University of Virginia

Report on the Use of the Commonwealth Research Initiative Funds

Legislative Provision

The University of Virginia shall report on the use of these funds and the progress made under this initiative to the Chairman of the House Appropriations and Senate Finance Committees by October 1, 2007. The report shall include, but not be limited to: 1) how the funds were used, 2) the amount of federal and private funds that were leveraged, 3) collaborative efforts in support of private industry, 4) the number of junior and senior faculty recruited in each field, 5) the amount of federal or other grant funds received as the result of those recruitments, 6) additional grants or contracts being pursued, 7) the level of instructional activity conducted by these faculty, 8) the impact of research activities on undergraduate instruction, 9) the use of graduate student aid funds, and 10) recommendations for future investment.

Overview

The Commonwealth Research Initiative Funds have provided critical, foundational support for research activities at the University of Virginia. As a result of the state's investment of $19.3 million ($11.45 million GF and $7.85 million ETF), the University has received $52.6 million in external federal and private funds (excluding any pending funding), representing a return of 272%. Collectively, these funds have substantially increased the institution's research capacity by providing for the recruitment of distinguished faculty, the acquisition of research equipment, and advances in research strategic priorities, such as morphogenesis and regenerative medicine. Investments in higher education research contribute to the educational experience of students, promote economic growth, and benefit the citizens throughout Virginia and the world at-large. The University is grateful for the past state appropriations and requests that the state make continued investments in research for further advancement.

(1) How the funds were used

The University of Virginia used these funds to recruit distinguished science, medicine, and engineering faculty members in strategic priority fields and to acquire equipment for building research capacity. Our internal strategic plans and the current Virginia Research and Technology Advisory Commission (VRTAC) research priority plan consistently identify morphogenesis and regenerative medicine; computer science and technology; advanced materials; and sustainability and environmental science as top opportunities for research excellence and economic development. In morphogenesis and regenerative medicine, for example, the University has made significant investments to accelerate pioneering basic research in the processes by which cells develop into tissues and organs and translational research in diagnostics, drugs, and therapies for correcting and repairing problems in cell development, such as birth defects, cancer, kidney failure, and musculoskeletal dysfunction. With state funds, we have capitalized on opportunities to add important niche capacity in regenerative medicine—and other fields as well.

A. Faculty recruiting: We recruited 11 faculty members (9 senior, 2 junior) in biology, cell biology, chemistry, electrical and computer engineering, environmental science, molecular physiology and biological physics, psychology, and public health genomics.

Six of these new faculty members are part of the University's $150 million Board of Visitors Distinguished Science and Engineering Faculty Recruitment Program that also includes

construction of two new research buildings. State funds, including ETF funds, were used to complete recruitment packages:

- Joe Campbell, Electrical and Computer Engineering (from University of Texas-Austin)
  Dr. Campbell is a member of the National Academy of Engineering and an expert in integrated optics. He previously worked in private industry for Texas Instruments and AT&T Bell, where he conducted research on a variety of optoelectronic devices, including semiconductor lasers, optical modulators, waveguide switches, photonic integrated circuits, and photodetectors. He supervises large post-doc and student groups. His research crosses several department and school boundaries and typically involves industry collaboration and support; he already has received new research awards from industrial and federal sponsors.

- Steve Rich, Center for Public Health Genomics (from Wake Forest University).
  Dr. Rich is a highly distinguished investigator, with a long record of scientific productivity and demonstrated skills as both a program-builder and academic leader in the field of human genomics. He has authored or co-authored twenty book chapters and over 200 peer-reviewed scientific articles. His highest impact work has appeared in *The New England Journal of Medicine* (3 articles), *Nature*, and *Nature Genetics*. These articles alone have been cited over 1,300 times by colleagues. He ranks as one of the top NIH investigators in total dollars awarded and has an impressive track record of large multi-investigator projects.

- John Yates, Chemistry (from University of Pittsburgh)
  Dr. Yates is recognized as one of the top surface chemists in the world and is a member of National Academy of Sciences. He teaches a large undergraduate course, Chemistry for Engineers, from a textbook he created. He moved his surface science research activity to UVA and in addition is developing new research programs in astrochemistry. He already has received new sponsored research awards since moving to UVA.

