ADVANCED **PHARMACEUTICAL** MANUFACTURING

Region 4
Talent Pathways Initiative
June 2025

GO VIRGINIA

TABLE OF CONTENTS

"On behalf of Brightpoint Community College, I want to sincerely thank the Go Virginia Region 4 Council for the opportunity to lead the Talent Pathways Initiative Planning for Advanced Pharmaceutical Manufacturing and Information Technology. No one group can do it alone, and I am especially thankful for the expansive network of representatives from the public, private, and nonprofit sectors whose valuable insights and support were fundamental to the preparation of these reports. Strong regional planning and collaborations lead to the growth of in-demand industries and sustained socioeconomic vitality, and Brightpoint is proud to be an active partner in the Central Virginia region's vibrant ecosystem."

—DR. BILL FIEGE, President, Brightpoint Community College

ACKNOWLEDGMENTS

This report was produced through the collaborative efforts of numerous organizations and individuals dedicated to strengthening the workforce and economic opportunities in GO Virginia Region 4. The research, analysis and findings in this report were developed as part of the GO Virginia Talent Pathways Initiative (TPI) and reflect the invaluable input of stakeholders from education, industry and economic development sectors.

We extend our sincere appreciation to the Region 4 Talent Pathways Initiative Advisory Board and partners for their insights and guidance throughout this process:

- Brightpoint Community College
- ChamberRVA
- Chesterfield County Economic Development
- City of Hopewell
- City of Petersburg
- City of Richmond Department of Economic Development
- CodeRVA Regional High School
- Commonwealth Center for Advanced Manufacturing
- Community College Workforce Alliance (CCWA)
- Community Foundation for a greater Richmond
- County of Prince George
- Dinwiddie County
- Grow Capital Jobs Foundation
- Greensville County
- Hanover County Economic Development
- Henrico County Economic Development
- J. Sargeant Reynolds Community College
- Maxx Potential
- Richmond Technology Council (RVA Tech)
- Virginia Gateway Region

This work would not have been possible without the time, expertise and perspectives shared by business leaders, education providers and workforce professionals who participated in interviews, roundtable discussions and data-collection efforts. Their contributions provided valuable context and helped shape the findings and recommendations in this report.

Finally, we recognize the dedicated efforts of all those involved in fostering a thriving talent ecosystem in GO Virginia Region 4. Through continued collaboration, we can build sustainable pathways that align workforce development with the evolving needs of the advanced pharmaceutical manufacturing and information technology sectors.

SPECIAL THANKS

This project was funded in part by GO VIRGINIA, a state-funded initiative administered by the Virginia Department of Housing and Community Development (DHCD) that strengthens and diversifies Virginia's economy and fosters the creation of higher wage jobs in strategic industries.

We extend our deepest appreciation to the organizations that provided generous financial support for this initiative. Their investment in the future of workforce development and regional economic growth has made this work possible.

We are especially grateful to GO Virginia for its leadership and commitment to advancing talent development across the commonwealth. Additional financial support was provided by the Commonwealth Center for Advanced Manufacturing, the Community Foundation for a greater Richmond, ChamberRVA, Chesterfield County Economic Development, City of Richmond Department of Economic Development, Henrico County Economic Development, Hanover County Economic Development and Brightpoint Community College.

Their contributions reflect a shared dedication to building a strong, resilient and forward-looking GO Virginia Region 4 workforce.

METHODOLOGY

The Talent Pathways Initiative Report was completed in two phases, each addressing specific deliverables essential to understanding and supporting the regional APM workforce.

Phase One

The first phase focuses on gathering foundational data and insights, structured around four primary deliverables:

- A situational analysis of the region's APM employers and workforce needs.
- An asset map of the region's APM training resources, including career and technical education, workforce certifications and degree programs.
- An analysis of the occupational, skills and training gaps that could hinder growth in the APM sector.
- A development plan for the APM Talent Pipeline.

To meet these deliverables, an experienced external consultant with a background in workforce and education strategy conducted research. The approach included online research, stakeholder interviews and community discussions. Engagements involved diverse stakeholders, such as community members, economic development professionals, industry representatives, employers, educators and the general public, and occurred through individual interviews, small group sessions and professional meetings. These interactions informed the research direction and ensured a broad range of APM-related perspectives. This phase culminated in a draft report synthesizing the findings aligned with each project deliverable.

Phase Two

In the second phase, findings from phase one were further refined through additional engagement with the APM community. This phase invited stakeholders to review, provide feedback and contribute additional insights, ensuring comprehensive coverage of all relevant viewpoints and priorities. This collaborative review will also help to identify any overlooked gaps and allow for a reassessment and reprioritization of critical findings.

Given the broad scope of skills, talents and technological developments encompassed by the APM field, this methodology prioritizes inclusivity and thoroughness to create a report that accurately reflects the region's unique characteristics and workforce dynamics.

"Building a strong and sustainable talent pipeline is essential to fueling the long-term growth opportunities in biotechnology and IT. By fostering partnerships between business, education, and workforce development, we can align skills with industry needs and create pathways to meaningful, future-ready careers."

—DR. LORI J. DWYER,
Vice President of Academic Affairs,
Reynolds Community College

EXECUTIVE SUMMARY

APM in GO Virginia Region 4: Workforce and Economic Development Strategies

This report, developed as part of the GO Virginia Region 4 TPI, comprehensively analyzes the advanced APM industry within the Greater Richmond-Petersburg region. It identifies workforce needs, maps existing educational and training assets and examines critical skills and occupational gaps that must be addressed to sustain industry growth. The findings are informed by extensive stakeholder engagement, data analysis and economic research, culminating in strategic recommendations to strengthen the region's pharmaceutical manufacturing talent pipeline.

Key Findings

1. Situational Analysis of the APM Workforce and Industry Needs

The Richmond-Petersburg region has rapidly emerged as a national hub for APM, bolstered by significant federal and state investments, designation as an APM Tech Hub by the U.S. Economic Development Administration (EDA) and a strong ecosystem of industry and research partners. Key findings include:

- The region hosts major APM employers, including Phlow, AMPAC Fine Chemicals (now Novo Nordisk) and Civica Rx, which are driving growth in pharmaceutical manufacturing and reshoring critical drug production.
- The demand for a skilled APM workforce is expected to grow substantially, with employment projections suggesting up to 5,500 or more new jobs in the next decade. These projections were created with a 7% growth rate, which the industry has doubled or tripled. The numbers may soon be modified to align more closely with 11% growth over the next year.
- Industry employers emphasize the need for a wide range of employees, from entry-level work through specialized subject-matter expertise and into upper-level management. Communication between postsecondary institutions and industry leaders has helped develop current and newly implemented educational pathways.

2. Asset Mapping of APM Training and Educational Resources

The region has a robust educational ecosystem supporting APM workforce development, including a developing best-in-class, end-to-end career pathway with middle school exposure, high school Career and Technical Education (CTE) programs, community colleges and four-year universities. Key assets include:

- The Community College Workforce Alliance (CCWA) offers rapid upskilling opportunities through industry-recognized certifications.
- Virginia Commonwealth University (VCU) and Virginia State University (VSU) provide research and degree pathways, including VCU's Ph.D. in pharmaceutical engineering, the first of its kind in the U.S.
- Brightpoint Community College and Reynolds Community College offer specialized certificates and associate degrees in pharmaceutical manufacturing and biotechnology.
- GO TEC® Program

Despite these strengths, challenges remain in scaling training programs, expanding apprenticeships and integrating advanced manufacturing technologies into curricula.

3. Occupational, Skills and Training Gaps

The APM industry faces critical gaps in workforce readiness, particularly in:

- Technical Skills: Companies considering the region for development and expansion desire skills in cleanroom operations, quality assurance, regulatory compliance and advanced manufacturing automation.
- Soft Skills: Communication, teamwork, critical thinking and adaptability are areas where employers report deficiencies among new hires.
- Experiential Learning: Limited access to work-based learning programs — including paid internships, apprenticeships and industry-driven training opportunities — makes it challenging for students to gain hands-on experience before entering the workforce. To bridge these gaps, industry and educational institutions must collaborate on developing curricula, hands-on learning opportunities and workforce-aligned career pathways that encompass a range of work-based learning models, each offering distinct advantages.

4. APM Talent Pipeline Development Plan

To address these gaps and maximize economic opportunities in APM for the region and the commonwealth, the report proposes a regional, scalable Talent Pipeline Development Plan focusing on four strategic priorities:

- Governance: Establishing a regional APM workforce coalition to align stakeholders, coordinate education-industry partnerships, and advocate for sustained investment. Develop a scalable structure and playbook to support future growth.
- Education and Training: Expanding APM-focused education at all levels, strengthening STEM pathways and continuing to invest in stackable credentials to support lifelong learning.
- Experiential Learning and Workforce Alignment: Developing scalable work-based learning models, including apprenticeships and internships, incentivizing employer participation and increasing real-world learning opportunities.
- Sustainable Investment: Securing long-term funding for workforce initiatives, expanding infrastructure to attract APM companies, investing in moving new innovations to commercial scale and leveraging regional incentives to sustain industry growth.

The Greater Richmond-Petersburg region is well-positioned to become a global leader in APM. While the region has made remarkable progress in establishing an APM industry cluster in just under five years, continued investment in workforce development, education and infrastructure are essential to sustaining this momentum. By implementing a coordinated talent-development strategy, fostering industry-education partnerships and embracing innovative manufacturing technologies, the region can solidify its role as a cornerstone of domestic pharmaceutical production, contributing to economic resilience and national security.

This report serves as a roadmap for policymakers, educators and industry leaders to create a strong, skilled and adaptive APM workforce that meets the sector's evolving needs and supports regional economic prosperity.

INTRODUCTION

This report is the product of a regional partnership led by Brightpoint and Reynolds Community colleges and the Community College Workforce Alliance and made possible by a GO Virginia Region 4 Talent Pathways Initiative grant. Additional support from regional civic and economic partners and advisers ensured the initiative's success. This report will explore the APM industry cluster in the Capital Region, identifying the talent gaps and the best pathway to leveraging various business, community and economic partners. The key foci for this report include:

- Situational analysis of the region's advanced pharmaceutical manufacturing employers and workforce needs (TPI#1)
- Asset map of the region's advanced pharmaceutical manufacturing training resources, including career and technical education, workforce, certifications and degrees (TPI#2)
- Analysis of the occupational, skills and training gaps that could hinder industry growth (TPI#3)
- APM Pipeline Development Plan (TPI#4)

What is Advanced Pharmaceutical Manufacturing?

APM encompasses modern, often highly automated pharmaceutical production processes, emphasizing efficiency, precision and quality control. It integrates innovative technologies such as continuous manufacturing, robotics, artificial intelligence and data analytics to enhance production speed, reduce human error and ensure consistent product quality. This approach contrasts with traditional batch manufacturing, which is generally slower and more labor intensive.

Impacted and Related Industries

APM directly influences several sectors within and beyond pharmaceutical manufacturing, impacting businesses involved in:

1. **Pharmaceutical Manufacturing and Supply Chain:**
Companies in this sector adopt APM to produce drugs more efficiently and meet market demands.

2. **Pharmaceutical Research and Development:**
R&D organizations benefit from APM technologies for faster and more precise experimental drug production, helping accelerate drug discovery and testing phases.

3. **Biotechnology Companies:**
Biotech firms focusing on bio-based drug production use APM to streamline biological processes, producing treatments such as vaccines, gene therapies and biologics more efficiently.

4. **Analytical and Laboratory Services:**
Labs providing analytical and quality testing services are involved in APM for quality assurance, ensuring drug safety and efficacy.

5. **Supply Chain and Distribution:**
APM affects logistics and distribution companies tasked with managing the increased speed and volume of drug outputs, necessitating advanced warehousing and delivery systems.

6. **Health Care Providers and Medical Institutions:**
Institutions relying on the timely availability of high-quality pharmaceuticals benefit indirectly from the efficiencies brought by APM, mainly as drugs are produced more rapidly and with less variability.

APM is central to various sectors within the life sciences and health care ecosystem. It promotes partnerships among manufacturing, research, technology and logistics companies by enhancing drug production efficiency, reliability and scalability. Regionally, the term biopharma is also used to talk about the same or parallel efforts within the industry and educational pathways.

APM in the Context of State and Federal Priorities

In recent years, state and federal policymakers have emphasized the critical need to bolster domestic pharmaceutical manufacturing to address national security concerns, economic resilience and supply- chain vulnerabilities. GO Virginia Region 4's focus on APM directly aligns with these priorities, including:

- Federal Priorities: The U.S. Economic Development Administration's designation of the Richmond-Petersburg area as an APM Tech Hub underscores the region's potential to strengthen the national pharmaceutical supply chain.
- State Initiatives: Virginia's TPI, as part of the broader GO Virginia program, has prioritized workforce development in high-growth sectors such as APM to stimulate economic competitiveness and job creation.
- National Security: Efforts to reshore manufacturing, particularly for active pharmaceutical ingredients (APIs), align with federal objectives to reduce reliance on foreign production and enhance health-care readiness.

Pharmaceutical Industry Growth within the Region

The pharmaceutical manufacturing industry cluster has grown in the region over the past eight years. The regions Tech Hub designation (via the United States Economic Development Administration: US EDA)[1] resulted from the energy and work of many individuals, businesses, economic development agencies and funding. These efforts engage the innovations that were part of the Medicines for All[2] project and continued actions through VCU. They also build upon some anchor businesses that support regional economic growth and onshoring pharmaceutical manufacturing — a concern throughout the COVID-19 pandemic.

Medicine for All — A Start for APM Industrial Growth within the Region

The Medicines for All Institute (M4All)[3] at VCU is a leading research institute focused on improving access to essential medicines by making pharmaceutical manufacturing more efficient and affordable. Founded in 2017, M4All develops cost-effective and sustainable methods to produce active pharmaceutical ingredients (APIs), primarily benefiting low- and middle-income countries.

M4All reduces the cost of essential medicines by re-engineering API production and partnering with the pharmaceutical industry, government and global health organizations. Using advanced chemical engineering, process intensification and green chemistry, the institute shifts from traditional batch to continuous flow manufacturing, lowering costs and environmental impacts.

In collaboration with the Gates Foundation and other global health organizations, M4All has made significant advances in producing affordable treatments for diseases such as HIV/AIDS, malaria and tuberculosis, impacting millions worldwide.

Since M4All's inception, the region has attracted private and state funding, NSF Engines, GO Virginia grants, Tech Hub designations and U.S. EDA's Good Jobs Challenge to support this expanding sector.

1 "The Power of Partnership - the Richmond-Petersburg Region Secures Designation as Tech Hub by Biden-Harris Administration and U.S. Department of Commerce."
2 "Medicines for All Institute."
3 "Medicines for All Institute."

Previous Funding Support and Efforts with APM

A lot of the work to build up pharmaceutical manufacturing within the region occurred within the past four years, when it was expected to take three to four times that timeframe. As described by Joy Polefrone, an APM lead for the region, in her presentation at the Commonwealth Center for Advanced Manufacturing Industry Day[4] — this shows accelerated progress!

2020

- Federal Funding for Phlow Corporation: Phlow, a public benefit corporation, received $354 million in federal funding to advance manufacturing for essential medicines.
- Strategic Planning at VCU: VCU's College of Engineering and the Medicines for All Institute received funding from the commonwealth of Virginia to develop a strategic plan for APM.
- The Alliance for Building Better Medicine: Activation Capital led a coalition that secured $2.5 million in seed funding from the commonwealth and other sources, establishing the Alliance for Building Better Medicine (ABBM) as a cluster development initiative.

2021

- Phase 1 Build Back Better Regional Challenge (BBBRC) Award: The coalition successfully advanced in Phase 1 of the Economic Development Administration's BBBRC, receiving $500,000 to support detailed planning for six integrated impact projects.

