

## ARTICLE

# Teaching About the Brain and Reaching the Community: Undergraduates in the Pipeline Neuroscience Program at the University of Pennsylvania

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This article provides an overview of the University of Pennsylvania School of Medicine's Pipeline Neuroscience Program, a multi-tiered mentorship and education program for Philadelphia high school students in which University of Pennsylvania undergraduates are integrally involved. The Pipeline Neuroscience Program provides mentorship and education for students at all levels. High school students are taught by undergraduates, who learn from medical students who, in turn, are guided by neurology residents and fellows.

Throughout a semester-long course, undergraduates receive instruction in neuroanatomy, neuroscience, and clinical neurology as part of the Pipeline's case-based

curriculum. During weekly classes, undergraduates make the transition from students to community educators by integrating their new knowledge into lesson plans that they teach to small groups of medically and academically underrepresented Philadelphia high school students. The Pipeline program thus achieves the dual goals of educating undergraduates about neuroscience and providing them with an opportunity to perform community service.

*Key words: community educators; mentoring; community service; service learning; case-based curriculum; neuroscience; neuroanatomy; clinical neurology*

Undergraduate neuroscience education at major universities is typically focused on curricula taught in a formal classroom setting. Undergraduates interested in pursuing a career in the neurosciences may join extracurricular interest groups or pursue neuroscience-related research initiatives. Yet these extracurricular activities often lack the comprehensive instruction and mentorship that are critical to career development. Furthermore, these activities are typically not integrated with community service projects, to which undergraduates devote a significant proportion of their extracurricular time (Boyd and Rush, 1999). In order to provide undergraduates with neuroscience instruction and career guidance within the context of a community service initiative, the University of Pennsylvania School of Medicine established the Pipeline Neuroscience Program, a multi-tiered mentorship and education program in which undergraduates help teach the fundamental principles of neuroscience and neurology to inner city high school students in Philadelphia.

The University of Pennsylvania Pipeline Neuroscience Program began in 1998 as part of *Project 3000 by 2000*, an ambitious program launched by the Association of American Medical Colleges' Division of Community and Minority Programs, with the goal of increasing the matriculation of underrepresented minorities in medical school. Responding to a growing need for community educators and mentors in Philadelphia high schools, undergraduates at the University of Pennsylvania have been serving as teaching assistants (TAs) in the Pipeline program since its inception. These undergraduates have been instrumental in the ongoing success of the program, playing an increasingly important role in curriculum development and lesson planning.

This article provides an overview of the evolution of the Pipeline program since its inception in 1998. Preliminary qualitative feedback from high school, undergraduate, and medical school participants suggests that the Pipeline program is meeting its major educational, mentoring, and community service objectives. More definitive quantitative efforts are underway to evaluate the long-term success of the program in increasing the involvement of underrepresented minority students in college, medical school, and neuroscience-related fields.

## PARTICIPANTS

Each year the Pipeline Neuroscience Program recruits eight University of Pennsylvania undergraduates and ten to twenty-five medical students. A single fourth-year medical student serves as a logistical coordinator, ensuring the smooth day-to-day operation of the program. Six to eight neurology residents and a member of the neurology faculty also participate on a yearly basis, writing the clinical cases that are the foundation of the case-based curriculum. The neurology faculty member has the ultimate responsibility for organizing the program and approving the case topics.

The Pipeline program has drawn high school students from three Philadelphia institutions: William L. Sayre, Thomas A. Edison, and Overbrook high schools (Figure 1). The University of Pennsylvania School of Medicine's Office of Minority Affairs formed partnerships with these three high schools because they are part of the University's local community, and because their student bodies are predominantly African American or Hispanic and financially disadvantaged. These partnerships were created to fulfill the Association of American Medical College's stated mission of increasing the matriculation of underrepresented minorities in medical school.