- Mark Yeager (MD/PhD), Molecular Physiology (from the Scripps Research Institute)
  Dr. Yeager is a leading physician/scientist, with an MD/PhD from Yale and cardiology residency, fellowship, and postdoc at Stanford. He is a cardiologist in the clinic one day a week and at the same time a cell biologist doing research on the structural biology of membrane proteins, a specialty of considerable strength at UVA. Dr. Yeager uses electron microscopy, which complements our other investigators, and publishes results in top journals. He is internationally recognized for work on gap junction channels and virus structures. At Scripps he was the lead scientist-administrator in catalyzing translational research; he plans the same for the University of Virginia.

- Bernard and Christine Thisse, Cell Biology (from the Institute of Genetic, Molecular, and Cell Biology, France)
  The Thisses are outstanding developmental biologists and geneticists from the Institute of Genetics and Molecular and Cellular Biology (IGBMC) in Strasburg, France who pioneered analysis of the genome of the zebrafish, an important animal model for understanding cell and organ development. The Thisses bring a very special range of talents and expertise that does not exist at UVA. The zebrafish has become one of the leading organisms for modern biological research, especially in morphogenesis, organogenesis, and vertebrate genetics. As one of the leading zebrafish groups in the world, they bring instant recognition to UVA in zebrafish genomics and informatics.

Campbell, Rich, Yeager and Yates (Campbell and Yates are National Academy members) have relocated their research groups and laboratories to the University and bring over **$40.8 million** in new and continuing research funding. The Thisses, who arrived during the summer, only recently completed relocation and are in the process of transferring research projects and preparing new proposals. For senior faculty members such as these, related recruitments quickly follow: in FY 08 Rich will recruit 8 new faculty members, and Yeager will bring 6 faculty members from the Scripps Institute. Campbell already has recruited a distinguished African-American junior faculty member to his research group.

Two other senior faculty recruits, Edmond Brodie III in biology and Manuel Lerdau in environmental science, constitute a new generation of leadership for the University's field research stations at Mountain Lake and Blandy Farm that provide significant research and education programs for Virginia higher education and K-12 programming.

B. Equipment: In addition to equipment for faculty recruiting, we used state funds to build research capacity for top groups in astronomy, chemistry, and physics. In astronomy, for example, faculty members used new equipment to construct state-of-the-art instrumentation for the Large Binocular Telescope, a multi-institution facility under construction in Arizona (when complete, it will be the largest aperture optical telescope in the world). In chemistry, faculty members used new equipment to develop lasers with significant potential for military use (in detecting explosives in Iraq) and chemical engineering processes (catalysts for higher efficiency fuel use and alternative energy development). In most of these cases, state funding for research equipment is used as part of federal agency research proposals, so state funding immediately translates into additional financial support.

C. Research Projects: We also used state funds to seed three top priority research projects in morphogenesis and regenerative medicine. These projects will enable three UVA units that conduct research in regenerative medicine to work more closely together and accelerate translational research: the Morphogenesis and Regenerative Medicine Institute (a multi-disciplinary research unit); the Department of Orthopedics (a clinical department in the School of Medicine); and the Department of Biomedical Engineering (a joint department in the School of Medicine and the School of Engineering and Applied Science):

- *Morphogenesis and Regenerative Medicine Institute*: "Adhesion-Mediated Mechanotransduction in Morphogenesis," $500,000. Martin Schwartz (Microbiology, SOM), Doug DeSimone (Cell Biology, SOM), with collaborators from Biomedical Engineering and the College. This project will advance our understanding of the mechanical or physical forces that underlie the control of cell shape, cell polarity, motility, and gene expression. Recent breakthroughs by Schwartz will enable this group to create and measure molecular forces in living cells. The role of mechanical or physical forces in cellular processes is an important open question in the basic science of cell development and will play an important role in tissue engineering and regenerative medicine.

- *Department of Orthopedics, School of Medicine*: "Musculoskeletal Regeneration and Tissue Engineering," $300,000. Cato Laurencin, MD/PHD (Department Chair). This project will support a series of interlocking projects on novel biomaterial synthesis, scaffold engineering and fabrication, cartilage tissue regeneration, bone tissue regeneration, drug delivery, and new treatments for fracture repair. Preliminary data

from these projects already has led to a $2.0 million NSF research center grant (one of 12 funded from 250 proposals) on musculosketal regeneration.