2022

- Major BBBRC Investment: The ABBM was awarded $52.9 million as winners of the BBBRC, matched by $13.6 million from local public and private partners, resulting in a total investment of $66.5 million.
- Additional Commonwealth Investment: The commonwealth of Virginia allocated $44.6 million in its 2022–23 budget to further enhance economic growth and create high-quality jobs in the APM sector.

2023

- Continued Regional Investment: Coalition members secured an additional $41 million in state and philanthropic funding, bringing the total regional investment in APM to $689 million within four years.
- EDA Tech Hub Designation: The ABBM APM Consortia was designated as an EDA Tech Hub, with the Commonwealth Center for Advanced Manufacturing (CCAM) serving as the lead applicant.

2024

- New Funding Secured: The APM Coalition received:
  - A National Science Foundation (NSF) Engines Type-1 grant ($2 million).
  - An EDA Tech Hubs Accelerator Award ($500,000).
  - Funding from America Achieves ($200,000).

2025

- EDA Good Jobs Challenge: Under the leadership of the CCWA and written by Reynolds Community College, the region secured a landmark $3.94 million federal grant through the U.S. EDA's Good Jobs Challenge Award5.

4 Polefrone, "The Power Of Partnership: Experiences And Learnings Through The Advanced Pharmaceutical Manufacturing (APM) Coalition's Collective Work."

5 "Good Jobs Challenge."

GO VIRGINIA REGION 4 — SITUATIONAL ANALYSIS

TPI#1: Situational analysis of the region's advanced pharmaceutical manufacturing employers and workforce needs

Review of Regional Efforts in Pharmaceutical Manufacturing in the Richmond-Petersburg Region

Existing Assets and Opportunities

The Richmond-Petersburg region is experiencing a period of rapid growth in APM, driven by a confluence of factors:

- Increased National Demand: The COVID-19 pandemic exposed the fragility of the U.S. pharmaceutical supply chain, which led to a national call for reshoring essential medicine manufacturing.
- Federal Investment: The region has attracted substantial federal funding for APM initiatives. Phlow Corporation, a public benefit corporation committed to strengthening the U.S. essential medicine supply chain, received a significant contract from the Biomedical Advanced Research and Development Authority (BARDA).
- Research and Development: VCU's Medicines for All Institute (M4All) is a globally recognized APM research and development leader, particularly in continuous-flow manufacturing. M4All's innovative work focuses on developing more efficient and cost-effective methods for producing essential medicines.
- Emerging Cluster: The region boasts over 30 pharmaceutical companies, research institutions and supporting organizations. This cluster benefits from industry leaders such as Phlow, AMPAC Fine Chemicals, now Novo Nordisk (which operates a large API manufacturing plant in Petersburg), and Civica Rx, a nonprofit generic drug company. These companies, M4All and other stakeholders are working together to establish a robust and resilient end-to-end supply chain for essential medicines.

These efforts have the potential to:

- Generate Economic Growth: The growth of the APM cluster has created hundreds of jobs in the region and projects to add thousands more in the coming years. This growth is particularly significant for Petersburg, which has struggled economically in recent decades.
- Increase Access to Affordable Medicines: The regional APM efforts aim to reduce drug costs and make essential medicines more accessible by developing more efficient manufacturing processes and strengthening the domestic supply chain.
- Position the region as a Leader in Advanced Manufacturing: The Richmond-Petersburg region is rapidly becoming a national hub for APM, attracting investment, talent and recognition for its innovative work.

The growth of the APM cluster has created hundreds of jobs in the region and projects to add thousands more in the coming years.

Regional Pharmaceutical Manufacturing Growth

The region started with a great foundation, and built upon it.

Research Institutes

Go Virginia Region 4 hosts two prominent research universities — VCU and VSU, a historically Black college and university (HBCU) — each contributing substantially to pharmaceutical manufacturing through specialized research initiatives and resources, supported by more than $400 million in sponsored research.

VCU

As a top-100 research university, VCU is a hub for pharmaceutical research and development with several specialized institutes directly supporting advancements in pharmaceutical manufacturing:

- M4ALL Institute: Supported by the Gates Foundation, this institute aims to improve global health by making essential medicines affordable and accessible using cost-effective manufacturing processes.
- The Institute for Engineering and Medicine: Focuses on interdisciplinary research to develop engineering solutions in health care, including scalable manufacturing techniques.
- VCU Institute for Molecular Medicine: Conducts cutting-edge research in molecular science that drives innovation in drug development and personalized medicine.
- VCU Research Institute for Social Equity: Examines health equity, including pharmaceutical access, thereby informing policies for the broader distribution of essential medicines.
- VCU Survey and Evaluation Research Laboratory: Provides data analysis and insights essential for evaluating pharmaceutical needs and impacts in various populations.
- VCU da Vinci Center: An interdisciplinary hub that connects engineering, business and design students to develop innovative solutions in the biotechnology and pharmaceutical fields.

VSU

VSU supports pharmaceutical manufacturing through the following:

- The Center for Pharmaceutical Engineering and Science: Dedicated to advancing pharmaceutical manufacturing processes, focusing on efficiency and scalability.
- The Entrepreneurship Center provides resources and training to support business innovations in the pharmaceutical sector and promote the commercialization of new technologies and products.

These two institutions collectively provide critical research, innovation and technical support to propel the pharmaceutical manufacturing industry forward, addressing current needs and future developments. Other private institutions and community colleges also support the region's pharmaceutical manufacturing research and work including support of and matriculation into these two institutions as a pathway to APM careers.

According to the Virginia Office of Education Economics (VOEE), the region is home to considerable science and engineering talent, especially in the pharmaceutical industry. As reported in the Post-Secondary Completion dashboard at VOEE[6], the third-most-popular degree is in biology/biological science, and registered nursing is sixth, with 886 degrees offered in the 2022–23 school year. Although this may not tie directly to pharmaceutical manufacturing, it does point to a potential audience and pool from which students can be recruited to meet growing needs or changes within the pharmaceutical manufacturing workforce.

6 "Virginia Post-Secondary Completion Dashboard — The Virginia Office of Education Economics."

Existing Footprint for Pharmaceutical Companies

Virginia Life Science Numbers (VEDP Life Sciences Brochure)[7]

Virginia Wide: Virginia Bio reports that the life-sciences industry contributes $8 billion to Virginia's economy, and more than 26,000 Virginians work in the life-sciences industry.

- 25% of U.S. federally funded research and development centers are in Virginia. Virginia is ranked No. 4 for federal research and development funding.
- More than 50 major packaging establishments in Virginia provide services to the life-sciences industry.

GO Virginia Region 4: The life-sciences commercial community is growing.

- Total employment is 660,000 in the Richmond metro area, with 5,800 employed in life sciences.
- Home of the ABBM, whose mission is to reshore pharma manufacturing.
- VCU's School of Engineering is home to the first Ph.D. pharma engineering program in the U.S.
- Virginia was ranked in the top 10 biopharma clusters in the U.S. (GEN)[8]
- Over 70 companies are part of the VA Bio+Tech Park, housed in Richmond, a 34-acre life sciences and technology hub that hosts nearly 70 private companies, nonprofits, research institutes and laboratories.
- Petersburg Industrial Park, a campus spanning over 200 acres and supported by nearly $1 billion in federal and private investments to establish the nation's premier end-to-end APM campus. Prominent industry leaders located within this campus include Phlow, AMPAC, Civica Rx, and ties to the United States Strategic Active Pharmaceutical Ingredient Reserve (SAPIR).

Regional Investments have helped grow development of this industry sector within the region. A $354 million Health and Human Services Biomedical Advanced Research and Development[9] contract provides funding to Phlow, a pharmaceutical manufacturer, to expand pharmaceutical manufacturing capabilities in Petersburg in partnership and with investment from AMPAC Fine Chemicals and CivicaRx. The contract can be extended for up to $812 million over 10 years. The EDA and the state of Virginia[10] have also continued additional support:

- ABBM raised $2.5 million from the State to help form a regional governance for this work.
- BBBRC received $52.9 million for six regional projects tied to pharmaceutical manufacturing.
  - Water and Wastewater Infrastructure — supporting the Petersburg Industrial Park
  - Innovation Center
  - Scale-Up Center
  - Talent Pipeline
  - VCU-VSU Joint Degree Project
  - Supply Chain Project
  - EDA Good Jobs Challenge received $3.94 million to increase good paying jobs through this growing industry.[11]

7 "Life Sciences in Virginia."
8 "Life Sciences | Greater Richmond Partnership | Virginia | USA."
9 Corp, "Phlow Corporation Awarded $354 Million HHS/ASPR/BARDA Contract to Manufacture Essential Medicines in Shortage."
10 "Richmond-Petersburg Region Is a Winner of the National Build Back Better Regional Challenge."
11 "Good Jobs Challenge."

Regional Pharmaceutical and Economic Development

More than 30 prominent pharmaceutical companies and medicine manufacturers are in the region, making up 14% of Virginia's pharmaceutical industry[12]. Between 2015 and 2020, the area saw employment growth in APM that was 80% above the national average and 70% higher than the state average. Since 2019, members of the ABBM have received nearly $500 million from federal, state and local sources. These investments align with the region's comprehensive economic development strategies.

The greater Richmond-Petersburg region is poised to capture 12.8% of the national market of active pharmaceutical ingredient production (245 of 1,910 metric tons). While local industry has yet to reach this capacity, it is expected to achieve this goal within the next 10 years. The region's commitment to economic development underscores its ambitious plans for employment growth. From 2015 to 2020, the area experienced 80% higher employment growth in pharmaceutical manufacturing compared to national averages and 70% higher growth compared to statewide averages. As of 2020, approximately 2,700 APM jobs were in Virginia; the Richmond Metropolitan Statistical Area (MSA) contained 30% of them. (*VEDP Projections Report for BioPharma, August 2023*). Regional businesses are set to significantly increase their current employment base of 1,000 employees to 5,500 within the same time frame. In more recent conversations (winter 2024), members of the ABBM and stakeholders working on writing a grant were informed by the U.S. EDA that their pharmaceutical manufacturing projection estimates were conservative, and they expected a more significant growth.

The region is also in an excellent strategic location[13]

- Halfway between existing biotechnology centers in Rockville, Md., and Research Triangle Park, N.C.
- Boasts a sophisticated supply chain Infrastructure that includes key transit intersections points with the convergence of Interstate Highway 64, I-95 and I-85.
- Includes Richmond International Airport's cargo facilities offering 750,000 square feet of cargo apron and 142,000 square feet of air cargo warehouse space with direct apron access, along with included carriers of DHL, FedEx and UPS and Foreign-Trade Zone 207.
- Less than an hour from the most technologically advanced port on the East Coast, the port of Virginia, which operates the Richmond Marine Terminal.
- Globally connected with state-of-the-art resiliency through three high-capacity, low-latency intercontinental subsea cables

In October 2023, the EDA designated the Richmond-Petersburg region as an APM Tech Hub. This initiative, led by the Commonwealth Center for Advanced Manufacturing, aims to bolster domestic production of essential pharmaceuticals by leveraging regional assets and fostering public-private partnerships. The designation builds upon a previous $52.9 million award from the EDA's Regional Challenge program, underscoring the region's growing prominence in the pharmaceutical manufacturing sector.[14]

12 "Pharmaceutical and Medicine Manufacturing Companies in Virginia, United States of America."

13 Polefrone, "The Power Of Partnership: Experiences And Learnings Through The Advanced Pharmaceutical Manufacturing (APM) Coalition's Collective Work."

14 "The Power of Partnership — the Richmond-Petersburg Region Secures Designation as Tech Hub by Biden-Harris Administration and U.S. Department of Commerce."

Onshoring/Reshoring Pharmaceutical Manufacturing

The COVID-19 pandemic and escalating geopolitical tensions have brought to light the urgent need to address significant U.S. pharmaceutical supply chain vulnerabilities. The increasing reliance on foreign manufacturing, particularly from China and India, for APIs and other critical drug components has raised severe national security concerns. The strategic onshoring or reshoring of pharmaceutical manufacturing to the United States is now more crucial than ever to mitigate these risks, enhance supply chain resilience and protect public health.

According to a report by Dennis Hall from US Pharma[15] on Nov. 14, 2024, and in a report by the ABBM, the following percentages of products are made outside the United States:

- 95% of Key Starting Materials
- 80% of API
- 40 % of Finished Dosage Forms

Concerns with Current Offshoring Practices

The primary problem with offshoring pharmaceutical manufacturing is the significant dependency on foreign countries. From 2011-2021, pharmaceutical imports have nearly doubled. According to the report by CPA[16], China and India account for 91% of generic drug prescriptions in the U.S. and over 90% of new active pharmaceutical ingredient filings. Medicine for All and the ABBM reported findings similar to those mentioned above in Dennis Hall's presentation. These trends highlight the U.S. health care system's vulnerability to disruptions. The COVID-19 pandemic highlighted these liabilities, as supply chain disruptions led to shortages of essential medicines.

The reliance on foreign manufacturing has also been linked to quality control issues, as highlighted in "China Rx: Exposing the Risks of America's Dependence on China for Medicine"[17] by Rosemary Gibson and Janardan Prasad Singh. The book argues that the U.S.'s dependence on Chinese pharmaceuticals not only compromises drug safety but also poses a severe national security threat, as foreign entities could potentially weaponize this dependency in geopolitical conflicts. This sentiment was reiterated by Assistant Secretary for Preparedness and Response Dawn O'Connell (pictured to the right) in her presentation at Phlow on August 27, 2024, when she expressed the concern that approximately 27% of our military medicines come from China.

James H. Loving photography

Impacts of Onshoring

The offshoring of pharmaceutical manufacturing has also had profound economic and employment effects in the United States. The Economic Policy Institute's 2022 report[18] outlines how globalization and policy decisions have hurt U.S. manufacturing jobs, particularly affecting Black and female workers. They have also negatively impacted impoverished regions, potentially cutting off pathways to the middle class. The loss of these jobs has contributed to broader economic inequalities and weakened the U.S. industrial base.

15 Hall, "Will AI/ML Change How Pharmaceuticals Are Made?"
16 Iacovella, "How to Address America's Historic Drug Shortage Crisis — Coalition For A Prosperous America."
17 Gibson and Singh, *China Rx*.
18 Scott et al., "Botched Policy Responses to Globalization Have Decimated Manufacturing Employment with Often Overlooked Costs for Black, Brown, and Other Workers of Color."

Bringing pharmaceutical manufacturing back to the United States is a strategic imperative. It would address critical national security concerns, mitigate supply chain vulnerabilities and revitalize the U.S. economy by creating jobs and fostering innovation.

James H. Loving photography

Bringing pharmaceutical manufacturing back to the U.S. is a matter of national security and would significantly boost the economy. The White House's 2021 report[19] on building resilient supply chains underscores the need for a robust domestic manufacturing base to support national security and economic growth. Reshoring efforts would reduce dependency on foreign sources, create high-quality jobs and drive innovation within the U.S. pharmaceutical industry, contributing to the country's economic stability.

The Greater Richmond area, with its established pharmaceutical manufacturing capabilities, is poised to play a leading role in onshoring efforts. The region's strategic location, skilled workforce and existing infrastructure make it an ideal candidate for expanding domestic pharmaceutical production. The area has already seen significant investments in advanced pharmaceutical manufacturing, with projects planned around the efforts of Advanced Pharmaceutical Manufacturing which aims to create a globally competitive APM Tech Hub in Richmond. As outlined in the APM Tech Hub Overarching Narrative[20], this initiative seeks to leverage regional strengths in biotechnology and manufacturing to accelerate the reshoring of pharmaceutical production. Eric Edwards, CEO and cofounder of Phlow (pictured below), mentioned in an August 27, 2024 presentation, that Phlow has facilities that could run 24 hours, producing small and large quantities of pharmaceutical products.

