more, spreading a wide carpet of opportunity and success.

The ethnic isolation experienced elsewhere in the nation is a strong motivator to make a geographic change. Minority engineers in an array of industries are finding welcoming arms in Atlanta and Georgia tech companies, unlike they have experiences in a decade or more. This is certainly a testament to the attitude and opportunity expressed by this states' economic decision makers. Georgia Tech and historically black colleges such as Morehouse and Spelman, which are producing more black engineers than anywhere in the country, are enjoying this nearby pipeline of talent.

"Y'all come. Make yourself at home", are welcoming words if you're seeking a more affordable lifestyle, a better quality of living, a diversity that is inclusive and the perfect location to unleash your tech entrepreneurial juices. The fertile, unique business and racial atmosphere of Atlanta continues to grow, so constant focus, dedication to excellence and expansion of opportunities must continue into the next generation of tech professionals.

Atlanta has everything a startup need's, and the people who are willing to help.

Georgia STEM Day 2022

March 4th

Learn More

Affirmative Traction *via* The ePortfolio

Richard C. Larson

Massachusetts Institute of Technology

Prior to Covid, standardized tests (SAT and ACT) served as "gold standard" indicators of a high school junior's math and verbal skills. In this Covid world, many colleges and universities are eliminating the test requirement. Very recently, Harvard announced "test optional" through 2026.

But some pundits are now alarmed by the "standards vacuum" created by the de-emphasis of standardized tests. As we know, "Nature abhors a vacuum!" We recently read the headline, "UC dumped college entrance exams. Big Mistake." (Los Angeles Times, Dec. 1). Similar headlines have appeared elsewhere. The "vacuum" presents us with a once-in-a-generation opportunity to invent something new, something better than standardized tests, more inclusive, equitable, and – yes- rigorous, something where students from diverse environments can demonstrate both their classroom knowledge and their creative accomplishments. For college admissions, we argue for Student ePortfolios.

From the recent Harvard announcement, "Students who do not submit standardized test scores will not be disadvantaged in their application process," said Harvard Dean of Admissions and Financial Aid William R. Fitzsimmons… "Their applications will be considered on the basis of what they have presented, and they are encouraged to send whatever materials they believe would convey their accomplishments in secondary school and their promise for the future."

The ePortfolio can structure and scale the Harvard position nationally. This is our proposal: During each of the four years of high school, the student submits to her/his assigned mentor their non-transcript accomplishments for that year. Examples: Project-Based Learning exercises, science fair projects, community volunteerism efforts, accomplishments in organized sports, etc.

At the end of each year the student writes a short reflective essay about what she/he has learned that year, what went right or wrong and why, and the student's goals for the upcoming year. These submissions are digitized and certified, and saved in read-only format on a secure server. No later changes allowed! At the end of four years, there are four such submissions by the students. The ePortfolio represents the emerging, reflective resume for the student. This four-year natural process stands in contrast to the typical stress-laden junior year, spent cramming for standardized tests. With the ePortfolio, we treat high school students as adults.

The ePortfolio promises increased equity, inclusiveness and rigor. Since the ePortfolio would not require money from parents, it is more equitable (fair) across all socio-economic conditions. Prior to Covid, families spent an average of $1,700 for standardized tests and application fees. Upper middle class families often spent considerably more — for professional tutors, multiple test taking, etc.

Students from socio-economically challenged environments were at a severe disadvantage. Regarding inclusivity, standardized tests have been viewed by many as culturally biased, quite non-inclusive. While the "personality" of the test may be familiar to students in wealthy suburbs, it is often alien to students in low-income urban and rural areas.

The inclusivity of the ePortfolio is rooted in the environment and culture of the school and the student's community, welcoming inputs from a wide variety of learning experiences and accomplishments. Different communities, different cultures, will give rise to wonderfully diverse contributions to the ePortfolios.

The rigor derives not from student performance on a standardized test but from their many, often unique, certified accomplishments.

Several will likely reveal advanced application of classroom materials in complex community settings. These ideas are consistent with Harvard's announcement. While not sporting a numerical score, the ePortfolio is just as rigorous as your resume!

The ePortfolio can live side by side with standardized tests. The importance weights of the standardized test vs. the ePortfolio can be announced by the college, or perhaps even chosen by the applicant! If a mentor is provided to students for each of the four years of high school, he or she could provide on-going helpful guidance as to how the student can plan and structure activities that will contribute to the ePortfolio. If we think of a student from an underserved community "climbing a steep path towards college admission," such four-year mentoring — helping to avoid falls along the path — may be called "Affirmative Traction."

In today's "vacuum period," the easy answer is to avoid the implementation challenges of ePortfolios, and simply reinstate culturally-biased standardized tests as gating mechanisms for college admission. But, the education of all of our young people is the most important national investment we ever make. What we decide now will likely last for generations.

A new and improved college-applications system, more equitable, inclusive and rigorous, will reap huge rewards to our young people and to our nation.

SUPERHEAVY Science:

ORNL's actinide abilities enable the discovery of new elements

By Kristi L Bumpus / ORNL

It's elemental — scientists agree that the periodic table is incomplete.

And when it comes to unveiling parts of the periodic table yet undiscovered, the Department of Energy's Oak Ridge National Laboratory is doing some heavy lifting.

A combination of unique facilities, people with specific skills and expertise, and a storied history has the lab leading the effort for superheavy element discovery. But why do we care about expanding the periodic table?

Understanding atoms

Why scientists want to discover new elements is easier to explain than how they do it. Hint: It's all about the atoms.

"When scientists worldwide are exploring the periodic table, it's really the exploration of nuclear physics: What makes up an atom?" said nuclear engineer Susan Hogle, group leader for the Target Design, Analysis, and Qualification Group in ORNL's Radioisotope Science and Technology Division. "We can predict the chemical behavior of most elements on the periodic table, but there are certain regions of the table where you can't predict the behavior."

From the discovery of new elements, scientists learn more about existing elements — specifically, are they in the right places on the periodic table? Elements are placed on the table according to their atomic numbers — the number of protons in the

Nuclear engineer Susan Hogle stands outside ORNL's Radiochemical Engineering Development Center, the facility equipped to allow scientists to physically handle materials used in superheavy element discovery. Credit: Genevieve Martin/ORNL, U.S. Dept. of Energy

nucleus of an atom. That number determines the chemical properties of an element, scientists theorize. The current periodic table postulates that elements that share chemical properties are grouped together; therefore, you could determine the properties of an element by where it falls among the table's "periods."