- *Department of Biomedical Engineering, School of Medicine-School of Engineering and Applied Science:* "Translational Biomedical Engineering Research," $1 million. Tom Skalak (Department Chair). State funds will support computational and experimental research projects by four newly recruited senior and junior faculty members: mechanics of cardiac scarring after heart attack; low-cost medical imaging systems; systems bioengineering of a cure for malignant glioblastoma (the most deadly form of brain cancer); tools for relieving middle ear inflammation in children (the most common childhood ailment requiring surgery); and tissue engineering the growth of new blood vessels in skull fractures.

(2) Amount of federal and private funds that were leveraged

A. Faculty recruiting (faculty member, leveraged funds, and pending funding where known)

- Joe Campbell, Electrical and Computer Engineering: FY06: $1,244,679 FY07: $990,852 (and pending NSF grants)
- Stephen Rich, Public Health Genomics: FY07: $35,789,966
- John Yates, Chemistry: FY07: $986,000 (and pending NSF grant)
- Mark Yeager, Molecular Physiology: $1,200,000 (NIH grants transferring from Scripps)
- Bernard and Christine Thisse, Cell Biology: TBD (French grants do not transfer; pending NIH grants)
- Edmund Brodie III, Biology: FY08: $250,000 (and pending NSF grants)
- Manuel Lerdau, Environmental Sciences: TBD (pending $2.9 million NSF grants, including GK-12 outreach)
- Stephan De Wekker, Environmental Sciences: TBD (pending $546,000 NSF grants)
- Steve Boker, Psychology: FY07 $215,961 (and pending: $1.1 million NIH grant)

TABLE 1: **State Support for UVA Faculty Recruitment and Funding Leveraged**

		Awarded & Pending Funding			Leveraged Funds		
Faculty Member	Discipline	Federal Funding	Private Funding	Total	State ETF	State Investment	Total
Joe Campbell	Electrical and Computer	$ 1,244,679	$ 990,852	$ 2,235,531	$ 1,732,600	$ -	$ 1,732,600
		+ pending NSF grants					
Archie Holmes	Electrical and	$ 159,038	$ -	$ 159,038	$ -	$ -	$ -
Stephen Rich	Public Health	$ 35,789,966	$ -	$ 35,789,966	$ 2,000,000	$ 3,350,000	$ 5,350,000
John Yates	Chemistry	$ 765,000	$ 221,000	$ 986,000	$ -	$ 60,000	$ 60,000
		+ pending NSF grants					
Mark Yeager	Molecular Physiology	$ 1,200,000	$ -	$ 1,200,000	$ -	$ 1,186,817	$ 1,186,817
		+ NIH grants transferring from Scripps					
Bernard & Christine Thisse	Cell Biology	TBD, French grants do not transfer, pending NIH grants			$ -	$ 4,480,683	$ 4,480,683
Edmund Brodie	Biology	$ 250,000	$ -	$ 250,000	$ 158,000	$ -	$ 158,000
		+ pending NSF grants					
Manuel Lerdau	Environmental Sciences	TBD, $2.9M pending NSF grants, including GK-12 outreach			$ 60,000	$ -	$ 60,000
Stephan De Wekker	Environmental Sciences	TBD, $546K pending NSF grants			$ 80,000	$ -	$ 80,000
Steve Boker	Psychology	$ 215,961	$ -	$ 215,961	$ 80,000	$ -	$ 80,000
		+ pending $1.1M NIH grants					
Total		$ 39,624,644	$ 1,211,852	$ 40,836,496	$ 4,110,600	$ 9,077,500	$ 13,188,100

Total funds awarded due to faculty recruitment: $40.83 million
*$572,500 of state general funds remain unallocated pending budget reductions