Bringing pharmaceutical manufacturing back to the United States is a strategic imperative. It would address critical national security concerns, mitigate supply chain vulnerabilities and revitalize the U.S. economy by creating jobs and fostering innovation. The Greater Richmond area stands out as a prime location for these onshoring efforts, offering the necessary infrastructure and expertise to support the growth of the domestic pharmaceutical manufacturing industry.

19 "Issue Brief."
20 "Tech Hubs."

Virginia and GO Virginia Region 4 Data

Advanced pharmaceutical manufacturing data includes North American Industry Classification System (NAICS) codes for pharmaceutical products, biological products, diagnostic substances, testing laboratories and research organizations.

The Virginia Economic Development Partnership prepared a document on the job growth estimates in central Virginia biopharma for tech hubs in August 2023. The information focuses on potential job growth in the biopharma industry in central Virginia and the state.

- The Virginia Economic Development Partnership (VEDP) estimates that Virginia could see 3,000 to 6,000 new direct biopharma jobs over the next 10 years. The central Virginia region could see a potential increase of 5,000 jobs above the 10-year forecast.
- These estimates include several factors:
  - Analysis of historical trends and projected U.S. employment
  - Comparisons to similar states and metro areas with comparable investments
  - Evaluation of the impact of recent job announcements
- The study also emphasizes the potential for accelerated growth if additional federal funds are invested in the APM cluster.
- The report includes data on the economic impact of NIH funding in Virginia, highlighting its positive effects on job creation and economic activity.

Their research presents a positive outlook for biopharma job growth in Virginia, particularly in the central Virginia region. The current growth forecasts (based on 2022 and earlier data) show the direct biopharma growth at 400 new jobs over the next 10 years. This data is based upon historical information and does not include the influx of financial support and industrial development the region has recently experienced. Compared to similar regions, the area can look at projections that will more closely match the expected growth and how to best prepare for it over the next 10 years. Their research indicates that:

The Virginia Economic Development Partnership (VEDP) estimates that Virginia could see 3,000 to 6,000 new direct biopharma jobs over the next 10 years.

- If we use central Virginia's fast-paced peer metro area and capture the same growth, we will move from 400 to 2,200 new jobs in biopharma.
- If we compare the region to a top-growing peer metro area, biopharma job growth could reach 3,600 new jobs.
- If we compare the central Virginia region to a top-growing metro area with similar project wins, job growth expectations would reach 4,500.
- Compared to the top peer metro for biopharma job growth, the regional numbers would reach 5,500 new jobs.

These numbers help provide insight into the region's growth and momentum and will help prepare for various direct, indirect and induced elements that will impact it. These are projections from 2022 to 2032.

IMPLAN Analysis for the Richmond MSA in 2024

IMPLA projections are based on scenarios in which the region (Richmond MSA) attracts 15 new projects. The topline takeaway is that this scenario could result in an estimated 10,975 jobs across all industries and generate $1.3 billion in value added to the regional economy, with 775 direct jobs in pharmaceutical manufacturing.

Note on methodology for the IMPLAN data:

- The analysis is based on an optimistic but realistic scenario in which the region secures 15 new projects.
- The projects include one megaproject (transformational manufacturing project), four medium projects and 10 startup/commercialization projects.
- The estimated jobs and capital expenditures profile for each project are based on real examples from VEDP's project pipeline.

IMPLAN is an input-output model that estimates direct, indirect and induced jobs that could result from "events" that can occur in a given region. It includes construction jobs that can result from significant capital investment, e.g., new manufacturing facilities. Their data, not including construction, shows Direct employment in pharmaceutical manufacturing jobs at 775, and it includes an additional 2,480 indirect jobs and 1,516 induced jobs for a total regional impact of 4,771 jobs. If you include construction, the total number of jobs comes in at more than double that number.

Indirect jobs that support pharmaceutical manufacturing roles are usually seen as individuals within the business, such as human resources, accounting, management, etc. Induced jobs created by the increase in pharmaceutical manufacturing employment include anything from local gas and food to schools and community support.

The numbers in the JobsEQ and IMPLAN research shared by VEPD use 2022 data. New projections are in the works. As mentioned earlier, the U.S. EDA informed members of the Alliance for Building Better Medicine and stakeholders working on writing a grant that their pharmaceutical manufacturing projection estimates were conservative. They commented that similar projects predicted more significant growth and that our region should be less reserved in its reporting.

Novo Nordisk is a new partner within this region's advanced pharmaceutical alliance, recently buying AMPAC Fine Chemical late in 2024. Its leadership team has already expressed interest in supporting the current APM efforts and sharing with the organization their efforts in other areas, including the North Carolina BioWork[21] program, which started more than a decade before the Richmond-Petersburg efforts. *North Carolina's pharmaceutical work started over 50 years ago.* Novo Nordisk has a proven track record of working with regional educational pathways to support growing a regional workforce and supporting continuing education for staff.

In January 2025, Novo Nordisk met with several ABBM-affiliated partners and stated that it is interested in continuing its pathways work. The company currently employs 100 people at the Petersburg plant and estimates that an additional 50-70 new staff will be hired at all educational/skill levels over the next nine months. That will significantly add value to the region's APM biotechnology growth.

From 2015 to 2020, the area experienced 80% higher employment growth in pharmaceutical manufacturing compared to national averages and 70% higher growth compared to statewide averages.

21 "BioWork | NCBioNetwork.Org."

VOEE breaks down the data differently. Below is information from the Education and Workforce Alignment Dashboard[22] for GO Virginia Region 4.

VOEE Career Cluster	VOEE Career Pathway	2022 Workforce	2027 Projection	Projection Change in 5 years #	Projection Change in 5 years %	Avg Annual Openings Next 5 yrs
Health Science	Biotechnology Research and Dev.	329	452	123	37.6%	28
Health Science	Pharmacy	3766	4001	235	6.2%	319
STEM	Life Science	840	894	54	6.4%	84
STEM	Engineering and Technology	4207	4395	188	4.5%	297
Manufacturing	Management and Operations	16094	17388	1294	8.0%	1560
Manufacturing	Production - Food	1630	1796	166	10.2%	249
Manufacturing	Production - General	18675	20316	1641	8.8%	2739
Manufacturing	Prod. - Process Development	4470	4325	-144	-3.2%	406
Manufacturing	Quality Assurance	3205	3467	262	8.2%	407

The VOEE Career Cluster and Career Pathways listed in the chart above do not all directly relate to APM jobs; however, they are related to and include APM roles and competition for these roles.

- Health science is seeing huge growth percentage-wise within the region; however, the numbers are still small. The influx of new potential businesses, which would match the VEDP projections, would show that this growing market (with an expected increase of 37.6%) would stress current educational pathways. *Newly implemented APM educational pathways are documented in the education section.*
- STEM in both life science and engineering and technology is seeing growth. Some of the newer roles in the Richmond-Petersburg region will be focused on manufacturing engineering. This will create competition for students within the engineering pathway and potential employability, especially since the market will annually look for nearly 300 engineers.
- A variety of positions fall under the manufacturing career cluster. The career pathways listed above all relate to pharmaceutical manufacturing processes. Civica RX has hired staff from both the science and manufacturing side. The work in this area is growing; using the VOEE chart above, the region will look to hire an annual average of over 5,000 manufacturing jobs, plus additional jobs in related health and STEM fields. The pharmaceutical industry will have to compete for employees, especially due to the large food, chemical and packaging companies within the region that require similar clean-manufacturing practices.

Data collected for a Workforce Work Group report on pharmaceutical manufacturing collected in 2020 showed the three main anchor pharmaceutical manufacturing businesses in the area (AM-PAC Fine Chemicals, Civica Rx and Phlow) predicting hiring rates that included 20 Ph.D.s, 67 B.S. degree holders and 119 technical/production workers to be hired by January 2023. Since then, AMPAC Fine Chemicals was purchased by Novo Nordisk, which claims it expects to hire 50 to 70 additional staff within the year. Civica Rx and Phlow are finalizing their certifications for production and should be ready for full production in summer 2025. When Civica and Phlow reach full production, their hiring rates will increase to meet their production plans, but they may grow more as additional shifts or expansions may occur. Civica reported that it currently employs around 180 people in Virginia and plans to expand to 350 full-time positions over the next two years.

22 "Education and Workforce Alignment Dashboard — The Virginia Office of Education Economics."

	Jobs	Companies Expanded	Companies Created
Activation Capital	3	Activation Capital	
Civica	100	Civica	
Ampac	100	Ampac	
Phlow	23	Phlow	MedPhlow
Brightpoint	8	Brightpoint	
Reynolds	0	reynolds infrastructure with labs	
GRP	1.25	GRP	
VGR	1	VGR	
Petersburg - Engineer (Poor Creek)	1	City of Petersburg	
City of Petersburg - hired for poor creek	2		
JMT	2	JMT	
Waco Inc	2.5	Waco	
VSU	5	Virginia State University	
CCAM	1	CCAM	
RE Developer	1	Roslyn Farms Development	
Petersburg Public Library	1	Petersburg Public Library	
VEDP	1	VEDP	
CCWA	0.5		
USP	7	USP	
			Sterile Solutions
Total	**260**	**17**	**2**

Virginia Biotechnology Research Park (VA Bio+Tech Park) contacted regional businesses requesting information on jobs and businesses created, and businesses expanded between September 2021 and June 2024 as a direct or indirect result of the APM regional activity. The VA Bio+Tech Park collected all of the data through interviews with the organizations directly.

Since 2020 the region's three main pharmaceutical manufacturing pillars, AMPAC Fine Chemicals, Civica and Phlow have led to 465 jobs throughout the Richmond-Petersburg area.

High-Wage, High-Tech Opportunities

Regional APM efforts will strive for a 20-30% wage increase for participants within two years of placement. APM partners in the Richmond-Petersburg area committed to investing in the local workforce by supporting the Good Jobs Challenge proposal. Authored by Reynolds Community College, the proposal was awarded $3.94 million in January 2025.

The principles that the Good Jobs Challenge strategic partners agreed to ensure every APM job offers a competitive wage, full benefits and a pathway to skills and career advancement. All employers will strive to provide comparable or higher pay than the average APM technician-level salary in the region ($50,845). In addition, per standards set by the Bureau of Labor Statistics for private industry workers, employers will commit to benefits packages worth at least 29.7% of a worker's total compensation. Finally, this project will give workers tools to progress into career pathways through local educational programs, such as offered through the Community College Workforce Alliance and community college programs at Brightpoint and Reynolds community colleges. This will provide a well-designed stepping stone for those interested in four-year (plus) degree programs at VCU and VSU.

"The Richmond-Petersburg region is an emerging leader in advanced pharmaceutical manufacturing (APM), spurring local innovation, and playing a critical role in securing the U.S. supply of medicines. As the local industry grows, so will the region's need for skilled talent. That's why it's incredible to see how workforce stakeholders in the region - with leadership from the Community College Workforce Alliance, Reynolds and Brightpoint Community Colleges, the Commonwealth Center for Advanced Manufacturing - are collaborating under the Alliance for Building Better Medicine to implement best practices to meet employer needs and expand the skilled workforce ready for good jobs in the industry. This includes establishing a new intermediary to quarterback the development of a sector partnership much like other regions leading the way on workforce development."

—JOANNA MIKULSKI, CEO and Founder Mikulski Strategies LLC.

Infrastructure

The Petersburg, Va., region has been actively developing infrastructure to bolster pharmaceutical manufacturing. A key initiative is establishing the APM Cluster, which aims to revitalize domestic production of essential medicines and reduce reliance on foreign supply chains.

The APM Cluster focuses on creating a 200-acre, state-of-the-art industrial park equipped with advanced facilities tailored for pharmaceutical production. This includes modern utilities, efficient waste treatment systems and preparing land for specialized laboratories to support research and development. The infrastructure also supports a regional medical facility. Build Back Better Regional Challenge funding helped kick off these efforts.

By investing in this infrastructure, the Petersburg region seeks to attract pharmaceutical companies, stimulate job creation and enhance economic growth. Such developments are crucial, as infrastructure plays a vital role in economic development by providing essential services that facilitate production and improve quality of life.

Governance

The Alliance for Building Better Medicine and Advanced Pharmaceutical Manufacturing Consortium

The Alliance for Building Better Medicine (ABBM) was created in 2019 as part of the original Build Back Better funding and initial Tech Hub efforts. The Advanced Pharmaceutical Manufacturing (APM) Consortium emerged from grant development efforts originating from a Tech Hub second-round funding opportunity in 2019.

Alliance for Building Better Medicine Members — collaborative efforts since 2020:

- Activation Capital
- AMPAC Fine Chemicals
- City of Petersburg
- City of Richmond
- Commonwealth Center for Advanced Manufacturing
- Civica
- Community College Workforce Alliance
- Greater Richmond Partnership
- Medicines for All Institute
- Phlow
- Virginia Economic Development Partnership
- Virginia Innovation Partnership Corp.
- Virginia Gateway Region
- Virginia State University
- Walmart
- US Pharmacopeia

In addition to the above organizations, the alliance has engaged numerous additional committed organizations working to collaboratively accelerate the APM industry.

The Commonwealth Center for Advanced Manufacturing (CCAM), on behalf of ABBM, with 40 consortia members, plans to further develop the region's official Tech Hub status for pharmaceutical manufacturing through the United States Economic Development Administration, created the APM Consortium. These efforts were in response to the growing concern over the heavy reliance on foreign manufacturing for APIs, which poses significant risks to national security, economic stability and public health.

The APM Consortium was designed to operate under a robust governance framework to foster collaboration among its diverse members, including institutions of higher education, state and local governments, industry leaders, economic development organizations and workforce training entities. The current Tech Hub designation enabled the region to apply for $40 to $70 million to continue its efforts, but the funding was declined, leaving the consortium with limited capacity. However, the EDA did provide a partial award to help create a governance model while the group seeks a longer-term, sustainable model.

The APM Consortium was designed to operate under a robust governance framework to foster collaboration among its diverse members, including institutions of higher education, state and local governments, industry leaders, economic development organizations and workforce training entities.

Despite lacking consistent funding, ABBM maintains a governance role — assembling key partners, assisting with communications, supporting relationship building and applying for additional grant opportunities. ABBM and its affiliated partners have also engaged in research and efforts to continue to grow a regional alliance, looking at various governance models and seeking the next best steps to help maintain the momentum within the APM/biotech community. Key members developed a model and framework geared toward a more sustainable governance model.

APM and affiliated partners have set ambitious goals for the time when they achieve a Regional Technology and Innovation Hub (APM Tech Hub) status. Then the consortium will be able to expand its capacity for deploying and commercializing advanced manufacturing technologies and catalyze significant job growth. by adding up to 5,500 new biopharma jobs over the next decade. By enhancing its technological focus areas, including automation, biotechnology and medical technology, the partnership aims for the region to be a global leader in end-to-end pharmaceutical manufacturing.

In addition to these goals, the partnerships are committed to fostering a strong pipeline of innovation and commercialization, ensuring that the region remains competitive on a global scale. This includes ongoing efforts to attract investment, develop cutting-edge manufacturing processes and build a skilled workforce capable of meeting the demands of the rapidly evolving pharmaceutical industry.

The region would benefit significantly from continued efforts to build a sustainable, cooperative governance that supports regional stakeholders and includes business, educational and economic development leadership.

GO VIRGINIA REGION 4 — ASSET MAPPING

TPI#2: Asset map of the region's advanced pharmaceutical manufacturing training resources, including career and technical education, workforce, certifications and degrees

Educational and Training Pathways

Educational pathways within the region, which propel various pharmaceutical manufacturing careers, meet or exceed expectations regarding skills, training and the number of graduates. These pathways include on- and off-ramps to postsecondary certifications, degrees and professional/continued learning. Interviews revealed that local pharmaceutical manufacturing businesses have hired employees without the appropriate training, and existing community college programs have been recommended as a means to ensure staff is appropriately trained and certified. The more significant concern is the capacity to create a continuous pipeline of individuals entering the industry workforce and scaling up to meet the needs of the regional industry. While the prospects are promising, ongoing assessments are needed to ensure success in graduate numbers as well as skill and talent development.