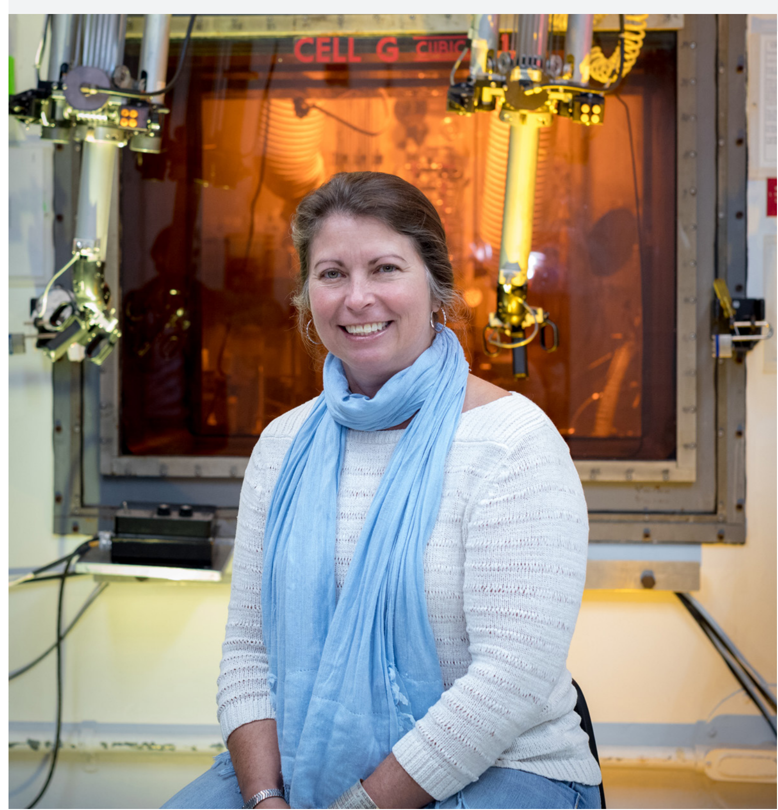
"Once we go beyond currently discovered portions of the periodic table, we're not sure what the chemical behavior of those elements are going to be," Hogle said. "If we can find that out, it will help lead us to the understanding of why those elements behave in a certain way. What does that tell us about the basic properties of atoms?"

The discovery of new, heavier elements could change not only the look of the table, but — someday — the way elements are arranged on it.

"Right now, the table looks nice and pretty and complete," said nuclear engineer Julie Ezold, who heads ORNL's Radioisotope Production and Operations Section. "But the next piece is when we start to be able to do the chemistry and really understand if everything is where it's supposed to be from a chemistry point of view. Is the chemistry of superheavy elements really the same as the chemistry in those columns? Learning the answers to that, to me, would be fascinating."

Ezold was one member of the ORNL team that helped discover element 117 — named tennessine for the roles of ORNL, the University of Tennessee and Vanderbilt University — in 2010.

Julie Ezold sits in front of the Radiochemical Engineering Development Center's Hot Cell G, where Caiifornium-252 is processed. Ezold led the 2008 revival of ORNL's Cf-252 program. Credit: Carlos Jones/ORNL, U.S. Dept. of Energy



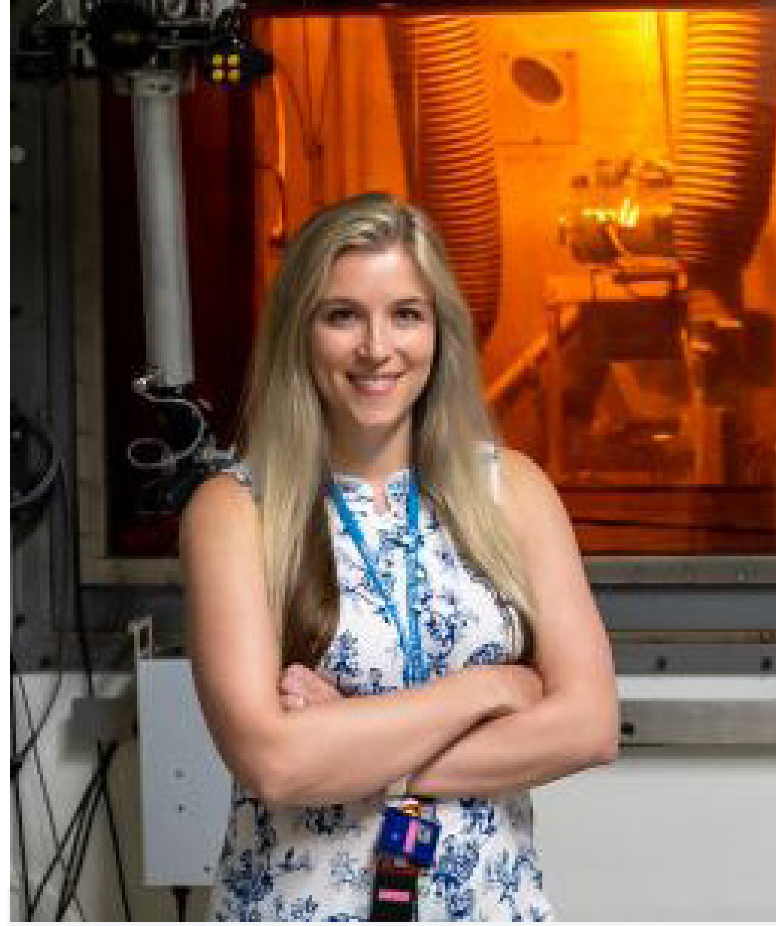
The most recently discovered element, it's now the second heaviest on the periodic table, behind oganesson, discovered in 2002 and named for Russian nuclear physicist Yuri Oganessian, who led the discovery of element 118 and others.

Both elements could fall in the "island of stability," a theorized portion of the periodic table that could explain why some superheavy elements are more stable, when the other known elements beyond element 83, bismuth, decrease in stability. Discovery of new elements could confirm the island of stability exists.

On the periodic table, these superheavy elements, also called transactinides, immediately follow the actinides — the 15 metallic chemical elements from 89 to 103, which are radioactive and release energy when they decay.