The number of high school students enrolled annually has ranged from 25 to 46. According to 2005-2006 data from the School District of Philadelphia, 77.8% of Edison students are Latino and 19.3% are African American. The student bodies at Sayre and Overbrook are 98.5% and 98.8% African American, respectively. Additionally, 84.5% of Edison students, 61.7% of Sayre students, and 70.7% of Overbrook students were eligible for the Federal School Lunch Program in the 2005-2006 school year (School District of Philadelphia, 2006). The demographics of students participating in the program closely reflect those of their home schools. For example, in 2007, 100% of the 26 participating high school students from Sayre were African American. There were 24 sophomores, one junior, and one senior. Overbrook and Edison high schools did not participate in 2007 because University of Pennsylvania administrators focused on building its partnership with Sayre, where a dedicated science teacher has championed the program. The Pipeline program counts towards a Philadelphia Unified School District requirement that students participate in activities that are of civic value.



**Figure 1.** Map of Philadelphia showing the University of Pennsylvania and the high schools that have participated in the Pipeline Neuroscience Program: Overbrook, Edison, and Sayre. (Reprinted with permission from Hamilton et al., 2007.)

A faculty coordinator at each high school selects students for the program based on interest and, at Sayre High School, based on student performance during a fall-semester introductory neuroscience class. This weekly introductory class is taught by University of Pennsylvania undergraduates and medical students as part of Sayre's life science curriculum. High school students who perform well and have excellent attendance and homework completion rates in the fall-semester class are encouraged to enroll in the spring-semester Pipeline program.

Similarly, undergraduate TAs who excel as educators and mentors in the fall-semester class are encouraged to interview for the eight undergraduate TA positions available in the Pipeline spring-semester program. Interviews for the undergraduate TA position are conducted by the fourth-year medical student coordinator in December, after sending out an e-mail announcement to the pre-medical undergraduate list serve in the fall.

The introductory fall-semester course at Sayre not only allows selection of the high school students to be performed on the basis of merit, but also ensures that high school students have learned fundamental principles of neuroscience and neuroanatomy before starting the Pipeline program. In addition, the fall-semester class gives undergraduates an opportunity to form collaborative relationships with Sayre High School students in their school environment, facilitating effective teaching and mentorship in the spring-semester class held at the University of Pennsylvania.

## ORGANIZATIONAL STRUCTURE

Pipeline classes are held at the University of Pennsylvania School of Medicine on a weekly basis during the spring semester. Neurology residents create the clinical vignettes around which the class is structured and give preparatory lectures to the medical students and undergraduates in order to enrich their understanding of the subject matter and help them generate ideas for teaching the high school lessons (Figure 2). Residents and fellows take turns attending the high school class sessions, serving as a teaching resource for the medical students and undergraduates. Classes are 90 minutes long.

Teams of two or three first-year medical students and a fourth-year medical student lead the classes for the high school students. The fourth-year medical students have completed a pre-clinical neuroscience course and a clinical rotation in neurology, while the first-year medical students are taking the pre-clinical neuroscience course at the same time that they teach the Pipeline course. Undergraduate students act as TAs, with each undergraduate TA leading a small group of three to four high school students during class activities. These small groups are maintained throughout the semester, facilitating strong mentoring relationships between the undergraduates and high school students. Approximately half of each 90-minute class is run by the medical students, while half is dedicated to small group lessons or activities run by the undergraduates.

The estimated time commitment for each undergraduate is approximately three and one-half hours per week during the spring semester – 30 minutes before class reviewing the lesson plan, 90 minutes in class, 30 minutes debriefing with the Pipeline team after class for quality improvement purposes, and approximately 60 minutes in didactics, literature review, or self-directed learning between classes.

In 2007, undergraduates received formal lectures from medical students and neurology residents on the epidemiology, pathophysiology, diagnosis, and treatment of traumatic brain injury, crack-cocaine addiction, and Alzheimer's disease. Relevant articles and *Powerpoint*

presentations prepared by medical students are reviewed by neurology housestaff for accuracy, then distributed to undergraduates before each weekly class so that undergraduates can prepare lessons and activities for their small groups of high school students.

groups in reviewing the medical literature, performing internet searches, preparing *Powerpoint* slides, and practicing public speaking skills. The final public speaking exercise is attended by the high school students' parents and faculty from the University of Pennsylvania. The program is funded entirely by the University of Pennsylvania School of Medicine. The current annual budget is \$2600.

