CORE CONCEPTS BIBLIOGRAPHY

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This bibliography contains some 100 articles pertaining, directly or indirectly, to the core concepts of physiology. I make no claims that it is in any sense complete. I am sure there are older articles I have not seen, and new articles are appearing almost daily. I will be updating the list as often as I can.

The citations have been checked for correctness, but they are not in a consistent format.

I have tagged each citation with indications of the topic(s) dealt with in the paper. Below is the description of the categories for which I have created tags.

- [1] Foundations and reforms of bioscience education
- [2] Defining Core Concepts of Physiology
- [3] Conceptual frameworks
- [4] Concept Inventories and assessment
- [5] Implementation of core concepts in the classroom (course)
- [6] Implementation of core concepts in the curriculum
- [7] Specific core concepts
- [8] Resources for teaching with core concepts
- [9] Outcomes of teaching with core concepts
- [A] Cell-cell communication
- [B] Cell membrane
- [C] Cell theory
- [D] Energy
- [E] Evolution
- [F] Flow down gradients
- [G] Genes to proteins
- [H] Homeostasis
- [I] Levels of organization

- [J] Local control
- [K] Mass balance
- [L] Physical properties of matter
- [M] Scientific reasoning
- [N] Structure/function
- [O] System integration
- [P] Other core concepts of Physiology
- [Q] Core concepts in other biosciences
- [R] Core concepts in other STEM disciplines

You can you use Word's "Find" function to search for articles on the topics that interests you.

Please address any comments to jmichael40@gmail.com.

American Association for the Advancement of Science. *Vision and Change in Undergraduate Biology Education: A Call to Action*. Washington DC, 2011. **[1]**

Anderson DL, Fisher KM, Norman GJ. Development and Evaluation of the Conceptual Inventory of Natural Selection. *J Res Sci Teach* **39**: 952-978, 2002. doi.org/10.1002/tea.10053 **[4] [Q]**

Arthur, W. The emerging conceptual framework of evolutionary developmental biology. *Nature* **415**, 757–764, 2002. https://doi.org/10.1038/415757a **[3] [Q]**

Association of American Medical Colleges and Howard Hughes Medical Institutes. *Scientific foundations for future physicians*. Washington, DC, 2011. **[1]**

Ball KL. Foundations in physiology: an introductory course using the core concepts. *Adv Physiol Educ* **47**: 501-507, 2023. doi:10.1152/advan.00135.2022 **[5]**

Banerjee A, Ahmad A, Bhalla P, et al. (August 10, 2023) Assessing the Efficacy of ChatGPT in Solving Questions Based on the Core Concepts in Physiology. *Cureus* **15**(8): e43314. doi:10.7759/cureus.43314 **[4]**

Billman GE. Homeostasis: The underappreciated and far too often ignored central organizing principle of physiology. *Front Physiol* **11**:200, 1-12, 2020. doi.org/10.3389/fphys.2020.00200 **[7] [H]**

Branchaw JL, Pape-Lindstrom PA, Tanner KD, Bissonnette SA, Cary TL, Couch BA, Crowe AJ, Knight JK, Semsar K, Smith JI, Smith MK, Summers MM, Caroline J. Wienhold C, Wright CD, Brownell SE. Resources for Teaching and Assessing the *Vision and Change* Biology Core Concepts. *CBE-Life Sci Educ* 19, Issue 201 Jan 2020. <u>doi.org/10.1187/cbe.19-11-0243</u> **[8]**

Brown D, Uebergang T, Masters N, Towstoless M, Hayes A, Hryciw DH, Lexis L, Tangalakis K, Task Force. Unpacking the "movement of substances" core concept of physiology by an Australian team. *Adv Physiol Educ* **47**: 514-520, 2023. doi:10.1152/advan.00149.2022 **[3] [F]**

Brownell SE, Freeman S, Wenderoth MP, Crowe AJ. BioCore Guide: A Tool for Interpreting the Core Concepts of Vision and Change for Biology Majors. *CBE—Life Sci Educ* **13**: 200–211, 2014. **[6]**

Carter KP, Prevost LB. Formative assessment and student understanding of structure-function. *Adv Physiol Educ* **47**: 615-625, 2023. doi:10.1152/advan.00215.2022 **[4] [N]**

