VIRGINIA BIOINFORMATICS INSTITUTE

2010 Annual Report

VIRGINIA BIOINFORMATICS INSTITUTE AT VIRGINIA TECH VBI

VirginiaTech
Invent the Future®

OUR MISSION

Our Mission is to solve society's most important problems in the life sciences and biomedicine through transdisciplinary research and education.

OUR VISION

VBI will be a world leader in transdisciplinary life science and biomedical research and education. In practice this means that VBI is committed to making transformative discoveries, solving important problems, developing the next generation of transdisciplinary researchers, influencing public policy, and transitioning scientific research into use.

5,000 students and parents VBI's Education and Outreach group interact with each year

450 students attending each session of Kids' Tech University

80 student participants in VBI's 2010 summer programs

Introducing children to science

VBI AT A GLANCE

Making transformative discoveries

29 Sponsored Research Agreements

28 Invention Disclosures

28 Provisional Patent Filings

17 Patent Filings

15 Small Business Innovation Research Awards

over **700** customers who have used VBI's Core Laboratory Facility

72 Students Employed

35 Graduate Research Assistants

106 Faculty and Researchers

238 total employees

130,000 ft^2 of working space on Virginia Tech's campus

Cultivating scientific advancement

Tackling critical problems

$120M current total active funding awards

$150M total amount of awards since 2000

more than **90** papers published in scientific journals in 2010

9 journal covers featuring research from VBI faculty

2010 Annual Report

Virginia Bioinformatics Institute

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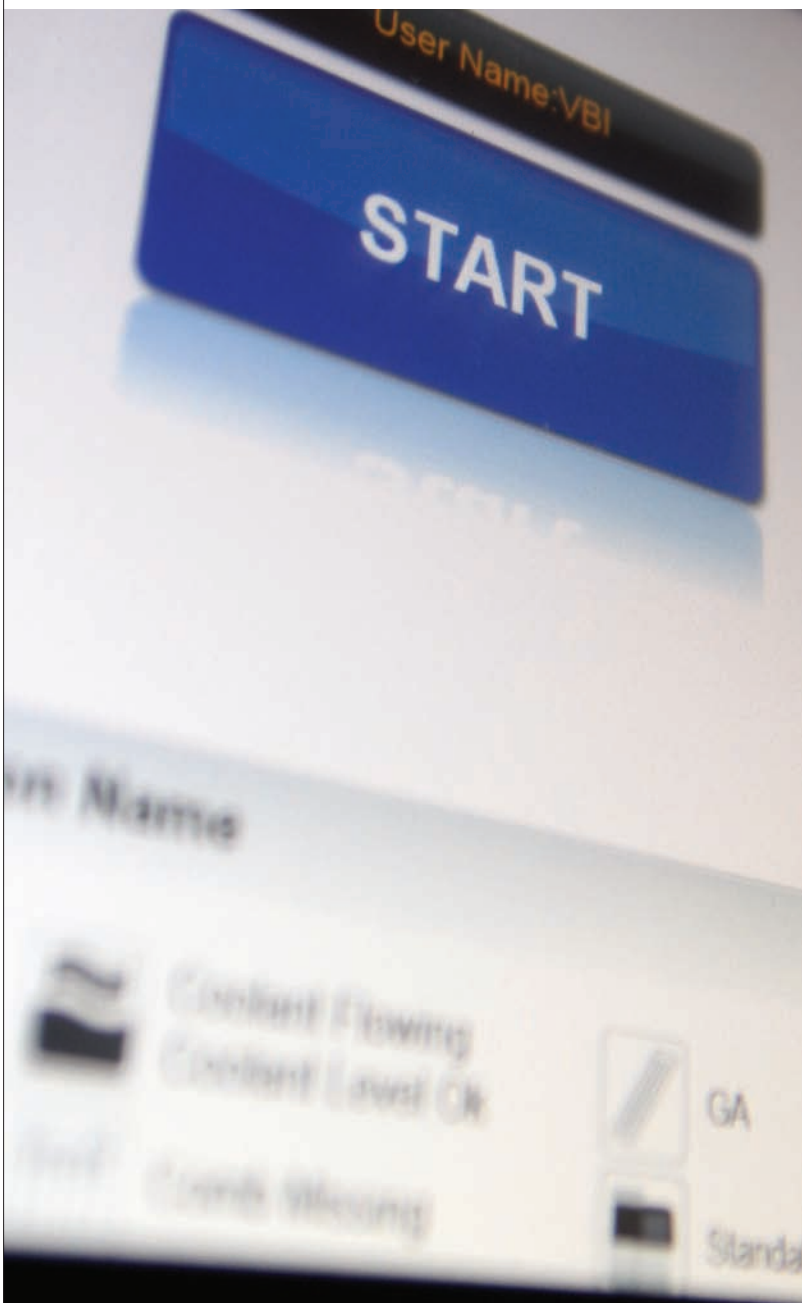
The 2010 annual report of the Virginia Bioinformatics Institute was created and designed by the VBI Marketing and Communications team.

Printed on recycled paper containing 30% post consumer waste



CELEBRATING 10 YEARS OF

SUCCESS IS JUST A START

Message from ***Charles W. Steger****, President, Virginia Tech*

Foreseeing the promise of biotechnology, Virginia Tech established the Virginia Bioinformatics Institute (VBI) 10 years ago. Both the university and the Commonwealth of Virginia recognized the tremendous potential for biotechnology to become an economic catalyst for Blacksburg and the state, contributing to the university's growth in research activities and providing major benefits to the region by way of entrepreneurial activities arising from the advancement of this emerging field.

Ideas and innovations are important components of the new global economy and research is its driver. The only way this can be successfully translated into real benefits for our community is if there is adequate support for scientific and technological discovery. Just as we worked to establish VBI 10 years ago, Virginia Tech has continued to uphold the land-grant tradition of transforming knowledge into economic value by investing in comprehensive and flexible research environments that span many disciplines and integrate research and education throughout the university. VBI has certainly been one of our success stories.

We continue to strengthen our foundation for future success – by supporting scientific discovery and technological innovation, and educating the researchers of the future. VBI has been a critical part of this foundation and we are confident the institute will make many more significant contributions to Virginia Tech and the Commonwealth as we move forward. When Dr. Harold "Skip" Garner was named the new executive director for VBI in 2009, I presented him with a lofty goal – double the size of the institute in the next 10 years. I am confident that with the support of the university community, the talent and knowledge of VBI's team of faculty and staff, and the pressing need for research advances in the life sciences and health, we will be celebrating this achievement in 10 years time.

Message from ***Robert W. Walters*** *Vice President for Research, Virginia Tech*

Thanks to the hard work of our faculty, staff, and students, Virginia Tech's research programs have seen significant growth and expansion over the past year. Specifically, the Virginia Bioinformatics Institute (VBI) has made major contributions to the university's research successes. In October of last year, the National Institutes of Health awarded approximately $27 million to VBI, the largest one-time federal award in the history of Virginia Tech. The five-year contract will fund the CyberInfrastructure Division's work to expand a major international resource used to combat infections such as the flu and to defend our country against bioterrorism. This project is a prime example of Virginia Tech's expanding focus on health-related research and is poised to deliver major contributions to our research program in the near future.