## CURRICULUM

The Pipeline Neuroscience Program utilizes a case-based curriculum. Three cases are taught per year, with each case being covered in three weekly class sessions. The 2005 curriculum focused on basic neuroanatomy, elements of synaptic transmission, and the intracellular constituents of neurons. The cases used to underscore these themes were an epidural hematoma, Parkinson's disease, and new variant Creutzfeldt-Jakob disease. The 2006 curriculum featured cases that highlighted the neurologic manifestations of common medical illnesses such as hypertension, alcoholism, and HIV. The related cases were hypertensive cerebellar hemorrhage, Wernicke-Korsakoff syndrome, and central nervous system toxoplasmosis presenting as a seizure.

The recently completed 2007 course focused on neurological diseases that have a high prevalence in Philadelphia's inner city communities. The three cases taught were traumatic brain injury in a high school football player (See Appendix I), crack-cocaine addiction in a college student, and Alzheimer's disease in an elderly grandparent. New additions to the curriculum in 2007 included a sheep brain dissection and a career day. Undergraduates helped lead their small groups of high school students in dissecting a sheep brain. Emphasis was placed on the temporal lobe structures, such as the hippocampus, that are involved in Alzheimer's disease. On career day, undergraduate and high school students received presentations from a neurologist, a psychiatrist, allied healthcare workers, and a University of Pennsylvania health career advisor. Fourth-year medical students entering the fields of neurosurgery and neuroradiology introduced the students to these medical subspecialties.

Throughout the course, undergraduates build mentoring relationships with the three to four students in their small groups. Undergraduates discuss the benefits of a college education and provide insight into the collegiate experience to high school students, many of whom are the first members of their families to apply to colleges and universities. Undergraduate TAs also make phone calls to the high school students' parents to discuss each student's progress in the course. While serving as high school mentors, the undergraduates simultaneously receive mentorship from medical students, neurology residents, and a neurology faculty member. Career advice and guidance is provided to the undergraduates on an informal basis before class and during after-class debriefing sessions. Formal mentoring activities, such as attending resident journal clubs, are currently being integrated into the curriculum. Undergraduates are also invited to attend classes with medical students and visit the various

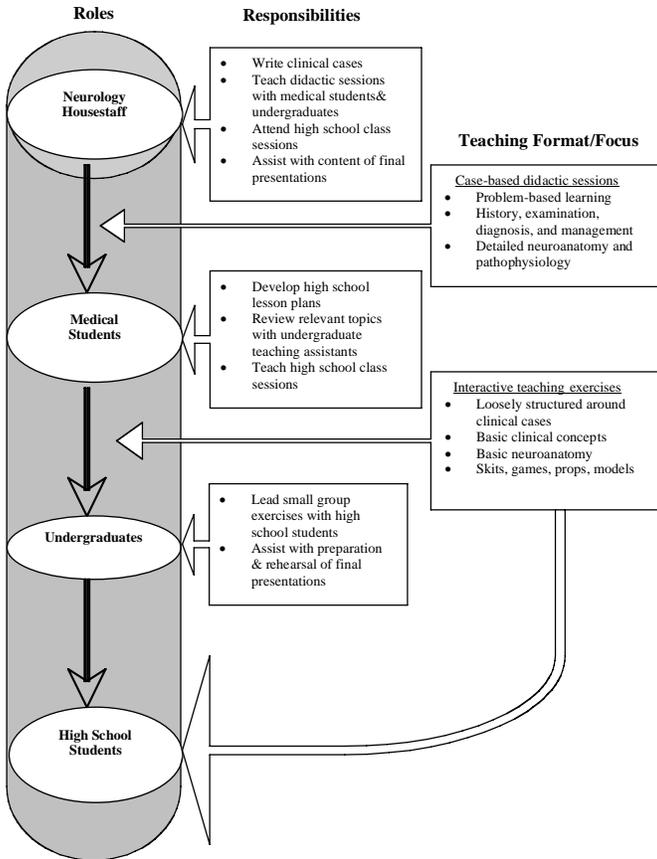


Figure 2. Schematic of the teaching pathway of the Pipeline Neuroscience Program, summarizing the roles and responsibilities of neurology housestaff, medical students, and undergraduates. (Reprinted with permission from Hamilton et al., 2007.)