B. Equipment (used to leverage federal and private funds)

- Astronomy: $315,000 for $740,000 NSF funds (also part of UVA commitment to Large Binocular Telescope)
- Chemistry: $285,000 for $693,000 ($590,000 from NSF; $103,000 from SAIC; plus $1.3 million pending proposal to NSF)
- Physics: $340,000 for $4,970,000 ($3.75 million from NSF; $1.22 million from industry, plus pending NSF proposals)
- Environmental Sciences: $200,000 (in non-recruiting equipment funds) for $38,350 in private and NSF funds; plus pending NSF proposals
- College/School of Medicine: $600,000 for $2,000,000 (800 Mhz NMR NIH equipment grant). This equipment supports 8 researchers and dramatically enhances our ability to analyze large protein systems and low protein concentrations. There is no such instrument in the state of Virginia.
- School of Medicine: $2,000,000 to support equipment purchases for the new Carter-Harrison biomedical research building. The new 200,000 gross square foot, $97.4 million research facility will house cancer, immunology, and infectious disease researchers who are expected to bring in millions of dollars in research.

Total funds awarded from equipment: $8.44 million

C. Research Projects

Department of Biomedical Engineering, School of Medicine-School of Engineering and Applied Science (T. Skalak) research now in progress, already led to $250,000 from Eli Lilly; $200,000 from other companies; $600,000 NSF grant, for $1,050,000 (plus pending grants to NSF for $20 million and NIH for $15 million).

Department of Orthopedics, School of Medicine (C. Laurencin): Musculoskeletal Regeneration and Tissue Engineering research now in progress, already led to $2 million NSF Emerging Frontiers in Research and Innovation grant and $250,000 Army grant, for $2,250,000.

*Morphogenesis and Regenerative Medicine Institute (DeSimone/Schwartz). This r*esearch is in progress; there are no directly related external awards to date.

Total funds awarded from research projects: $3.35 million

TABLE 2: State Support for UVA Research Projects/Departments and Funding Leveraged

Project Seed Funding Projects/Departments	Awarded & Pending Funding			Leveraged Funds		
	Federal Funding	Private Funding	Total	State ETF	State Investment	Total
Department of Biomedical Engineering, School of Medicine-School of Engineering and Applied Sciences (Tom Skalak)	$ 650,000	$ 450,000	$ 1,100,000	$ -	$ 1,000,000	$ 1,000,000
Department of Orthopedics, School of Medicine (Cato Laurencin)	$ 2,250,000	$ -	$ 2,250,000	$ -	$ 300,000	$ 300,000
Morphogenesis and Regenerative Medicine Institute (DeSimone/Schwartz)	TBD	$ -	$ -	$ -	$ 500,000	$ 500,000
Total	$ 2,900,000	$ 450,000	$ 3,350,000	$ -	$ 1,800,000	$ 1,800,000
Astronomy	$ 740,000	$ -	$ 740,000	$ 315,000	$ -	$ 315,000
Chemistry	$ 590,000	$ 103,000	$ 693,000	$ 285,000	$ -	$ 285,000
Physics	$ 3,750,000	$ 1,220,000	$ 4,970,000	$ 340,000	$ -	$ 340,000
Environmental Science	$ 38,350	$ -	$ 38,350	$ 200,000	$ -	$ 200,000
SOM/College NMR	$ 2,000,000	$ -	$ 2,000,000	$ 600,000	$ -	$ 600,000
New Carter-Harrison Research	TBD	$ -	$ -	$ 2,000,000	$ -	$ 2,000,000
Total	$ 7,118,350	$ 1,323,000	$ 8,441,350	$ 3,740,000	$ -	$ 3,740,000

Total funds awarded due to projects and department funding: $11.79 million

**** TOTAL FUNDS AWARDED DUE TO STATE SUPPORT: $52.62 million**

(3) Collaborative efforts in support of private industry

- The Skalak Biomedical Engineering research project used state funds to leverage private industry contributions ($450,000) and establish a framework for collaboration.

- Chemistry faculty members used state equipment funds to secure support from SAIC ($103,000) to develop detectors for explosives with near-term applications in Iraq; these collaborations may lead to others using additional state-of-the-art chemistry equipment.

- Physics faculty members used state equipment funds to further collaborative advanced materials research with Boeing (DARPA grant for space applications, $820,000) and GE (ONR grant for power systems, $400,000). The Boeing-UVa collaborative project is funded by DARPA/AFOSR for light structural amorphous metals for space applications. The GE-UVa collaborative project is funded by ONR for nanostructured soft magnetic materials for power systems.