The actinides were grouped and named by nuclear physicist Glenn Seaborg, who believed the periodic table might go as high as an element with the atomic number 153. Uranium and thorium, the first actinides discovered and the most abundant on earth, found initial use in nuclear weapons and nuclear reactors. Today, they and other actinides — which also include actinium, plutonium and neptunium — play diverse roles in energy, medicine, national security, space exploration and research.

For some actinides, ORNL is the only place in the world where they're made.

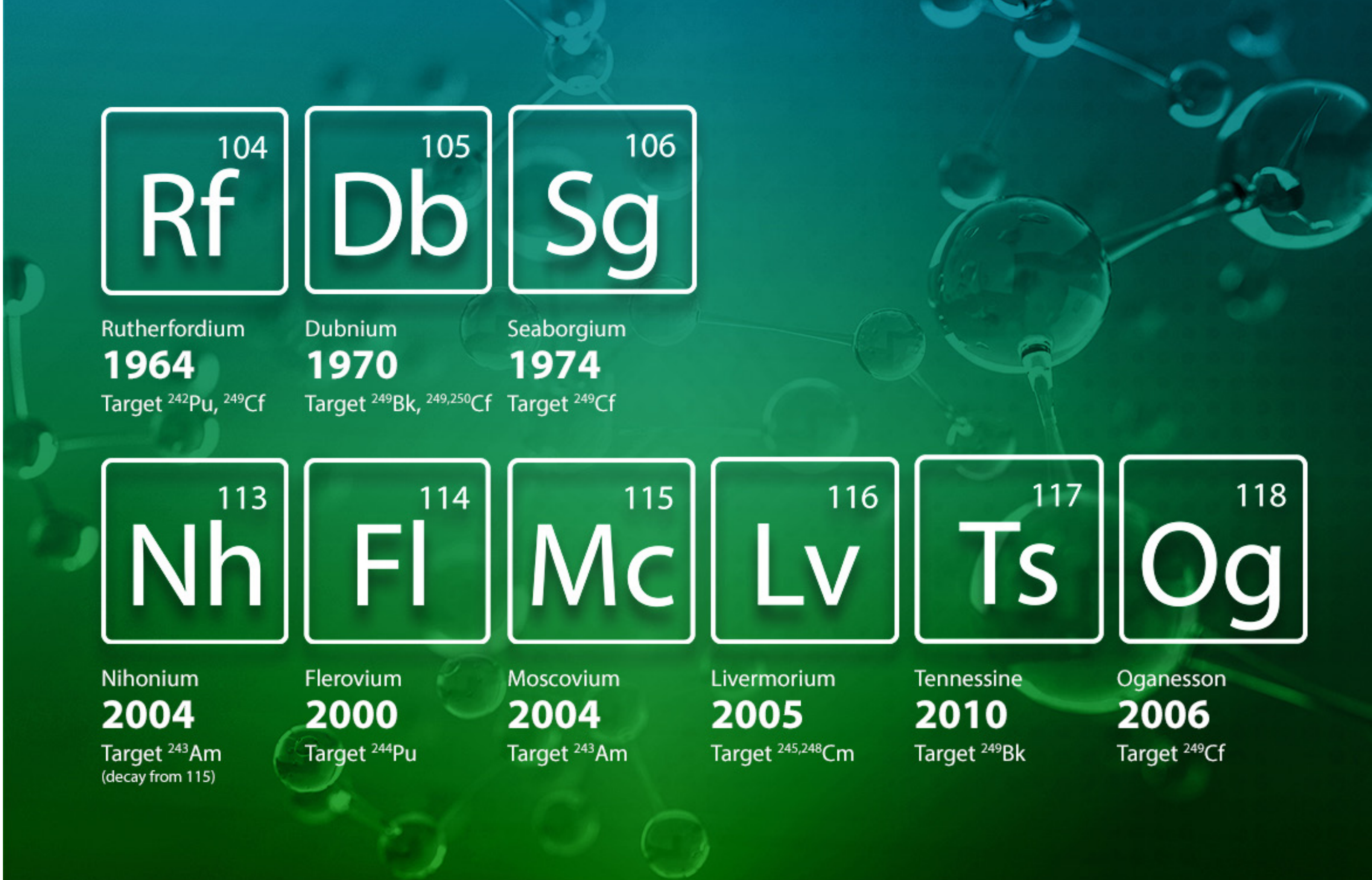


Chemist Sam Schrell specializes in actinide research and development in ORNL's Radioscience and Technology Division. Credit: Carlos Jones/ORNL, U.S. Dept. of Energy

Only at ORNL

ORNL's actinide production makes the lab essential in the hunt for superheavies. Right now, ORNL and other U.S. institutions are engaged in joint experimental programs to find elements 119 and 120, collaborating with Riken, Japan's largest comprehensive research institution, and the international Joint Institute for Nuclear Research in Dubna, Russia.

The DOE Isotope Program funds ORNL's production of these actinides and has contributed them to the international superheavy element community to enable the science.



Nine superheavy elements have been discovered with help from target materials produced at ORNL Some scientists believe the periodic table might extend as high as an element with the atomic number 153. Credit: Jaimee Janiga/ ORNL, U.S. Dept. of Energy

We are only one of two places in the world that can make the actinide target materials that are necessary to do the superheavy element discovery," Ezold said. "In order for these discoveries to happen, it takes international collaborations. One organization, one country, cannot do these alone at this time."

Once, scientists looked for new elements in nature. These days, new elements are created in laboratories by putting a heavier element onto a target and then using a beam accelerator to fire projectiles of a lighter element at it, at a rate of a trillion or more per second. Add together the number of protons between the two elements, and the total could be the number of a new element. It might appear for only fractions of a second, but scientists can observe what it decays into and work backward to verify its existence.

But getting the elements needed to create new elements is no easy feat. They're rare, expensive and highly radioactive, with short half-lives. The process of creating them takes months of irradiation, decay, separation from byproducts and purification, all done by an experienced team in unique facilities built specifically for the processing of highly radioactive materials.

All that effort yields minuscule amounts

Shelley M VanCleve - Einsteinium is separated from fermium for purification at ORNL, one of only two places in the world that can make the actinide target materials necessary for superheavy element discovery. Credit: ORNL, U.S. Dept. of Energy

— but enough to put on a target to go under a beam.

“With the Radiochemical Engineering Development Center, we have the facilities for physically handling these materials, which give off a lot of radiation,” Hogle said. “We’ve been working really closely with the nuclear physics community for decades now. ORNL supplied the materials for every superheavy element discovery since 2000: elements 114 through 118.”