Pharmaceutical Manufacturing Pathways in Pre-K–12

Middle School

Middle schools in the region provide courses designed to help students explore potential career pathways. The availability and content of these courses vary significantly by school and district. While students may encounter a wide range of options, exposure to manufacturing, specifically pharmaceutical manufacturing, could be more consistent. In some cases, these topics are introduced through STEM or engineering programs.

A GO TEC® initiative, in collaboration with the CCAM, aims to address this gap by offering a more targeted approach to introducing manufacturing concepts, including pharmaceutical manufacturing, across the GO Virginia Region 4 middle schools. Schools began incorporating this subject matter in 2024, but it has not yet gained universal implementation throughout the region. Additionally, educators report that manufacturing careers are not consistently highlighted within middle school exploratory courses. Where manufacturing is introduced, it is often tied to additive manufacturing technologies, such as 3D printing, with limited direct connections to pharmaceutical manufacturing outside of the GO TEC® initiative.

High School

The GO Virginia Region 4 encompasses 16 school districts, 15 of which fall within Superintendent Region No. 1 and one in Superintendent Region No. 8. Brightpoint and Reynolds community colleges support all districts in Superintendent Region No. 1, providing high school students with opportunities to enroll in dual-enrollment courses, including options relevant to pharmaceutical manufacturing.

Several districts offer Career and Technical Education (CTE) programs that include courses in manufacturing or pharmacy technology. Additionally, Reynolds Community College enables high school students to enroll in biotechnology courses that align with entry-level pharmaceutical manufacturing opportunities. However, Southside Community College, serving Greensville County in Superintendent Region No. 8, does not currently offer specific programs in pharmaceutical manufacturing or biotechnology, though several students from that region have elected to take courses through Brightpoint Community College.

Despite these opportunities, access to courses relevant to pharmaceutical manufacturing is limited primarily to 11th and 12th graders who participate in dual-enrollment programs. This limitation creates a gap in exposure to manufacturing and pharmaceutical manufacturing pathways for students in grades 9 and 10. While principles of technology or STEM electives might offer indirect exposure to manufacturing concepts, the curriculum is not explicitly focused on these industries, and coverage often depends on the initiative of individual educators.

Homeschooling in Virginia accounts for nearly 5% of the student population[23]. It is higher in rural areas. When asked, The Home Educators Association of Virginia (HEAV)[24] and other interviewees stated that many students within the homeschool system have various levels of training and support; however, when it comes to college and career pathways exploration, it often falls to regional networks of homeschool youth or statewide conferences and events where students have the opportunity to engage with postsecondary and career options. The GO Virginia Region 4 area effectively engages homeschooled youth, and between Brightpoint and Reynolds community colleges, they graduated 127 homeschooled students in 2024.

Postsecondary Options, Including Certifications and Degrees

Certifications

The Community College Workforce Alliance (CCWA) offers pharmaceutical manufacturing and pharmacy technician certifications. These certifications are not complete semester programs through community colleges, but quicker options for adults to gain initial certifications or, in some cases, professional and continued learning opportunities. CCWA industry credential training typically lasts four months, preparing graduates for entry-level pharmaceutical positions such as active pharmaceutical ingredient manufacturing technician, packing and shipping technician, machine operator and process technician. CCWA works with Brightpoint and Reynolds community colleges to offer programs at their campuses.

Brightpoint Community College also offers a career studies certificate in pharmaceutical manufacturing. This two-semester option (approximately nine months) prepares students for entry-level pharmaceutical positions such as quality assurance auditor/associate; quality control associate; isolator operator; fill-finish operator and laboratory technician.

With the assistance of regional pharmaceutical industry staff, CCWA and Brightpoint created relatable, relevant coursework to prepare their students. Civica helped develop the curriculum and has provided support to ensure graduates have experience using similar tools and techniques employed within their facilities. These certificates offer focused training on pharmaceutical manufacturing processes, quality control, regulatory compliance and Good Manufacturing Practices (GMP). They typically cover pharmaceutical formulation, process validation and sterile manufacturing techniques.

Associate Degrees

Reynolds Community College has started biotechnology laboratory technician major, a new biotechnology option that provides an on-ramp to a four-year degree. This associate degree option helps students master lab techniques and hone critical thinking skills they can apply in regional pharmaceutical businesses.

Richard Bland College offers a clinical lab sciences degree. This associate of science in clinical lab science degree is designed for students interested in careers and majors in forensic science, allied health and related fields, medical/clinical lab technology, medical research or medical sales. This program could dovetail into the pharmaceutical world or fit into continued education opportunities at one of the universities.

Brightpoint will start an associate degree in fall 2025 that could lead to options in VCU's manufacturing engineering, chemistry or pharmaceutical science programs.

23 South, "Across Cultural Lines, Home Schooling Has Boomed since COVID-19 Hit, *Virginia Mercury*."
24 "Virginia Homeschool | Home Educators Association Of Virginia."

Bachelor's Degrees

VCU offers several degree programs, especially its new B.S. pharmaceutical sciences, in fit into the pharmaceutical industry cluster. Other options include chemistry or engineering, which can lead to options within the pharmaceutical industry cluster or create a pathway to continued education.

VSU also offers a B.S. in chemistry and manufacturing engineering. Both support regional pharmaceutical businesses and provide pathways to continued education.

Both VCU and VSU support undergraduate research in the pharmaceutical sciences and provide opportunities for students to present their research. Longwood University, just outside the region, also offers degrees in clinical lab science and chemistry that attract students from the Richmond area.

These three regional institutions within GO Virginia Region 4 also offer a B.S. in chemistry:

- University of Richmond
- Virginia Union University
- Randolph Macon College

Master's Degrees

VCU provides options in the pharmaceutical sciences and supporting degrees in the sciences and engineering.

Doctoral Degrees

VCU offers a first-of-its-kind Ph.D. in pharmaceutical engineering in addition to a Ph.D. in pharmaceutical sciences.

South University offers a doctorate in pharmacy.

Professional and Continued Learning Options

The Commonwealth Center for Advanced Manufacturing and the Community College Workforce Alliance have expressed interest in and are fully prepared to offer additional training and educational programs for regional pharmaceutical industry partners. The groups have also assured local pharmaceutical business partners that they will provide supportive services when needed, paving the way for continued growth in training opportunities.

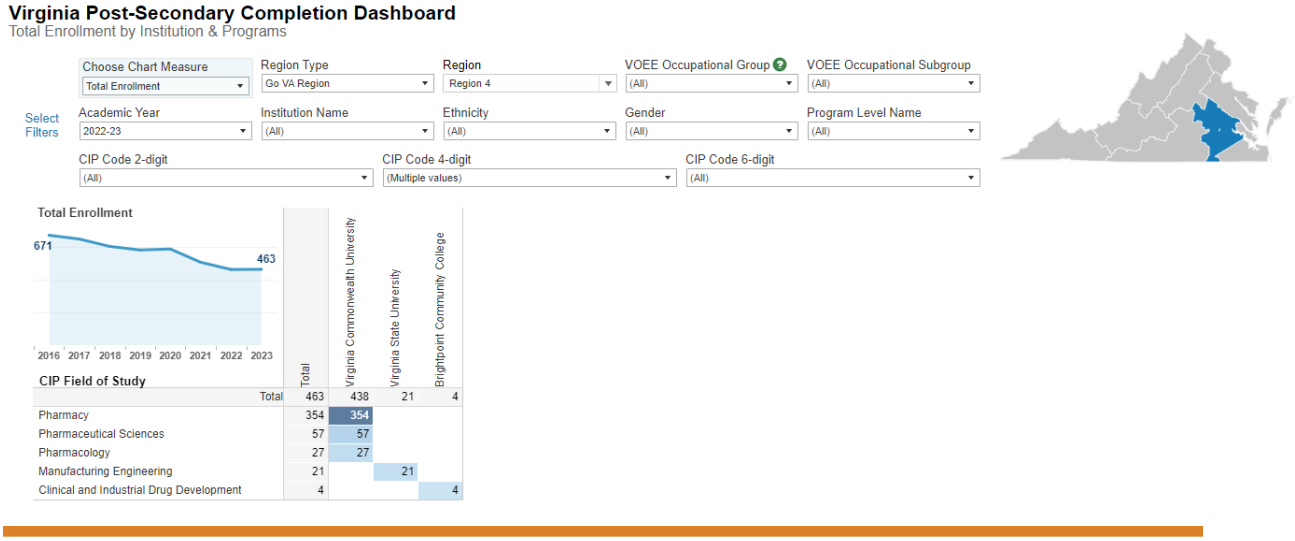
VSU also started a graduate-level certificate program with VCU that aims to provide higher-level courses to help upskill staff within existing pharmaceutical-related businesses. Among their recommendations: regional governance pathways for microcredentialing or certificates that could with programming to assist industry professionals.

Through interviews and focus group sessions, it has become clear that the existing programs (CCWA/Brightpoint certifications) have met content needs. In fact, individuals hired without the certifications were encouraged to enroll in these programs. Hiring managers have not identified gaps in content; however, gaps in soft skills have become apparent. Weak soft skills are a workforce concern across industries in the United States.

APM pathways are relatively new, so it is essential to consider a consistent measure of success as the programs mature. This includes evaluating graduation rates to ensure student retention and measuring students' skill development success.

The following chart, reflecting the 2022–23 school year, shows there are limited students within the pipeline to support a growing pharmaceutical manufacturing industry cluster. This chart of the most recent data represents information collected from state institutions but not private ones. The Classification of Instructional Programs (CIP) codes used were:

14.36 Manufacturing Engineering
26.10 Pharmacology and Toxicology
26.12 Biotechnology
41.01 Biology/Biotechnology Technologies/Technicians
51.20 Pharmacy, Pharmaceutical Sciences, and Administration



Since the data is from the 2022–23 school year, it does not represent the current program offerings nor the increase in program admission or graduation. Many of the programs have been created since the data collection, including those through the Community College Workforce Alliance and Brightpoint Community College. The CCWA has enrolled 45 students through nine training cohorts and has graduated 37 pharmaceutical manufacturing technician degree holders since spring 2023. CCWA plans to host five cohorts in 2025. As of December 2024, Brightpoint Community College had 53 students in its program; since spring 2023, 27 have completed their career studies certification in pharmaceutical manufacturing. The data above also reflects an error in CIP classification that should be fixed within the next year. It lists Brightpoint Community College's program as CIP 51.20 (Clinical and Drug Development), when it should be listed under CIP 41.01 (Biology/Biotechnology Technologies/Technicians).

The Virginia Post-Secondary Completion Dashboard highlights another issue: the numbers presented indicate that the region does not have enough people in the pathway to meet the needs of the expected job growth, as presented by the Virginia Economic Development Partnership. Current hiring shows that there are enough students in the pathway to meet those needs, but the industry is just building up, and the expectation will be more demand for the educational pathways and their capacity to scale up.

As of fall 2024, Brightpoint had 31 active enrolled students in its career studies certificate program, with a full associate degree option starting in fall 2025. Of those 31 students, two are high school students enrolled in the concurrent class options. Reynolds Community College started a biotechnology program in fall 2024 and has already enrolled 17 students (11 of whom

completed a summer bridge program). VCU/VSU, in fall 2024, began dual-degree track — a B.S. in chemistry from VSU and B.S. in chemical and life science engineering, with a concentration in chemical engineering, that could enroll 30 students on a rolling basis. This past fall they had 6 students engaged in their undergraduate research and development track presenting research to peers and professionals in the field.

Many other university and college programs impact the regional workforce within Virginia and beyond. Several institutions offer bachelor's or graduate programs that may impact competition for regional degree holders in pharmaceutical and manufacturing. Two significant influences include the University of Virginia and Virginia Tech.

Options for Graduates of the Regional Community College Programs

Below are some additional pathways for students considering regional community colleges. Their programs offer degrees with many options, so students entering APM pathways can have a head start in related career pathways, ensuring their training has value in tangential fields and provides a broader option for their continued career growth. Many of the skills learned at the Community College Workforce Alliance, Brightpoint or Reynolds community colleges are adaptable to other research and clean manufacturing industries.

Brightpoint Community College

A certificate in pharmaceutical manufacturing can present various career opportunities within the pharmaceutical or related industries such as food, cosmetic or tobacco production as well as general manufacturing practices. Below are some roles that could be a good fit for certificate holders if are not opportunities within the pharmaceutical sector are lacking:

- Production technician/operator: Responsible for operating and maintaining manufacturing equipment, following standard operating procedures (SOPs) to ensure the efficient production of products.
- Quality control technician: Conducts inspections, tests and analyses on raw materials, in-process samples and finished products to ensure compliance with quality standards and regulatory requirements.
- Validation specialist: Supports the validation of equipment, processes and systems used in pharmaceutical manufacturing, ensuring they meet regulatory standards and performance criteria.
- Packaging technician: Works in the packaging area, operating packaging equipment, labeling products and ensuring that packaging materials meet specifications and regulatory requirements.
- Documentation specialist: Manages and maintains manufacturing documentation, including batch records, SOPs and regulatory submissions to ensure accuracy, completeness and compliance.
- Inventory control coordinator: Oversees inventory management processes, including receiving, storing and dispensing raw materials, components and finished products in accordance with regulatory requirements and GMP.

- Compliance auditor: Conducts internal audits to assess compliance with regulatory standards, company policies, and quality management systems, identifying areas for improvement and ensuring corrective actions are implemented.
- Cleanroom technician: Works in controlled environments, such as cleanrooms and sterile processing areas, to perform aseptic manufacturing processes and maintain cleanliness and sterility standards.
- Process improvement specialist: Identifies opportunities for process optimization and efficiency improvements within manufacturing operations, implementing continuous improvement initiatives to enhance productivity and quality.
- Regulatory affairs associate: Supports regulatory submissions and compliance activities, ensuring that pharmaceutical products meet regulatory requirements and facilitating communication with regulatory agencies.

Reynolds Community College and Richard Bland College

An associate degree as a biotechnology laboratory technician or in clinical lab sciences can open up various career opportunities within the biotechnology, pharmaceutical, health care and related industries, such as environmental testing, agriculture and food safety. Below are some roles that could be well-suited for degree holders if there are not current opportunities within the biotechnology sector:

- Laboratory Technician: Responsible for conducting experiments, preparing reagents, and maintaining laboratory equipment in a variety of settings, including research, clinical, and industrial labs.
- Quality control technician: Conducts tests and inspections on biological samples, products or raw materials to ensure compliance with quality standards and regulatory requirements, often in biotech or pharmaceutical manufacturing.
- Research assistant: Supports scientific research by assisting in experiments, collecting and analyzing data, and maintaining accurate records, often supervised by senior researchers in academic, government or corporate laboratories.

An associate degree as a biotechnology laboratory technician or in clinical lab sciences can open up various career opportunities within the biotechnology, pharmaceutical, health care and related industries, such as environmental testing, agriculture and food safety.

- Clinical laboratory technician: Performs diagnostic tests on patient samples, such as blood, urine or tissue, to aid in the diagnosis and treatment of diseases in clinical settings such as hospitals and diagnostic laboratories.
- Environmental technician: Works in environmental testing labs, conducting analyses on air, water, soil and other environmental samples to monitor pollution levels and ensure compliance with environmental regulations.
- Agricultural laboratory technician: Supports agricultural research and development by conducting experiments on plant and soil samples, helping to develop new agricultural products or practices.
- Bioprocess technician: Operates and monitors equipment used in the production of biologics, such as vaccines or therapeutic proteins, ensuring that manufacturing processes adhere to strict regulatory and quality standards.