(4) Number of senior and junior faculty members recruited in each field

A. Electrical and Computer Engineering (2): Joe Campbell (senior; who in turn recruited one junior faculty member, Archie Holmes)

B. Public Health Genomics (1): Steve Rich (senior; who will recruit 8 new faculty members in FY08)

C. Biology (1): Edmund Brodie III (senior)

D. Cell Biology (2): Bernard Thisse, Christine Thisse (senior)

E. Chemistry (1): John Yates (senior)

F. Environmental Sciences: (2) Stephan DeWekker (junior), Manuel Lerdau (senior)

G. Molecular Physiology and Biological Physics (1): Mark Yeager (senior; who will bring 6 new faculty members from Scripps Institute in FY08)

H. Psychology (1): Steve Boker (senior)

Total: 9 senior; 2 junior (by end of FY08, these 11 recruits will leverage to 26 new faculty members)

(5) Amount of federal or other grants received as the result of these recruitments

See Table 1 above.

(6) Additional contracts or grants being pursued

Over $40.8 million in pending NIH and NSF grants

- Manuel Lerdau, Environmental Sciences: pending $2.9 million NSF grants, including GK-12 outreach
- Stephan De Wekker, Environmental Sciences: pending $546,000 NSF grants)
- Steve Boker, Psychology: pending $1.1 million NIH grant
- Chemistry: pending $1.3 million proposal to NSF)
- Department of Biomedical Engineering: pending grants to NSF for $20 million and NIH for $15 million

(7) Level of instructional activity conducted by these faculty members

UVA School of Medicine faculty members instruct post-docs and graduate students through laboratory groups and occasionally include undergraduate students in their laboratory groups. As active investigators Rich, Yeager, and the Thisses will supervise post-doc and graduate student research.

Joe Campbell teaches graduate student courses and supervises graduate student research in the School of Engineering and Applied Science.

Professors Brodie, DeWekker, Lerdau, Yates, and Boker teach graduate and undergraduate courses in the College of Arts and Sciences, including large introductory courses.

** SEE APPENDIX A for list of fall 2007 courses taught by current recruits

(8) Impact of research activities on undergraduate instruction

Research activities in the College of Arts and Sciences and School of Engineering and Applied Science have a very significant impact on undergraduate instruction.

The College field stations, Mountain Lake (Biology) and Blandy Farm (Environmental Sciences), support student field projects and outreach for UVA and the Commonwealth.

A. The Mountain Lake Biological Station is a field research and teaching facility located in the deciduous hardwood forest of the Appalachian Mountains of southwestern Virginia. It provides a wide array of natural environments for research as well as two modern laboratories. Scientists from UVA and other universities study plant and animal population biology, behavioral ecology, life history evolution, community ecology, ecological genetics, biosystematics, epidemiology, conservation biology, and the physiology of behavior.

   Mountain Lake Biological Station's Research Experiences for Undergraduates (REU) program is sponsored by the National Science Foundation and brings undergraduate students together for a program of guided, but independent, original research in field biology. Student researchers work closely with researcher mentors in compatible fields of interest. Students take leadership roles in all aspects of the study; they design the study and prepare the proposal, collect data and perform analysis, and finally they interpret the results and prepare a written and oral presentation. Many projects are submitted for publication in leading biological journals. Students also participate in a weekly seminar

about the conduct of biological research. REU participants have access to state-of-the-art facilities and are granted full use of all Station scientific and computer equipment.

B. Blandy Experimental Farm is a 700-acre research facility situated in the northern Shenandoah Valley, about 10 miles east of Winchester and 60 miles west of Washington, D.C. Blandy Experimental Farm is also the home of the State Arboretum of Virginia, with more than 8,000 trees and woody shrubs. The collections include more than half the world's pine species, the Virginia Native Plant Trail, the Boxwood Memorial Garden, a spectacular grove of more than 300 ginkgo trees, an herb garden featuring culinary, medicinal and ornamental herbs, and much more. The mission of Blandy Experimental Farm is to increase understanding of the natural environment through research and education on plants, plant biology, ecology, evolution, the environmental sciences, and the manner in which all of these are used and affected by humans.