Undergraduate responsibilities and opportunities for teaching the high school students have increased significantly over the past three years. For example, in the 2007 course one undergraduate led a 20-minute topical review on traumatic brain injury, another led a demonstration on the pathophysiology of brain contusions, and groups of undergraduates have prepared other interactive classroom activities and homework assignments. One such activity in the 2007 course was a "Jeopardy"-style game that highlighted the key points of a case on cocaine addiction. Undergraduates have also assumed the responsibility of educating each other by posting independently researched educational materials on a Pipeline email list serve.

Since 2005, the small groups of high school students have concluded each year's course by giving oral presentations on topics in neurology. Undergraduates assume the primary responsibility of assisting their small

research laboratories in which medical students, neurology residents, and neurology faculty are conducting clinical and basic science research.

The didactic sessions that neurology residents teach to medical students and undergraduates employ clinical vignettes resembling those used in the problem-based curricula of many medical schools. Residents teach the clinical presentation of diseases, neuroanatomic localization, differential diagnosis, pathophysiology, and treatment. The medical students use the information provided by the neurology residents and fellows to generate lesson plans that are accessible, interactive, and engaging for the high school students. Undergraduates integrate the information into small group activities that reinforce the medical student lessons. While these lessons and activities are loosely structured around the cases written by the neurology residents, much of the class time is devoted to teaching exercises that illustrate basic concepts about the nervous system and neurological diseases. Skits, games, props, models, and humor are routinely incorporated into the lesson plans. There are no required textbooks and the students are not assigned outside reading, but they receive short homework assignments based on the material covered in class.

In 2005, groups of high school students prepared oral presentations for their final projects and performed patient-physician dramatizations related to the cases covered during the course. In 2006, the students gave more in-depth oral presentations that fell into four broad categories: neuroanatomy, seizures, stroke, and neurologic complications of alcohol abuse. Within the groups each student researched and presented a specific topic. For example, A.W., a 17-year-old in the 11<sup>th</sup> grade at Sayre, presented the neuroanatomy of the limbic system, which had not been covered during class. He discussed the role of the hypothalamus in autonomic and endocrine function, the amygdala in emotional conditioning and fear responses, the nucleus accumbens in reward signaling, and the hippocampus in memory formation. Lastly, he touched on the mammillary bodies as a location affected in amnesic patients with Wernicke-Korsakoff Syndrome. In 2007, groups of high school students gave their final oral presentations on attention deficit hyperactivity disorder, heroin addiction, crystal methamphetamine addiction, and Alzheimer's disease.

Because many high school students did not have access to computers or the internet at home, the two final class sessions were spent preparing the presentations. Undergraduates lead these preparatory sessions, answering questions on the topics that students had chosen, directing them to appropriate online review articles and neurology-related websites, and helping them to develop the computer skills required to prepare their talks. The neurology faculty coordinator reviews the high school students' computer slides for the final presentation in order to ensure accuracy.

## FEEDBACK

Every year high school students provide informal feedback to their faculty coordinators, who use this information to

recommend improvements to the curriculum. In addition, 10 high school students who participated in the Pipeline in 2005 and 2006 were asked to give videotaped exit interviews describing their experiences. Students were asked how they felt the Pipeline had benefited them and how it had impacted their long-term goals.

In 2007 surveys were introduced into the Pipeline in order to assess undergraduate goals, expectations, satisfaction, and learning in the program. Current and former undergraduate TAs were asked to evaluate the Pipeline program in a variety of areas, including the quality of teaching and mentorship, and the impact of the Pipeline program on their career goals and their commitment to working with academically underrepresented communities. In order to quantitatively assess how well undergraduates are being taught by more senior members of the Pipeline, current undergraduates were given a 50-question true-false quiz on basic neuroanatomy, neuroscience, and clinical neurology at the beginning of the 2007 course. Their collective performance on this pre-class assessment will be compared to their performance on an identical post-class assessment quiz. At the end of the course, undergraduates also receive feedback from the medical school coordinator, Director of the Office of Minority Affairs, and the neurology faculty coordinator. In addition, the Director of the Office of Minority Affairs writes a formal letter of recommendation for each undergraduate's application to medical school.