Cary T, Branchaw J. Conceptual Elements: A Detailed Framework to Support and Assess Student Learning of Biology Core Concepts. *CBE—Life Sci Educ* **16** (2), Jun 2017. doi.org/10.1187/cbe.16-10-0300 **[4] [Q]**

Cary TL, Wienhold CJ, Branchaw J. A Biology Core Concept Instrument (BCCI) to Teach And Assess Student Conceptual Understanding. *CBE—Life Sci Educ* **18** (3), 2019. doi.org/10.1187/cbe.18-09-0192 **[4] [Q]**

Cerchiara JA, Kim KJ, Meir E, Wenderoth MP, Doherty JH. A new assessment to monitor student performance in introductory neurophysiology: Electrochemical Gradients Assessment Device. *Adv Physiol Educ* **43**:211–220, 2019. doi:10.1152/advan.00209.2018. **[4] [P]**

Champagne Queloz A, Klymkowsky MW, Stern E, Hafen E, Köhler K (2017) Diagnostic of students' misconceptions using the Biological Concepts Instrument (BCI): A method for conducting an educational needs assessment. *PLoS* ONE 12(5): e0176906. doi.org/10.1371/journal.pone.0176906 **[4] [Q]**

Chen A, Phillips KA, Schaefer JE, Sonner PM. Community-Derived Core Concepts for Neuroscience Higher Education. *CBE—Life Sci Educ* **22** (2), 2023. doi.org/10.1187/cbe.22-02-0018 **[Q]**

Chopin LK, Choate J, Rathner JA, Towstoless M, Hayes A, Hryciw DH, Lexis L, Tangalakis K, and Task Force. Unpacking and validating the "cell-cell communication" core concept of physiology by an Australian team. *Adv Physiol Educ* **47**: 443-452, 2023, doi:10.1152/advan.00145.2022 **[3] [A]**

Christianson RG, Fisher, KM. Comparison of student learning about diffusion and osmosis in constructivist and traditional classrooms. *Inter J Sci Educ* **21** (6): 687-698, 1999. **[9] [F]**

Cliff WH. Teaching with core concepts to facilitate the integrated learning of introductory organismal biology. *Adv Physiol Educ* **47**: 562-572, 2023. doi:10.1152/advan.00134.2022 **[5] [Q]**

Cooper SJ. From Claude Bernard to Walter Cannon. Emergence of the concept of homeostasis. *Appetite* **51**: 419-427, 2008. **[7] [H]**

Couch BA, Wood WB, Knight JK. The Molecular Biology Capstone Assessment: A Concept Assessment for Upper-Division Molecular Biology Students. *CBE—Life Sci Educ* 14 (1), 2017. doi.org/10.1187/cbe.14-04-0071 [4] [Q]

Couch BA, Wright CD, Freeman S, Knight JK, Semsar K, Smith MK, Summers MM, Zheng Y, Crowe AJ, Brownell SE. GenBio-MAPS: A Programmatic Assessment to Measure Student Understanding of *Vision and Change* Core Concepts across General Biology Programs. *CBE—Life Sci Educ* **18** (1), 2019. https://doi.org/10.1187/cbe.18-07-0117 **[4] [Q]**

Crosswhite PL, Anderson LC. Physiology core concepts in the classroom: reflections from faculty. *Adv Physiol Educ* **44**, 640-645, 2020. doi:10.1152/advan.00183.2019.6401043-4046/20 **[5]**

Crowther GJ. Teaching the Core Concepts of Physiology: What, Why, and How. *CBE—Life Sci Educ* **16** (4), 2017. doi.org/10.1187/cbe.17-09-0198 **[5]**

Crowther GJ, Knight TA. Using Test Question Templates to teach physiology core concepts. *Adv Physiol Educ*, **47**: 202-214, 2023. Mar 17. doi:10.1152/advan.00024.2022 **[4] [8]**

D'Avanzo C. Biology concept inventories: Overview, status, and next steps. *Bioscience* **58**: 1-7, 2008. **[4] [Q]**

D'Avanzo C. Post–*Vision and Change*: Do We Know How to Change? *CBE—Life Sci Educ* **12** (3), 2017. doi.org/10.1187/cbe.13-01-0010 **[1]**

Deane T, Nomme K, Jeffery E, Pollock C, Birol G. Development of the Biological Experimental Design Concept Inventory (BEDCI). *CBE—Life Sci Educ* **13** (3), 2017. doi.org/10.1187/cbe.13-11-0218 **[4] [M]**

