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PERSPECTIVES

Discovering physiology: a high school student's journey into STEM: perspective and advice

Krish Taneja,[1,2] Steven Didik,[1] and Alexander Staruschenko[1,3]

[1]*Department of Molecular Pharmacology and Physiology, University of South Florida, Tampa, Florida, United States;* [2]*Berkeley Preparatory School, Tampa, Florida, United States; and* [3]*Hypertension and Kidney Research Center, University of South Florida, Tampa, Florida, United States*

Abstract

Pursuing a career in science, technology, engineering, and mathematics (STEM) can be an exciting yet intimidating journey for high school students. This perspective provides a unique firsthand insight from a high school student working in a medical research laboratory and pursuing a STEM career. It explores the current high school STEM landscape, briefly covering coursework, university summer internships, and science fairs while discussing the importance of early STEM engagement and the opportunities and challenges students face. Additionally, this work highlights how fostering STEM interest at the high school level can enhance critical thinking and problem-solving skills essential for careers in fields such as engineering and artificial intelligence. Extracurricular opportunities, including the American Physiological Society Physiology Understanding (PhUn) Week and research internships, are also briefly covered. Furthermore, insights from a high school student, a Ph.D. student, and a principal investigator provide advice on gaining research experience. Finally, this Perspectives article discusses potential career pathways and opportunities that stem from early STEM engagement.

high school; internship; job opportunities; STEM

INTRODUCTION

How does one become interested in science, technology, engineering, and mathematics (STEM)? It is a question I have been asked many times throughout my journey of discovering a passion for science. My response is never simple because the path to STEM is always unique. My journey began when I was 9 years old and had my first experience working with a microscope. I enjoyed viewing leaves, rocks, sand, and shells and comparing their structures. I believe all it takes is something small to spark a creative interest; from there, the imagination can run wild. My imagination did, and since then, I have chosen to pursue a career in the sciences. I have found my journey in the sciences very rewarding; thus, the purpose of this article is to offer perspective and advice for high school students in the STEM community from my point of view.

STEM is a broad subject that spans a variety of different topics, such as engineering, chemistry, mathematics, physics, and biology. An interest in science can happen at any time; it's just a matter of how. For me, it was a combination of encouragement from my school and my parents. My parents were particularly supportive, whether by buying me the iconic "Weird but True" books or fostering my curiosity through small, hands-on activities. Middle school also played a pivotal role, with opportunities like dissection laboratories that deepened my fascination with the natural world. But this is not all about my journey; it is about how other kids become interested in and pursue science from an early age. I recommend attempting little bits of everything and seeing what sparks your interest. Initially, I thought that I was going to enjoy physics and engineering because of my love of math and LEGOs, which I enjoyed building when I was young, but it never stuck with me because I never fell truly in love with the principle. On the other hand, when I attempted chemistry, I instantly felt drawn to the topic. Chemistry provided clear answers to many of my questions, and its principles felt intuitive to me. By combining my interest in chemistry with my love of biology, particularly physiology and the main principles of how the human body works, I knew I had found my true passion: pharmaceutical engineering and drug design. Of course, this path may evolve over time.

THE CURRENT STEM HIGH SCHOOL EXPERIENCE

I currently attend Berkeley Preparatory School in Florida, which provides a wide range of learning opportunities for students interested in STEM, including different classes to take and clubs to join. From AP Biology to AP Chemistry to AP Quantum Physics, Berkeley, like many schools, provides students with a variety of different STEM opportunities focused on real-world problem-solving. For example, course assignments are often designed to apply lessons taught to

Correspondence: K. Taneja (tanejkri@berkeleyprep.org); A. Staruschenko (staruschenko@usf.edu).
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solve real-world challenges, such as a physics problem to engineer a structure in a hands-on laboratory. I took full advantage of these opportunities by enrolling in as many science courses as possible to broaden my understanding and knowledge base. At Berkeley, my love of science has flourished. In addition, from my experience and at most schools, if no course or club is available to your interests, you are permitted to submit a club or course proposal to create a club tailored to your interests. For example, my classmate and I were interested in chemistry and pharmaceuticals and wanted to expand our knowledge and show others why it is a great field of study, so we founded the "Pharma Know" Club at Berkeley. The mission of the Pharma Know Club is to further our knowledge of the field by hosting guest speakers, organizing a journal club, and sharing new volunteer research opportunities. In addition, Berkeley, like many schools, provides a wide range of scientific equipment for students use. My love for science has truly prospered at Berkeley, and I believe an active STEM school is essential in inciting the passion for science in students. It has also been instrumental in my scientific development process.