Beginning in 2007, outcome data from high school students and undergraduates will be tracked longitudinally. The Director of the Office of Minority Affairs and the neurology faculty coordinator will maintain a database of high school and undergraduate participants. High school students will be followed at yearly intervals to determine rates of college enrollment and assess career plans, while undergraduates will be followed yearly to determine rates of medical school enrollment or pursuit of other biomedical or neuroscience related careers.

## RESULTS

From 1998 to 2007, 339 high school students, 119 undergraduates, and 177 medical students have participated in the Pipeline. A total of 234 high school students (69% of participating students) have completed the program. The addition of a more rigorous curriculum and a final presentation requirement has not detracted from course completion rates. Between 2005 and 2007, 93 students participated in the program and 76 (82% of participants) successfully completed the final public-speaking exercise. In 2006, four Sayre students did not complete the program. Two of these students changed schools in the middle of the spring semester, while two did not complete the Pipeline program because of Sayre's "credit recovery" policy, which requires students to complete missing credits during the spring semester in order to graduate to the next grade. In 2007, the Pipeline coordinators aimed to increase retention by ensuring that participating Sayre students were not at risk of being pulled from the class because of credit recovery. As a result, 23 of 26 students completed the 2007 program, and the three

students who did not complete the program left because of lack of interest or poor attendance.

Several other changes in student selection and programmatic structure have also contributed to improved retention rates over the past few years. First, the decision to focus exclusively on a partnership with Sayre has dramatically improved retention. This improvement can be attributed to the dedication of a Sayre science teacher who coordinates the Pipeline program at Sayre and has served as an advocate for the program. Each week, this Sayre coordinator reviews the previous week's lesson with the students, elicits student feedback, and assists with the completion of homework assignments. Second, the introduction of a first-semester, introductory neuroscience class at Sayre has ensured that Sayre students are better prepared for the Pipeline curriculum. The introductory course has been expanded over the past four years from one science class to seven, an expansion that has allowed the Pipeline participants to be chosen from a larger pool of students. (In 2007, 200 Sayre students participated in the weekly, semester-long introductory course.) Furthermore, by selecting the Pipeline participants on the basis of performance in the first-semester course, we ensure that the high school participants are motivated and interested in the program. At this time, no factors have been identified that predict which students will not complete the program. Since there were only one junior and one senior in 2007 Sayre class, it is not possible to assess whether grade level factored into success in the program.

In 2007, 30 undergraduates from the University of Pennsylvania were interviewed and eight were selected to participate in the Pipeline Neuroscience Program. All eight undergraduate TAs are enrolled in pre-medical course work and plan on pursuing a career in medicine. Five are seniors, one is a junior, and two are sophomores. Majors include biological basis of behavior (four), chemistry (one), biochemistry (one), bioengineering (one), and healthcare management at The Wharton School (one).

On the "goals and expectations" questionnaire that was distributed to undergraduate TAs at the beginning of the course (See Appendix II), all eight TAs stated that the opportunity to mentor underrepresented minorities was a "very important" factor in their decision to participate in the Pipeline Neuroscience Program. Seven TAs said that improving their teaching skills was "somewhat important" or "very important," and six said that learning more about neuroscience was "somewhat important" or "very important." Five of the eight TAs were either "somewhat likely" or "very likely" to pursue a career in a medical subspecialty that focuses on the nervous system (neurology, neurosurgery, neuroradiology, or neuropathology). Five were "somewhat likely" or "very likely" to do basic science or clinical research relating to the nervous system, and five were somewhat or very likely to teach residents, medical students, undergraduates, or high school students in their future careers.