Isotopes of newly discovered elements have such a short half-life — sometimes existing only for fractions of a second— that they don’t yet have any practical uses, Hogle said.

“But in terms of what they could teach us about nuclear physics, there are untold benefits there,” she said. “It really is a vast unknown.” Their short half-lives don’t mean they’ll never be useful. Take americium, for example. When it was discovered in 1944, the short half-life seemed to preclude any utility. It took decades to harness it for one of its best-known uses: the most common type of household smoke detector.

“Actinides are like no other element in the periodic table,” said chemist Sam Schrell, who specializes in actinide research and development in ORNL’s Radioscience and Technology Division. “Their chemistry is rich but unpredictable, which makes them intriguing to study. Discovering how useful some of these elements can be, whether it’s for medical applications or national security, is exciting.”

Focused on the future

Some research taking place at ORNL involves creating targets that are better able to withstand being bombarded with the periodic table’s heavier elements with higher atomic numbers, such as titanium, vanadium and chromium. The heavier the beam, the harder it is on the targets, and the lower the probability the two elements will fuse to create a new element.

Another focus of the lab is finding ways to create larger quantities of in-demand isotopes — for example, californium-252, which is used to start up nuclear reactors. “Cf-252 is a great neutron source because of its short half-life, but there’s just not a lot of it,” said ORNL radiochemist Shelley VanCleve. “Fortunately, less Cf-252 material is necessary to make the same source compared to other radioactive elements. Cf-252 gives off a lot of neutron decay, and the neutron is more difficult to shield compared to an alpha particle. We have the capabilities at REDC — hot cells and smaller caves — that we can work with larger quantities of it.”

VanCleve’s work played a role in processing legacy Cf-252 sources in which most of the Cf-252 had decayed to curium-248. Her team separated the long-lived californium from curium daughter ingrowth for target fabrication. Those long-lived californium targets are used for superheavy element research.

“The material produced here is very pure,” VanCleve said. “It goes through so many different separations. Customers really appreciate the quality of material that we give to them.”

VanCleve was involved in the final purification of the berkelium used to discover tennessine.

“It’s very exciting, but it’s humbling when you think about all the different people who have to be involved,” she said. “I played a very small part. The material is first separated in the hot cells, then it goes up to the alpha labs. I did the final cleanup of the material before it was shipped off site.”

Einsteinium
Einsteinium is separated from fermium for purification at ORNL, one of only two places in the world that can make the actinide target materials necessary for superheavy element discovery. Credit: ORNL, U.S. Dept. of Energy

Isotope production happens with researchers, hot cell technicians, analytical chemists, operators of ORNL's High Flux Isotope Reactor (a Department of Energy Office of Science user facility), and staffers who keep the reactor and research facilities up and running — along with the customers who need the isotopes for their world-changing research.

"Anything is possible; what's important is the curiosity of it," VanCleve said. "That's the great thing about the customers we work with: their curiosity, their desire to continue their research and continue moving forward. They're very passionate people, and they're fun to work with. I know that every customer needs our best quality in order to get their research done — and that's what we're trying to provide."

Hogle's group is working on new designs and novel ways to produce isotopes in HFIR, hoping to increase the availability of these short-lived isotopes for the DOE Isotope Program, which manages isotope production efforts makes the isotopes are available for research and industry through the National Isotope Development Center.

"Our program was developed in the 1960s-1970s, producing californium, and we've always kind of done things the same way," she said. "It's an amazing story, how we took the byproducts of a weapons campaign, and we turned them into radioisotopes that are being used all over the world for industrial and research purposes. In a 50-year of tradition of excellence, we've learned a lot. It excites me that, after doing something a certain way for 50 years, we could suddenly revolutionize the way we're doing this production activity."

Hogle finds it rewarding to see how isotopes are used once they leave ORNL.

"Sometimes when you're a researcher, you do a lot of theoretical work — you do a calculation, and that's where it stops," Hogle said. "It's really exciting to see the work you do actually makes something physical that you can see. We occasionally get letters from people overseas and elsewhere thanking us for supplying these materials to them. It makes you happy to be able to enable other people's work." With every improvement in the production of actinides, scientists learn more about their properties.

"Continuing to understand the fundamental science of the actinides will provide insight to their medical applications, how they behave in the environment, and how we can harness their unique properties for new applications that we have yet to discover," Schrell said. "Actinide science at ORNL has a long, rich history that we hope to continue to build upon.

At ORNL, we are well-positioned to have a multidisciplinary actinide science effort that reaches across directorates to advance actinide science and train the next generation of scientists and engineers."

UT-Battelle manages ORNL for the Department of Energy'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, please visit:

energy.gov/science

Kristi L Bumpus
Oak Ridge National Laboratory

What Experienced Teachers Wish They'd Known When They Started

Dr. Judy Willis

"Certainly, the learning curve is steep for new teachers. But take heart. As I work with teachers at conferences and in their schools and districts, I invite discussions about what they've learned over their careers. It helps us all to recognize and acknowledge our own progress as we've become more experienced teachers. In addition, the wisdom of experience, becomes valuable as practical advice for new teachers."

Here I've consolidated some of the wisdom of experienced teachers in response to the question, "What I know now that I wish I had known as a first year teacher." From the practical to the philosophical, they offer their insights and suggestions, presented here as edited, condensed bullet points.

Classroom Climate: When students have strong perceptions of potential threat, it inhibits learning. If students feel the classroom is a safe place, they are more open to receiving information taught, asking questions, and even making mistakes.

From the start: Clear Expectations for Classroom Behavior

I didn't know how important it was to go over good rules and procedures at the beginning of the school year. I was struggling with classroom management and ended up getting frustrated. I didn't know that all I had to do sometimes was go over these again, perhaps in a different way, such as with modeling or examples.

I wish I started the year with as much planning for how I'd respond to student behavior as I did on content planning. It took a while, but when I focused on sustaining a consistent plan of responses, at least for the most common behavior challenges, the students became more responsible for the expectations I held for them. It really works to start the year with plans for your responses and cut yourself slack if you are not always perfect.

With my insecurity, I lost my cool and "reacted" instead of "reflected" on my response to behavior challenges. With experience and guidance from colleagues and mentors, I build up my leadership style to be more calm, consistent, and confident.