Interestingly, when I spoke to friends at other schools about their interest and opportunities in STEM, they said that they did not have the equipment or funding at their school to pursue their interest in STEM. Also, they felt the topic was very intimidating; therefore, they lost interest. This is a major issue high school education faces. Because of this, I believe there should be more equity and funding for STEM programs at every high school to help encourage others to participate. This would help immensely in spreading STEM to more students and strengthen the field of STEM, which is growing at a rapid pace. For students attending schools without resources similar to those at my school, external programs, community outreach initiatives, and partnerships with local universities or organizations can help bridge the gap. These opportunities, such as summer internships, science fairs, and STEM outreach events, are critical to fostering scientific curiosity. My experiences have shown me how important it is to ensure that every student, regardless of their school's resources, has the chance to explore and pursue their interest in science.

THE IMPORTANCE OF STEM IN HIGH SCHOOL

Science is an important concept for all students at the high school level because of the many benefits it can have in all lines of work. Computer science is one of the sciences that is gaining popularity across all lines of work because of the rise of artificial intelligence (AI) as society enters "the 4th industrial revolution." AI-related jobs and markets are expected to increase by ~37% by 2030 (1). This trend is why many high school students have shifted their interest to STEM. Additionally, other STEM-related subjects such as chemistry, biology, and physics are essential to have a basic understanding of because of the major impact each has on our daily lives. Establishing a learning foundation in these subjects early at the high school level is essential for success in these fields at the professional level. Additionally, STEM education in high school can directly impact students' health. For example, a basic understanding of biology, chemistry, nutrition, and anatomy allows students to understand how the foods they eat and the amount of exercise they perform impact their health and daily lives. For me, this was one of the most important lessons I learned during my time in biology and chemistry because it helped me understand what I needed to do to keep my body healthy. Finally, STEM in high school allows students to develop critical thinking and problem-solving skills. These skills are highly sought after in the workforce. Many businesses and companies look for innovators who can think outside of the box and find new pathways and solutions to many global issues. For these reasons, I believe that STEM is essential at the high school level to shape tomorrow's thinkers, creators, and innovators to help solve some of society's biggest challenges.

CURRENT OPPORTUNITIES AND CHALLENGES IN HIGH SCHOOL STEM

The main challenges STEM high school students face are finding outside opportunities to enhance their learning and research skills as well as getting students to express interest and stay engaged in STEM. When I began looking for opportunities outside of school concerning STEM, I did not know where to start. This is a fundamental problem for many students interested in STEM because STEM opportunities are often limited and not well encouraged by high schools outside of school. The American Physiological Society (APS) has actively engaged in K–12 outreach through initiatives like Physiology Understanding (PhUn) Week, aiming to enhance student understanding of physiology and inspire future careers in the field. PhUn Week has conducted nearly 600 events across the United States in the first 10 years, involving APS members in K–12 outreach (2). PhUn's science outreach program has also been successful in rural regions (3).

Personally, I began exploring opportunities at the university level, focusing on the University of South Florida (USF), a leading institution for STEM in the Tampa Bay area. I encourage other students to take a similar approach by reaching out via email to laboratories at your local university. However, it's important to acknowledge that this process can be challenging, as many professors may hesitate to accept high school students because of concerns about lack of experience, legal restrictions on hiring minors, and the absence of specific incentives from universities. In addition to contacting principal investigators (PIs) directly, it can be beneficial to reach out to postdoctoral fellows, graduate students, or other laboratory members. Leveraging personal connections, such as through friends, neighbors, or parents, can also open doors. I was fortunate to find a laboratory that aligned with my interests and welcomed me as part of their team. This was a great opportunity that I came across, and I believe that this helped further my love for STEM.