Doherty JH, Scott EE, Cerchiara JA, Jescovitch LN, McFarland JL, Haudek KC, Wenderoth MP. What a Difference in Pressure Makes! A Framework Describing Undergraduate Students' Reasoning about Bulk Flow Down Pressure Gradients. *CBE-Life Sci Educ* **22** (2), 2023. doi.org/10.1187/cbe.20-01-0003 **[3] [F]**

Duschl RA, Schweingruber HA, Shouse AW. *Taking science to school: Learning and teaching science in grades K-8*. Washington, DC: National Academies Press, 2007. **[1]**

Elizabeth AH, Beckett, VG, Bakker AJ, Towstoless M, Hayes A, Hryciw DH, Lexis L, Tangalakis K, and Task Force. Unpacking the homeostasis core concept in physiology: an Australian perspective. *Adv Physiol Educ* **47**: 427-435, 2023; doi:10.1152/advan.00141.2022 **[3] [H]**

Etherington SJ, Callan N, Koh SH, Hourani T, Nolton, M. Re-creating an introductory physiology unit in the Core Concepts form - helping students to think like a physiologist. *Adv Physiol Educ* **47**: 638–651, 2023. doi:10.1152/advan.00027.2022 **[5]**

Etherington SJ, Moorhouse AJ, Paravicini TM, Towstoless M, Hayes A, Hryciw DH, Lexis L, Tangalakis K, Task Force. Unpacking and validating the 'Cell Membrane' Core Concept of Physiology by an Australian team. *Adv Physiol Educ* **47**: 575-581, 2023. doi:10.1152/advan.00143.2022 **[3] [B]**

Feder ME. Aims of undergraduate physiology education: a view from the University of Chicago. *Adv Physiol Educ* **29**: 3-10, 2004. **[2]**

Fisher KM, Williams KS, Lineback J. Osmosis and diffusion conceptual assessment. *CBE-Life Sci Educ* **10** (4):418-29, 2017. https://www.lifescied.org/doi/abs/10.1187/cbe.11-04-0038. **[4] [F]**

Garvin-Doxas K, Klymkowsky M, Elrod S. Building, using, and maximizing the impact of concept inventories in the biological sciences: Report on a National Science foundation-sponsored conference on the construction of concept inventories in the biological sciences. *CBE-Life Sci Educ* **6** (4): 277-282, 2007. doi.org/10.1187/cbe.07-05-0031 **[4] [Q]**

Gormally C, Brickman P, Lutz M. Developing a test of scientific literacy skills (TOSLS): Measuring undergraduates' evaluation of scientific information and arguments. *CBE—Life Sci Educ* **11**(4), 364-377, 2007. doi.org/10.1187/cbe.12-03-0026 **[4] [M]**

Hake RR (1998). Interactive-engagement versus traditional methods: a six-thousand-student survey of mechanics test data for introductory physics courses. *Am J Physics* 66: 64-74. [1] [R]

Halpin P. (2014, November 17). Core Concepts in Animal Physiology. [Online forum Blogger] Core concepts in Animal Physiology were generated by the APS ITL--Animal Physiology Group at the APS Institute on Teaching and Learning Physiology. Physiology Educator Community of Practice (PECOP) Blog. Retrieved from https://blog.lifescitrc.org/pecop/2014/11/17/creatingcore-concepts-in-animal-physiology/ **[2]**

Harlen W. *Principles and big ideas of science education*. Hatfield, UK: Association for Science Education, 2010. **[1]**

Hayes A, Tangalakis K. Australian core concepts to align learning outcomes, curriculum design, and assessment. *Adv Physiol Educ* **47**: 582-583, 2023. doi:10.1152/advan.00213.2022 **[6][4]**

Hiatt A, Davis GK, Trujillo C, Terry M, French DP, Price RM, Perez KE. Getting to Evo-Devo: Concepts and Challenges for Students Learning Evolutionary Developmental Biology. *CBE—Life Sci Educ* **12** (3), 2017. doi.org/10.1187/cbe.12-11-0203 **[Q]**

Howard Hughes Medical Institute (HHMI). BioInteractive Teaching Resources. 22 April 2020. https://www.biointeractive.org/classroom-resources/ **[8]**

Hsu JL, Halpin PA. Exploring physiology instructors' use of core concepts: pedagogical factors that influence choice of course topics. *Adv Physiol Educ* **46**: 667-676, 2022. doi:10.1152/advan.00114.2022 **[5]**

