

9-2020

The Case for Coordinating Efforts to Establish Program Guidelines and Strengthen Physiology Undergraduate Degree Programs


Erica A. Wehrwein
Michigan State University

Lisa C. Anderson
University of Minnesota - Twin Cities

Anne R. Crecelius
University of Dayton, acrecelius1@udayton.edu

Claudia I. Stanescu
University of Arizona

James M. Poteracki
Follow this author's additional works at: https://ecommons.udayton.edu/hss_fac_pub

 Part of the [Biomechanics Commons](#), [Exercise Physiology Commons](#), [Exercise Science Commons](#), [Musculoskeletal System Commons](#), [Sports Management Commons](#), [Sports Sciences Commons](#), and the [Sports Studies Commons](#)
See next page for additional authors

eCommons Citation

Wehrwein, Erica A.; Anderson, Lisa C.; Crecelius, Anne R.; Stanescu, Claudia I.; Poteracki, James M.; Halliwill, John R.; Aguilar-Roca, Nancy M.; and Rogers, Jennifer, "The Case for Coordinating Efforts to Establish Program Guidelines and Strengthen Physiology Undergraduate Degree Programs" (2020). *Health and Sport Science Faculty Publications*. 103.
https://ecommons.udayton.edu/hss_fac_pub/103

This Article is brought to you for free and open access by the Department of Health and Sport Science at eCommons. It has been accepted for inclusion in Health and Sport Science Faculty Publications by an authorized administrator of eCommons. For more information, please contact frice1@udayton.edu, mschlengen1@udayton.edu.

Author(s)

Erica A. Wehrwein, Lisa C. Anderson (0000-0003-2261-1921), Anne R. Crecelius, Claudia I. Stanescu, James M. Poteracki, John R. Halliwill (0000-0003-3001-1715), Nancy M. Aguilar-Roca, and Jennifer Rogers (0000-0003-3319-8124)

1 **The case for coordinating efforts to establish program guidelines and strengthen**
2 **physiology undergraduate degree programs**

3

4 Erica A Wehrwein¹, Lisa C Anderson², Anne R Crecelius³, Claudia I Stanescu³, James M
5 Poteracki⁵, John R Halliwill⁶, Nancy Aguilar-Roca⁷, and Jennifer Rogers⁸

6

7 1 Michigan State University, Department of Physiology, East Lansing, MI USA

8 2 University of Minnesota-Twin Cities Campus, Department of Integrative Biology and
9 Physiology, Minneapolis, MN USA

10 3 University of Dayton, Department of Health and Sport Science, Dayton, OH, USA

11 4 University of Arizona, Department of Physiology, Tucson, AZ, USA

12

13 5 Wake Forest University, Department of Integrative Physiology & Pharmacology, Winston-
14 Salem, NC USA

15 6 University of Oregon, Department of Human Physiology, Eugene, OR, USA

16 7 University of California, Irvine, Department of Ecology and Evolutionary Biology, Irvine CA,
17 USA

18 8 University of Iowa, Department of Health and Human Physiology, Iowa City, IA, US

19

20

21 **Corresponding Author:**

22 Erica A Wehrwein

23 567 Wilson Rd, Room 2201J BPS

24 East Lansing, MI 48823

25 517-884-5043

26 Wehrwei7@msu.edu

27

28

29

30 Undergraduate degree programs named “Physiology” have existed for over 50 years. The
31 number of programs and enrolled students has been growing since ~2005 (5, 8). There are
32 many thousands of students currently enrolled in physiology programs across the United States
33 and indeed across the world. Despite the long history and current popularity of the physiology
34 major, there is no coordinated plan articulated for the design, administration, or assessment of
35 degree programs in physiology at the undergraduate level.

36 Although several professional societies have invested in undergraduate physiology education in
37 various ways, none have undertaken the task of developing programmatic guidelines at the
38 level of a degree program. This paper outlines the work being done by multiple stakeholders in
39 physiology undergraduate education in the hopes of building a collaboration among interested
40 parties. A large-scale collaboration could result in establishing consensus national
41 programmatic guidelines. Through coordinated efforts, we ensure that entities with common
42 educational interests are working together, and we collectively strengthen our programs to help
43 our students succeed.