VBI and our other research institutes at Virginia Tech were created to enhance the university's efforts to perform large-scale research projects by crossing traditional disciplinary and college boundaries. Along with the Virginia Tech Carilion Research Institute, VBI is helping to establish a firm foundation for further growth and expansion of our research mission, extending the research portfolio of both institutes to include applied, translational, and commercialization projects.

With world-class talent and sophisticated research facilities, VBI is a vital component of our efforts to build on our traditional research strengths and grow new areas of discovery.

Message from ***Harold "Skip" Garner****, Executive Director, Virginia Bioinformatics Institute at Virginia Tech*

I am honored to be serving as the Virginia Bioinformatics Institute's (VBI) executive director as it has reached this important milestone marking 10 years of success on the Virginia Tech campus. While this report serves to recognize our achievements over the past decade, our team of talented faculty, staff, and students has our focus clearly set on the next 10 years, and we will enter this next stage of the institute's development with passion, excitement, and a firm commitment to making significant contributions towards solving some of society's most important problems in the life sciences and biomedicine.

Our goal at VBI is to embrace the full life-cycle of applied research – capturing the interest of children, preparing the next generation of transdiciplinary researchers, providing employment opportunities for the region, identifying critical needs and addressing them, making transformative discoveries, and transitioning our research into real applications that improve people's health and their quality of life. Our world is demanding it.

In November, bioinformatics found a place in popular culture when it was featured in Gary Trudeau's comic strip, "Doonesbury." In the strip, two students are discussing college life. One of the students is complaining about the amount of work she has for one of her classes.

"G-g-grad school…hard?" the other student asks.
"It's this one professor. She thinks the students are hired help…she gets away with it because she's one of the big stars in her field," she replies in the next frame.
"W-w-what field?" her friend asks.
"Bioinformatics in proteomics. Has to do with protein analysis."

Although Virginia Tech saw it coming 10 years ago, bioinformatics has finally arrived as a mainstream discipline, and we couldn't be more excited about the possibilities for the future. A firm foundation has been established for the institute, but the best is yet to come. Stay tuned, join us, and together we will impact our world.

VBI Scientific Advisory Board

Members of the Scientific Advisory Board of the Virginia Bioinformatics Institute (VBI), which include scientific leaders in fields such as high-performance computing, biology, bioinformatics, and nanotechnology/engineering, serve as scientific advisors for the institute. They provide regular external reviews of research strengths as well as guidance on new strategic scientific initiatives and funding opportunities.

During its 2010 meetings, the Scientific Advisory Board evaluated the institute's new strategic plan, placing particular emphasis on the research portfolio; worked to help define VBI's position within Virginia Tech's campus-wide high-performance computing effort; and provided suggestions regarding the institute's quality management and scientific reporting processes.

According to Stephan Bieri, chairman of the Scientific Advisory Board, "We've been very impressed with the achievements the Virginia Bioinformatics Institute has made in its first 10 years and especially since our review in 2007. We're confident that the institute has a very bright future ahead of it. Both the Scientific Advisory Board and VBI's executive director agree that the institute is in a perfect position to pursue exciting new opportunities, especially involving clinical research areas. VBI's portfolio must be focused, and the search for talented young scientists is of growing importance."

ESTABLISHED IN 2000, VBI is the premier bioinformatics institute in the world. Building on a solid foundation of life science research and a long list of progressive scientific achievements, the institute is ushering in its second decade with a focus on several new highly interactive research directions, making the VBI the definitive authority in applied bioinformatics.

A Decade In Review

2000 - 2009

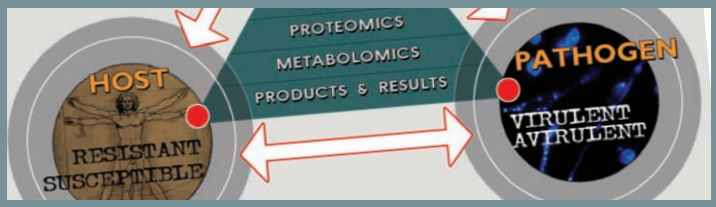
- Sowing The Seeds Of Innovation
- Targeting Infectious Diseases
- Strengthening National Security
- Building Tools For Complex Networks
- Expanding Facilities
- Making Data Generation History
- Combating Deadly Plant Pathogens
- Improving The World's Food Sources
- Creating The Scientists of Tomorrow
- Bringing "Big Science" To Virginia Tech

2010 and Beyond

Ushering In A New Spirit Of Collaboration

2000 | Sowing The Seeds Of Innovation

- The Virginia Bioinformatics Institute opens its doors in the Virginia Tech Corporate Research Center in July 2000.
- Officials envision a center capable of organizing and analyzing the vast amounts of information that result from genetic research to help solve problems involving human health and feeding the world's populations, as well as provide high-tech job opportunities in the region.
- Bruno Sobral is recruited to serve as VBI's founding executive and scientific director.

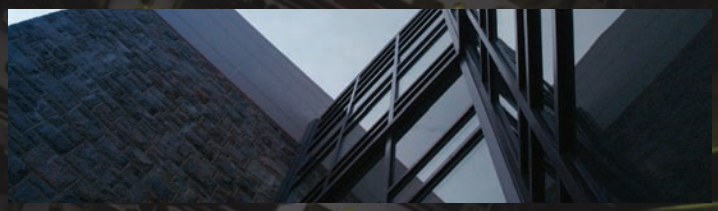


2001 | Targeting Infectious Disease

- VBI forms a $10 million bioinformatics research collaboration with the Johns Hopkins Bloomberg School of Public Health to target human infectious diseases.
- This collaboration sparks the establishment of the institute's stronghold in infectious disease research, particularly involving the examination of interactions between infectious disease pathogens, hosts, and their environments.

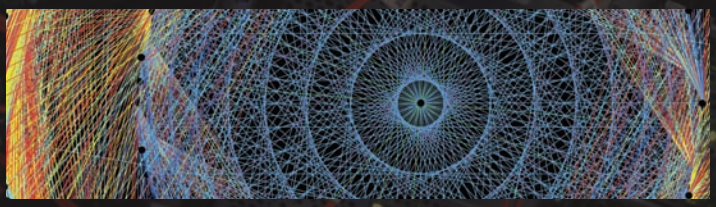
2002 | Strengthening National Security

- VBI creates PathPort, a portal connecting pathogen databases from around the world, allowing for the rapid detection and identification of high-priority pathogens, including infectious diseases and those that could potentially be used as biological weapons.
- The institute receives funding from the U.S. Department of Defense to develop the comprehensive pathogen information system, providing an important decision-making tool to advance the nation's security efforts and long-term biomedical efforts to cure infectious disease.



2003 | Expanding Facilities

- Construction is complete for the first phase of VBI's on-campus facility, which is soon followed by the completion of the second phase, providing the institute with more than 130,000 square feet of space while still maintaining a presence at the Virginia Tech Corporate Research Center.
- The facility features a range of laboratories, including VBI's Core Facilities, as well as capabilities to support the latest in bioinformatics research platforms.