- Forensic science technician: Assists in criminal investigations by analyzing biological samples, such as DNA or blood in forensic laboratories, contributing to the identification and analysis of evidence.
- Veterinary laboratory technician: Conducts diagnostic tests and analyses on animal samples in veterinary labs, supporting the health and well-being of animals in veterinary clinics, research facilities or agricultural settings.
- Regulatory affairs associate: Supports regulatory compliance by preparing and submitting documentation required for the approval of biotech products, ensuring that products meet all regulatory standards.

These roles require a combination of technical knowledge, laboratory skills, attention to detail and adherence to safety and regulatory standards. With a certificate or associate degree, individuals can pursue entry-level positions in these areas and advance their careers through experience, further education and professional development.

Internship/Apprenticeship Models

Regional businesses have stated that they will work toward an internship model once fully operational. Conversations between Brightpoint Community College, Phlow and Civica have stated an interest in and support of interns once their facilities stabilize from their current growth and certification period. AMPAC, now owned by NOVO Nordisk, also provides a promising internship/apprenticeship future. It has a robust European model and has continued efforts in North Carolina with the NC BioNetwork[25].

The North Carolina Life Sciences Apprenticeship Consortium, partnering with nine regional community colleges, will provide financial aid for 220 BioWork[26] program students pursuing preapprenticeships. Students completing preapprenticeships will be eligible for full apprenticeships — one-year, full-time, paid positions with standard benefits at regional affiliated businesses. Many apprenticeship graduates are hired full time by their employers. Employers also support reimbursable continuing education and training. The NC BioWork program is seen as a gold standard in developing a strong workforce pathway, from Pre-K–12 through college for businesses that need a prepared workforce. The Richmond-Petersburg APM partners have started work with NC BioWork, from curriculum development and sharing of models and best practices to identifying partners that can help support the next steps.

The Richmond-Petersburg APM region can aspire to create a similar model — helping people enter the educational pathway by providing paid apprenticeships that enable them to move into full-time employment. This desired outcome offers a key reason to consider the pathway, help make it an affordable program for many who may otherwise opt out because of the cost and help support growing workforce needs within the region.

25 "BioWork | NCBioNetwork.Org."
26 "NC Life Sciences Apprenticeship Program | NCBioNetwork.Org."

GO VIRGINIA REGION 4 — ADDITIONAL IMPACTS/ANALYSIS ON REGIONAL PHARMACEUTICAL MANUFACTURING

TPI#3: Analysis of the occupational, skills and training gaps that could hinder industry growth

The Richmond-Petersburg region presents significant opportunities for growth in advanced pharmaceutical manufacturing. However, gaps across education, business and community alignment, and environmental factors threaten to hinder its development. Addressing these gaps is critical to building a sustainable and competitive APM sector. This analysis identifies challenges in three key categories: Education/Training, Business and Community, and Regional and Economic Barriers.

TPI research identified many gaps that may help the community, businesses and, especially, the talent and workforce pathways. All of the gaps can directly or indirectly impact the success of business growth, hiring rates and community connectedness to APM as a career pathway. Some are more directly tied to how we can best prepare a capable and competent workforce that meets the needs of APM-related businesses. Other gaps, marked with an asterisk (*) and in orange, are worth mentioning but do not deal as directly with the intent of the Talent Pathways efforts and will not be a focus within the recommendations.

Education/Training Gaps

A well-prepared workforce is essential for the continued growth of the advanced pharmaceutical manufacturing (APM) industry in GO Virginia Region 4. However, significant gaps in education and training pathways limit awareness and accessibility to careers in this field. These challenges range from early career exposure in middle and high school to the availability of hands-on learning opportunities and seamless transitions into postsecondary education and employment. Addressing these gaps will require coordinated efforts among educational institutions, industry leaders and workforce development agencies to create clearer career pathways, enhance hands-on training opportunities and strengthen educator support systems. The following analysis highlights four key challenges and potential solutions to bridge these educational barriers in the APM sector:

1. **Career Awareness**

- *Limited Exposure to APM Pathways:* APM careers are rarely introduced in middle and high school curricula, leading to a need for more awareness about the field. Programs like GO TEC® serve as a starting point but are accessible to only a fraction of students in the region, with inconsistent delivery across schools. For example, introducing pharmaceutical manufacturing as a specific career option in STEM or Career and Technical Education programs could significantly enhance visibility and interest. Coordinating statewide initiatives or campaigns to promote APM pathways could address this gap. In many cases, these exploratory courses are electives, which means students must declare an interest in these programs and engage in potential career pathways in pharmaceutical manufacturing.
- *Overexposure to pathways:* APM wants to ensure that students are presented with the possibilities of a career pathway in pharmaceutical manufacturing and that their educators can offer opportunities for them to consider this industry for education and employment. The region has several initiatives to coax educators and engage students in promoting various career pathways. These pathways include nursing, aviation, general contracting (electrician, plumber, masonry, carpenter) and submarine construction/fabrication jobs. There is a heavy push to get schools, educators and students to consider these career pathways, while APM is making the same push. If the APM outreach is not separated from the other options, it can become overwhelming to the individuals we are trying to reach.
- *Unequal Engagement with Diverse Populations:* Economically disadvantaged schools often prioritize basic academic skills over elective or exploratory programs that could introduce students to APM. This discrepancy creates systemic inequities, as students in under-resourced schools are less likely to discover or pursue manufacturing-related careers. To bridge this gap, schools could partner with local industry to offer guest lectures, site visits or mobile lab experiences, ensuring equitable access to career exposure.
- *Gaps in Elective Options for Ninth and 10th Grades:* Early high school years are pivotal for guiding students toward career-focused electives. Students may miss critical elective opportunities without targeted courses or engagements with business mentors or academic entities. Incorporating pre-APM coursework for ninth and 10th graders, aligned with upper-grade dual enrollment pathways, could fill this void.

A well-prepared workforce is essential for the continued growth of the advanced pharmaceutical manufacturing (APM) industry in GO Virginia Region 4. However, significant gaps in education and training pathways limit awareness and accessibility to careers in this field.

- *Visibility within the Community:* Schools, such as Brightpoint Community College, can be seen at many different community events, as well as college and career fairs; however, industry partners are infrequent participants. The more businesses attend to support students in selecting pathways, the more power there may be in advocating for an educational pathway.
- *Lack of a Career Map/Guide:* Few individuals clearly understand the APM career pathway and the skills needed beyond entry-level education offered by local community colleges. A clear, consistent marketing strategy that promotes educational options, pathways for career advancement and job openings/future projections would help educators and guidance counselors support potential workforce entrants.

2. Skills Gaps in Secondary Education

- *Outdated or Inconsistent Curricula:* Many exploratory and elective programs use curricula that lack updates on modern pharmaceutical manufacturing processes, such as continuous manufacturing, automation and advanced analytical techniques. Schools need partnerships with local industry and higher education to codevelop curricula that reflect current and emerging APM trends.
- *Strengthen Educator Pipelines:* Attract and retain skilled STEM and manufacturing instructors, particularly in underserved areas.
    - Pair Parity with Educators: Attracting educators within certain industries is hard, especially if industries pay higher salaries than educators make serving in supportive roles. APM may consider pay enhancements or a change in qualifications so business leaders can teach part time without taking significant pay cuts. (Additional Pay Parity information can be found in the Appendix)
- *Limited Hands-on Learning Opportunities:* Advanced manufacturing relies on cleanroom operations, precision instrumentation and digital systems — skills that cannot be learned in theory alone. Establishing regional or mobile hubs with simulation labs or leveraging mobile cleanroom units for high schools would provide practical exposure to APM environments.
- *Inconsistent Technology Integration:* Even where technology resources such as 3D printers or basic lab equipment exist, their integration into APM-relevant lessons is absent or, at best, uneven. Professional development for educators on incorporating APM-related applications into their teaching would help ensure consistent exposure to relevant technologies.

3. Barriers in Career Pathways and Transitions

- *Challenges in Transition Points:* Students moving from high school to postsecondary programs often need more structured advising or mentorship, which lead to fragmented progress. High schools, community colleges and APM employers can partner to establish clear transition pipelines — including articulation agreements and bridge programs. This can ensure smoother transitions and reduce drop-off rates.
- *Pathway Continuum Leaks:* The region has worked hard to identify gaps and fill them by adding additional associate degrees, bachelor's degrees and training; however, it is difficult to determine if there are flaws within the system that cause students to drop out. We must create a means to monitor successes and failures, ensuring that any identified gaps can be mended to provide a successful career path for students interested in APM.
- Bridge Programming: It could also boost the skillsets and confidence of those who fear the career pathway due to grades or self-perceived deficiencies. Several regional partners currently use bridge programming. Reynolds Community College launched its biotechnology associate degree with a bridge program in summer 2024. The impact of this program is worth monitoring and potentially scaling up with comparable programs.

4. **Support for Lifelong Learning**

- *Insufficient Professional Development:* With rapid advancements in APM technologies and practices, educators and trainers need access to up-to-date resources and certification opportunities to remain effective. Creating a regional professional development consortium could pool resources and ensure consistent training across schools and training centers.

Business and Community Gaps

A strong and sustainable APM sector relies on a skilled workforce and a well-coordinated business ecosystem that supports talent development, hiring practices and industry alignment. While significant progress has been made in developing training programs and establishing industry partnerships, several gaps remain in workforce-demand forecasting, hiring consistency and career pathway clarification. Employers and educational institutions must collaborate to align technical and soft skills, provide structured internships and apprenticeships, and address industry-wide job expectations.

Additionally, businesses must adapt to evolving younger professionals' workforce expectations, particularly regarding diversity, inclusion and work-life balance. Strengthening stakeholder communication through advisory boards and governance structures can further support regional talent development and ensure that APM businesses remain competitive in an increasingly dynamic labor market. The following analysis outlines eight key business and community gaps and explores strategies for enhancing regional workforce alignment and industry engagement.

1. **Supply vs. Demand in Entry-Level Roles**

- *Temporary Oversupply of Trained Graduates:* While regional community colleges have produced pharmaceutical manufacturing career certificate graduates, current industry hiring lags behind the supply of trained candidates. Temporary placement in adjacent industries (e.g., food manufacturing, chemical manufacturing or quality control) can keep graduates engaged while waiting for full-scale APM production to ramp up.

  This temporary oversupply of graduates has changed considerably since the start of this TPI project in January 2024. The workforce demand has increased. Recent graduates have had opportunities to be interviewed by APM industry staff, and nearly all of them have been hired right out of their programs. There is the potential for this gap to flip, and the educational pipelines will need to expand to meet the demand for regional growth.

Civica estimates its full capacity workforce to reach 350 employees. Of these roles, approximately 120 could be filled by individuals trained through a community college program.

Civica, for example, has successfully hired Brightpoint Community College career studies certificate program graduates for entry-level pharmaceutical manufacturing positions. Civica's relationship with Brightpoint has extended beyond hiring to include support for curriculum development, a commitment to interview graduates and assist in providing experience with industry-relevant equipment. Civica estimates its full capacity workforce to reach 350 employees. Of these roles, approximately 120 could be filled by individuals trained through a community college program.

2. Mismatch Between Technical and Soft Skills

- *Soft Skills Deficiencies:* Employers have reported that new hires often lack workplace readiness, including communication, punctuality and teamwork. Embedding soft skills training into technical education programs, combined with employer-led workshops or mentoring initiatives, could better prepare students for the workplace.

This is a universal problem across job sectors and geographical boundaries. Extensive research underscores the critical role of soft skills, such as communication, teamwork, problem-solving and adaptability, in hiring across the United States. Employers increasingly prioritize these competencies, recognizing their profound impact on workplace efficiency and employee retention.

A study highlighted by Reuters reveals that mentored individuals earn 15% more than their nonmentored peers. This emphasizes the value of soft skills such as confidence and teamwork, which are often lacking in young recruits. This finding suggests that enhancing soft skills can significantly improve workplace readiness and productivity.[27]

Further, research published in the *International Journal of Educational Technology in Higher Education* indicates a discernible demand for soft skills, such as critical and analytical thinking, problem solving, communication skills and creativity with flexibility, especially within technologically driven domains. The study analyzed job postings from 19,000 distinct organizations over five years, revealing that employers frequently seek these competencies even in technology-focused fields.[28]

Moreover, a Forbes survey found that 84% of the workforce insists that job candidates must demonstrate soft skills, with 90% of men and 80% of women acknowledging their value in the workplace. This consensus among employees highlights the universal importance of soft skills in professional settings.[29]

The U.S. Department of Labor also emphasizes that while technical skills are fundamental, employers view soft skills, such as professionalism, communication, teamwork and problem solving, as even more crucial to work readiness.

A focus group session suggested that the Richmond region should consider creating a scalable model to address soft skill concerns that bridges all industries. A couple of models are currently used in Colorado: Colorado Succeeds[30] and the Colorado Education Initiative[31].

A study highlighted by Reuters reveals that mentored individuals earn 15% more than their nonmentored peers.

27 Balch, "Brand Watch."
28 Poláková et al., "Soft Skills and Their Importance in the Labour Market under the Conditions of Industry 5.0."
29 Robinson, "84% Of Workforce Insists Job Candidates Must Demonstrate Soft Skills, New Study Finds."
30 "Colorado Succeeds — Building a Strong Workforce Starts in Our Schools."
31 "The Colorado Education Initiative Igniting the Power of Public Education."

3. Inconsistent Hiring Practices

- *Unwritten Requirements:* Variability in hiring criteria, such as preferences for bachelor's degrees over certificates, confuses job seekers and limits access to APM roles. Establishing a regional hiring framework endorsed by major employers could standardize qualifications and promote inclusivity in hiring practices.

The Talent Pathways Initiative focused specifically on the pharmaceutical manufacturing sector, meaning there are three primary regional employers for this talent: AMPAC Fine Chemicals, Phlow and Civica Rx. However, related industries, such as food manufacturing (including tobacco) and other regional manufacturing facilities, also value similar skillsets, particularly in areas such as quality assurance and control.

Through interviews with AMPAC, Phlow and Civica, a clear alignment in hiring expectations emerged. All three companies have baseline educational and training requirements, though these vary by employer. Depending on the role and the specific company, candidates were expected to have a certification, an associate degree or a bachelor's degree.

For instance, a regional vice president of operations and engineering with a proven track record in building sustainable workforces prefers candidates with a bachelor's degree, particularly in engineering for some production roles. This underscores the importance of fostering connections between regional community colleges and four-year institutions to create pathways for students to seamlessly transition into advanced-degree programs. It also reinforces the need for community colleges to maintain strong partnerships with industry, ensuring students understand their options for pathways into the workforce and continuing education in order to meet the evolving demands of the industry.

4. Inconsistent Terminology Across the Industry

- *Lack of Standardized Language:* Variations in job titles, skills descriptions and qualifications hinder alignment between education and industry needs. Developing an APM-specific skills and job taxonomy, supported by a regional advisory board, would improve workforce alignment and curriculum design. Developing this common language would also help create a map of various APM-related roles and the competencies needed to fulfill the needs of these roles. A competency map such as this would help interested individuals identify the clearest educational/experiential pathway to their desired career.

5. Insufficient Support for Internships and Apprenticeships

- *Limited Access:* APM students need practical experience to transition smoothly into the workforce, yet there are too few structured internship and apprenticeship opportunities. Regional businesses and community colleges have discussed this deficit. Both Civica's and Phlow's willingness to build internship programs once they reach full production, will further enhance talent development within the region. Novo Nordisk also supports pathways development and is sharing experiences from its other facilities.
- *Barriers to Unpaid Internships:* Many students need financial assistance in order to take unpaid positions, disproportionately excluding underprivileged populations. Employers could partner with local governments or nonprofits to provide stipends or financial support to interns.

6. Need for a Regional Advisory Board

- *Enhanced Communication and Coordination:* Establishing a robust advisory board, with representatives from APM businesses, educational institutions and workforce development agencies, could address skill gaps, curriculum alignment and emerging trends in the sector. The board could also oversee collaborative projects such as curriculum updates and apprenticeship expansions.