44 The goals of this paper are to: 1) draw attention to the lack of national, program-level guidelines
45 for physiology undergraduate degree programs, 2) share ongoing efforts by stakeholders in
46 physiology undergraduate education, 3) suggest a mechanism for coordination among
47 stakeholders, and 4) discuss challenges and considerations for development of programmatic
48 guidelines for physiology programs.

49 **1. Why care about the lack of national program-level guidelines for physiology**
50 **degree programs?**

51 Curriculum guidelines are used at the K-12 and higher education levels. Guidelines can help
52 educators make informed decisions about their courses, provide for a more uniform student
53 experience among different schools, serve as a basis for assessment, and can improve student

54 achievement (16). In higher education, many STEM fields have established community
55 consensus on undergraduate program-level guidelines in their respective disciplines, ranging
56 from minimal guidelines to full program accreditation (Table 1). Most guidelines focus
57 specifically on a sequence of courses, as this is the bedrock of any degree program.
58 Recommended course sequencing is particularly beneficial for design and establishment of new
59 programs. Some fields go beyond curricular content guidelines to establish broader
60 programmatic guidelines that include student learning outcomes to be achieved over a full
61 degree program. Programmatic guidelines may include professional skills development,
62 experiential learning, internships, advising, and career planning, in addition to field content
63 mastery.

64 Establishing program guidelines for undergraduate physiology majors would: A) define
65 fundamental physiology knowledge and skills, B) communicate to internal and external
66 audiences the strengths of an undergraduate physiology education, C) provide cohesive
67 guidelines for undergraduate physiology programs and departments, D) establish guidelines for
68 new and developing programs, E) ensure better preparation for students entering medical,
69 professional and graduate programs, and F) promote and articulate career readiness for
70 success in research, science education, healthcare, and other fields in which a scientific or
71 analytical background is advantageous. In the absence of guidelines, each program individually
72 sets the course offerings, course sequencing, and overall focus on the major based on local
73 expertise leading to lack of fidelity across programs. However, this is a problem because many
74 degrees have a physiology emphasis, but the degree is not called “physiology”.

75 **INSERT TABLE 1 HERE**

76

77 2. **What are the recent actions of societies in support of undergraduate physiology**
78 **education?**

79

80 Association of Chairs of Departments of Physiology (ACDP):

81 ACDP departments are primary focused on graduate and medical education, but an estimated
82 5% also include undergraduate programs. A key concern among the ACDP Chairs is that stand-
83 alone medical school physiology courses are being lost in favor of integrated curricula that
84 merge physiology into case-based learning and disease focused modules. Therefore,
85 physiology education at the undergraduate level becomes increasingly important. ACDP has an
86 interest in helping to set program guidelines for physiology undergraduate programs to ensure
87 that students entering medical school, other professional schools, and graduate programs have
88 the appropriate background for success.

89 With the intention of better understanding the training happening within undergraduate
90 physiology programs that educate the students enrolling in their graduate and medical schools,
91 ACDP hosted sessions at their annual leadership retreat on physiology undergraduate
92 programs in 2015, 2016 and 2018. Discussions were related to the current state of
93 undergraduate physiology programs, professional skills development at the undergraduate
94 level, and inclusion of the Core Concepts of Physiology (14) at the course- and program-
95 level. In 2016 ACDP established a committee to evaluate core concepts of physiology, or
96 recurring themes that apply to numerous physiological processes, recommended for inclusion in
97 undergraduate physiology coursework.

98

99 Human Anatomy and Physiology Society (HAPS):

100 HAPS has been a major contributor to anatomy and physiology (A&P) education. HAPS hosts
101 annual meetings to support A&P educators at all levels. It provides strong support in particular
102 for 4-year institutions and community colleges, hosts a community-driven discussion forum,
103 provides a vibrant community for educators, maintains learning outcomes for one and two-
104 semester A&P courses, and curates standardized exams for A&P courses. HAPS recently
105 released learning outcomes for stand-alone anatomy courses and is currently writing learning
106 objectives for stand-alone physiology courses at the undergraduate level. The HAPS anatomy
107 and physiology learning outcomes have been adapted by several major A&P textbook
108 publishers in the United States (21). This is a solid foundation upon which to build, bringing the
109 discipline a step closer to the establishment of a common set of learning outcomes that can be
110 applied at the program level.