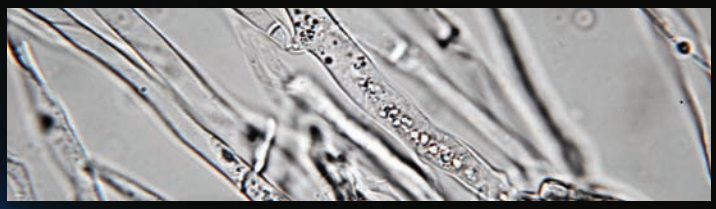


2004 | Building Tools For Complex Networks

- VBI welcomes Chris Barrett and his Network Dynamics and Simulation Science Laboratory (NDSSL) to the institute.
- The group designs and develops modeling tools to understand extremely large biological, information, social, and technological systems and implements them using high-performance computer systems.
- These tools are used to better understand many real-world issues, such as the spread of infectious diseases, population dynamics, energy systems, wireless networks, commodity markets, and computational economics.

2005 | Making Data Generation History

- VBI's Core Laboratory Facility (CLF) begins work on the largest ever Affymetrix GeneChip® agriculture microarray study in an academic research setting.
- The experiment explores the counter-play of plant and pathogen genes during infection of soybean by the root-rot pathogen *Phytophthora sojae*, and includes a focus on mechanisms of long-lasting disease resistance.



2006 | Combating Deadly Plant Pathogens

- VBI Professor Brett Tyler leads a team of researchers who publish the draft genome sequences of two deadly plant pathogens, *Phytophthora ramorum* and *Phytophthora sojae*, in the journal Science.
- The sequences have served as a fundamental resource with wide-ranging applications for the *Phytophthora* community, aiding in the development of much needed countermeasures against these deadly pathogens.

2007 | Improving the World's Food Sources

- VBI Professor Andy Pereira and colleagues produce a new type of rice – *HARDY* rice – that grows better and uses water more efficiently than other rice crops.
- The discovery is contributing in a sustainable way to maintaining high crop yields under conditions of limited water availability, which will help feed the world.

2008 | Creating the Scientists of Tomorrow

- Kids' Tech University (KTU), a pioneering educational program designed to spark children's interest in science and provide them with a real university experience, is introduced to the community.
- Held over the course of a semester on the Virginia Tech campus, KTU features student-focused sessions with internationally recognized scientific researchers, as well as hands-on activities to encourage further exploration of the lecture topics.

NIAID

U.S. Department of Health and Human Services
National Institutes of Health

2009 | Bringing "Big Science" to Virginia Tech

- VBI's CyberInfrastructure Division receives a five-year, $27 million grant from the National Institute of Allergy and Infectious Diseases (NIAID) – the largest one-time federal award in Virginia Tech's history – to support the biomedical research community's work on infectious diseases.
- The funding is being used to integrate vital information on pathogens, provide key resources and tools to scientists, and help researchers to analyze genomic, proteomic and other data arising from infectious disease research, as well as to develop vaccine, diagnostic or therapeutic targets for countermeasures.

2010 and Beyond...

As evident from the accomplishments over the previous 10 years, VBI has attracted a strong core of people who develop and support big ideas in science. It was this group of people that helped the institute establish its roots – a critical component of the larger goal of making VBI the world authority in applied bioinformatics. A clear plan has now been established to move VBI forward. VBI's new executive director, Harold "Skip" Garner, joined the institute at the end of 2009, and with this came a fresh perspective for VBI's next decade. With a challenge from Virginia Tech President Charles Steger to double VBI's size over the next 10 years, VBI faculty members have a reinvigorated commitment to ushering in the next phase of VBI's development with a new spirit of collaboration.

Ushering In A New Spirit Of Collaboration

VBI is truly a full service organization – from getting children interested in science at an early age; to training and recruiting scientists; to identifying critical needs, finding solutions, and making them available to the world. With a collection of dynamic research programs housed in four divisions, coupled with a powerful group of service-based Research Resources that provide cutting-edge data generation and analysis technologies, VBI has a strong foundation to support its future success.

The institute is working to not only expand its research in its traditional areas of strength, including systems biology and infectious disease research, but also to forge ahead with several areas of interest, including:

- Leading Virginia Tech's efforts to establish a sustainable high-performance computing environment.
- Introducing a Medical Informatics and Systems (MIS) Division to further expand both the institute's focus on human disease and clinical operations and its collaborations with the Virginia Tech Carilion School of Medicine and Research Institute.
- Increasing and expanding "omics" and core computational services for researchers at Virginia Tech and beyond.
- Translating research into real-world applications by increasing intellectual property, commercialization, and entrepreneurial activities.
- Further strengthening its partnership with Virginia Tech's Genetics, Bioinformatics and Computational Biology (GBCB) Ph.D. program to prepare the next generation of scientists.

VBI'S RESEARCH DIVISIONS serve as a framework for the scientific research being conducted at the institute. With a focus on traditional strengths in infectious disease research, as well as new areas involving biomedical projects with clinical applications, these divisions are the driving force of the institute – composed of faculty and scientific staff dedicated to making discoveries that will impact the world.

Research Divisions

- **BioSystems**
- **CyberInfrastructure**
- **Network Dynamics and Simulation Science Laboratory**
- **Medical Informatics and Systems**

BioSystems Division

The impact of an infectious disease is related to what kind of pathogen (germ) is attacking a host (animal, plant, or human) and how this host defends itself against the pathogen. This process involves complex interactions between genes from both the pathogen and the host. VBI's BioSystems Division focuses on these host-pathogen interactions, promoting a transdisciplinary approach to science that bridges both plant and human health research.

Using genetic network analysis, VBI researchers are studying the relationship between these host and pathogen genes to uncover new ways to combat or even prevent infection. While this would be a major achievement, many more pathogens and hosts need to be studied, which is challenging, both computationally and scientifically. In the years ahead, the BioSystems Division is poised to advance the knowledge of how pathogens of humans and plants cause disease through a combination of cutting-edge computational and experimental biology approaches.

FIGHTING INFECTION

VBI Professor Brett Tyler led an international team of scientists that cracked the genetic code of a plant pathogen that causes major losses to crops as diverse as maize, grapes, and lettuce. The team sequenced the genome of the downy mildew pathogen *Hyaloperonospora arabidopsidis*, which attacks the widely studied model plant *Arabidopsis thaliana*. Their results, which were featured on the cover of the journal *Science*, shed light on the differences in the ways microbes interact with their host and how those differences evolve. The payoff could be new ways to investigate how these pathogens wreak havoc and, in the long-term, finding how to prevent billions of dollars of losses for farmers growing crops across the globe. This work came on the heels of the group's discovery of a fundamental entry mechanism that allows fungal microbes to infect plants and cause disease. Working with VBI Associate Professor Chris Lawrence, who studies fungal-associated diseases in humans, they were also able to show that the entry process into some human cells takes place by the same mechanism.