Since the start of the Talent Pathways initiative research into APM pathways, the Alliance for Building Better Medicine was identified as the regional governance body for APM efforts. During 2024 and into 2025, ABBM and affiliated partners began researching effective governance models, working with projects such as the U.S. EDA Good Jobs Challenge. CCWA is now endeavoring to identify a convener and champion to continue the work of the regional APM affiliated partners.

7. **Workforce Diversity and Inclusion**

- *Limited Outreach Efforts:* Engaging underrepresented populations, including women and minorities, requires targeted recruitment strategies, outreach programs and scholarship opportunities to ensure a diverse and inclusive workforce. This effort is active within the GO Virginia Grant, led by Drexel Harris at Brightpoint Community College.

8. **Change in Workforce Focus**

- *Cultural shift for work/life balance:* Younger professionals increasingly seek careers that offer more than just a paycheck; they desire positions that provide a sense of fulfillment through positive community impact, environmental stewardship and societal contribution.

Recent research indicates a significant shift among younger workers, particularly Generation Z and millennials, who prioritize purpose-driven employment that aligns with their personal values more than traditional financial incentives. The 2024 Deloitte Global Gen Z and Millennial Survey reveals that nearly all respondents desire purposeful work, with many willing to decline assignments or employers that conflict with their ethical beliefs, including concerns about environmental impact and social inequality. This trend underscores a growing demand for roles that contribute positively to society and the environment.[32]

Recent research indicates a significant shift among younger workers, particularly Generation Z and millennials, who prioritize purpose-driven employment that aligns with their personal values more than traditional financial incentives.

Further emphasizing this shift, a study by Bupa highlights that two-thirds of Gen Z individuals experience anxiety related to environmental issues, with 64% considering an employer's environmental actions crucial when evaluating job opportunities. Notably, 31% would refuse roles at companies lacking strong ecological, social and governance commitments, and over half are willing to accept a pay cut to work for organizations that reflect their ethical values.[33]

The good news is that, after interviewing staff at one APM-related business, it was discovered that staff see their employment as tied to a positive vision, mission and goals, and their work aims to help people and support community growth.

Additional Information on the sustainability considerations of regional pharmaceutical efforts can be found in the appendix.

32 "The Deloitte Global 2024 Gen Z and Millennial Survey."
33 "Gen Z Seek Ethical Workplaces as Environ-Mental Health Burden Bites."

Regional and Economic Barriers to APM Workforce Growth

The Richmond-Petersburg region has made significant strides in establishing itself as a hub for APM, yet several regional and economic challenges could hinder sustained workforce and industry growth. High living costs, competition with more established biotech hubs and fragmented leadership structures create barriers to attracting and retaining talent. Additionally, workforce expansion efforts must be balanced against business demand to ensure continued industry growth without outpacing available employment opportunities.

Further challenges arise from regulatory complexities, shifting political priorities and the rapid evolution of APM technologies, all of which require proactive solutions to maintain the region's competitiveness. By addressing these structural and economic obstacles, such as enhancing business incentives, streamlining regulatory training and ensuring a unified regional vision, Virginia can solidify its position as a leading location for pharmaceutical manufacturing. The following analysis outlines key regional and economic barriers and potential strategies for overcoming them.

1. **Economic and Financial Barriers**

- **High Housing Costs:* The cost of living impacts the capacity for new employees to consider the Richmond-Petersburg area and makes attracting and retaining IT talent challenging, particularly for early-career professionals who may need help to afford housing on entry-level salaries.
- Poverty-Related Constraints: Tuition, transportation and child-care costs create barriers for many potential workers, limiting access to training and career pathways.

2. **Regional and Industrial Competition**

- **Competition with Established Hubs:* Richmond-Petersburg faces stiff competition from established pharmaceutical and biotech hubs, such as the North Carolina Research Triangle Park and the Interstate Highway 270 Biotech Corridor in Rockville, Md. These regions benefit from decades of investment, established reputations and robust research institutions, private sector companies and workforce pipelines.

  As highlighted by Dr. Frank Gupton at the VCU College of Engineering Pharmaceutical Manufacturing Day in September 2024, Civica initially considered other locations for its startup due to the region's lack of workforce-ready talent. The efforts by Brightpoint and CCWA to ramp up training programs have since helped meet the region's staffing needs and promote the educational infrastructure that is critical to attracting new businesses.

  Fragmented Communication on Regionality

  One of the challenges the region faces is fragmented communication. Different stakeholders represent various elements of the community without a united vision, language, goals or marketing strategy. There are at least three distinct viewpoints that influence the APM effort in Virginia:

  - **BioHealth Capital Region:** This larger regional effort spans Maryland, Washington D.C., and Virginia and includes the Richmond-Petersburg hub, positioning APM within a sprawling biohealth ecosystem.
  - **Virginia Research Triangle:** As presented by Gov. Glenn Youngkin and Dr. Gupton, this triangle includes the University of Virginia and Virginia Tech, with Richmond-Petersburg as the manufacturing arm for innovations developed by these institutions.
  - **Richmond-Petersburg as a Tech Hub:** According to the U.S. Economic Development Administration, this region has been designated as a Tech Hub, focusing on pharmaceutical manufacturing growth.

These competing visions have different leaders, champions and funding streams, leading to occasional overlaps and conflicting goals, which hampers progress. It also limits the ability to present a unified voice for the region. Leaders within these groups have changed, as has leadership for APM development within the Richmond-Petersburg region.

- *Talent Drain to Other Industries:* Competing sectors such as aerospace, construction and logistics aggressively recruit from the same talent pool, increasing competition for skilled workers. A substantial submarine construction project[34] aims to hire 100,000 to 150,000 people in the next decade to help meet the nation's submarine-construction goals. This has sparked a national search for talent; however, the Hampton Roads region may claim a lot of the work and potential employees.
- **Competitors are Ahead:* According to a couple of sources, investors and companies seeking locations to build or grow their APM companies are identifying two major reasons why the Richmond-Petersburg region is not as competitive. First is the available workforce. Even though the area is scaling up, the numbers are not yet adequate. Second are incentives. Other locations, sometimes outside U.S., are providing more support or upfront financial incentives.

3. **Regulatory Challenges**
- **Complex Compliance Regulations:* Navigating FDA and GMP regulations adds significant time and cost to scaling APM operations. Establishing local compliance training centers could help businesses and workers meet regulatory standards more efficiently.

4. **Political Uncertainty**
- **Policy Shifts:* Federal or state policy changes could disrupt funding or operational priorities for APM businesses. Advocacy efforts at the state and federal levels could ensure that pharmaceutical manufacturing remains a strategic priority.

5. **Technological Advancements**
- **Adaptation Delays:* The region's readiness to incorporate advancements such as continuous manufacturing and AI-driven processes into pharmaceutical production could impact its ability to scale effectively. *This also relates to the resources needed for educational pathways that best prepare the workforce for using these technologies.*

34 "The Mission | Building the U.S. Naval Submarine Fleet."

PIPELINE PLANNING — APM IMPLEMENTATION RECOMMENDATIONS

TPI#4: APM Talent Pipeline Development Plan

This section presents a set of strategic recommendations to foster a robust and sustainable APM sector in the region by ensuring a healthy workforce pathway that is prepared to meet industry needs.

Developed in collaboration with GO Virginia representatives and other regional stakeholders, these recommendations emphasize actionable steps that the APM community can refine as additional insights emerge. While the initial recommendations outlined below represent the starting point, they can evolve and adapt as new perspectives and best practices inform the region's path forward.

APM — A Region of Growth

The Richmond-Petersburg region has steadily positioned itself as a hub for APM. Initial efforts in 2016–17 laid the foundation, with significant acceleration occurring after 2020. Key developments in collaboration, governance, funding and education have strengthened the region's ability to attract and retain industry stakeholders, fostering an ecosystem primed for continued growth.

As awareness of the region's competitive advantages in APM increases, strategic action is needed to sustain momentum, address emerging challenges and meet the rising demand for a highly skilled workforce. The following recommendations outline a roadmap to secure the region's leadership in pharmaceutical manufacturing by strengthening workforce pathways and fostering industry partnerships.

Focus Areas for Advancement/Development

I. Governance: Establishing a Unified Voice
II. Education: Preparing the Next Generation
III. Education: Professional Development and Continued Learning

These focus areas provide a strategic framework to align industry, education and workforce development efforts. By fostering collaboration and leveraging shared resources, the region can build a sustainable, high-performing APM workforce pipeline.

I. Establishing a Regional Governing Organization

GO Virginia Region 4's APM ecosystem includes businesses, educational institutions and workforce development agencies, each contributing to industry growth. However, these efforts often operate independently, leading to fragmented initiatives. A regional governing organization would provide structure, align workforce development with industry needs and drive long-term strategy.

Building upon existing resources such as the Alliance for Building Better Medicine and the Commonwealth Center for Advanced Manufacturing, this governing entity would be a central coordination hub to support collaboration and workforce alignment.

Key Areas of Focus:

1. Champion/Convener Role
2. Bridging Education, Workforce and Business: Developing a Competency Mapping Tool
3. Strengthening Partnerships Between Education, Workforce and Industry

1. Champion/Convener Role

A dedicated convener is essential for aligning regional workforce efforts, fostering collaboration among industry, education and workforce stakeholders, and ensuring that the APM sector remains competitive and sustainable. This role will serve as the central point of leadership, driving strategic workforce initiatives and ensuring all partners work toward common goals.

- Serving as a central liaison among APM employers, educational institutions, workforce development organizations and policymakers to foster collaboration, communication and alignment with industry needs.
- Maintaining performance metrics to track progress, measure program effectiveness and ensure accountability allows stakeholders to assess workforce development initiatives' impact.
- Securing funding and resources to support training programs, industry expansion efforts and workforce pipeline development, leveraging federal, state and private-sector funding opportunities.
- Advocating for policies and initiatives that strengthen the region's position as a leader in APM, ensuring sustained industry growth and a well-prepared workforce.

Ongoing efforts under the Good Jobs Challenge Grant are already supporting these objectives, but long-term governance strategies must focus on establishing a sustainable and effective model that can adapt to industry needs and support continued workforce development in the region.

2. Bridging Education, Workforce and Business: Developing a Competency Mapping Tool

A structured competency mapping tool is critical for aligning training programs with employer expectations, ensuring students, job seekers and workforce professionals have clear guidance on career pathways within APM. This tool will provide a centralized framework for defining skills, competencies and industry requirements, helping educators tailor curricula, employers refine hiring expectations and job seekers navigate career progression.

- Defining essential skills and competencies for various APM roles, ensuring training programs reflect current and emerging industry standards and adapt to technological advancements and regulatory changes.
- Standardizing industry terminology to create a common language between education providers, workforce organizations and employers, reducing confusion and improving workforce alignment.
- Providing a centralized, publicly accessible resource that outlines:
  - Career pathways and the education/training required for different roles.
  - Job opportunities and workforce projections, giving job seekers insight into regional demand.
  - Employer expectations, ensuring alignment between training outcomes and industry needs.

3. Strengthening Partnerships Between Education, Workforce and Industry

Stronger collaboration between stakeholders is essential to ensuring that education and workforce programs remain responsive to industry needs. A coordinated approach among educational institutions, workforce development organizations and APM employers will help create clear career pathways, enhance training opportunities and sustain industry growth. Strengthening these partnerships will also ensure that funding, curriculum development and hands-on learning opportunities align with real-world workforce demands.

- Establish an industry advisory board comprising APM employers, educational leaders and workforce development professionals to guide curriculum development, workforce strategies and emerging industry trends.
- Expanding structured internship and apprenticeship programs to provide hands-on experience in cleanroom environments, quality control, manufacturing operations and regulatory compliance, ensuring that students gain practical, industry-relevant skills.
- Aligning public and private funding sources to support high-impact workforce development initiatives, leveraging grants, state and federal workforce programs as well as employer investment to sustain and expand training opportunities.
- Defining the regional scope of APM workforce efforts and assessing whether expanding beyond GO Virginia Region 4 would enhance workforce reach, strengthen industry partnerships and support broader economic growth.

A coordinated approach among educational institutions, workforce development organizations and APM employers will help create clear career pathways, enhance training opportunities and sustain industry growth.

II. Education: Preparing the Next Generation

Developing a strong workforce pipeline requires early exposure to APM careers, hands-on learning opportunities and seamless transitions from K–12 to postsecondary education. Addressing gaps in STEM education, industry awareness, and technical training will help build a skilled workforce capable of meeting industry demands.

Key Areas of Focus:

1. Integrating APM Concepts into K–12 Education
2. Enhancing Educational Experiences for Educators and Students
3. Strengthening Connections with Community Colleges
4. Supporting Student Transitions into APM Careers
5. Leveraging Industry Hubs for Best Practices

1. Integrating APM Concepts into K–12 Education

Many students lack awareness of APM career opportunities due to limited exposure in Pre-K–12 education. Without early engagement, students may not consider APM as a viable career path, leading to missed opportunities for workforce development. By integrating APM concepts into STEM and Career and Technical Education (CTE) programs, the region can increase awareness, spark interest and build foundational skills that support future workforce growth.

- Developing curriculum modules that introduce APM concepts into STEM and CTE programs, ensuring that students:
  - Are exposed to pharmaceutical manufacturing, bioprocessing and quality control as early as middle school.
  - Have career exploration opportunities in grades nine and 10, a critical period when students can no longer access career pathways courses but are not yet ready for CTE or community college APM programs.
- Providing professional development for educators to help them integrate APM topics into classroom instruction and make connections between academic lessons and local industry needs.
- Offering hands-on learning experiences, including:
  - Industry site visits to APM facilities that allow students to see real-world applications of their learning.
  - Project-based learning activities that simulate pharmaceutical manufacturing processes.
  - Guest lectures from industry professionals that expose students to career opportunities, skill requirements and industry innovations.
- Implementing proven models, such as NC BioWork's model and programs, which have successfully introduced biopharmaceutical manufacturing concepts into education and workforce development programs.

2. Enhancing Educational Experiences for Educators and Students

To prepare students for careers in APM, educators must have access to industry-relevant training. Students also need immersive, hands-on learning experiences that reflect real-world industry practices. Strengthening both educator preparation and student engagement will ensure that workforce training programs produce highly skilled professionals who meet employer needs.

- Offering workshops, internships and certification programs for educators to help them stay current with industry trends, regulatory requirements and emerging technologies in APM. These opportunities will enable educators to bring real-world applications into the classroom and better prepare students for APM careers.
- Strengthening the pipeline of qualified STEM and manufacturing instructors, particularly in biopharmaceutical manufacturing and related fields.
    - Address pay parity concerns for educators. Wage gaps between industry professionals and instructors make recruiting and retaining qualified teachers challenging. Collaborative solutions, such as adjunct teaching, industry-education partnerships and financial incentives may help attract skilled professionals to teaching roles. (More information is in the Appendix under Pay Parity Concerns.)
- Expanding access to immersive learning experiences by providing:
    - Simulation labs and cleanrooms where students can practice industry-specific skills in a controlled environment.
    - Mobile labs and outreach programs that bring APM training to rural and underserved communities, increasing access to high-quality technical education.
    - Industry-sponsored training centers where students can gain practical experience with pharmaceutical manufacturing equipment and processes.

3. Strengthening Connections with Community Colleges

Community colleges are critical to developing the APM workforce, bridging high school education, technical training and industry employment. However, to maximize their impact, more substantial alignment between high schools, two-year programs and industry needs is required to ensure workforce readiness and seamless career progression.