111 American Physiological Society (APS):

112 Within the APS, engaged individuals have spoken on behalf of undergraduate education for
113 many decades and there have been multiple committees formed to address key issues. APS
114 sponsors both the Teaching Section and the Physiology Educators Committee (formerly
115 Education Committee). Since 2014, APS has hosted a biennial education-focused conference
116 for faculty who teach physiology at the college and medical school level (Institute on Teaching
117 and Learning). APS formerly kept a database of physiology undergraduate and graduate
118 programs in the USA.

119 A subcommittee of the APS Education Committee completed extensive work in 2014-2015 in
120 consideration of a certification process for undergraduate physiology programs, even drafting an
121 unpublished white paper on undergraduate degree programs and best practices for
122 engagement with undergraduate students. Key recommendations included: 1) host a recurring
123 networking session for physiology degree programs at Experimental Biology, investigate how
124 other societies support their related undergraduate programs, 2) investigate how other societies

125 support their related undergraduate programs, 3) generate a survey instrument to learn more
126 about undergraduate programs, 4) publish white papers on the issues facing undergraduate
127 education, 5) create a collection of relevant documents for undergraduate programs in
128 physiology, and 6) consider a grant to host a conference for undergraduate programs in
129 physiology. While this initiative for exploration and support of undergraduate programs within
130 APS did not materialize, direct support of undergraduate students has been accomplished
131 through a research-focused directive to host robust summer research fellowships (the APS
132 Undergraduate Summer Research Fellowship program) and conference travel awards to
133 support the pipeline of undergraduate students interested in careers in research. Recently,
134 undergraduate physiology education has been featured in several APS publications, indicating
135 the renewed and dedicated interest of APS (11, 18–20).

136 National Association of Advisors of Health Professional (NAAHP):

137 NAAHP is the society for higher education advisors for pre-health care career undergraduate
138 students. Therefore, it is a very important group for physiology program to coordinate with since
139 ~90% of students enrolled in our programs are aspirational pre-health track (15). This group is
140 well informed about admission requirements and updates for a wide range of programs
141 including medicine, physical therapy, and physician assistant. While to date there has not been
142 a formal partnership between NAAHP and physiology societies, this would be a natural
143 progression.

144 **3. A possible mechanism for coordinating efforts: The Physiology Majors Interest**
145 **Group (P-MIG)**

146 Briefly, the collegiate programs that joined the independent, grassroots collective called P-MIG
147 shared a focus on human and integrative physiology with a population of students that are
148 largely pre-health care track. P-MIG has been working across society boundaries since 2015

149 with a focus on issues at the level of the undergraduate degree program (17). P-MIG's diverse
150 membership can serve to coordinate of the efforts noted above to strengthen undergraduate
151 degree programs. See companion paper for more information about the history of P-MIG (17).
152 We envision co-hosting a "summit" where a representative from each of the various stakeholder
153 groups and other experts in discipline-based education research and curricular guidelines would
154 join to share ideas.

155 P-MIG currently has three committees devoted to development of program guidelines:
156 curriculum & core concepts, professional skills, and advising. These committees represent the
157 vision of P-MIG to provide guidance not only on the coursework and content in physiology, but
158 also to focus on excellent advising, career development, and professional skills training to
159 ensure career success regardless of a student's path. However, hiring trends show that many
160 students will track into different career paths despite their pre-health professional goals, which
161 are explored more in other papers in this collection. These committees are making progress on
162 this work, as well as pilot assessment, rubrics and other tools to assess the programs and
163 monitor student learning outcomes in the major (8, 13).