GENETICALLY ENGINEERING MICROORGANISMS

While synthetic biology continues to grab headlines, as well as the attention of drug makers, energy executives, and high-ranking government officials, VBI continues to make strides with its Synthetic Biology Research Program, led by VBI Associate Professor Jean Peccoud. Synthetic biology is a rapidly emerging area of biological research that utilizes methods developed in engineering to design artificial biological systems for useful purposes, as well as to re-design natural systems to better understand the fundamental properties of living organisms. The group recently received funding from the National Science Foundation to advance its work on GenoCAD, a web-based Computer Assisted Design environment for synthetic biology. The open-source software tool allows the non-specialist to design and validate large-scale genetic systems for use in basic biological research or product development programs. The idea is to use DNA as a language to program living organisms instead of computers. The future applications of synthetic biology are vast. By genetically engineering microorganisms to perform specific functions, researchers will be able to develop medications, create alternative forms of energy, and detect deadly chemicals in the environment. Peccoud's team at VBI is exploring possibilities of using GenoCAD for vaccine development – a promising application of synthetic biology that could revolutionize the human vaccination process. The group's goal is to deliver a "plug and play" platform for a DNA vaccine that would require a very short manufacturing cycle as compared to traditional vaccinations and be fairly inexpensive to produce.

CyberInfrastructure Division

The process of scientific and medical discovery hinges on the availability of cutting-edge resources for researchers and clinicians. A key component in the process of developing systems that drive data and functional resources to meet the requirements of scientists and clinicians is to understand their research questions and needs. Led by VBI Professor Bruno Sobral, the goal of VBI's CyberInfrastructure Division is to provide high-utility, user-friendly computational resources for infectious disease and other life science researchers, as well as clinicians. The group designs informatics-based methods and resources to integrate and analyze data about infectious disease and uses translational systems informatics to support scientific discovery and clinical outcomes. By employing user-centered design and development, the group can quickly deliver working systems and elicit user feedback to refine and improve functionality.

The team considers their work a success when researchers get the information they need quickly in a data-rich, intuitive format that does not require knowledge of how to invoke computational tools, develop complex queries, or connect to the underlying hardware systems.

The CyberInfrastructure Division is developing rich, web-based resources such as PATRIC, which allows researchers to make meaningful comparisons across hundreds of bacterial pathogens.

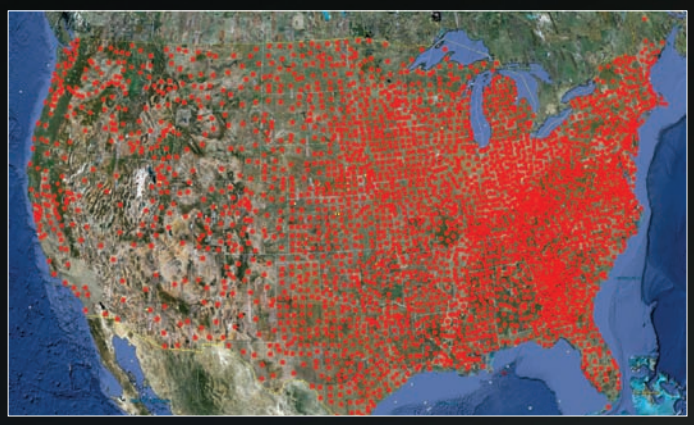
UNDERSTANDING THE BODY'S RESPONSE TO GASTROINTESTINAL PATHOGENS

Scientists in the CyberInfrastructure Division's Nutritional Immunology and Molecular Medicine Group uses computational resources to better understand how the body's immune system responds to infection, allowing for the identification of drug targets for treatment and prevention. The group and their collaborators received a $10.6 million grant from the National Institute of Allergy and Infectious Disease (NIAID) to determine how the human immune system reacts to infection caused by pathogens of the gut, such as persistent diarrhea, gastric cancer, inflammation, and ulcers. The Center for Modeling Immunity to Enteric Pathogens (MIEP) is generating new hypotheses based on computer simulations of the immune responses in the gut and performing pre-clinical and clinical experiments that will reveal how the immune system works when intestinal pathogens invade the human body. Growing medical costs, productivity loss, and premature death are linked to pathogen outbreaks that target the intestinal tract of humans. This project sets out to address the need for more informed scientific research that translates into effective clinical solutions for gastrointestinal infections.

ADVANCING INFECTIOUS DISEASE RESEARCH

The CyberInfrastructure Division is working to integrate vital information on pathogens, provide key resources and tools to scientists, and help researchers to analyze genomic, proteomic, and other data arising from infectious disease research. In September 2009, the National Institute of Allergy and Infectious Diseases (NIAID), part of the National Institutes of Health (NIH), awarded the CyberInfrastructure Division the largest one-time federal award in Virginia Tech's history – a 5-year, $27,670,448 contract to support the biomedical research community's work on infectious diseases. The new contract covers the development of two web-based resources for biomedical research. The first part of the project supports the development of the Pathogen Portal for the entire Bioinformatics Resource Center (BRC) program, which serves as an informatics coordinating center and gateway for four newly established BRCs across the nation. The second part of the project supports the development of the PATRIC 2.0 BRC for all bacterial species in the selected NIAID category A-C priority pathogens list.

Network Dynamics and Simulation Science Laboratory Division



Statistically-based model showing disease progression nationwide (Day 200).

Before our nation's decision makers can make preparations and design an action plan in the event of a major disease outbreak, they need to have as much useful information as possible involving what could happen if such an event were to occur. While these situations are difficult to predict, researchers have been creating models and simulations of pandemic infections – of outbreaks that have already happened, as well as theoretical outbreaks – to help advance preparation and planning efforts.

In addition to disease outbreak, the use of high-performance computing capabilities can be used to better understand a number of other societal problems, which is a unique capability of VBI's Network Dynamics and Simulation Science Laboratory (NDSSL). Led by VBI Professor Chris Barret, NDSSL's focus involves basic and applied simulation science. Researchers in this division design, develop, and implement modeling tools to understand large biological, information, social, and technological systems.

The group's research and development program is advancing the science and engineering of co-evolving complex networks and developing innovative computational tools based on these advances to support the emerging field of policy informatics. Not only does their work have public health applications, but it can also be used to better understand energy systems, wireless networks, power grids, commodity markets, and computational economics.

One key feature of NDSSL's work is the scale and scope of the systems represented. Constructing large simulations of co-evolving networks representing real-world complex systems is challenging and novel. These systems are affected by physical laws, as well as human behavior, the actions of regulatory agencies, and a number of other factors, all of which must be considered to develop an accurate simulation.

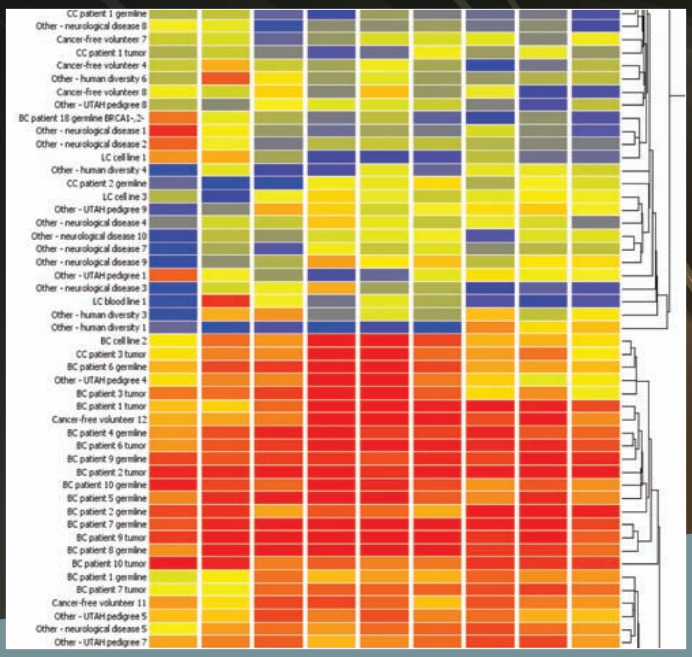
MODELING MILLIONS OF PEOPLE TO IMPROVE STUDY OF DISEASE