During my first year, I didn't realize how important it was to take the time to talk about rules and procedures clearly. However, I learned my lesson well and now know that whenever something is working, I take the time to provide more clarity in what they are supposed to do. If it's a new procedure, I learned that I can't just make them do it, they need to know "how".

From the start: ***A safe community***

Create a safe community to reduce stress and promote participation with a learning environment in which they feel safe from potential threat but also to take the risks of participating and even making mistakes.

The only person in the room you can control is yourself. Every behavior a child exhibits is a reaction. These reactions are outcomes you can help reduce. You can't change what is going on at children's homes, but you can make your classroom a safe place for all.

The most important of classroom rules regarding the perception of safety by students are those that assure them that their physical person, property, and feelings will not be hurt.

Trust is very important – the trust you earn as their teacher. Students count on their teachers to enforce the rules that are in place. Assure students that you will indeed be there to enforce the rules is by demonstrating early on that you are aware of times when their property, person, or feelings are perhaps being threatened and that you will intervene promptly.

When you need to step in because a student is infringing on a classmate's or class comfort levels, regarding their

physical, property, or emotional safety, keep the interaction calm. Reinforce your role of keeping all students safe. Change the situation to remove the person causing the distress from the interaction.

Acknowledge to the class that you recognized the problem and have things in control. Your subsequent intervention with the student who caused the problem should be private or supervised away from classmates. Emphasize your wanting to understand the causes of the behavior and desire to work with them to prevent recurrence.

As you build knowledge of your students, you'll build trust in yourself

A frequent theme in the suggestions of the accomplished educators was being aware of and responsive to the strengths, interests, motivators, and needs of one's students. Some reflections follow.

- Understand the brain response to high stress in students is not voluntary

- There are no lazy or bad kids. They may react that way when stressed by perceived threat, sustained boredom, or frustrations from repeated failures

- Be honest and respond fairly and consistently to their behavior and follow through with plans

- Love your students, even when they aggravate you. Be empathetic towards them. They won't care about what you have to teach, unless they know you care about them!

Reduce mistake fear and boost participation from the start

/ Create a learning environment in which students feel comfortable, and they'll take the risks of making mistakes.

/ Each moment presents us with opportunities and challenges. We succeed when we know our students as individuals, know our subjects well, and trust ourselves to respond creatively and learn from our mistakes.

/ Ask great questions and make time for students to think deeply. Don't be afraid to say, "I don't know. Let's find out together" when you do not know the answer to a student's question.

Be Kind and Fair to Yourself

Be kind fair loving to yourself as you begin teaching and during challenging times, and even setbacks and mistakes. As a wise educator reflected, "I wish I had known that the students would be so forgiving of my mistakes – almost endlessly so. I kept encouraging them to take risks without taking many myself."

The Exciting World of Environmental Microbiology:
Using the genome to understand the phenome

An interview with Dr. Eric Wommack of the University of Delaware

By Ankit Singh

What is a genome? An organism's complete set of DNA is called its genome. Virtually every single cell in the body contains a complete copy of the approximately 3 billion DNA base pairs, or letters, that make up the human genome.

What is a phenome? The phenome is the complete set of phenotypes resulting from genetic variation in populations of an organism. Saturation of a phenome implies the identification and phenotypic description of mutations in all genes in an organism, potentially constrained to those encoding proteins.

Environmental microbiologist Dr. Eric Wommack always had an interest in natural environments. "I am an environmentalist, and I have always had an affinity for the outdoors." That combined with the exciting process of scientific discovery led him to environmental microbiology. "The process of discovery and unraveling the natural world, essentially, how the world works and explaining why things are, not just accepting them. Scientists just don't accept things as they are without question. We want to know the mechanisms, how things come to be as they are as we observe. That to me is very exciting – when you discover how things work," he added.

Dr. Wommack got his Ph.D. from the University of Maryland in the Marine Estuarine Environmental Sciences, M.S. in Physiology from the University of St. Andrews in Scotland, and a double major in biology and economics from Emory University.

He became interested in the then little-known world of microbes after completing his undergraduate studies in 1987.

"It occurred to me, said Wommack, that we were studying plant and animal communities and how the interactions between plant and animal populations helped ecosystems do what they do but when it came to microbes and we were there, we really couldn't say much. It is essentially a black box, meaning that complex organic matter came in and simple compounds came out that fed the plants, and ultimately, the plants fed the animals.

I was very curious about what was happening among the microbes. Nobody seemed to know. And it's where most of the diversity of life on Earth exists. That was what brought me to environmental microbiology. More accurately, I would call myself a microbial ecologist. At the time I complete my undergraduate in 1987, microbial ecologist wasn't a thing. It was an upcoming field."

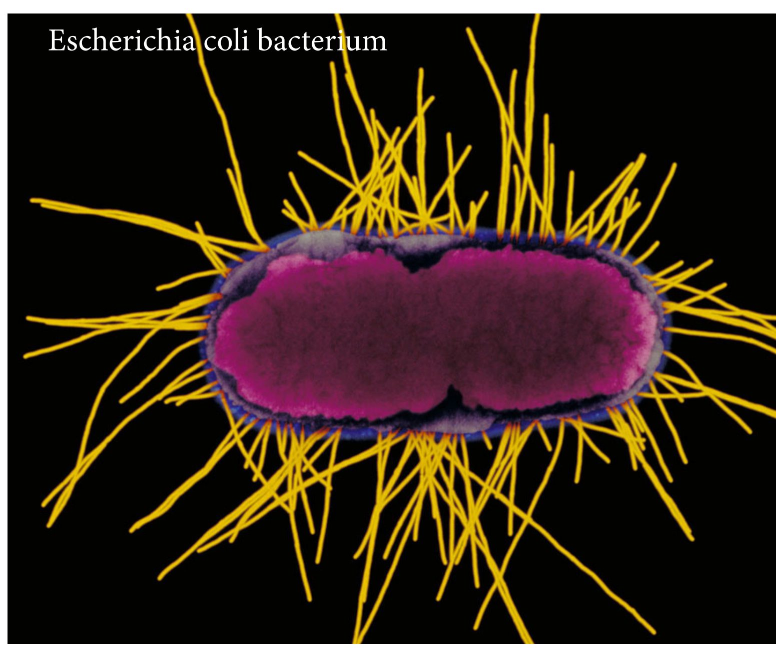
Can you give a general overview of environmental microbiology and why it is important to study?