164 To serve the community, P-MIG has launched a website and listserv (22). We aim to keep a
165 repository of program resources and a list of physiology programs up to date. Teaching and
166 learning resources featured include tools for programmatic assessment, learning progressions
167 in physiology and other standardized assessments such as Phys-MAPS (12), professional skills
168 development (2, 3), concept inventories on homeostasis (9), core concepts of physiology,
169 course level learning objectives, and other course-specific resources. This serves as a
170 supplement to the plethora of resources for individual physiology courses provided by
171 publishers, individual faculty, in the literature on the scholarship of teaching and learning, and in
172 the LifeSciTRC (23).

173

174 P-MIG is the current incarnation of dedicated individuals who naturally joined forces to solve a
175 collective problem and share ideas about undergraduate education. The founding mission was
176 broad and simple – to address common issues facing undergraduate degree programs in
177 physiology, such as identifying best practices regarding course requirements and program
178 outcome measures. The timing of P-MIG launching coincided with a period of growth of
179 enrollment in programs and addition of new programs. There was a time when perhaps it was
180 perceived that the physiology major was dying, but given its resurgence, it is timely that a
181 national discussion takes places on what it means to be a physiology major. Certainly, this is
182 not the first, nor will it be the last, group to tackle challenges in physiology education. In fact, it is
183 not the first time a group convened to talk about program level issues. The group “stands on
184 the shoulders of giants”. It is only due to innumerable individual efforts and work within
185 stakeholder societies that any of the current work in P-MIG could be happening.

186

187 **4) If there are so many invested groups, why haven't programmatic guidelines for**
188 **physiology degree programs already been set?**

189 The issues that need to be addressed for developing program guidelines are largely in three
190 areas as revealed in P-MIG discussions with members: pre-health care focused students,
191 defining what a physiology major is, and determination of natural boundaries for inclusivity for
192 programs that would be served by guidelines.

193 A key issue that has likely contributed to the lack of guidelines is that the primary career
194 aspirations of students within physiology majors is a range of pre-health care tracks including
195 medicine, physician’s assistant, and physical therapy (7, 15). Therefore, the student body is not

196 strictly the purview of any single professional discipline or society. To complicate matters,
197 students may also pursue a range of other careers in research, policy, administration, and other
198 fields. Career aspirations and career trends are discussed in depth in the cited companion
199 papers (10, 15). Which society could oversee the whole of pre-health care student learning?
200 What society is most likely to oversee the curriculum for pre-health majors? What scientific
201 society is interested in the training of future health care providers in all sectors? How would a
202 society oversee top notch training for healthcare careers while also supporting the pipeline for
203 basic science research and other biomedical careers?

204

205 Another challenge in setting national programmatic guidelines is the diversity in what is
206 considered a “degree program in physiology”. In the Blue Book of College Majors, only
207 programs with the one-word title of “Physiology” are listed. We find this definition too limiting.
208 What if “physiology” is part of the program name (e.g. Human Physiology, Applied Physiology,
209 Integrative Physiology, Exercise Physiology, Comparative Physiology, Mammalian Physiology,
210 Plant Physiology, Cell Physiology)? What if “physiology” is a formal concentration or track within
211 a broader major (e.g. Biology with a focus in Physiology, Health Science with a concentration in
212 Physiology)? The National Center for Education Statistics Center degree coding system
213 (Classification of Instructional Codes (CIP)) allows for programs to choose their designation
214 based on the degree titles listed in **Table 2** (24). Would physiology program guidelines be
215 targeted at those who are listed under the broad heading “Physiology, Pathology and Related
216 Sciences” or should it be limited to “Physiology, General”? Are forthcoming program guidelines
217 to based on the name of the degree, the CIP code, the student career aspirations in the major,
218 the common courses in the curriculum, or something else?

219 **INSERT TABLE 2 HERE**

220 Degree programs are commonly named by the discipline or department that contributes most of
221 the courses to the program. Physiology defies this convention because of its dependence on
222 multiple natural sciences (e.g. biology, chemistry, physics, biochemistry) and inherently
223 interdisciplinary qualities. Depending on the size and type of institution, it may not be possible
224 or realistic to have an entire department devoted to physiology. Thus, when thinking of
225 programs that are “physiology programs” we must be fairly inclusive in particular with respect to
226 small schools who do not have a physiology department.