People are an integral part of social network simulations and the NDSSL has received funding from the National Science Foundation (NSF) to develop petascale computing environments that will allow the team to model millions of individuals in extremely large social and information networks. The goal of the work is to use new computer technology breakthroughs to study events like disease pandemics, financial crises, as well as the spread of opinions, attitudes, or social beliefs, through populations on a global scale. To build a detailed model of a population, NDSSL researchers typically start with census information, public surveys, and transportation data, which help provide a realistic picture of the daily activities of simulated people within a population and allow for detailed estimates of social contacts. These models are then used to demonstrate how social mixing patterns change under different interventions, such as the closing of schools or workplaces. Important information related to a specific infectious disease, such as H1N1 influenza for example, can be added, allowing researchers to pinpoint the best intervention strategies in a variety of situations.

PREVENTING THE SPREAD OF COMPUTER VIRUSES AND POWER GRID FAILURES

Just as a flu virus can quickly spread through a population, computer viruses and power grid failures spread fast and wide by proximity. NDSSL is working to create a unified mathematical framework that can track the spread of pandemics among populations and malware across wireless computer networks, as well as how a blackout occurring on one major power grid can cause a cascade of additional neighboring networks to fail. VBI Assistant Professor Anil Vullikanti received funding from the U.S. Department of Energy to create a computationally designed framework with an eye toward preventing future pandemics such as the recent H1NI flu virus and the 1918 influenza pandemic that is said to have killed an estimated 50 million people worldwide. This can also be used to help prevent malware/computer virus attacks and mass power grid network disasters akin to the so-called Northeast Blackout of 2003 that left 10 million Canadians and 45 million U.S. residents in eight states without power. The work will detect vulnerabilities and improve robustness in the areas of health care, computer networking, and power grid controls, in order to address key concerns for health care workers, computer industry personnel, and various policy planners.

Medical Informatics and Systems Division



New laboratory technologies reveal DNA signatures that differentiate normal (top) from cancer (bottom).

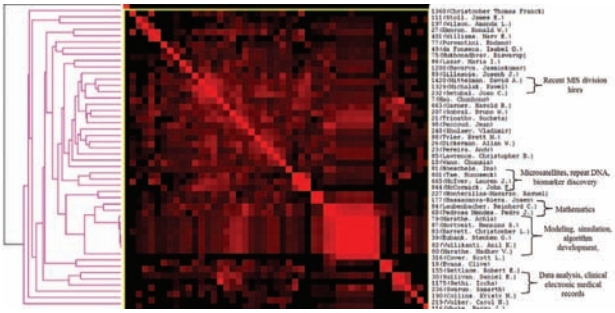
UNCOVERING THE GENETICS OF CANCER IN UNSUSPECTING PLACES

Creating robust biomarkers to detect diseases in their early stages will help inform doctors and patients about disease susceptibility, development, and progression. VBI's Medical Informatics and Systems (MIS) Division, which is led by VBI Executive Director Harold "Skip" Garner, is working to pinpoint these genetic biomarkers by looking at an individual's "junk" DNA. The majority of DNA is non-coding, meaning it's not transcribed into protein. The largest amount of this type of DNA consists of microsatellites – specific repeated sequences of one to six nucleotides within the genome. There are over 2 million microsatellites in the human genome, yet only a small number of these repetitive sequences have previously been linked to disease, particularly neurological disorders and cancer. Using clinical observables and deep phenotypes of patients with cancer and neurological disorders that are correlated with deep genotyping, especially in microsatellites, MIS researchers hope to discover new diagnostic and prognostic markers, drug targets, and other intervention strategies. The team and their colleagues recently found that longer DNA sequences of a repetitive microsatellite were much more likely to be present in breast cancer patients than healthy volunteers. The particular repeated DNA sequence in the control (promoter) region of the estrogen-related receptor gamma (ERR-γ) gene – AAAG – contains between five and 21 copies. The team found that patients who have more than 13 copies of this repeat have a cancer susceptibility rate that is three times higher than those who do not. The group is now working to translate this biomarker into the clinical setting. Much like the major breast cancer biomarkers BRCA1 and BRCA2, this will be of particular benefit to those high-risk patients with a history of cancer in their family. These results can be used now as a new test for breast cancer susceptibility and, as the data suggests, for colon cancer susceptibility and possibly other types of cancer.

As medicine continues to advance and people live longer, the demand for access to higher quality healthcare is growing more quickly than ever before. This higher level of care would, of course, equate to higher costs. Detecting disease earlier and treating patients more effectively and efficiently can help provide higher quality healthcare at a more reasonable cost. With a focus on using new technologies to allow more opportunities for individualized medical treatment, generating and analyzing new biomedical data, and integrating bioinformatics into medical student training and research experiences, VBI is expanding its research interests to aggressively pursue projects related to human disease. More specifically, the institute has established a new division, Medical Informatics and Systems (MIS) that will help facilitate this expansion and strengthen its partnership with the new Virginia Tech Carilion School of Medicine and Research Institute and provide new opportunities for collaboration with the broader Virginia Tech research community.

The MIS Division works at the interface of medicine, molecular biology, and informatics. Its research focuses on the study of human disease from an "omics" perspective, specifically the analysis, integration, and use of very large data sets, and the analysis of clinical operations to create health information technology (Health IT) solutions.

Research in MIS is inherently transdisciplinary, with research oscillating between the laboratory and informatics analysis, where informatics can inspire a laboratory validation experiment or be used to analyze and interpret large data sets that are generated by laboratory experiments to create new knowledge. This ultimately yields new discoveries and work that can be translated into clinical practice.



VBI'S SCIENTIFIC ACHIEVEMENTS over the past 10 years are the result of dedicated researchers with forward-thinking ideas, using a strong and stable foundation of resources designed to create an environment where scientific discovery and innovation is inspired, encouraged, and nourished. From data generation and analysis to translation of scientific discoveries into marketable applications, the institute provides substantial resources to support all aspects of the research process.

Research Resources

- Core Facilities
- Education and Outreach
- Administration
- Financial Review
- Business Development and Philanthropy


Personality
Don't blink.
You'll miss it.
Bioinformatics Algorithms
Running Blindingly Fast
The World's First Hybrid-Core Computer.
CONVEY

Core Facilities

Scientific discoveries that help enhance our health, food, and security require effective, cutting-edge technologies to generate the data needed to make important findings. As life science technologies continue to advance at lightning speeds, data is being produced more quickly and in higher volumes. This has compromised the scientific discovery process, leaving researchers with large amounts of data and limited options for making use of the information in a meaningful way. This is exactly why VBI developed its Core Facilities – to create a seamless, flexible, and expansive process to transform scientific ideas into tangible results. VBI's Cores work closely with life science customers worldwide to design a results-driven plan of action, while providing access to best-in-class technologies for discovery and analysis.