Undergraduate education is one of the highest priorities in the Blandy Farm mission. Since 1992 Blandy has provided Undergraduate Research Fellowships to students in ecology and environmental science with funding from the National Science Foundation Research Experience for Undergraduates (REU) program. The primary goal is to teach students to formulate testable hypotheses about important ecological and evolutionary questions. The format of the program encourages students to develop skills in experimental design, data collection, analysis, and critical reading of primary scientific literature. Students also learn to prepare and communicate scientific information to other scientists and the general public. Research activity increases during the summer when Blandy provides opportunities for 20-25 undergraduate, graduate, and post-doctoral researchers to conduct ecological research while in residence.

In addition, projects supported by equipment acquisition, such as the Shenandoah Watershed Study, involve students who learn field and laboratory techniques for investigating the role of acid rain and other landscape processes, such as non-point pollution. In Chemistry and Physics, research with new equipment will enable student participation, including independent student research projects, and strengthen undergraduate student instruction in the sciences.

(9) Use of graduate student aid funds

We used an annual allocation of $1.6 million for graduate student aid. Graduate students engaged in scholarly research support the research mission of the University by helping to drive the process of discovery, gathering preliminary data for research proposals, producing new knowledge that is published in archival journals, and mentoring undergraduates who participate in research projects, thereby imparting the skills and encouragement necessary for future graduate study. In 2006-07, we supported some 325 graduate students in four of the University's graduate schools.

The graduate aid funds allocated by the Commonwealth were used to create competitive recruitment and retention programs. The primary goal of these programs is to enhance the University's ability to attract the highest quality graduate students and to recognize research excellence among currently enrolled graduate students. At the same time, the aim of the program is to address projected workforce needs for highly skilled labor. Table 1 represents a summary of the programs developed with the new funds.

TABLE 3: Graduate Programs supported by Commonwealth allocation of $1.6 million

School and/orUnit	Annual Allocation	Purpose(s)
Graduate School of Arts & Sciences	$640,000	(1) To raise stipends associated with the President's Fellowship to $18,000 per year; (2) to extend the term of the President's Fellowship to four years.
School of Engineering & Applied Science	$450,000	To create first-year fellowships for recruiting outstanding Ph.D. applicants in engineering.
School of Medicine (biomedical sciences)	$180,000	(1) To create first-year fellowships for recruiting outstanding Ph.D. applicants in the biomedical sciences; (2) to provide merit fellowship supplements to outstanding students in the biomedical sciences.
School of Architecture	$130,000	(1) To create full-tuition fellowships for recruiting outstanding graduate applicants in architecture; (2) to create graduate assistantships, inclusive of tuition and fees, tuition differential, stipend, and healthcare subsidy.
Office of the Vice President for Research & Graduate Studies	$200,000	To encourage and reward students who successfully compete for prestigious external fellowships by leveraging such awards with state funds to make them more attractive to high-quality graduate students.
Total	**$1,600,000**	

Source: Office of the Vice President for Research & Graduate Studies

The programs implemented by the School of Medicine and the Office of the Vice President for Research and Graduate Studies (VPRGS) focused on attracting students supported by, or with future potential to be supported by, prestigious federal and private fellowships. Many such fellowships provide stipends and some level of tuition assistance. However, they often do not cover the entirety of tuition, fees, and/or health insurance subsidy. Such fellowships are portable and allow students to attend the institution of their choice. In such cases, additional funding is needed to attract, and provide full support to, such promising students.

In addition to attracting the most highly qualified graduate students, such funds also encourage currently enrolled graduate students to compete for the most prestigious national awards. As a result of a similar program, implemented by the School of Nursing, using newly allocated state funds from 2005, UVA has received more NIH National Research Services Awards (NIH-NRSA) than any other institution in the United States. The associate dean for graduate student services notes, "the supplemental awards have encouraged more nursing Ph.D. students to submit NRSA (F31) individual grants. Successful NRSA recipients are now able to receive the NIH-supplied fellowship plus the extra enhancement award. This makes undergoing the federal grant application process much more enticing."

