15 undergraduate programs offering BS degrees in physiology had been identified. In 2014, Wehrwein and colleagues (4) described strategies to promote the teaching of physiology at universities in the U.S. These in- 

The Evolution of Undergraduate Physiology Programs

At the beginning of the 21st century, only a handful of established undergraduate degree programs awarding BS degrees in physiology (or physiological sciences) existed at universities in the U.S. These included well known, sizable programs at UCLA, Michigan State University, and the University of Arizona. Since that time, impressive growth in the number of programs awarding BS degrees in physiology has taken place. By 2006, when the American Physiological Society organized a summit to discuss strategies to promote the teaching of physiology at colleges and universities (2), 10 programs awarding a BS or a bachelor of arts (BA) in physiology had been identified. In 2014, Wehrwein and colleagues (4) described 15 undergraduate programs offering BS degrees in physiology, integrative physiology, or human physiology. Many, if not most, of these physiology programs evolved from what had previously been kinesiology/exercise science programs. In addition, they identified 23 undergraduate degree programs in biology with an emphasis, concentration, or specialization in physiology, and 3 programs offering a bachelor’s degree in neuroscience/neurobiology combined with physiology (4). It is clear that the number of undergraduate programs offering degrees in physiology or an emphasis/concentration/specialization in physiology has increased tremendously over the last 15 years.

In addition to the increased number of domestic undergraduate programs offering BS degrees in physiology since 2000, enrollments in these physiology majors have also exploded during this time period. The physiology major at the University of Arizona College of Medicine is a prime example of this development (3). In 2000, there were 467 undergraduates enrolled in this program. This number increased to 1,260 by 2007, and by 2014 the number of physiology majors at the University of Arizona had reached 2,064, more than a fourfold increase since 2000. Impressive increases in enrollments in physiology programs have been experienced in other programs, such as the Integrative Physiology Program at the University of Colorado-Boulder (from 675 majors in 2003 to 1,916 in 2014) (Enoka R, personal communication), the BS in Human Physiology Program at the University of Iowa (from 175 in 2010 to 930 in 2014) (Kregel K, personal communication), the Human Physiology Program at the University of Oregon (from 254 in 2003 to 1,142 in 2014) (Haliwall I, personal communication), the Physiology and Human Biology Program at Michigan State University (from 700 in 2000 to over 1,600 in 2014) (Wehrwein E, personal communication), and the Human Physiology Program at Gonzaga University, a small, private institution (from 116 in 2009 to 162 in 2014) (McCann D, personal communication). In general, the growth of these physiology programs has far exceeded the increases observed in overall undergraduate enrollments at these institutions.

The Physiology Undergraduate Degree Curriculum

While there is no standardization of the curriculum in undergraduate physiology degree programs in the U.S., and there is no accrediting body for these programs, in general there are several common features in the course requirements of most domestic physiology undergraduate degree programs. These curricular requirements have been meticulously assessed by Erica Wehrwein and James Poteracki at Michigan State University (Ref. 4; and personal communications). A comprehensive discussion of the various curricular requirements of domestic undergraduate physiology degree programs is beyond the scope of this editorial. In brief, however, most physiology programs awarding the BS degree require up to two semesters of basic human anatomy and physiology lecture courses and laboratories, and several programs require upper division courses in cellular physiology, biochemistry, or genetics. Moreover, most of these programs have basic requirements in mathematics (up to calculus II or statistics), introductory biology, general and organic chemistry, and physics. All programs require successful completion of several upper division elective courses covering a wide variety of physiology specialty topics.

Aspirations of Physiology Undergraduate Majors

The vast majority of undergraduates enrolled in physiology degree programs have a long-term interest in a health profession, which requires substantial additional post-baccalaureate professional training. In 2013, we surveyed students at the University of Arizona graduating with a BS degree in physiology regarding their professional aspirations (Stanescu C, personal communication). Almost half indicated a desire to become a medical doctor (46%, with no differentiation between allopathic and osteopathic medicine). Other professional aspirations included physician assistant (15%), attaining a doctorate or Masters degree in a biological science program (10%), and a variety of other professional aspirations (24%). In general, the growth of these programs is a positive indicator of the increased interest in and recognition of the need for a professional education in physiology.
science (12%), physical therapy (10%), dentistry (4%), doctor of pharmacy (3%), optometry (2%), or various other professions (8%). These results generally confirmed those from a previous survey we conducted in 2010 (3). Informal conversations with faculty associated with other large domestic undergraduate physiology degree programs (e.g. Michigan State University, University of Colorado, University of Iowa, University of Oregon) have revealed that their students share these same general professional aspirations.

**Future Challenges for Undergraduate Physiology Programs**

Over the past 15 years, key academic departments at American universities have met the challenge of increasing the availability and capacity of programs designed to meet the needs of undergraduates seeking a BS degree in physiology. A key question that must be addressed at present and in the coming years is: Can the development of new physiology degree programs and the expansion of established undergraduate physiology programs continue to accommodate this ever-expanding demand? There are numerous factors at work that will make this a challenging task. First, these departments will need to hire additional faculty, both in the tenure track and in the lecturer track, to be able to provide instructors for the coursework that these programs demand. In light of retirements in an aging faculty population in many of these programs, this will be an especially demanding task. Second, with increasing enrollments in these programs, increased class sizes and additional sections of courses will be necessary, and the issue of classroom availability to meet these expanding needs will be challenging for many institutions. The prospect of online courses to meet this demand certainly merits discussion. Third, many institutions may have issues finding appropriate laboratory space for additional sections of large core courses, such as human anatomy and physiology. Finding well-trained ancillary personnel to run these laboratory sections, such as graduate teaching assistants and adjunct faculty, may be problematic. Fourth, there must be financial resources to pay for all of this, and an overriding issue at hand is the trend in many states for continued substantial reductions in financial support for their public university systems.

A final challenge relates to the question of whether these students actually achieve their professional goals following graduation with a BS degree in physiology. The general consensus among faculty associated with large undergraduate physiology programs is that an accurate determination of the professional outcomes of their graduates is an extremely difficult task. Anecdotal evidence indicates that many students ultimately do attain their post-graduation goals using their excellent physiology backgrounds. However, a critical challenge for undergraduate physiology programs will be the implementation of evidence-based strategies for determining the actual professional outcomes of these numerous physiology graduates.

In closing, it is clear that the demand for these undergraduate physiology degree programs in the U.S. remains very high, and institutions of higher education will continue to make every effort to create and expand programs to meet this demand for broad-based physiology education.

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**References**