227 Since the founding members of P-MIG were all from programs titled physiology that served
228 aspirational pre-health students (17), the emphasis of P-MIG thus far has been on human
229 and/or integrative physiology. Programs with common student career goals and an emphasis
230 on human/integrative physiology have joined P-MIG seeing themselves as similar. Those that
231 do not formally include physiology in the title (e.g. exercise science, health science, or
232 integrative biology) may consider themselves “physiology” programs if they contain multiple
233 physiology courses and have similar programmatic goals or if they have selected a CIP code in
234 that category. P-MIG members’ programs, regardless of degree title, are active in the group,
235 participate in committees, and seek for the guidelines to be inclusive to their programs.

236 Given the above complexities, it would be hard to argue that all degree programs that have
237 physiology in a title, or see themselves as physiology-focused, could all have the same needs.
238 This makes the probability unlikely that one set of highly prescriptive standards or an
239 accreditation model for all programs would be appropriate. It would be more likely that a more
240 general set of overarching program guidelines would be more suitable.

241

242 Despite the challenges of defining a physiology major from a wide range of programs names
243 and types, program guidelines has been developed to address a range of named programs that

244 serve students interested in diverse careers has been accomplished by other
245 organizations. The American Kinesiology Association (AKA) has published program guidelines
246 and departmental rubrics for their undergraduate programs (6). Much can be learned from the
247 AKA guideline model because: 1) it serves an excellent model for a national society to take the
248 lead on setting and maintaining program guidelines at the undergraduate level, 2) it is a model
249 for future Physiology program guidelines because there is some crossover of student interest
250 whom these programs serve (e.g. physical therapy), and 3) AKA has generated rubrics and
251 guidance for programs evaluation using the guidelines. In fact, some have even argued that
252 perhaps the work of AKA can include physiology programs. However, there are distinctions
253 such as the focus on exercise physiology and the predominance of pre-physical therapy track
254 students over pre-medical students make the AKA guidelines not applicable to many of the
255 programs in P-MIG. Therefore, while the work of AKA may be exemplar, it is insufficient for
256 many programs (1, 8, 13).

257

258 Current Status and Next Steps

259 This paper is part of a special collection of papers in which P-MIG members report in detail on
260 the efforts to date for writing curriculum guidelines that include the core concepts of physiology
261 (4, 14), best practices for advising the physiology student (4), considerations for incorporation of
262 professional skills development in degree programs (5), the launch of a novel curriculum
263 mapping tool to allow alignment of course objectives to program guidelines (13), applications
264 and utility for program guidelines (8), and a comprehensive. Please refer to our future directions
265 paper (1) that serves as a summary of the collection and articulates a plan for how the
266 community can move forward together. As noted above, a “summit” of stakeholders would be a
267 productive next step. In addition, we are seeking partnerships with experts in curricula reform,

268 survey methods, and physiology education research to join this work to meet the needs
269 identified by the P-MIG membership.

270

271 Summary

272 There are numerous stakeholders that support undergraduate physiology education in
273 meaningful ways, namely APS, HAPS, ACDP, NAAHP, and many key individual educators. P-
274 MIG is immensely grateful to those who came before us and laid the foundation for our work as
275 we seek to partner in establishing national guidelines for programs. P-MIG is taking the lead to
276 better understand what a physiology major is and help articulate a unified vision of excellence in
277 physiology degree programs worldwide. This work will benefit the student learning experience in
278 our programs, faculty designing courses in the majors, overall cohesion among related
279 programs, and will enhance career success for our graduates.