In focused interviews conducted halfway through the 2007 Pipeline course, current and former undergraduate TAs strongly endorsed the Pipeline program in several key areas. Undergraduates unanimously agreed on the

following points: the Pipeline program increased their knowledge of neuroanatomy, neuroscience, and clinical neurology; teaching the subject matter to high school students positively impacted their mastery of the material; the Pipeline course influenced their career goals or their plans for a medical subspecialty; they were able to establish helpful mentoring relationships with medical students or physicians over the course of the semester; and teaching in the Pipeline strengthened their commitment to working with medically and academically underrepresented minorities. The following is representative feedback from undergraduate interviews:

- "I've taken just about every neuroscience class at Penn and I've learned more about the clinical applications of neuroscience in the Pipeline than in all of those classes combined. I feel like Pipeline is giving me a much more complete, integrated understanding of how neuroscience and neuroanatomy relate to neurological diseases."
- "The mentorship has been one of the greatest parts of the whole program.... As an undergrad about to embark on the medical school journey, it is so comforting and beneficial to see the incredible people who are in the midst of their own journey."
- "The Pipeline course has solidified my interest in academic medicine. I love teaching and allowing students to explore their intellectual curiosity, and I now know that this is something that I want to incorporate into my future career."

A current Pipeline medical student who also participated in the Pipeline program as an undergrad TA said that "seeing how much this population of [high school] students benefited from the program has greatly strengthened my commitment to underrepresented minorities. Penn Med's dedication to working with and improving the surrounding community in innovative ways was one of the reasons that I decided to stay at Penn for medical school." Several undergraduate TAs agreed that the presence of a Pipeline-like program would be a priority for them in choosing a medical school.

Medical school student feedback for the Pipeline program has also been positive. Of 165 medical student participants who participated between 1998 and 2006, 148 (89.7%) felt that the program had improved their ability to communicate medical information, and 127 (77.0%) indicated that what they had learned would be applicable to future physician-patient relationships. Medical students unanimously (165 of 165) endorsed the Pipeline Program as a positive experience and wrote that they would be interested in teaching in the program again.

Praise for the program was similarly unanimous among the 10 high school students interviewed; five of them (50%) stated that the Pipeline program had led them to consider careers in medicine. For example, when asked about the impact of the Pipeline on his long-term goals, A.W. commented, "I'm trying ... to reach my goal to be a doctor. I've still got a positive attitude to be a doctor...to be the most committed doctor of them all. The Pipeline program influenced me to try to be a neurologist."

Some students' interest in medicine has endured long

after completion of the program. Each year since the inception of the program, two Pipeline high school students have been chosen to be part of the Summer National Youth Leadership Forum on Medicine, in which some attention is given to careers in neuroscience. One Sayre student from the 2006 program attended a "Mini-Med School" course at Drexel University in the spring of 2007, and another Sayre student from the 2004 program is planning to pursue a collegiate degree in nursing.

Interest in medicine, research and teaching is also strong among the undergraduate TAs. One of the undergraduate TAs from the 2007 program is taking a year off before medical school to do neuroimaging research examining cerebral blood flow in pediatric patients undergoing cardiac surgery. Another undergraduate TA from the 2007 program partnered with the neurology faculty coordinator of the Pipeline program on a cognitive neuroscience project employing transcranial magnetic stimulation during her senior year. This TA is taking a year off before medical school to teach science to inner city high school students in New York City.

## DISCUSSION

### Strengths of the Pipeline Neuroscience Program

The Pipeline Neuroscience Program provides undergraduates with the opportunity to increase their knowledge of common neurological illnesses and deepen their understanding of neuroscience and neuroanatomy. Unlike most neuroscience-related extracurricular activities, the Pipeline program provides undergraduates with a semester of formal instruction and mentorship from medical students, neurology housestaff, and neurology faculty. By interacting with academically successful mentors who are at three different stages of training, undergraduates gain valuable insight into the processes of entering medical school and training to practice as a medical specialist.

By enlisting undergraduates as TAs and asking them to synthesize newly learned information into effective lesson plans, the Pipeline builds on the principle that teaching others is one of most effective ways to master new subject matter. As one undergraduate TA explained, "I have discovered that teaching not only requires a heightened understanding of the material but also more preparation in order to communicate the material effectively and with confidence." The success of this multi-tiered approach to teaching is consistent with prior evidence suggesting that programs that employ advanced students as instructors for high school students are effective at educating both high school students and the older students who teach them (Schmidt and Stavray, 1997).