Offering a cohesive and comprehensive range of services to move biological research projects from conception to publication

Core Laboratory Facility

VBI's Core Laboratory Facility (CLF) is a dedicated multi-user resource for the development and application of state-of-the-art, high-throughput technologies. The CLF offers a wide range of "omic" technology platforms for the study of DNA, RNA, and proteins, and serves as a "one-stop" shop, providing researchers access to these services, as well as an experienced staff.

Available services:

- Genomics
- Second generation sequencing
- Gene expression analysis
- Molecular biology applications
- Custom services

Core Computational Facility

VBI's Core Computational Facility (CCF) has positioned the institute at the forefront of life science-oriented computational capabilities, providing a secure, stable, and manageable infrastructure to support VBI's data-intensive research. The architecture focuses on scalability and flexibility to ensure fulfillment of future computational and data requirements. The goal of the CCF is to enable excellence through proactive technological development and implementation.

Available services:

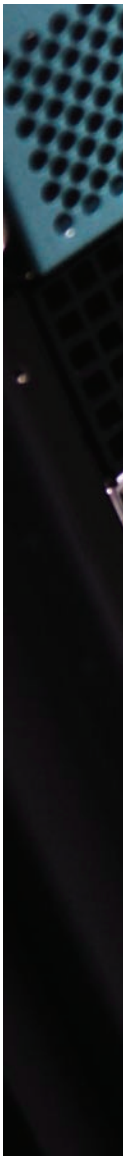
- Server (dedicated and shared/virtual) hosting
- High-performance computing
- Storage and backup
- Database hosting
- Data support
- Enabling services to support research collaborations
- Building and supporting unique systems

Data Analysis Core

VBI's newest addition to its Core Facilities, the Data Analysis Core (DAC), was established to support data analysis and interpretation, helping to accelerate life sciences and biomedical research. The DAC was created to remove data analysis as an obstacle to performing the highly complex and data-intensive experiments required to solve modern problems in life science research. The DAC team includes experienced staff available to provide guidance and support in designing and executing properly powered and controlled experiments.

Available services:

- Experiment design
- Data analysis
- Publications
- Data sharing and hosting
- Quality assurance
- Statistical Analysis



GENERATING DATA THAT IMPROVES OUR WORLD

VBI's Core Laboratory Facility (CLF) has served as an integral part of several high-profile research projects, generating data that is critical for scientific success. For example, the CLF has helped crack the genetic code of the domesticated turkey and the woodland strawberry. The availability of the Roche GS-FLX™ Titanium sequencing technology at VBI allowed researchers to efficiently establish an early draft of the turkey genome and rapidly generate the complete sequence of the woodland strawberry genome. This work provided information that will help improve turkey production (meat yield and quality, health and disease resistance, fertility, and reproduction) and strawberry growth (nutritional value, flavor, flowering time, and response to disease).

PROVIDING THE LATEST TECHNOLOGIES TRANSLATES INTO USEABLE RESULTS FOR RESEARCHERS

VBI's Core Facilities have resources available to bring biomedical researchers, transdisciplinary scientists, and information technologists together to more effectively and efficiently solve a wide range of problems. A critical component of the Core's cyber-infrastructure is the ability to bridge this gap and create solid solutions to the problems posed to the institute. VBI is committed to bringing the latest genomic and computational technologies to the Virginia Tech campus and beyond to help researchers make groundbreaking scientific discoveries.

ANSWERING COMPLEX QUESTIONS ABOUT THE WORLD WITH THE HELP OF HIGH-PERFORMANCE COMPUTING

While making huge advances with next-generation sequencing capabilities, the amount of data being generated is outpacing the ability to turn that data into useable knowledge. Already a computational powerhouse, VBI's Core Computational Facility (CCF) is working with Virginia Tech to develop a new high-performance computing hub for the university. Virginia Tech has a strong history of developing experimental computers that span engineering, computer science, biology, and other life science applications. The CCF is developing supercomputing on-demand services that will cater to the expansion in clinical applications that has accompanied the recent opening of the Virginia Tech Carilion School of Medicine and Research Institute. VBI recently installed Convey Computer Corporation's hybrid-core computing platform to support the institute's work in computationally-intensive areas such as decision and policy informatics and text data mining, as well as its data analysis work for the 1000 Genomes project.

Education and Outreach

Science helps solve the pressing issues citizens face across the globe. It is important that an interest in science is cultivated in younger students, while those studying scientific disciplines now are properly prepared to make the scientific discoveries needed for the future. One of VBI's missions is to encourage future generations to pursue careers in science and prepare students for the changing landscape of science and technology. VBI's Education and Outreach Division develops a variety of programs aimed at preparing current undergraduate and graduate students studying bioinformatics and related disciplines for the world of scientific research, as well as encouraging younger students' interest in science. The team also provides training for science and math teachers at all levels, helping them incorporate bioinformatics concepts into their classroom curriculums.

EXCITING SCIENCE CAN BE INFECTIOUS

The Education and Outreach Division coordinated VBI's involvement in the first USA Science & Engineering Festival in October, when the institute joined more than 350 of the nation's leading science and engineering organizations. VBI engaged festival attendees with an experiment – willing participants were provided wristbands to pass along to others, simulating how a virus or bacteria can spread through casual contact. These contacts were tracked by a computer and used to create a simulation of how infections spread.

- The activity demonstrated how infections spread through a population and how to identify the best ways to stop an epidemic before it even starts.
- Over 2,300 wristbands were distributed during the event, with over 1,000 participants "infected," meaning their wristbands were returned to the VBI exhibit and scanned so they could be tracked.
- A website allowed participants to continue to learn more about the experiment after the event.

ENGAGING CHILDREN ACROSS THE COMMONWEALTH AND BEYOND

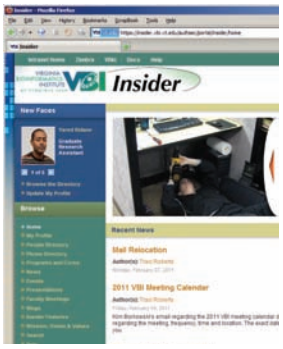
VBI's Kids' Tech University (KTU) program continues to grow, introducing children to the exciting possibilities offered through the science, technology, engineering, and mathematics (STEM) disciplines. Partnering with the Virginia Cooperative Extension's 4-H Youth Development Program, the Education and Outreach Division brings KTU to the Virginia Tech campus four Saturdays over the course of a semester.

- Approximately 450 children between the ages of 9 and 12 participate in the program each semester.
- The program features student-focused sessions with scientific researchers and hands-on activities designed to encourage further exploration of the lecture topics.
- Teacher-training workshops help teachers bring STEM topics to the classroom while providing an opportunity for professional career development.
- KTU offered its first off-campus event at Virginia State University in Richmond, Va., and there are plans for future KTU events at other universities.