Programs implemented by the School of Medicine and the Office of the Vice President for Research and Graduate Studies (VPRGS) leveraged state funds by providing supplemental aid to students supported by, among others, the following fellowships:

> The American Heart Association; Department of Defense – Congressionally Directed Medical Research Programs; Department of Homeland Security Fellows Program; Federal Highway Administration Eisenhower Transportation Fellowship; Jacob K. Javits Fellowship (Department of Education); National Defense Science and Engineering Graduate Fellowship; National Institutes of

Health – National Research Service Award; National Aeronautics and Space Administration – Graduate Research Scientists Program; National Science Foundation – Graduate Research Fellowship Program; and NIH training grants focusing on biotechnology, cell and molecular biology, cardiovascular medicine, informatics, medical scientist training, neuroscience, and pharmacology.

Two additional programs created or expanded upon competitive fellowship programs aimed at attracting the highest quality graduate students. The School of Engineering and Applied Science (SEAS) created the Commonwealth Fellowship, a first-year fellowship providing full tuition, health insurance, and competitive stipend support. The Graduate School of Arts and Sciences (GSAS) enhanced the President's Fellowship, the most prestigious University fellowship, by increasing the annual stipend to $18,000 and the duration of the fellowship to four years.

These graduate aid funds also have brought high-quality instruction to undergraduates. As part of their award, many students participating in the programs implemented by GSAS and SEAS engage in teaching responsibilities. Graduate teaching assistants (GTAs) enhance the undergraduate experience by leading introductory language and service courses, providing small discussion sections to complement large lecture courses, and allowing for hands-on laboratory courses. They assist faculty in creating intimate learning communities, characterized by high-quality instruction, which remains the hallmark of a positive undergraduate experience. Without such instructional assistance, faculty would be hard-pressed to provide the individualized attention expected by today's undergraduates.

(10) Recommendations for future investment

The University of Virginia actively participates in VRTAC and supports the VRTAC research initiatives outlined in the report *Collaborative Research and Development Strategies and Directions for the Commonwealth of Virginia (March 2007).* In this report, VRTAC calls for $45 million per year for 5 years to be matched with $15 million per year from university and external funding for collaborative projects. The availability of state funding is essential to leveraging external funding. The combined funding allows us to bring the very best talent in science, medicine, and engineering to Virginia. With increased competition for federal funding, it also is important for Virginia research universities to establish strategic priorities for research excellence. Our requests for state funds—and our successful leveraging of state funds—have been based on strategic priorities that involve both basic and translational research, aligning with the state's VRTAC research initiatives.

Over the next ten years the University plans to hire approximately 150 new faculty members in science, medicine, and engineering as part of our strategic planning process (*UVA Ten Year Academic Plan* [2006]; *Commission on the Future of the University* [2007]). To sustain our research excellence and external research funding a significant fraction of these new faculty members must be comparable to the 11 new faculty members that we have recruited with our state funds. To continue to recruit faculty members such as these, we will need special resources, as well as the strong expression of state support for research excellence.

Our use of state funds to enhance strategic research priorities demonstrates that, with good alignment between the state and its research universities and with competitive financial resources, we can attract world-class intellectual capital to Virginia.

A sustained focus on priorities that will enhance research excellence and the economic and quality-of-life benefits associated with translational research will produce lasting benefits to the University and beyond, to all corners of the Commonwealth. Therefore, we recommend the state research initiative funding be included in an ongoing budget so the results reported above can be sustained and the Commonwealth's research competitiveness maintained and enhanced.

APPENDIX A

Commonwealth Research Initiative Funds -
Recruited Faculty Fall 2007 Teaching Courses

Joe Campbell
- Optics and Lasers (ECE 541)

Archie Holmes
- Introductory Circuit Analysis (ECE 203)
- Intro Circuit Analysis Lab (ECE 203)
  - Lab 900 CW
  - Lab 900 NX
  - Lab 900 P6
  - Lab 900 RQ
  - Lab 900 SH
  - Lab 900 U2

Edmund Brodie
- Microevolution (BIOL 873)
- Research: evolution (BIOL 915)

Stephan Dewekker
- Mountain Meteorology Seminar (EVAT 793)
- Mesoscale Modeling (EVAT 795)
- Mesoscale Modeling Lab (EVAT 795L)

John Yates
- Physical Chemistry I (CHEM 351)
- Nanoscience on Surfaces (CHEM 983)

Steven Boker
- Exploratory and Graphical Data Analysis (PSYC 881)
- Research in Dynamical Systems (PSYC 905)