Microbiology is very broad. Probably, the most familiar that people are with microbiology is our food systems and public health. In our food systems, we are, of course, concerned with food safety, a way to keep pathogens out of the food supply. There's an infectious disease in public health.

We are amid the coronavirus pandemic that is actually, an area of environmental microbiology. Another area people might be familiar with is biotechnology and that's using microbes to do technologically important things. For instance, fermentations. Microbes are extraordinarily important in food. Think yogurt, cheese, cured meats, and all sorts of products, very important products that are based on microbiology. Environmental microbiology is a component of microbiology.

There are scientists like myself who want to understand how microbes and what they do impact ecosystems. This can be natural ecosystems like the oceans and soil, or man-made ecosystems like sewage treatments plants, industrial waste treatments, etc. In natural ecosystems, we are concerned about the flow of nutrients, in particular, carbon through the system.

Sometimes, we are also concerned about pollutants, how compounds are transformed by microorganisms into less harmful, or sometimes, into more harmful forms of chemicals as they move through ecosystems.


Escherichia coli bacterium

What are you studying currently?

When I just started my master's degree at the University of St. Andrews, I was working on a project looking at the physiology of fish muscle protein and how muscle protein helps them adapt to temperatures. I remember reading an article in Nature magazine about this discovery in 1989 that there were abundant viruses in the ocean, ten times more free viruses than there were bacteria. We had only learned a few years earlier that bacteria were extraordinarily abundant in the ocean. That piqued my interest.

So, my work, probably in the biggest sense, is to understand how the interaction of viruses and their microbial host impact the cycling of carbon and nutrients through ecosystems. I am also interested in how the virus-cell interactions impact the evolution of organisms because it turns out that viruses are good at transferring genes around.

Most single- celled microorganisms are clonal. They are asexual and make more of themselves simply by dividing. They don't have a mechanism for exchanging genes like organisms that undergo sexual reproduction where literally, the genes are all mixed up at every round of replication.

It turns out that viruses and other mechanisms are really important to moving genes around and they are the engine of evolution for single-celled organisms.

The most revolutionary thing in microbiology in the last 20 years has been DNA sequencing. DNA sequencing is very inexpensive now and we can get more data than we know what to do with. We use the tools of DNA sequencing to try and understand unknown viruses.

The two ways in which we learn about microorganisms are by culturing them in the lab or by sampling them in the field. And it turns out that what we can grow in the lab is a tiny fraction, maybe 1% of what's out there. Most of what we are going to know about microorganisms is going to come from sequence data that we sample directly out of the environment. That's been a big driver in my work – using DNA sequencing data to learn more about unknown viruses and their impact on ecosystems.

Has the COVID-19 pandemic changed your areas of study and impacted how you do your research?

The pandemic itself has had a big impact on laboratory science because we had to shut down labs. It was a real setback for progress, especially early on, as for about 4-6 months we did not get a lot of work done in the lab! One of the fortunate things in my lab is that we have a lot of computer work because we deal with lots of sequence data so at least, that work was able to keep progressing.

The New Castle County in Delaware was very proactive early in the pandemic. They decided to monitor the progress of

the pandemic by examining wastewater, looking in sewage for the SARS COV2 virus. Ironically, even though it is a respiratory virus, it is shed in feces which I don't think, the medical community completely understands yet.

It is easy to monitor very large populations of people by simply looking at the levels of the virus in wastewater. The University of Delaware does this at a lower cost compared to independent companies. With a local partnership with a civil and environmental engineering firm and the county, we set up the Center for Environmental Waste Water and Epidemiology Research (CEWER) and along with another faculty member, we began monitoring COVID-19 virus levels in the wastewater of New Castle County.

We've also been monitoring dormitories at the University of Delaware through wastewater and the real advantage of this is the earliest of early indicators is wastewater.

The occurrence of COVID-19 rises in wastewater before you see it in positive clinical cases. This becomes an important tool for local decision-makers because if you start to see the levels spike in wastewater then you can think about the need to start scaling up in the hospital in about 2 weeks. It allows for more time to react to the progress of the pandemic. We've published a paper on our work in this area, on sampling and strategies and we are working on another one that looks at the timing of sampling. It matters what time of day and for how long your sample is.

It also matters when you study, the duration and the size of the sample, meaning, how many people were you sampling at the time. We also look at the coordination with the clinical results on campus. So hopefully, this will not only inform the next steps in the current pandemic but the next time it happens, we'll have a better understanding of how to do this.

A lot of countries around the world have started doing this. Delaware is not unique and several universities around the country have been monitoring wastewater. It's a public health tool that is only now beginning to be appreciated.

Your research focuses on dsDNA viruses in particular. Why is studying them important?

All eukaryotes – plant cells, animal cells – have double-stranded DNA. The human genome is double-stranded DNA. However, there are multiple forms of nucleic acid – RNA and DNA. Both DNA and RNA can be single or double-stranded. In single-stranded, there is the positive and negative sense. In double-stranded DNA, one strand codes the gene, and the other strand is the antisense strand. The positive strand makes the messenger RNA that is translated into protein.

The interesting thing about viruses is that they have all sorts of interesting kinds of genomes. Cells including bacteria have double-stranded DNA. Viruses can be double-stranded DNA; single-stranded DNA, positive/negative sense; double-stranded RNA; single-stranded RNA, positive/negative sense. There are multiple different genome types for viruses and it turns out that at least among microbial viruses, many of them are double-stranded DNA viruses.

Most of the viruses I study, i.e., bacteriophages, are double-stranded DNA-based. However, among animals, many human viruses are RNA viruses. The flu virus is an RNA virus, a segmented genome.