Administration

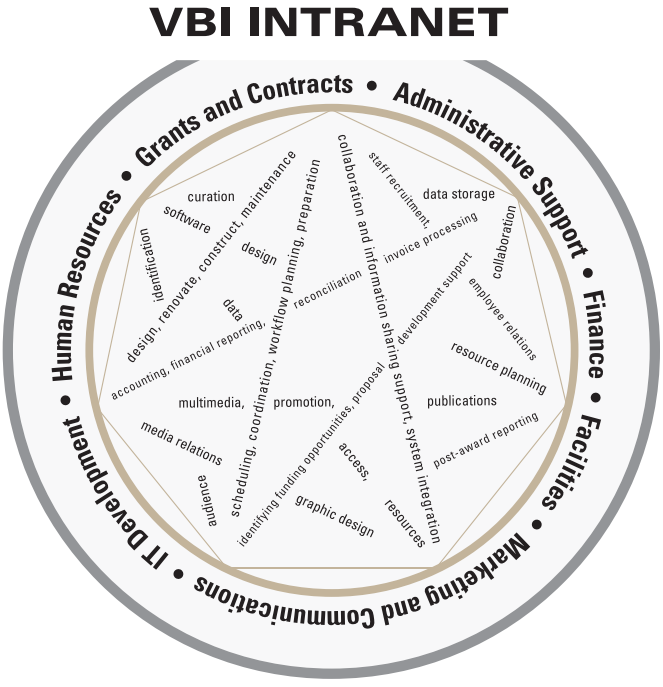
VBI's Administrative Team provides a stable foundation for the entire institute, handling a myriad of functions central to the general operations of VBI. Administrative Team members provide general support to all four research divisions as well as specialized services based on their areas of expertise. For example, the Grants and Contracts Team at VBI not only helps researchers identify funding opportunities and provides both pre- and post-award administration, but also handles the actual electronic (or paper) submission of the proposal. The overreaching goal of VBI's Administrative Team is to keep the institute running smoothly, allowing VBI researchers to focus less of their efforts on administrative duties and more on their science. This leverage is a key success factor for the institute.

CREATING COMMUNITY, FOSTERING INTERNAL COLLABORATION



While the Internet is a system of networks that connects billions of users worldwide, an intranet is a network used within an organization to connect internal users. VBI's IT Development Group has developed an intranet system to facilitate internal communication and collaboration within the institute. VBI's Administrative Team populates the "VBI Insider" with information and tools critical to research and administration-based day-to-day operations, as well as VBI's long-term vision. More importantly, the team is using this tool to create an online space that fosters a sense of community for the institute's faculty and staff. This has become a valuable resource for VBI's community of researchers and enables the administration staff to put important information at researchers' fingertips at the time it's needed. The site includes:

- Internal news items and feature articles, upcoming events, presentations from staff meetings, and blog posts about topics relevant to the institute.
- A profile page for each employee, which features standard contact and office location information and a photograph, as well as space to include information to facilitate collaborations within the institute, such as education and credentials, current and past jobs, expertise, research interests, and publications.



- Forms, instructions, and answers to frequently asked questions related to daily functions, such as requesting a service from an administrative group or coordinating travel arrangements.
- A search function that allows researchers to find collaborators with common interests as well as grant opportunities.

Financial Review

July 1, 2009 - June 30, 2010

In 2010, the Virginia Bioinformatics Institute (VBI) at Virginia Tech celebrated an important milestone – its 10-year anniversary. The past 10 years have been marked by many changes and achievements, driven by successes in securing extramural funding from federal agencies and corporations to support the research programs at the institute.

VBI recorded total active awards of $120.8 million at the end of the 2009-2010 fiscal year, with research expenditures of $15.3 million at fiscal year end. Three federal sponsors support 91% of our extramural research program: the National Institutes of Health (50.1%), the United States Department of Defense (28.1%), and the National Science Foundation (12.8%). Other leading federal agencies and academic institutions represent the balance of our funding. As the institute prepares itself to expand into new research areas, it continues to maintain a sound but diversified funding base.

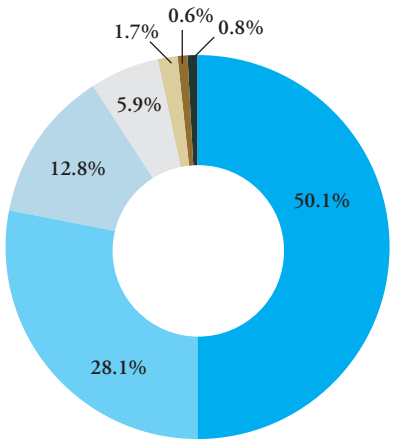
During this period, VBI received the largest single federal award to Virginia Tech. More than $27 million from the National Institutes of Health was granted to the CyberInfrastructure Division to support infectious disease research around the globe. This milestone further confirms the institute's ability to secure financial support for large-scale, transdisciplinary research projects. This approach will deliver significant opportunities for development in the years ahead.

VBI's success is due to the outstanding commitment that has been creatively demonstrated by its researchers and support staff over the past decade. The institute commenced operations with only a handful of employees in 2000 and has since grown to employ 238 highly qualified staff as of June 30, 2010. I would like to take this opportunity to thank all of our researchers and administrative and support staff for their achievements over the past 10 years of VBI's history.

Now, with a solid record of success behind us, we can plan for a future devoted to exploring new regions of biomedical and life sciences research by providing our scientists with administrative services and research resources to underpin our future.

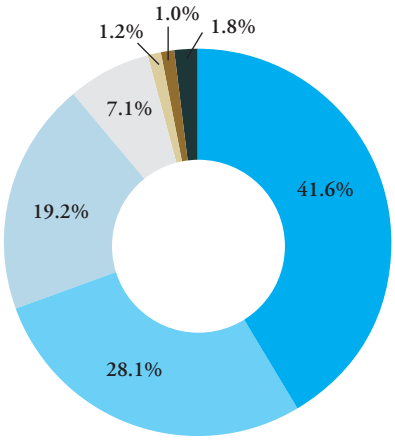
Lauren Coble
Chief Operating Officer

Active Awards by Sponsor



	(IN DOLLARS)
National Institutes of Health	$ 60,460,287
United States Department of Defense	33,998,548
National Science Foundation	15,441,151
United States Department of Agriculture	7,115,660
United States Department of Energy	2,006,919
National Aeronautics and Space Administration	741,167
Other sponsors	991,549
Total active awards	$ 120,755,281

Extramural Research Expenses by Sponsor



	(IN DOLLARS)
National Institutes of Health	$ 6,343,072
United States Department of Defense	4,300,033
National Science Foundation	2,923,467
United States Department of Agriculture	1,088,250
National Aeronautics & Space Administration	182,489
United States Department of Energy	147,187
Other sponsors	280,918
Total extramural expenses	$ 15,265,416

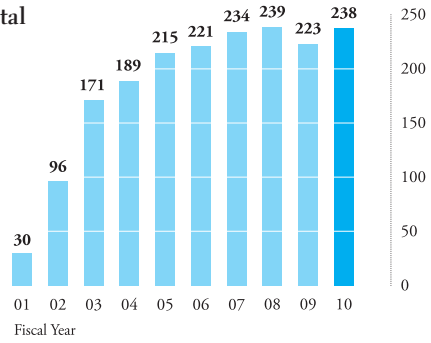
Financial Operating Activity

(FOR THE YEAR ENDED JUNE 30, 2010 & 2009)