Hull K, Jensen M, Gerrits R, Ross K. Core concepts for anatomy and physiology: A paradigm shift in course and curriculum design. *HAPS Educator* **21**(2): 73-79, 2017. **[5] [6]**

Human Anatomy and Physiology Society (HAPS). HAPS Anatomy and Physiology Learning Outcomes [online resource]. https://www.hapsweb.org/page/Learning_Outcomes, 2019. [9]

Kalinowski ST, Leonard MJ, Taper ML. Development and Validation of the Conceptual Assessment of Natural Selection (CANS). *CBE—Life Sci Educ* **15** (4), 2017. doi.org/10.1187/cbe.15-06-0134 **[4] [Q]**

Kaminske AN, Kuepper-Tetzel CE, Nebel CL, Sumeracki MA, Ryan SP. Transfer: A Review for Biology and the Life Sciences. *CBE—Life Sci Educ* **19** (3), 2020. doi.org/10.1187/cbe.19-11-0227 **[9] [Q]**

Khodor J, Halme DG, Walker GC. A Hierarchical Biology Concept Framework: A Tool for Course Design. *Cell Bio Educ* **3**(2): 111–121, 2004. doi: 10.1187/cbe.03-10-0014 **[3] [5]**

Kiesewetter A, Schmiemann P. Understanding Homeostatic Regulation: The Role of Relationships and Conditions in Feedback Loop Reasoning. *CBE—Life Sci Educ* **21**(3), 2022. doi.org/10.1187/cbe.21-04-0092 **[7] [H]**

Klymkowski MW. Thinking about the Conceptual Foundations of the Biological Sciences. *CBE*—*Life Sci Educ* **9** (4): 405-407, 2010. doi.org/10.1187/cbe.10-04-0061 **[1] [Q]**

Klymkowsky MW, Underwood SM, Garvin-Doxas R. Biological Concepts Instrument (BCI): A diagnostic tool for revealing student thinking. *arXiv preprint arXiv:1012.4501*. 2010. [4] [Q]

Kohn KP, Underwood SM, Cooper MM. Connecting Structure–Property and Structure–Function Relationships across the Disciplines of Chemistry and Biology: Exploring Student Perceptions. *CBE—Life Sci Educ* Volume **17** (2), 2018. doi.org/10.1187/cbe.18-01-0004 **[7] [N]**

Kuang SY. Advancing physiology education by understanding the multiple dimensions of homeostasis. *Front Physiol* **14**:1234214, 2023. doi: 10.3389/fphys.2023.1234214 **[7] [H]**

Lewis J, Leach J, Wood-Robinson C. Chromosomes: The Missing Link - young people's understanding of mitosis, meiosis and fertilization. *J Bio Educ* **34**(4): 189-199, 2000. **[7] [G]**

Lewis J, Wood-Robinson C. Genes, chromosomes, cell division and inheritance - do students see a relationship? *Int J Sci Educ* **22**(2): 177-195, 2000. **[7] [C]**

Luckie DB, Hoskinson AM, Griffin CE, Hess AL, Price KJ, Tawa A, Thacker SM. *Integrating Concepts in Biology* Textbook Increases Learning: Assessment Triangulation Using Concept Inventory, Card Sorting, and MCAT Instruments, Followed by Longitudinal Tracking. *CBE—Life Sci Educ* **16** (2), 2017. https://doi.org/10.1187/cbe.16-06-0204 **[4] [Q]**

Mahaffey AL. Examining the impact of the core principles of physiology with prelicensure BSN and BSES students: a qualitative analysis. *Adv Physiol Educ* **47**: 251-258, 2023. doi:10.1152/advan.00076.2022 **[6]**

Malmquist S. Flux, gradient and resistance. *HAPS Educator* **21**(Suppl.2): 44-49, 2017. doi: 10.21692/haps.2017.038. **[7] [F]**

Marbach-Ad G, Stavy R. Students' Cellular and Molecular Explanations of Genetic Phenomena. *J Bio Educ* **34**(4): 200-205, 2000. **[7] [Q]**

Marbach-Ad G. Attempting to break the code in student comprehension of genetic concepts. *J Bio Educ* **35**(4):183-189, 2001. **[7] [Q]**