The Pipeline Neuroscience Program also provides undergraduates with an opportunity to meaningfully contribute to their community as educators and mentors. This integration of undergraduate education with community service has gained support in recent years, with the number of university faculty teaching "service-learning" courses increasing three-fold from 2000 to 2004 (Ehrlich, 2006). The service-learning model has not only been

shown to be an effective model for educating undergraduates (Greenberg et al., 2003); it is also consistent with the priorities of undergraduates. Indeed, all eight undergraduate TAs stated that their desire to participate in the program was influenced by their interest in community service at least as much as their interest in learning more about neuroscience.

There is evidence that community-based learning programs also improve healthcare providers' communication skills and positively impact their attitudes toward the communities they serve (Beck et al., 2006; Seifer, 1998). Given that all eight of the undergraduate Pipeline TAs plan to train as physicians, learning to work productively and communicate effectively with diverse communities is clearly of significance. The feedback we have received from undergraduates indicates that they feel the program helps to prepare them for the next stage of their education. Similarly, a number of high school students reported that the program has led them to consider a career in medicine.

### Limitations of the Pipeline Neuroscience Program

One of the major challenges facing the Pipeline is quantifying its impact on undergraduate neuroscience education and career development. It is important to know what effect the program has on the subsequent academic achievements of its students and on their eventual career choices. The collection of longitudinal data, beginning in 2007, should facilitate programmatic evaluation.

The Pipeline program's impact on high school students' career plans should also be more comprehensively assessed. Data from similar programs suggests that early enrichment opportunities in biomedical science serve to increase the number of underrepresented individuals in medicine and related fields (Cregler, 1993). The extent to which this holds true for Penn's Pipeline program remains to be seen.

Another area in which the Pipeline has seen only limited success is in the continuity of mentorship. There is no formal mechanism in place yet for undergraduates, medical students, and neurology housestaff to form long-term relationships with high school participants.

One factor that may limit the applicability of our educational model to other institutions is its reliance on the presence of a medical school and a neurology residency program. While these resources lend themselves to the teaching of neurology, we believe that the Pipeline provides an example of a multi-tiered neuroscience education and mentorship experience, and that this framework can be applied in colleges that are affiliated with neuroscience-related training programs of all types. With regard to neurology education specifically, we are also currently developing a website that will help to make clinical neurology teaching materials available to programs that are not affiliated with medical schools or neurology departments.

### Future Directions

A number of steps are being taken to address the limitations of the program. More outcome data will be

collected from future Pipeline students and retrieved from past students. A graduate student at the University of Pennsylvania School of Social Policy and Practice is planning an investigational study of past, present, and future Pipeline students. Mentorship opportunities will also expand. Plans are taking shape for medical students and undergraduates to visit and mentor students at their home schools and to involve students with neurologists in the hospital. For example, a number of high school students have enjoyed being trained as standardized patients for medical student neurology clerkship didactic exercises. As opportunities for mentorship expand, the Pipeline program will continue to strengthen the partnership between the University of Pennsylvania and its surrounding community.

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## APPENDIX I

### Traumatic Brain Injury Case (Authored by University of Pennsylvania Neurology Residents)

James is a healthy 15-year-old who is the quarterback on his high school football team. In the third quarter of a game against his high school's biggest rival, he is sacked by a defensive lineman. His helmet, which was not strapped on, flies off and his head strikes the knees of several players. After the pile-up of players is cleared, James remains on the ground. He does not respond to his name or gentle shaking. A minute later he wakes up and he slowly stands up with help. He looks dazed and after repeated questioning, he is able to give his name but he does not know what happened. He keeps asking where he is and his speech is somewhat slurred. He walks unsteadily to the other team's sidelines and sits down.

The coach does a brief evaluation. James speaks clearly but slowly. He is able to give his name, but he does not know the

date or where he is. He has difficulty naming the days of the week backwards and he doesn't remember what happened during the game. His pupils react equally to light. His arms and legs are strong. When asked to touch his finger to the coach's finger, he misses at first with both hands.