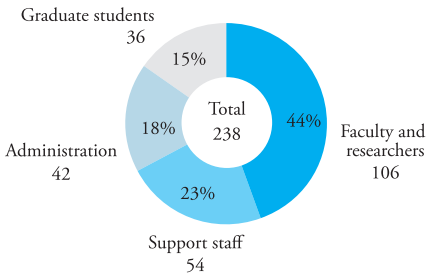
REVENUES	2010	2009
Grants and Contracts		
National Institutes of Health	$ 6,516,604	$ 6,536,043
United States Department of Defense	5,052,715	6,551,164
National Science Foundation	2,806,280	2,179,743
United States Department of Agriculture	1,109,537	1,701,635
United States Department of Energy	74,356	227,559
National Aeronautics & Space Administration	180,144	103,851
Industry	310,800	105,172
Foundations	77,089	59,276
Total grants and contracts	16,127,525	17,464,443
Commonwealth and university sources	2,955,261	3,218,143
Total operating revenue	19,082,786	20,682,586
EXPENSES		
Personnel Expenses	16,041,269	17,588,557
Operating Expenses		
Contractual services	307,978	381,602
Information technology	136,488	447,486
Travel and other	463,655	566,188
Supplies and vaterials	1,372,842	1,353,053
Building and other rentals	771,271	806,627
Subcontracts	1,702,070	1,791,789
Equipment	1,473,588	762,747
Total operating expenses	6,227,892	6,109,492
Indirect expenses	4,255,547	4,612,997
Total expenses	26,524,708	28,311,046
Non-Operating Sources		
University support	8,096,859	7,376,859
One time resource	1,200,000	300,000
One time budget reduction and raise reversions	(147,537)	(116,183)
Commonwealth Research Initiative	100,702	150,000
Total non-operating sources	9,250,024	7,710,676
Gain/(Loss) in Net Assets	$ 1,808,102	$ 82,216

Our People

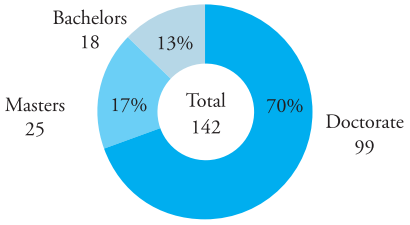
Total



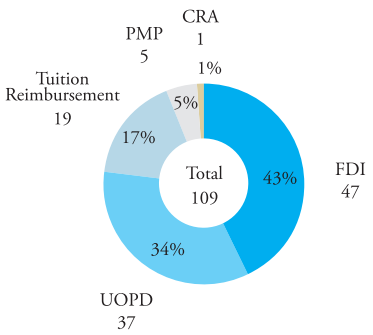
Composition



Graduate & Faculty



Professional Development



FDI - Faculty Development Institute
UOPD - University Organizational and Professional Development
PMP - Project Management Professional
CRA - Certified Research Administrator

Business Development and Philanthropy

Organizations must look to the future to ensure a strong position in an ever-changing world. This is of particular importance for scientific research. New discoveries cannot make substantial, real-world impacts if the process ends within the pages of a lab notebook or journal publication, which is why VBI encourages the development of new technologies, discoveries, and intellectual property that have commercial value and will benefit future research. Many VBI researchers have scientific findings with tremendous value that have yet to be realized, as well as a strong desire to share their discoveries to help improve lives all over the world.

The institute's goal is to establish productive and mutually beneficial relationships with businesses and other organizations to help move research advances from the laboratory and hard drive to the marketplace. VBI is committed to advancing discovery and innovation in the life science and biomedical research areas for many years to come and is looking for industry partners to join them as they move forward.

STRENGTHENING TIES WITH THE CORPORATE WORLD

Stan Hefta, Ph.D., serves as VBI's director of strategic business development and planning. With over 25 years of experience as a research leader and strategic planner in academia and the pharmaceutical and consulting industries, he works to create strong, productive relationships between VBI and companies interested in being a part of the institute's forward-looking vision. His experience includes directing basic and applied research at a global biopharmaceutical company; consulting for the biotechnology industry; developing and overseeing research with federal, corporate, and philanthropic funding; and working with venture capital firms to evaluate early-stage technologies. He has led product development and commercialization teams, served on various industrial scientific advisory boards, advised senior management of multinational corporations on strategic opportunities, negotiated licensing and contract agreements, and represented industrial and academic concerns on national and international regulatory committees.

... to bridge the gap between industry and academia

INDUSTRIAL AFFILIATES PROGRAM

VBI created its Industrial Affiliates Program to bridge the gap between industry and university research. The program is designed to facilitate strong cooperative relationships and partnerships, as well as research and information exchange opportunities, with industry. As a leader in transdisciplinary life sciences and biomedical research and education, creating partnerships with industry helps the institute strengthen its commitment to making transformative discoveries, solving important problems, developing the next generation of transdisciplinary researchers, influencing public policy, and transitioning scientific research into use. The financial assistance provided by industry partners will help support and advance the discoveries being made at VBI. The program offers companies two levels of sponsorship to support VBI research – Platinum and Gold Partner Membership. These opportunities provide partners a variety of benefits, such as serving on the institute's Research Advisory Panel, early licensing access to research information, and the option to earmark up to 80 percent of their contribution to support a graduate student fellowship.

Message from the Director
Virginia Bioinformatics Institute at Virginia Tech

Join us as we improve lives across the globe

The world in which we currently live depends on scientific research to provide real solutions to improve our quality of life. Making "quantum leap," high-impact, meaningful advances in health and medicine, agriculture, and our nation's security, as well as developing new biological-based products, requires an advanced research environment with sophisticated and innovative technologies. The systems that make up life are so complex that before real scientific progress can be made, data must be generated on a massive scale and analyzed by experts using cutting-edge computational methods. This calls for a new type of research institute. VBI is that place.

Simply put, VBI is the premier bioinformatics institute in the world. This report will show you why. We're heading into our second decade at full speed, building upon our established focus areas by launching several new highly interactive endeavors – Medical Informatics, Disease Genomics, High-Performance Computing, and Entrepreneurship. Working with collaborators and partners inside and outside Virginia Tech, we will make discoveries that transform the world.

Government support provided by grant funding cannot do it alone. Only external support will allow us to embark on high-risk, high-payoff research that will create the next new drug, medical diagnostic, resistive crop, or even the next Google. To have real impact, the research must be followed by commercialization. Investment and engagement is needed to form new companies, which will house new employees to make the new products that are emerging from our science. With your help, there will be no limit to the advances we can make in critical research areas that will touch our lives and those of people around the world. If you would like to learn more about how your private gift or expertise can help advance the groundbreaking research at VBI, please contact me at (540) 231-2582 or garner@vbi.vt.edu.

Sincerely,

Harold "Skip" Garner
Executive Director
Virginia Bioinformatics Institute at Virginia Tech.

VIRGINIA TECH
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THE VIRGINIA BIOINFORMATICS INSTITUTE (VBI) AT VIRGINIA TECH is a premier bioinformatics, computational biology, and systems biology research facility that uses transdisciplinary approaches to science combining information technology, biology, and medicine. These approaches are used to interpret and apply vast amounts of biological data generated from basic research to some of today's key challenges in the biomedical, environmental, and agricultural sciences. With more than 240 highly trained multidisciplinary, international personnel, research at the institute involves collaboration in diverse disciplines such as mathematics, computer science, biology, plant pathology, biochemistry, systems biology, statistics, economics, synthetic biology, and medicine. The large amounts of data generated by this approach are analyzed and interpreted to create new knowledge that is disseminated to the world's scientific, governmental, and wider communities.

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