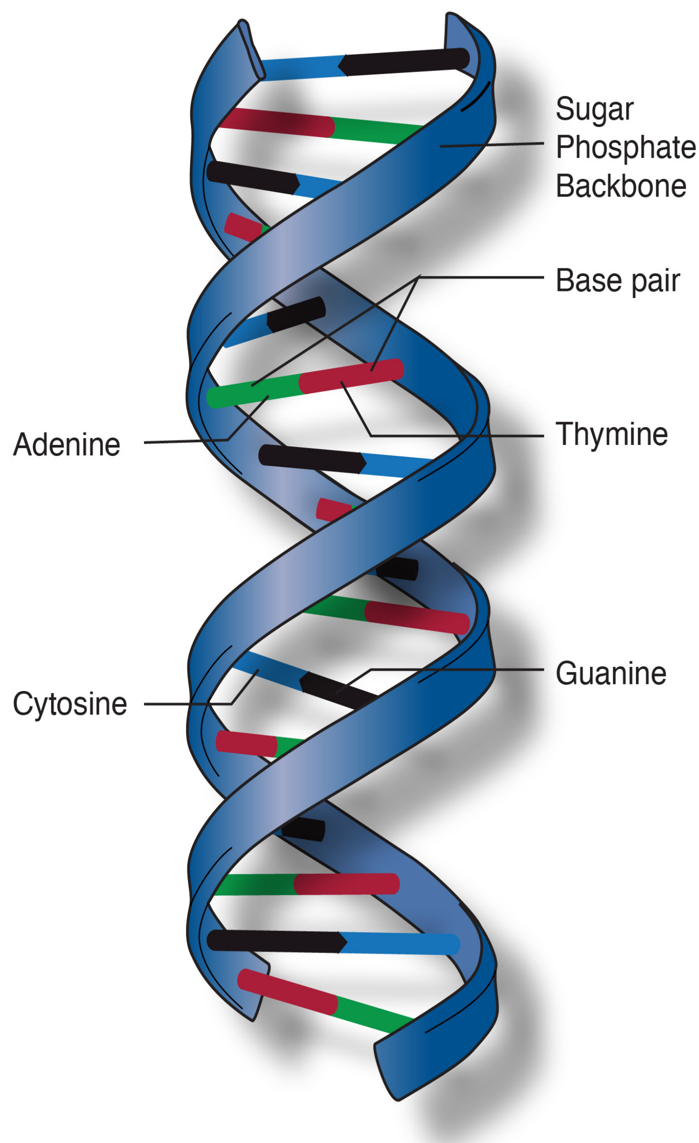
It's not in one piece, it's in 11 different pieces. HIV is an RNA virus but it's a retrotranscribing so it's a special enzyme that will take the RNA and make it a DNA template out of it. Many plant viruses are RNA viruses. Some RNA viruses infect microbes. RNA viruses tend to have much smaller genomes than double-stranded DNA viruses. Now we have discovered double-stranded DNA viruses that have extremely large genomes, a genome that is approaching or exceeding the size of a bacterial genome.

Viruses have arisen multiple times during the evolution of life on Earth. So, unlike cellular life – bacteria, archaea, eukaryotes, where there was probably a single common, or at least, one common ancestor – viruses, not so. We think that they probably arose multiple times and these different genome types are a little bit of a clue to the fact that viruses arose more than one time.

Can you summarize how you study these viruses? What type of methods do you use to sample their genomes?

Primarily, my lab takes environmental samples – water, soil, wastewater, feces – and we go through various steps to extract and purify viruses from the sample. In the case of water, we use a step like filtration to filter out anything that's the size of a bacteria or larger, and then whatever comes through there, we use an even smaller filter at the order of 100 kilodaltons or so, which is really what we call a molecular sieve, to filter further. This sieve would only let maybe some large proteins through and will retain viruses. So, we concentrate the viruses that way.

When we have a clean virus, a cell-free concentrate of viruses, we isolate the nucleic acid, which in our case is usually double-stranded DNA, and sequence it.



We also do some cultivation work. We take the same environmental sample and challenge one of our bacterial cultures with it to see if it doesn't isolate a virus.

This is done by plating the bacteria in a lawn on the Petri plate so it grows all across the Petri plate, then looking for spots where the lawn goes clear. It's called the plot and the spot is where a virus infected the cell and produced more viruses that infected more cells and killed all the cells in that little clear spot. That's how we isolate a new virus and try and propagate it multiple times.

These are then put in the electron microscope to see what it looks like. We purify, isolate its genome, and sequence it to understand more about it. We run experiments to understand its infection dynamics – how long it takes for it to infect the host, how many viruses does it produce for each cell that it kills, and those kinds of things. We do a lot of molecular biology in our work using the polymerase chain reaction (PCR).

We do a lot of computational work once we have the DNA sequence data. That's pretty exciting because that is where the actual new understanding comes.

What does the genome show you when you get it?

We identify an open reading frame where we can see the start and the end of the message and identify the code in between and the amino acids they code for. In the computer, we translate what protein would come from that gene and then take the protein sequence and compare that to hundreds of millions of protein sequences that exist in databases. If we get a match between our unknown sequence and some previously reported sequence, we can say, it is a gene seen before. Does this protein match another protein? So, once we look at the genome, we can understand what genes are encoded in the genome.

The reason this is interesting is that it starts to tell us something about the biology of that virus and we've discovered some pretty interesting things. We've discovered that some viruses carry the genes for photosynthesis. Why would a virus have a photosynthesis gene, it can't perform photosynthesis? It turns out, it carries a photosynthesis gene because when it infects its host, it uses that gene to sustain photosynthesis during infection.

So, viruses are pretty sneaky. They want to at least, have the host live long enough to produce more viruses. We found that they carry genes that we never expected that they would.

People usually, when they hear viruses, think they are bad as they cause infections and diseases but some viruses are helpful also. Tell us about them.

In the environment, viruses play a very important role. In the marine environment, they help carbon move through the system. Cells take up carbon but they also need to die and release carbon so that more cells can grow and that is the fuel of ecosystems. We learned in grad school how ecosystems work and plants photosynthesize to bring energy into the system.

"Not all viruses are bad."

However, plants need other things to make cells. They can't just make cells out of air. They need nitrogen, in particular. They need phosphorus. And where do they get that? They get that from their roots. But ultimately, they get that from microbes taking the decaying matter and making it into simpler compounds like ammonia and phosphate that the plant can take up to build its cells. So, viruses are critical in that entire process.

Viruses help microbial communities to be maintained through the process of evolution. Ecosystems can always change. The one thing that is assured in the universe is change. Living things have to be able to adapt to change.

Even though we are at a time of rapid change now in ecosystems because of climate change, the climate has always changed on Earth but it was much slower than it is now. It is more important than ever that natural ecosystems can adapt and sustain the planet. So, you are spot on – not all viruses are bad. In fact, in medicine, for a long time, there's been an interesting concept, phage therapy. As great as antibodies are, if we use too many antibiotics, the bacteria become resistant to the antibiotic. That's evolution – they will gain resistance.