Many students perceive STEM subjects as challenging, often associating them with intensive workloads and frequent exams. This perception can discourage engagement by overshadowing STEM's rewarding and enjoyable aspects. For that reason, we believe that STEM classes should have more interactive team-based problem-solving activities that students can participate in and be evaluated in. This would help STEM seem more appealing to a broader range of

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students and would help grow the number of students graduating with STEM majors.

EXTRACURRICULAR STEM OPPORTUNITIES

Two of the major, popular extracurricular STEM activities available to high school students are volunteer laboratory research work and participation in local, national, and international science fairs. To explain how volunteer laboratory research works, I feel it is essential to share my experience as a road map for students interested in pursuing it. I joined the Dr. Alexander Staruschenko laboratory as a volunteer intern in the summer of 2024. The Staruschenko laboratory specializes in renal physiology and covers a broad range of research topics, spanning from obesity to diabetes to hypertension research. Dr. Staruschenko was enthusiastic and supportive of my energy and drive to pursue diabetes research. I was grateful for this interaction because, as a PI, he has many obligations, and bringing a high school student on presents its own challenges. First, PIs should ensure that all volunteer paperwork and safety training were completed so that you can begin your research. From there, it would be beneficial if the PI assigned the student to a laboratory member, who would serve as their primary mentor on a daily basis, if such an opportunity exists. Dr. Staruschenko introduced me to his Ph.D. student, Steven Didik. First, Steven and I started creating my individual development plan for the summer (IDP; https://myidp.sciencecareers.org/). I shared my research interests with Steven, expressing my desire to work on an impactful study focused on developing a potential new therapy for diabetes. After reviewing Dr. Staruschenko's publications and recent literature, we developed a research plan for the summer. I was immediately hooked and eager to start. Throughout my time at the Staruschenko laboratory I gained valuable medical concept knowledge, technical laboratory knowledge, and time management skills. I was fortunate enough to be able to present my laboratory research at the Hillsborough County science fair. Excitingly, I won 1st overall for the biomedical health sciences category, best in vitro work, and the Regeneron biomedical health sciences awards and was advanced to present my project at the state level. My time at the Staruschenko laboratory has equipped me with an invaluable real-world professional setting skill set. Finally, knowledge and skills I have obtained will help me in the college application process and as I progress throughout my career. I hope that other high school students can take a similar path on an exciting project. The other extracurricular activity is participation in local and international science fairs. There are robotics competitions, AI and computer science competitions, and poster-style science fairs across the country that high school students can participate in, which can make the STEM experience very rewarding.

MENTORING A HIGH SCHOOL STUDENT: PERSPECTIVES FROM a Ph.D. STUDENT AND A PI

Ph.D. Student Perspective

When given the opportunity by Dr. Staruschenko to mentor a summer student, I was excited and eager to take on the task. Krish and I had much in common, including a love for science and soccer. Initially, I found it challenging to balance my thesis work, course work, and assisting Krish with his project. Over time, however, I quickly realized that being a good mentor and effective teacher made me a better student. Being able to explain and teach complex techniques and concepts effectively in conjunction with managing my time with Krish has helped me immensely professionally. I would gladly mentor more high school students during my tenure in my Ph.D. program. Finally, I found the experience highly rewarding, as I have seen firsthand Krish's profound growth as a scientist, as a professional, and, most importantly, as a person.

PI Perspective

As a PI managing multiple students, postdocs, and junior faculty, taking on a high school student is always an