280

281 ***This paper is published as part of a special collection/special issue from P-MIG, a grass-***
282 ***roots organization that has formed to help develop programmatic guidelines and serve***
283 ***those engaged in undergraduate physiology or physiology-related programs. To find out***
284 ***more about this collective, or get involved, please visit our website***
285 ***(<https://www.physiologymajors.org>) and consider joining our listserv.***

286

287 Acknowledgements

288 PMIG would like to recognize the individual supports who are leading the direction of the
289 discussion on undergraduate programs within ADCP: Michael Sturek, T. Richard Nichols, and

290 Janice Urban as well as Carissa Krane for leading the APS Education Committee in their work.
291 In addition, we recognize the decades of efforts by many individuals that have shaped
292 undergraduate education in physiology. In particular, we recognize the efforts for establishing
293 the Core Concepts of Physiology upon which future guidelines will be based.

294 **References**

- 295 1. **Aguilar-Roca N, Crecelius A, McFarland J, Rogers J, Wehrwein E.** Where do we go
296 from here: a forward thinking vision for physiology undergraduate degree programs. .
- 297 2. **Choate J, Demaria M, Etheve M, Cran S, Carroll D.** A professional development program
298 with an assessed ePortfolio: A practical solution for engaging undergraduates with their
299 career development in large student cohorts. *Journal of Teaching and Learning for*
300 *Graduate Employability* 10: 86–103, 2019. doi: 10.21153/jtlge2019vol10no2art788.
- 301 3. **Choate J, Harrison L.** Why Do Science Students Study Physiology? Career Priorities of
302 21st Century Physiology Undergraduates. *HAPS ED* 23: 53–63, 2019. doi:
303 10.21692/haps.2019.010.
- 304 4. **Crecelius A, Crosswhite P.** Advising Physiology Students: Perceptions from the Programs.
305 *Advances in Physiology Education* 44, 2020.
- 306 5. **French M, Choate J, Zubek J, Bryner R, Johnson K, Luttrell M.** Professional skills for
307 physiology majors: Defining and refining. *Advances in Physiology Education* 44, 2020.
- 308 6. **Henriksen EJ.** Undergraduate Physiology Degree Programs in the United States: from
309 Famine to Feast. *Physiology* 30: 254–255, 2015. doi: 10.1152/physiol.00015.2015.
- 310 7. **Henriksen EJ, Atwater AE, Delamere NA, Dantzler WH.** The Physiology undergraduate
311 major in the University of Arizona College of Medicine: past, present, and future. *Advances*
312 *in Physiology Education* 35: 103–109, 2011. doi: 10.1152/advan.00089.2010.
- 313 8. **Johnson K.** Putting the guidelines to work: Moving from physiology undergraduate
314 curricular guidelines to program development and improvement. .

- 315 9. **McFarland JL, Price RM, Wenderoth MP, Martinková P, Cliff W, Michael J, Modell H,**
316 **Wright A.** Development and Validation of the Homeostasis Concept Inventory. *CBE Life Sci*
317 *Educ* 16, 2017. doi: 10.1187/cbe.16-10-0305.
- 318 10. **Rogers J, McFarland J, Stanescu C, Crosswhite P, Crecelius A.** The 2019 P-MIG
319 Student Survey and Capturing the Undergraduate Perspective of Physiology Programming.
320 .
- 321 11. **Sedler J.** Anatomy of a Physiology Major. *Physiology* 30: 256–257, 2015. doi:
322 10.1152/physiol.00020.2015.
- 323 12. **Semsar K, Brownell S, Couch BA, Crowe AJ, Smith MK, Summers MM, Wright CD,**
324 **Knight JK.** Phys-MAPS: a programmatic physiology assessment for introductory and
325 advanced undergraduates. *Advances in Physiology Education* 43: 15–27, 2019. doi:
326 10.1152/advan.00128.2018.
- 327 13. **Shaltry C.** A New Model for Organizing Curriculum Alignment Initiatives. .
- 328 14. **Stanescu C, Wehrwein E, Anderson L, Rogers J.** Evaluation of Core Concepts of
329 Physiology in Physiology Curricula: Results from Faculty Surveys. *Advances in Physiology*
330 *Education* 44, 2020.
- 331 15. **Steele KJ, VanRyn VS, Stanescu CI, Rogers J, Wehrwein E.** Student career aspirations,
332 employment paths, and perceptions on career preparation in undergraduate physiology
333 degree programs. .
- 334 16. **Steiner D.** *Curriculum Research: What We Know and Where We Need to Go.* Standards
335 Work, 2017.