Marbach-Ad, G, Briken V, Frauwirth K, Gao L-Y, Hutcheson SW, Joseph SW, Mosser D, Parent B, Shields P, Song W, Stein DC, Swanson K, Thompson KV, Yuan R, Smith AC. A Faculty Team Works to Create Content Linkages among Various Courses to Increase Meaningful Learning of Targeted Concepts of Microbiology. *CBE--Life Sci Educ* **6**(2), 155–162, 2007. doi.org/10.1187/cbe.06-12-0212 **[6] [Q]**

McDaniel MA, Cahill MJ, Frey RF, Limeri LB, Lemons PP. Learning Introductory Biology: Students' Concept-Building Approaches Predict Transfer on Biology Exams. *CBE—Life Sci Educ* **21(**4), 2022. doi.org/10.1187/cbe.21-12-0335 **[9] [Q]**

McFarland JL, Michael JA. Reflections on core concepts for undergraduate physiology programs. *Adv Physiol Educ* 44:626-631, 2020. **[6]**

McFarland, JL, Price, RM, Wenderoth, MP, Martinková, P, Cliff, W, Michael, J, Modell, H, Wright, A. Development and validation of the Homeostasis Concept Inventory. *CBE-Life Sci Educ* **16** (2):ar35, 2017. doi.org/10.1187/cbe.16-10-0305 **[4] [H]**

McFarland J, Wenderoth, MP, Michael J, Cliff W, Wright A, Modell H. A conceptual framework for homeostasis: development and validation. *Adv Physiol Educ* **40**: 213-222, 2016. **[3] [H]**

Michael C, Silverthorn, DU, Predrag V. Core Concepts in Physiology: Teaching Homeostasis through Pattern Recognition. *Adv Physiol Educ*, **45**: 818-828, 2021. doi:10.1152/advan.00106.2021 **[7] [H]**

Michael J. Conceptual assessment in the biological sciences: A National Science Foundationsponsored workshop. *Adv Physiol Educ* **31**:389-391, 2007. **[1] [4]**

Michael J. What do we mean when we talk about "structure/function" relationships? *Adv Physiol Educ* 45: 880-885, 2021. **[3] [N]**

Michael, J. Use of core concepts of physiology can facilitate student transfer of learning. *Adv Physiol Educ* 46: 438-442, 2022. **[9]**

Michael, J, Cliff, C, McFarland, J, Modell, H, Wright, A. *The core concepts of physiology: A new paradigm for teaching physiology.* New York: Springer Nature, 2017. **[2] [5] [6]**

Michael J, Martinkova P, McFarland L, Wright A, Cliff W, Modell H. Validating a conceptual framework for the core concept of cell-cell communication. *Adv Physiol Educ* **41**: 260-265 2017. **[3] [A]**

Michael J, McFarland J. The core principles ("big ideas") of physiology: results of faculty surveys. *Adv Physiol Educ* **35**: 336-341, 2011. **[2]**

Michael J, McFarland J. Another look at the core concepts of physiology: Revisions and resources. *Adv Physiol Educ* 44: 752-762, 2020. **[2] [8]**

Michael J, McFarland J. The core concepts of physiology learning module. American Physiology Society, Center for Physiology Education, 2022. https://www.physiology.org/professional-development/career/cpe/teaching-integrative-physiology/core-concepts?SSO=Y [2]

Michael J, McFarland J. Letter to the Editor: Core concepts are a guide not a mandate. *HAPS Educ* 27 (1): 4-5, 2023. **[2] [5]**

Michael J, McFarland J, Wright A. The second Conceptual Assessment in the Biological Sciences workshop. *Adv Physiol Educ* **32**: 248-251, 2008. **[1] [4]**

Michael JA, Modell HI. *Active learning in secondary and college science classrooms: A working model for learning the learner to learn*. Mahwah, NJ: Lawrence Erlbaum Associates Publishers, 2003. **[1]**

Michael J, Modell H. A conceptual framework for the core concept of "cell membrane." *Adv Physiol Educ* **43**: 373–377, 2019. doi:10.1152/advan.00051.2019 **[3] [B]**

Michael J, Modell H. Validating the core concept of "mass balance." *Adv Physiol Educ* 45: 276-280, 2021. **[3] [K]**

Michael J, Modell H, McFarland J, Cliff W. The "core principles" of physiology: What should students understand? *Adv Physiol Educ* **33**: 10-16, 2009. **[2]**

Modell HI. How to help students understand physiology? Emphasize general models. *Adv Physiol Educ* **23**: 101-107, 2000. **[2]**