- Expanding dual-enrollment APM programs to allow high school students to earn college credit. This effort would also align with the VCCS's strategic plan, "Opportunity 2027," which aims to achieve equity in access, learning outcome, and student success. Expanding dual-enrollment programs in biotechnology and pharmaceutical manufacturing would allow high school students to gain early exposure to APM careers while earning college credit.
- Continuing to align community college programs with employer expectations ensures that training remains relevant, responsive and industry-driven, particularly as APM programs grow and mature. This alignment includes:
    - Regular employer advisory input to refine the curriculum.
    - Integration of industry certifications into academic pathways.
    - Flexible learning models (e.g., evening, weekend, or hybrid courses) to support working students and career changers.
- Developing structured career pathways that guide students from high school to industry-recognized certificates, associate degrees, and beyond, ensuring clear, step-by-step progression into high-demand APM careers.

4. Supporting Student Transitions into APM Careers

Many students struggle to transition from high school to college or from graduation to the workforce due to a lack of clear career guidance, structured support and industry awareness. Strengthening career transition pathways will ensure students can confidently navigate their educational and professional APM journeys.

- Implementing and monitoring the success of structured bridge programs to support students entering APM training programs, particularly those who need additional academic preparation before enrolling in advanced coursework.
- Providing targeted career counseling to help students understand industry pathways, career progression opportunities and required skillsets for various APM roles.
- Offering tutoring and academic support services to address skill gaps in science and mathematics, ensuring students are well-prepared for the technical demands of APM careers.
    - Incorporating soft skills training into support services to strengthen communication, teamwork, professionalism and workplace readiness, as employers have cited these as critical competencies needed in new hires.

5. Leveraging Industry Hubs for Best Practices

Engaging with established industry hubs, such as North Carolina's Research Triangle Park, is essential to developing successful workforce strategies and strengthening the region's position as a leader in APM. By learning from best practices, fostering research collaborations and enhancing regional branding, the region can attract top talent, industry investment and educational partnerships to support APM workforce development.

- Strengthening research partnerships with universities, including VCU and VSU, with potential expansion to Virginia Tech and the University of Virginia. These partnerships can:
    - Integrate cutting-edge research with workforce training.
    - Provide students and professionals with access to emerging technologies and industry advancements.
    - Facilitate internships, co-op programs, and joint research initiatives directly supporting APM workforce needs.
- Enhancing regional branding to position the area as a national leader in APM workforce development, ensuring that Virginia is recognized as a premier hub for pharmaceutical innovation and biomanufacturing talent.
- Expanding marketing efforts to:
    - Attract skilled professionals and students into the APM workforce pipeline.
    - Encourage industry investment by highlighting the region's training capabilities, research strengths and workforce readiness.
    - Build educational partnerships that connect community colleges, universities and workforce training programs with industry leaders.

III. Education: Professional Development and Continued Learning

Given the rapid advancements in APM, continuous workforce development is critical. Many smaller firms lack the resources for ongoing training, creating skill gaps that limit workforce readiness. A coordinated strategy for professional development will help the region retain and grow its APM workforce.

Key Areas of Focus:

1. Building a Regional Training Network
2. Enhancing Regulatory Compliance Training
3. Addressing Workforce Retention and Development Gaps

1. Building a Regional Training Network

A coordinated training network that brings together APM businesses, educational institutions and workforce organizations will strengthen the region's ability to develop and sustain a skilled workforce. By leveraging existing resources, expanding training accessibility and fostering industry collaboration, the region can create a more agile and responsive workforce pipeline for APM.

- Establishing a regional training consortium that brings together community colleges, universities and industry training programs to:
  - Align curriculum and skills training with employer needs.
  - Facilitate shared training facilities, labs and equipment.
  - Encourage collaboration on workforce development initiatives.
- Developing flexible training models, including online, hybrid and modular learning options, to accommodate:
  - Working professionals seeking upskilling opportunities.
  - Career changers entering the APM field.
  - Employers looking to provide ongoing workforce development.
- Supporting Virginia's High-Quality Work-Based Learning program to provide real-world, hands-on training for:
  - Students seeking career exposure and entry-level skills.
  - Early-career professionals who need on-the-job experience.
  - Employers looking to cultivate a pipeline of trained workers.

2. Enhancing Regulatory Compliance Training

Navigating FDA regulations and GMP is critical to APM. Ensuring that new and existing workforce members are well-versed in regulatory compliance is essential for maintaining product quality, safety and operational efficiency. A regional approach to compliance training will help businesses, particularly small and medium-sized enterprises (SMEs), understand and meet regulatory requirements, reducing barriers to market entry and ensuring workforce readiness.

- Establishing regional compliance training centers to provide:
  - Industry-recognized certifications in FDA and GMP regulations.
  - Workshops and continuing education programs for professionals at all career stages.
  - Training tailored to specific APM job roles, ensuring workers have the regulatory knowledge relevant to their positions.

- Developing digital resources and self-paced training modules to assist SMEs in navigating complex regulatory requirements, including:
  - Step-by-step guidance on FDA compliance and GMP best practices.
  - Regulatory checklists and toolkits for quality assurance and risk management.
  - On-demand learning options for employees who need flexible training.
- Partnering with regulatory experts to provide:
  - Industry-specific guidance on evolving compliance requirements.
  - Technical assistance and advisory services for businesses navigating FDA approval processes.
  - Access to regulatory mentorship programs, where experienced professionals can guide emerging companies and workforce members through compliance best practices.

3. **Addressing Workforce Retention and Development Gaps**

APM sector must compete with other industries for skilled talent, making workforce retention and continuous development critical to maintaining a strong, stable talent pipeline. The region must implement strategies that support professional growth, foster employee engagement and provide clear pathways for career advancement to ensure long-term success.

- Expanding opportunities for continuing education and professional advancement by:
  - Offering employer-sponsored tuition assistance for advanced certifications and degree programs.
  - Developing career progression roadmaps that outline clear advancement pathways within APM careers.
  - Providing specialized leadership and technical training to help employees transition into mid- and senior-level roles.
- Strengthening mentorship programs to support career development and retention by:
  - Pairing new employees with experienced professionals for on-the-job learning, career guidance, and industry insights.
  - Expanding professional networks through mentorship initiatives that connect employees to senior industry leaders.
  - Encouraging companies to establish internal mentorship programs that foster knowledge transfer and employee engagement.
- Aligning workforce retraining initiatives with emerging industry needs to ensure continuous skills adaptation by:
  - Providing upskilling and reskilling programs that align with advancements in areas such as automation, bioprocessing and digital manufacturing.
  - Ensuring displaced or transitioning workers from other industries can efficiently enter the APM workforce through targeted retraining programs.
  - Creating industry-responsive learning modules allows employees to stay ahead of regulatory and technological changes.

High-Level Budget Estimate for APM Workforce Development

(Estimated Range: $19 million to $35 million over five years)

This budget is designed to establish a sustainable and high-impact workforce development initiative in GO Virginia Region 4. The estimates include program development, personnel, infrastructure and industry alignment costs, ensuring a cohesive and well-funded strategy for long-term success.

I. Governance: Establishing a Unified Voice

Estimated Cost: $4.5 million to $8 million over five years

Justification:

A Regional Governing Organization will coordinate efforts among industry, education and workforce stakeholders, ensuring strategic alignment and long-term impact.

- Convener Staff and Operations ($2 million to $3 million): Includes three to four full-time staff members (executive director, workforce coordinator, industry liaison, and administrative support).
- Competency Mapping Tool Development and Maintenance ($1.5 million to $2.5 million): Creation of a regional career pathway tool, aligning industry needs with education/training programs.
- Industry Advisory Board & Engagement ($1 million to $2.5 million): Regular stakeholder meetings, employer engagement events and industry collaboration initiatives.

Potential Funding Sources:

- GO Virginia funding
- Private sector investment
- State/federal workforce development grants

II. Education: Preparing the Next Generation

Estimated Cost: $7.5 million to $12 million over five years

Justification:

To build a strong workforce pipeline, investments in K–12, community colleges and student transition support are essential.

- K–12 STEM and CTE Curriculum Development ($2 million to $3 million): Integration of APM-focused content into middle/high school STEM programs, plus educator training.
- Hands-on Learning and Outreach (mobile labs, cleanrooms, industry visits) ($2 million to $3.5 million): Expansion of mobile labs, student field experiences and industry partnerships modeled after NC BioWork.
- Dual Enrollment and Community College Partnerships ($2 million to – $3 million): Expansion of APM training at community colleges, including lab renovations, course development and student support.
- Student Transition Support (mentorship, tutoring, career counseling, soft skills training) ($1.5 million to $2.5 million): Programs focused on career awareness, industry mentorship and skill building for underrepresented students.

Potential Funding Sources:

- Virginia Department of Education (VDOE)
- Workforce Innovation and Opportunity Act (WIOA) grants
- Industry sponsorships

III. Education: Professional Development and Continued Learning

Estimated Cost: $5 million to $10 million over five years

Justification:

Ongoing workforce training is critical to keeping up with rapid industry advancements. This section focuses on regional training networks, compliance training and professional development for existing workers.

- Regional Training Network and Employer-Led Programs ($2 million to $4 million): Establish a consortium of community colleges, universities and industry to offer upskilling programs.
- Regulatory Compliance Training Centers ($1.5 million to $3 million): Creation of certification programs for FDA/GMP compliance to support small- and medium-sized businesses.
- Career Advancement and Retention Strategies (mentorship, continuing education, workforce retraining) ($1.5 million to $3 million): Focused on reducing talent attrition and providing clear growth pathways for mid-career professionals.

Potential Funding Sources:

- U.S. Economic Development Administration (EDA) grants
- Private-sector upskilling investment
- Public-private workforce initiatives

IV. Marketing, Branding and Industry Attraction

Estimated Cost: $2 million to $5 million over five years

Justification:

The Richmond-Petersburg region must be marketed as a national leader in APM to attract top talent, business investment and new educational partnerships.

- Regional Branding Campaign ($1 million to $2.5 million): Development of a cohesive brand identity to market APM workforce opportunities to students, employers and investors.
- Employer Engagement and Business Recruitment ($1 million to $2.5 million): Expansion of industry partnerships, outreach to national and global biotech firms, and employer networking events.

Potential Funding Sources:

- Local economic development agencies
- Industry sponsorships
- GO Virginia marketing funds

Summary Budget Estimate (Over 5 Years)

Category	Low Estimate ($ million)	High Estimate ($ million)
Governance: Establishing a Unified Voice	**4.5**	**8.0**
Education: Preparing the Next Generation	**7.5**	**12.0**
Education: Professional Development Continued Learning	**5.0**	**10.0**
Marketing, Branding, and Industry Attraction	**2.0**	**5.0**
Total Estimate (three to five years)	**$19 million**	**$35 million**

Why This Budget Matters

- Addresses the Full Workforce Pipeline: From K–12 education to mid-career workforce upskilling, ensuring a sustainable and high-impact workforce strategy.
- Aligns with Industry Growth Needs: Reduces workforce shortages, improves job readiness and supports regional APM expansion.
- Creates a Competitive Advantage for the Region: Positions Richmond-Petersburg as a leading APM hub, attracting investment, business expansion and talent.
- Leverages Public and Private Funding: The strategy integrates state, federal and private funding sources to ensure long-term sustainability.

Next Steps

1. Identify key funding sources (GO Virginia, private investment, workforce grants).
2. Establish a regional governing body to oversee implementation.
3. Engage employers and educational partners to refine workforce programs.
4. Begin pilot programs for curriculum development, competency mapping, and training expansion.

Conclusion: A Strategic Pathway to APM Workforce Growth and Sustainability

The Advanced Pharmaceutical Manufacturing Talent Pipeline Development Plan for GO Virginia Region 4 provides a comprehensive, actionable strategy to strengthen workforce alignment, expand career pathways and drive industry growth. Through targeted collaboration between industry, education and workforce partners, the region can establish a highly skilled, adaptable workforce that meets the demands of this rapidly evolving sector.

By implementing these recommendations, GO Virginia Region 4 can:

- Establishing a dedicated convener and structured workforce strategy will enhance regional coordination and governance and ensure long-term alignment with industry needs.
- Strengthen education-to-career pathways by integrating APM concepts into K–12 education, improving hands-on learning experiences and fostering stronger connections with community colleges and universities.
- Expand work-based learning opportunities, including internships, apprenticeships and industry-led mentorship programs, to ensure students gain practical, real-world experience.
- Address regulatory compliance and workforce retention challenges by developing regional compliance training centers, supporting continuing education programs, and implementing career progression frameworks to keep professionals engaged in the industry.
- Leverage best practices from industry hubs and expand regional branding efforts to position Virginia as a premier destination for APM workforce development and industry investment.

A coordinated, data-driven approach to APM workforce planning will help develop a robust talent pipeline and strengthen the region's competitive edge in pharmaceutical manufacturing. Through collaborative partnerships, strategic investment, and continuous innovation, GO Virginia Region 4 can establish itself as a national leader in APM workforce development, ensuring long-term industry sustainability, economic growth and high-quality job opportunities.

BIBLIOGRAPHY

Activation Capital. “Richmond-Petersburg Region Is a Winner of the National Build Back Better Regional Challenge,” September 2, 2022. https://activation.capital/richmond-petersburg-region-is-a-winner-of-the-national-build-back-better-regional-challenge/.

Alliance. “Tech Hubs.” Accessed November 4, 2024. https://buildingbettermedicine.com/tech-hubs/.

Alliance for Building Better Medicine Partners Secure $3.94 Million Federal Grant to Strengthen Richmond-Petersburg Region’s Pharma and Biotech Workforce and Talent System. “ABBM Partners Secure $3.94 Million Federal Grant,” January 15, 2025. https://buildingbettermedicine.com/abbm-partners-secure-3-94-million-federal-grant/.

Balch, Oliver. “Brand Watch: Why Investing in ‘Soft’ Skills Makes Hard-Headed Business Sense.” *Reuters*, February 24, 2025, sec. Boards, Policy & Regulation. https://www.reuters.com/sustainability/boards-policy-regulation/brand-watch-why-investing-soft-skills-makes-hard-headed-business-sense-2025-02-24/.

“BioWork |NCBioNetwork.Org,” March 7, 2023. https://www.ncbionetwork.org/biowork.

Colorado Succeeds. “Colorado Succeeds - Building a Strong Workforce Starts in Our Schools.” Accessed March 4, 2025. https://coloradosucceeds.org/.

Corp, Phlow. “Phlow Corporation Awarded $354 Million HHS/ASPR/BARDA Contract to Manufacture Essential Medicines in Shortage,” May 19, 2020. https://www.prnewswire.com/news-releases/phlow-corporation-awarded-354-million-hhsasprbarda-contract-to-manufacture-essential-medicines-in-shortage-301061648.html.

“Education and Workforce Alignment Dashboard - The Virginia Office of Education Economics.” Dashboard. VOEE. Accessed November 21, 2024. https://voee.org/education-and-workforce-alignment-dashboard/.

“Gen Z Seek Ethical Workplaces as Environ-Mental Health Burden Bites,” January 13, 2022. http://www.bupa.com/news-and-press/press-releases/2022/gen-z-seek-ethical-workplaces-as-environ-mental-health-burden-bites.

Gibson, Rosemary, and Janardan Prasad Singh. *China Rx: Exposing the Risks of America’s Dependence on China for Medicine*. Amherst, New York: Prometheus Books, 2018.

Hall, Dennis. “Will AI/ML Change How Pharmaceuticals Are Made?” Presented at the CCAM Industry Day 2024, Commonwealth Center for Advanced Manufacturing, November 14, 2024.

Iacovella, Nick. “How to Address America’s Historic Drug Shortage Crisis - Coalition For A Prosperous America,” June 20, 2024. https://prosperousamerica.org/how-to-address-americas-historic-drug-shortage-crisis/.

issuu. “Life Sciences in Virginia,” August 2023. https://issuu.com/vedpvirginia/docs/life_sciences_in_virginia.

“Life Sciences | Greater Richmond Partnership | Virginia | USA,” February 28, 2025. https://www.grpva.com/target-industries/life-sciences/.

“NC Life Sciences Apprenticeship Program | NCBioNetwork.Org,” September 15, 2023. https://www.ncbionetwork.org/nc-life-sciences-apprenticeship-program.