Viruses have been proposed as a way of controlling bad bacteria. If we can just find the viruses that will eliminate that bacterium it will become like medicine itself. That's another way that viruses can help us.

Your area of study is more on how viruses affect the environment, not so much the human body?

Yes, I have studied and now we appreciate, that in the human body, there are more bacteria than human cells. About 14 trillion bacteria exist on a typical human being and it turns out that wherever there are bacteria, there are phages. It also turns out that there are lots of phages that are associated. We don't understand how those phage populations might control the bacterial populations that contribute either positively or negatively to human health. Another active area of work.

Going back to the environmental aspect of microbes, do any environmental factors like climate change affect microbial communities?

It certainly does. We don't specifically know how microbial communities will respond but we do know that they respond quickly because clonal organisms turn over very rapidly depending on the environment. This means that their evolution is very quick. An active area of work is trying to possibly stimulate these communities to do things that are positive for climate change.

For instance, using them to sequester carbon, to create biofuels, etc. think algae that will grow on carbon dioxide and produce jet fuel that we can grow in the middle of the desert nobody wants to live anyway and make biofuels. That's just one example of how we might leverage environmental microbiology to help the climate crisis.

In your current research, what are your goals? What are you looking to maybe discover and achieve with your research?

What drives me is this – we have all the sequence data with which we can identify a whole bunch of viruses but what I would like to do is be able to predict the ecology and biology of that virus without even growing it by looking at the sequence data. That's what we are working on.

We can use gene sequences to classify populations according to their lifestyle. If you think about the forest, nobody would say that a pine tree is similar to an oak tree. Among viral communities, we can't even tell you what the oak trees and pine trees are. That's kind of the scale that I am at – can we take these gene sequences and put all these viruses together and say they infect these different hosts, grow in this particular way, and would have this kind of impact on the ecosystem? And there's another group of viruses that are here that behave differently. That's the most active area of work for us.

It's like using the genome to predict how viruses affect the environment?

The fancy word is using the genome to understand the phenome. In biology, the phenotype is the features of an organism. One of the great challenges in 21st-century biology is to use the genome to predict the phenotype. We are increasingly finding ways to use the human genome to predict disease and the likelihood of disease. That is an example of a genotype to phenotype. Sometimes our predictions aren't so great but sometimes they are pretty exact. We can now say with a great degree of confidence that if you have this gene, you have the risk of breast cancer, for instance. That's been one of the discoveries.

Author: Ankit Singh is a high school junior at the Charter School of Wilmington located in Wilmington, Delaware.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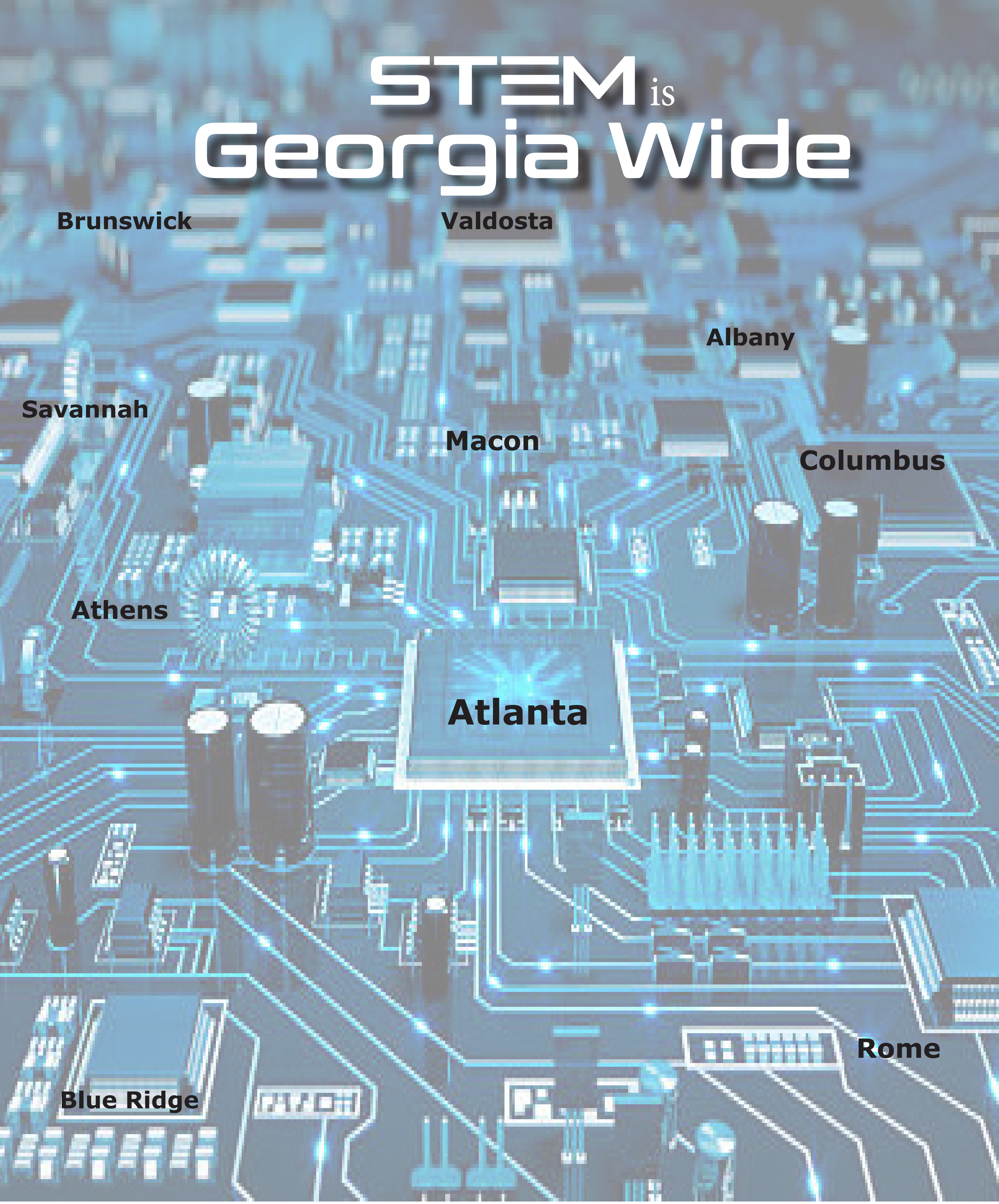

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