Modell H, Cliff W, Michael J, McFarland J, Wright A. A physiologist's view of homeostasis. *Adv Physiol Educ.* **39**, 259-266, 2015. **[7] [H]**

Momsen J, Speth EB, Wyse S, Long T. Using Systems and Systems Thinking to Unify Biology Education. *CBE—Life Sci Educ* Volume **21**(2), 2022. doi.org/10.1187/cbe.21-05-0118 **[O] [Q]**

Moro C, Douglas T, Phillips R, Towstoless M, Hayes A, Hryciw DH, Lexis L, Tangalakis K and Task Force. Unpacking and validating the "integration" core concept of physiology by an Australian team. *Adv Physiol Educ* **47**: 436-442, 2023. doi:10.1152/advan.00144.202 **[3] [O]**

Murphy MP, Hung W. Exploring progressive mental model representation of core physiology concepts in physician assistant students through word frequency and association analyses. *Adv Physiol Educ* **47**: 673-687, 2023. doi:10.1152/advan.00124.2022 **[4] [9]**

National Research Council. *Science Teaching Reconsidered: A handbook*. Washington, DC: National Academies Press, 1997. **[1]**

Newman DL, Snyder CW, Fisk JN, Wright LK. Development of the Central Dogma Concept Inventory (CDCI) assessment tool. *CBE—Life Sci Educ* **15**(2), 2017. doi.org/10.1187/cbe.15-06-0124, 2-16 **[4] [G]**

Nocke H, Meyer F, Lessmann V. Flow down gradients: the problem of pressure in this physiology core concept. *Adv Physiol Educ* **47**: 461-475, 2023. doi:10.1152/advan.00107.2022 **[7] [F]**

Odom AL, Barrow LH. Development and application of a two-tier diagnostic test measuring college biology students' under- standing of diffusion and osmosis after a course of instruction. *J Res Sci Teach* **32**: 45-61, 1995. **[4] [F]**

Perez KE, Hiatt A, Davis GK, Trujillo C, French DP, Terry M, Price RM. The EvoDevoCI: A Concept Inventory for Gauging Students' Understanding of Evolutionary Developmental Biology. *CBE—Life Sci Educ* **12**(4), 2013. doi.org/10.1187/cbe.13-04-0079 **[4] [Q]** Perry BD, Cameron MS, Cooke MB, Towstoless M, Hryciw DH, Hayes A, Lexis L, Tangalakis K, and Task Force. Unpacking the renal system component of the "structure and function" core concept of physiology by an Australian team. *Adv Physiol Educ* **47**: 453-460, 3 2023. doi:10.1152/advan.00150.2022 **[3] [N]**

Prestwich KN, Sheehy AM. Integrating Concepts in Biology: A Model for More Effective Ways to Introduce Students to Biology. *CBE—Life Sci Educ* **14** (3), 2017. doi.org/10.1187/cbe.15-04-0102 **[Q]**

Reed CR, Wolfson AJ. Concept Inventories as a Complement to Learning Progressions. *CBE*—*Life Sci Educ* **20** (2), 2021. doi.org/10.1187/cbe.20-09-0208 **[4]**

Richmond G, Merritt B, Urban-Lurain M, Parker J. The Development of a Conceptual Framework and Tools to Assess Undergraduates' Principled Use of Models in Cellular Biology. *CBE—Life Sci Educ* **9** (4), 2017. doi.org/10.1187/cbe.09-11-0082 **[3] [Q]**

Roche Allred ZD, Caobi LS, Pardinas B, Echarri-Gonzalez A, Kohn KP, Kararo AT, Cooper MM, Underwood MM. "Big Ideas" of Introductory Chemistry and Biology Courses and the Connections between Them. *CBE—Life Sci Educ* **21**(2), 2022. doi.org/10.1187/cbe.21-10-0301 **[Q] [R]**

Santiago M, Davis EA, Hinton T, Angelo TA, Shield A, Babey A-M, Kemp-Harper B, Maynard G, Al-Sallami HS, Musgrave IF, Fernandes LB, Ngo SNT, Christopoulos A, White PJ. Defining and unpacking the core concepts of pharmacology education. *Pharmacol Res Perspect* 2021;9:e00894doi.org/10.1002/prp2.894 **[3][Q]**