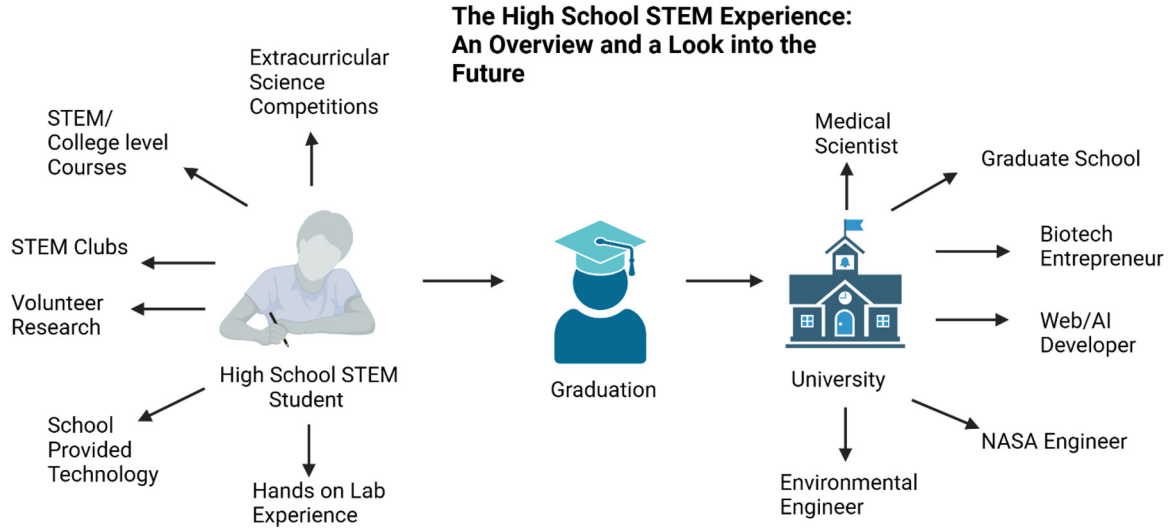

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Figure 1. An overview of the high school science, technology, engineering, and mathematics (STEM) experience. This figure illustrates the diverse experiences of high school students in STEM and highlights examples of potential career paths they can pursue.

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additional responsibility. There are no expectations that high school or even short-term undergraduate students will produce meaningful data or contribute significantly to a project. However, having low expectations can be beneficial; when students exceed them, it is particularly rewarding. When I agree to mentor a high school student, it is always with the understanding that this is not primarily for myself or the laboratory but rather to promote STEM education and inspire young minds to explore research careers. Engaging with high school students fosters the next generation of scientists, reinforcing the importance of early exposure to scientific inquiry. Small, well-defined projects can provide meaningful learning experiences while also potentially contributing to the laboratory's research. Additionally, bringing in high school students enhances the laboratory's culture of mentorship and teamwork, offering more senior trainees the opportunity to develop mentorship and teaching skills. In this particular case, it was a valuable learning experience for Steven.

IMPACT OF STEM IN HIGH SCHOOL FOR FUTURE CAREERS AND ENDEAVORS

Pursuing STEM in high school can open the door to careers that you never knew existed, such as fragrance chemist, environmental specialist, nuclear engineer, scientific liaison, and venture capitalist. These are all examples of careers that require a STEM background, demonstrating how such a foundation diversifies job candidates, sets them apart, and opens doors to a wide range of opportunities. A graphic describing the high school STEM experience to the professional workforce is shown in Fig. 1. These are just a few examples of the careers one can pursue with a STEM background. Common STEM jobs include being a doctor, engineer, or chemist. However, it is important to recognize that the skill sets learned through STEM education, such as high school, are translatable to a wide range of career options.

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CONCLUSIONS

In conclusion, we believe STEM is one of the most important and evolving subject areas in a high school, as it equips students with a broad skill set and hands-on experiences that prepare them for future careers. However, recent studies have highlighted a concerning decline in student enrollment in STEM programs. Moving forward, we need to address STEM students' challenges, such as student retention and access to extracurricular STEM activities. It is essential that we produce a strong, next-generation team of STEM professionals. We hope schools will expand their STEM opportunities to spark students' interest in these subjects and that universities will provide some incentive to their faculty to mentor and recruit a new generation of scientists as early as high school students. AQ: 7

DISCLOSURES

No conflicts of interest, financial or otherwise, are declared by the authors. AQ: 8

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XXXXX prepared figure; K.T, S.D, and A.S. drafted manuscript; K.T, S.D, and A.S. edited and revised manuscript; K.T, S.D, and A.S. approved final version of manuscript. AQ: 9

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