Questions for Discussion:

*What happened?*

*What is meant by losing consciousness? What is a concussion?*

*James' team is down by 6 points and they are at the 9 yard line. Can he get back in the game? What should the coach do?*

James' confusion does not improve after 15 minutes. He suddenly feels nauseous and throws up. An ambulance is called and he is brought to the local emergency room. In the emergency room, he becomes less responsive. The emergency room nurse has to yell and shake him to get him to give his name. His pulse is 50 beats per minute (normal is 60-100) and his blood pressure is 180/100 mmHg (normal is 120/80). His breathing is erratic. He is not able to follow commands. His left pupil is bigger than his right. When pinched hard he quickly withdraws his left arm and leg but not his right.

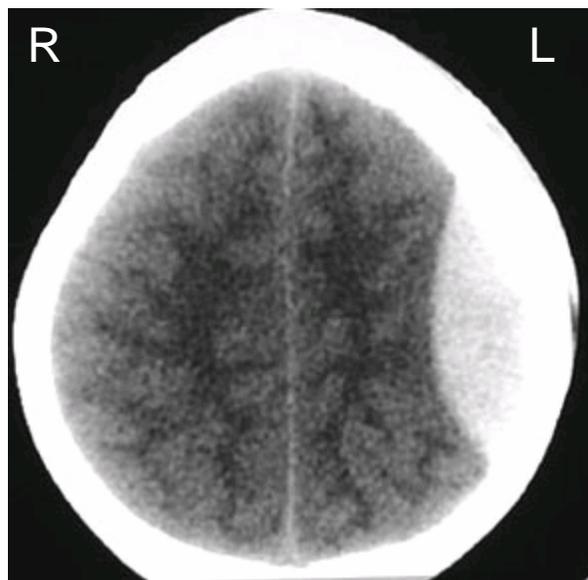
Questions for Discussion:

*What happened that caused James' condition to change so quickly?*

*What part of the brain is affected? Why are his right arm and leg not working?*

*Why is his blood pressure high and his pulse low? What happens when there is elevated pressure inside the skull?*

A CT Scan is performed which shows bleeding inside the skull, pressing on the left part of the brain.



*Why was James more alert and strong after the injury than when he got to the hospital 30 minutes later? What should be done now?*

James is rushed to the operating room where the blood is removed and a blood vessel, which is oozing blood, is cauterized (sealed up by heating). He recovers after the surgery and does

well. He does not return to playing football that season.

Four years later, James is a sophomore in college. He has spent all night studying for a test and the next day, while taking the exam, he cries out, his eyes roll back and his arms and legs begin to shake violently. His classmates put him on the ground. After 30 seconds, the shaking stops. James is groggy and confused. He does not know what happened. By the time the ambulance arrives 15 minutes later, he is back to normal but he is very tired.

Questions for Discussion:

*What happened?*

*What is a seizure? What should you do when you see someone having a seizure?*

*Is this related to injury he had four years ago?*

## APPENDIX II

### Undergraduate TA Goals and Expectations Survey

Please answer the following questions on a scale of 1–5, with 5 being “very likely” and 1 being “not likely at all.”

1. How likely are you to attend medical school?  
1      2      3      4      5
2. How likely are you to pursue a career in a medical subspecialty that focuses on the nervous system (neurology, neurosurgery, neuroradiology, neuropathology)?  
1      2      3      4      5
3. How likely are you to do basic science research relating to the nervous system?  
1      2      3      4      5
4. How likely are you to do clinical research relating to the nervous system?  
1      2      3      4      5
5. How likely are you to teach residents, medical students, colleges students, or high school students in your future career?  
1      2      3      4      5

Please answer the following questions on a scale of 1-5, with 5 being “very important” and 1 being “not important at all.”

6. How important was the opportunity to mentor high school students from medically underrepresented minorities in your decision to be a Pipeline TA?  
1      2      3      4      5
7. How important was the opportunity to improve your skills as a teacher in your decision to be a Pipeline TA?  
1      2      3      4      5
8. How important was the opportunity to learn more about neuroscience and clinical neurology in your decision to be a Pipeline TA?  
1      2      3      4      5

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