“Pharmaceutical and Medicine Manufacturing Companies in Virginia, United States of America.” Dun & Bradstreet. Accessed November 21, 2024. https://www.dnb.com/business-directory/company-information.pharmaceutical_and_medicine_manufacturing.us.virginia.html.

Poláková, Michaela, Juliet Horváthová Suleimanová, Peter Madzík, Lukáš Copuš, Ivana Molnárová, and Jana Polednová. “Soft Skills and Their Importance in the Labour Market under the Conditions of Industry 5.0.” *Heliyon* 9, no. 8 (July 27, 2023): e18670. https://doi.org/10.1016/j.heliyon.2023.e18670.

Polefrone, Joy. “The Power Of Partnership: Experiences And Learnings Through The Advanced Pharmaceutical Manufacturing (APM) Coalition’s Collective Work.” Presented at the CCAM: Industry Day, CCAM: Industry Day, November 2024.

Robinson, Bryan. “84% Of Workforce Insists Job Candidates Must Demonstrate Soft Skills, New Study Finds.” Forbes, April 4, 2024. https://www.forbes.com/sites/bryanrobinson/2024/04/04/soft-skills-in-the-workplace/.

Scott, Robert, Valerie Wilson, Jori Kandra, and Daniel Perez. “Botched Policy Responses to Globalization Have Decimated Manufacturing Employment with Often Overlooked Costs for Black, Brown, and Other Workers of Color: Investing in Infrastructure and Rebalancing Trade Can Create Good Jobs for All.” Economic Policy Institute, January 31, 2022. https://www.epi.org/publication/botched-policy-responses-to-globalization/.

South, Jeff. “Across Cultural Lines, Home Schooling Has Boomed since COVID-19 Hit, *Virginia Mercury*.” *Virginia Mercury* (blog), January 3, 2022. https://virginiamercury.com/2022/01/03/across-cultural-lines-home-schooling-has-boomed-since-covid-19-hit/.

“The Colorado Education Initiative | Igniting the Power of Public Education.” Accessed March 4, 2025. https://www.coloradoedinitiative.org/.

“The Deloitte Global 2024 Gen Z and Millennial Survey.” Accessed February 27, 2025. https://www.deloitte.com/global/en/issues/work/content/genz-millennialsurvey.html.

“The Mission | Building the U.S. Naval Submarine Fleet.” Accessed November 15, 2024. https://www.buildsubmarines.com/mission.

“The Power of Partnership - the Richmond-Petersburg Region Secures Designation as Tech Hub by Biden-Harris Administration and U.S. Department of Commerce.” Accessed November 21, 2024. https://www.prnewswire.com/news-releases/the-power-of-partnership–the-richmond-petersburg-region-secures-designation-as-tech-hub-by-biden-harris-administration-and-us-department-of-commerce-301966379.html.

The White House. “Issue Brief: Supply Chain Resilience | CEA,” November 30, 2023. https://www.whitehouse.gov/cea/written-materials/2023/11/30/issue-brief-supply-chain-resilience/.

Virginia Commonwealth University. “Medicines for All Institute.” Accessed November 21, 2024. https://www.vcu.edu/medicines4all/.

“Virginia Homeschool | Home Educators Association Of Virginia,” February 6, 2018. https://heav.org/.

“Virginia Post-Secondary Completion Dashboard - The Virginia Office of Education Economics.” Accessed November 15, 2024. https://voee.org/virginia-post-secondary-completion-dashboard/.

Appendix: A

GLOSSARY

A

- **Active Pharmaceutical Ingredient (API):** The biologically active component of a drug product responsible for its therapeutic effects.
- **Advanced Pharmaceutical Manufacturing (APM):** A modern approach to pharmaceutical production that incorporates advanced technologies such as continuous manufacturing, robotics, and data analytics to improve efficiency, quality and scalability.
- **Alliance for Building Better Medicine (ABBM):** A regional coalition focused on strengthening pharmaceutical manufacturing in the Richmond-Petersburg area.

B

- **Batch Manufacturing:** Traditional pharmaceutical production method where drugs are made in distinct, separate steps, as opposed to continuous manufacturing.
- **Biomedical Advanced Research and Development Authority (BARDA):** A U.S. government agency providing funding to support the development and manufacturing of medical countermeasures.

C

- **Cleanroom:** A controlled environment in pharmaceutical manufacturing designed to maintain low levels of pollutants, such as dust, airborne microbes and chemical vapors.
- **Continuous Manufacturing (CM):** A production method in which raw materials are continuously fed into the manufacturing process, resulting in a constant output of the finished product.

D

- **Dual Enrollment:** Educational programs allowing high school students to take college-level courses and earn credits toward a postsecondary degree or certification.

E

- **Economic Development Administration (EDA):** A U.S. federal agency supporting regional economic growth through grants and initiatives like Tech Hubs.

F

- **Finished Dosage Form:** The final manufactured product of a pharmaceutical drug, ready for distribution and use by patients.
- **Food and Drug Administration (FDA):** The U.S. federal agency responsible for regulating pharmaceuticals, medical devices and food safety.

G

- **Good Manufacturing Practices (GMP):** Guidelines that ensure pharmaceutical manufacturing processes meet quality standards and are consistently followed.

I

- **Infrastructure Investment and Jobs Act (IIJA):** Federal legislation funding infrastructure projects, including those that enhance regional manufacturing capabilities.
- **IMPLAN:** An input-output modeling system used to assess economic impacts, including job creation and regional value-added outcomes.

K

- **Key Starting Material:** Chemical components used in the early stages of pharmaceutical manufacturing to produce APIs.

N

- **National Institutes of Health (NIH):** A U.S. government agency that conducts and supports medical research, with funding impacting regional pharmaceutical growth.

O

- **Onshoring/Reshoring:** The practice of bringing manufacturing operations back to the U.S. to strengthen domestic supply chains and reduce reliance on foreign production.

P

- **Process Analytical Technology (PAT):** Tools and systems used for real-time monitoring and control of manufacturing processes to ensure product quality.
- **Petersburg Industrial Park (PIP):** A key location in Region 4 housing advanced pharmaceutical manufacturing facilities.

R

- **Regional Technology and Innovation Hub (Tech Hub):** A designation by the U.S. EDA to support regional economic clusters, such as the APM hub in Richmond-Petersburg.

S

- **Strategic Active Pharmaceutical Ingredient Reserve (SAPIR):** A reserve of essential APIs intended to mitigate supply chain disruptions and enhance national security.

T

- **Talent Pathways Initiative (TPI):** A GO Virginia program aimed at aligning workforce development with regional industry needs, including advanced pharmaceutical manufacturing.

V

- **Virginia Commonwealth University (VCU):** A major research university in Richmond, Va., that contributes to pharmaceutical innovation through initiatives like the Medicines for All Institute.
- **Virginia State University (VSU):** A historically Black college and university (HBCU) involved in workforce development for the pharmaceutical sector.

Appendix: B

COMPARATIVE ANALYSIS OF APM AND BIOTECH REGIONS: INSIGHTS FOR GO VIRGINIA REGION 4

1. Research Triangle Park (RTP), North Carolina

- Strengths:
  - RTP is one of the largest and most established biotech hubs in the United States, with over 600 life-science companies and a workforce exceeding 67,000 professionals.
  - Proximity to top-tier research institutions such as Duke University, UNC-Chapel Hill and NC State University fosters cutting-edge innovation and a steady pipeline of skilled graduates.
  - Strong public-private partnerships and state investment in infrastructure, including wet labs and incubator spaces, have positioned RTP as a global leader in life sciences.
  - Competitive incentive packages, such as tax credits for job creation, research grants and infrastructure support, attract top companies.
- Opportunities for GO Virginia Region 4:
  - Develop stronger ties between local research universities (e.g., VCU, VT and VSU) and the APM industry to mimic RTP's innovation ecosystem.
  - Invest in life-science-specific infrastructure such as shared cleanroom facilities or pilot-scale production labs to attract startups and scale-ups.
  - Expand marketing efforts to position Region 4 as a growing competitor to RTP, leveraging unique assets such as the Petersburg Industrial Park and the Medicines for All Institute.

2. I-270 Biotech Corridor, Maryland

- Strengths:
  - Known as "DNA Alley," this corridor boasts over 350 biotech firms and is home to leading federal agencies such as the NIH, the FDA, and the National Institute of Standards and Technology (NIST).
  - A dense concentration of pharmaceutical manufacturing and research organizations benefits from proximity to federal funding and regulatory agencies.
  - Maryland offers competitive incentive programs, including grants for infrastructure and tax exemptions for R&D expenditures.
- Opportunities for GO Virginia Region 4:
  - Strengthen connections with federal funding sources and agencies, leveraging NIH and EDA grants to boost pharmaceutical R&D.
  - Position Region 4 as a complementary hub to Maryland's Biotech Corridor, focusing on advanced manufacturing capabilities to support innovations developed there.
  - Advocate for state-level incentives targeted at attracting R&D-heavy firms to establish or expand operations in the region.

3. **Greater Boston Area, Massachusetts**

- Strengths:
  - Globally recognized as the leading biotech hub, with over 1,000 life science companies and close partnerships with top academic institutions such as Harvard and MIT.
  - Boston's ecosystem excels in translational research, venture capital access and early-stage innovation.
  - The region offers comprehensive support for biotech startups, including access to funding, incubators and mentorship programs.
- Opportunities for GO Virginia Region 4:
  - Explore partnerships with Boston-based venture capital firms to attract funding for APM-related startups in Region 4.
  - Expand local incubator and accelerator programs to support entrepreneurs and small businesses in the pharmaceutical sector.
  - Focus on promoting Region 4's strengths in advanced manufacturing and scalable production, differentiating it from Boston's research-oriented ecosystem.

Comparative Recommendations for GO Virginia Region 4

Strengths to Leverage:

- Strategic Location: Region 4's proximity to Washington, D.C., and its role as a transportation hub with access to ports, highways and airports make it attractive for manufacturing and logistics.
- Onshoring Advantage: The national push for reshoring pharmaceutical manufacturing aligns with Region 4's established infrastructure and ongoing investments in APM.
- Pioneering Initiatives: Efforts like the Medicines for All Institute and the Alliance for Building Better Medicine position the region as a leader in continuous manufacturing.

Areas for Improvement:

1. **Workforce Development:**

- Expand educational pathways to produce more skilled workers at all levels, from technical certifications to advanced degrees, mirroring RTP's strong talent pipeline.
- Create incentives for retaining local talent and attracting professionals from competing regions.

2. **Infrastructure:**

- Build shared-use facilities, such as pilot-scale labs or cleanrooms, to attract startups and reduce barriers to entry for small firms, as seen in RTP and Boston.
- Enhance funding for infrastructure through state and federal grants, ensuring competitive readiness.

3. **Regional Branding:**

- Develop a unified marketing strategy highlighting Region 4's strategic advantages and positioning it as a complement to established hubs such as the Biotech Corridor and RTP.
- Use success stories (e.g., Civica Rx and Phlow) to attract further investment and partnerships.

4. **Incentives and Support:**

- Advocate for competitive state-level incentives that rival those offered in RTP and Maryland, such as tax breaks, R&D credits and grants for job creation.

Appendix: C

SUSTAINABILITY CONSIDERATIONS IN ADVANCED PHARMACEUTICAL MANUFACTURING

Sustainability is a crucial factor in reshoring APM. Adopting environmentally friendly practices strengthens supply chain resilience, supports economic growth and aligns with corporate and federal sustainability priorities.

Key Environmentally Friendly Practices

Practice	Description	Sustainability Impact
Continuous Manufacturing	Reduces waste and energy use by eliminating batch-to-batch variability and streamlining processes.	Decreases material waste and greenhouse gas emissions.
Process Analytical Technology	Ensures real-time monitoring of production for quality and efficiency.	Minimizes rework and enhances resource efficiency.
Green Chemistry	Uses eco-friendly chemical processes to minimize hazardous substances.	Reduces toxic waste and protects ecosystems.
Water and Energy Efficiency	Incorporates advanced recycling systems and energy-efficient technologies.	Conserves water, lowers energy costs and reduces carbon footprint.
Circular Economy Approaches	Encourages recycling of materials such as solvents and packaging.	Reduces waste sent to landfills and promotes resource reuse.

Advantages of Sustainable Practices

- Cost Savings: Reduced waste and energy usage lower operational costs.
- Enhanced Public Perception: Boosts consumer and investor confidence in environmentally responsible practices.
- Regulatory Compliance: Anticipates and exceeds environmental regulations, minimizing legal risks.
- Alignment with Federal Incentives: Access to grants and tax credits for renewable energy and efficiency.

Regional Case Studies and Examples

1. **Medicines for All Institute (M4All):**
- Focus: Green manufacturing for APIs.
- Impact: Demonstrated significant reductions in energy use and material waste.

2. **Civica Rx:**
- Focus: Sustainability in sterile manufacturing processes.
- Impact: Improved water recycling and waste management systems.

Recommendations for Region 4

1. **Promote Green Infrastructure:**
- Use renewable energy and energy-efficient technologies in new facilities.
- Develop shared cleanroom facilities with sustainable design standards.

2. **Educate Stakeholders:**
- Create training programs on green manufacturing best practices.
- Partner with regional universities to integrate sustainability into curricula.

3. **Leverage Federal and State Incentives:**
- Secure funding through the Inflation Reduction Act and similar programs.
- Position Region 4 as a leader in sustainable pharmaceutical production.

Sustainability enhances the business case for reshoring APM. By integrating environmentally friendly practices, Region 4 can solidify its leadership in sustainable manufacturing, benefiting both the economy and the environment.

Appendix: D

PAY PARITY CONCERNS BETWEEN IT EDUCATORS AND INDUSTRY PROFESSIONALS

A major challenge in IT workforce development is the significant pay disparity between educators in Pre-K–12 and higher education institutions and their counterparts in the private sector. IT professionals with in-demand skills, such as cybersecurity, software development and artificial intelligence, can often earn considerably higher salaries in industry roles than they would as teachers or professors. This wage gap has several adverse effects on education and workforce readiness.

Key Impacts of Pay Disparities

1. **Difficulty in Attracting and Retaining IT Educators**
   - Many educational institutions struggle to hire instructors with industry experience due to noncompetitive salaries.
   - High turnover rates occur when educators leave teaching for better-paying industry positions, disrupting student learning and program stability.
2. **Declining Quality of IT Education**
   - Fewer qualified professionals enter teaching due to the lack of competitive pay, leading to outdated curricula that do not align with evolving industry standards.
   - Schools and colleges may rely on educators without real-world IT experience, which limits students' exposure to current trends and best practices.
3. **Inconsistencies in Pay Within Education**
   - Despite covering similar foundational content, high school IT teachers often earn significantly less than college-level instructors.
   - Community college faculty salaries lag behind four-year institutions despite their critical role in workforce-aligned IT training.
4. **Broader Workforce Implications**
   - If students do not receive instruction from industry-aligned educators, they may graduate without the skills employers need, widening the skills gap.
   - Employers may turn to alternative sources, such as coding bootcamps or self-taught professionals, bypassing traditional educational institutions.

Potential Strategies to Address the Issue

- Industry-Education Partnerships — Businesses could provide funding, guest lecturers or faculty sponsorships to supplement educator salaries.
- Incentive Programs — States and institutions could offer retention bonuses, professional development stipends or competitive salary adjustments to IT educators.
- Hybrid Teaching Models — Encouraging part-time teaching from active industry professionals can bring real-world experience into classrooms.
- Public Investment in IT Educators — Workforce-development grants or state-funded salary enhancements could support IT faculty recruitment and retention.

Addressing pay disparities is critical to ensuring that IT programs remain competitive, relevant and capable of preparing students for the evolving demands of the workforce. Strengthening compensation structures and leveraging industry collaboration can help bridge this gap, benefiting students and employers.