- 336 17. **Wehrwein E, Poteracki J, Halliwill J.** A brief history of the Physiology Majors Interest
337 Group (P-MIG), physiology undergraduate degrees, and existing resources for
338 undergraduate degree programs. *Advances in Physiology Education* 44: 2020, [date
339 unknown].
- 340 18. **Wehrwein EA.** Physiology is Alive and Well. Just ask an undergraduate student [Online].
341 *The Physiologist* 59, 2016. [https://web.archive.org/web/20170626181539/http://www.the-](https://web.archive.org/web/20170626181539/http://www.the-aps.org/mm/Publications/Journals/Physiologist/Archive/2016-Issues/November-2016-Vol-59No-6)
342 [aps.org/mm/Publications/Journals/Physiologist/Archive/2016-Issues/November-2016-Vol-](https://web.archive.org/web/20170626181539/http://www.the-aps.org/mm/Publications/Journals/Physiologist/Archive/2016-Issues/November-2016-Vol-59No-6)
343 [59No-6](https://web.archive.org/web/20170626181539/http://www.the-aps.org/mm/Publications/Journals/Physiologist/Archive/2016-Issues/November-2016-Vol-59No-6).
- 344 19. **Wehrwein EA.** Physiology: Dying ... or Thriving? *The Physiologist* Sept. 2019, 2019.
- 345 20. **Whaley B.** Integration and Inspiration: A Spartan's Take on Physiology. *Physiology* 31:
346 388–389, 2016. doi: 10.1152/physiol.00028.2016.
- 347 21. HAPS Learning Outcomes - Human Anatomy and Physiology Society [Online]. [date
348 unknown]. https://www.hapsweb.org/page/Learning_Outcomes [2 Jul. 2020].
- 349 22. Physiology Majors Interest Group [Online]. *pmig*: [date unknown].
350 <https://www.physiologymajors.org> [9 Dec. 2019].
- 351 23. LifeSciTRC.org - Life Science Teaching Resource Community [Online]. [date unknown].
352 <https://www.lifescitrc.org/> [3 Jul. 2020].
- 353 24. National Center for Education Statistics [Online]. *IPEDS Classification of Instructional*
354 *Programs (CIP): Physiology*. [date unknown].
355 <https://nces.ed.gov/ipeds/cipcode/searchresults.aspx?y=56&aw=Physiology> [2 Jul. 2020].
- 356

Table 1: National curricular guidance provided by discipline professional societies for undergraduate degree programs

No Undergraduate Guidelines
American Physiological Society
Course Level Guidelines
Human Anatomy and Physiology Society
American Society for Plant Biologists
Recommended Curricular Guidelines
American Kinesiology Association
American Society for Microbiology
Mathematics Association of America
American Association of Physics Teachers
Ecological Society of America
Approval/Certification of Programs
American Chemical Society
National Association for Biology Teachers
Accreditation
National Accrediting Agency for Clinical Laboratory Sciences

American Society of Biochemistry and Molecular Biology

Table 2: National Education Statistics Center Classification of Instructional Codes

Physiology, Pathology and Related Sciences
Physiology, General
Molecular Physiology
Cell Physiology
Endocrinology
Reproductive Biology
Cardiovascular Science
Exercise Physiology and Kinesiology
Visions Science/Physiological Optics
Pathology/Experimental Pathology
Oncology and Cancer Biology
Biomechanics
Physiology, Pathology, and Related Science, Other
Health/Medical Preparatory
Pre-Dentistry Studies
Pre-Medicine/Pre-Medical Studies
Pre-Pharmacy Studies
Pre-Veterinary Studies
Pre-Nursing Studies
Pre-Chiropractic Studies
Pre-Occupational Therapy
Pre-Optometry
Pre-Physical Therapy
Health/Medical Preparatory Programs, Others
Biology, General
Biology/Biomedical Sciences, General
Biomedical Sciences, General
Biological and Biomedical Science, Other
Biological and Biomedical Science, Other
Zoology/Animal Biology
Animal Physiology