Scheiner SM. Toward a conceptual framework for biology. *Quart Rev Biol* **85**:293-318, 2010. **[3] [Q]**

Schneeweiss N, Gropengiesser H. Organising levels of organisation for biology education: A systematic review of literature. *Educ Sci* **9**(3), 207, 2019. https://pdfs.semanticscholar.org/d2f0/d5a2c7c50fdc44420c475a1546a5da3db801.pdf **[I] [Q]**

Sears DW, Thompson SE, Saxon RS. "Reversible Ligand Binding Reactions: Why Do Biochemistry Students Have Trouble Connecting the Dots?" *Bio. Mol. Biol. Ed.* 35:105-118, 2007. **[Q]**

Silverthorn DU. Constructing the Wiggers diagram using core concepts: a classroom activity. *Adv Physiol Educ* **46**: 714-723, 2022. Nov 10. doi:10.1152/advan.00046.2022 **[8]**

Smith MK, Knight JK. Using the Genetics Concept Assessment to document persistent conceptual difficulties in undergraduate genetics courses. Genetics **191**: 21-32, 2012. https://doi.org/10.1534/genetics.111.137810 **[4] [Q]**

Stanescu CI, Wehrwein EA, Anderson LC, Rogers J. Evaluation of core concepts of physiology in undergraduate physiology curricula: results from faculty and student surveys. *Adv Physiol Educ* **44**: 632-639, 2020. doi:10.1152/advan.00187.2019.6321043-4046/20 **[6]**

Tangalakis K, Julien BL, Lexis L, Hryciw DH, Thomas CJ, Husaric M, Towstoless M, MacKinnon PJ, Miao Y, Hayes A. Mapping the core concepts of physiology across Australian university curricula. *Adv Physiol Educ* **47**: 411-418, 2023. doi:10.1152/advan.00139.2022 **[6]**

Tangalakis K, Lexis, L, Hryciw DH, Towstoless M, Bakker AJ, Beckett E, Brown D, Cameron M, Choate J, Chopin L, See all authors. Establishing consensus for the core concepts of physiology in the Australian higher education context using the Delphi method. *Adv Physiol Educ* **47**: 419-426I, 2023. doi:10.1152/advan.00140.2022 **[2]**

University of California Museum of Paleontology (UCMPa). Understanding Evolution. 2020. 22 April 2020 http://evolution.berkeley.edu/ **[7] [Q]**

University of California Museum of Paleontology (UCMPb). Understanding Science. 22 April 2020 <https://undsci.berkeley.edu/teaching/1316_activities.php />. **[7] [M]**

Wallace MJ, Zecharia A, Guilding C, Tucker S, McFadzean I. Developing a new undergraduate pharmacology core curriculum: The British Pharmacological Society Delphi Method. *Pharmacol Res Perspect* 2021;9:e00832.|1 of 9https://doi.org/10.1002/prp2.832 **[6] [Q]**

Walton KLW. Use of a short, in-class drawing activity to assess student understanding of core concepts of the cell membrane in an undergraduate physiology course. *Adv Physiol Educ* **47**: 508-513, 2023. doi:10.1152/advan.00218.2022 **[4] [B]**

Wang MC, Corbridge TC, McCrimmon DR, Walter JM. Teaching an intuitive derivation of the clinical alveolar equations: mass balance as a fundamental physiological principle. *Adv Physiol Educ* **44**: 145-152, 2020. doi:10.1152/advan.00064.2019.1451043-4046/20 **[7] [K]**

White PW, Davis EA, Santiago M, Angelo T, Shield A, Babey A-M, Kemp-Harper B, Maynard G, Al-Sallami HS, Musgrave IF, Fernandes LB, Ngo ANT, Hinton T. Identifying the core concepts of pharmacology education. *Pharmacol Res Perspect* **9**:e00836. 2021. doi.org/10.1002/prp2.836 **[Q]**

Wiggins G, McTighe J. *Understanding by design*. expanded 2nd ed. Arlington, VA: Association for Supervision and Curriculum Design, 2005. **[1]**

Wood AF, Chandle C, Connolly S, Finn G, Redmond C, Jolly J, Powell AD, Davies C, Grant A. Designing and developing core physiology learning outcomes for pre-registration nursing education curriculum. *Adv Physiol Educ* **44**: 464-474, 2020. doi:10.1152/advan.00139.2019. **[6]**

Wood-Robinson C, Lewis J, Leach J. Young people's understanding of the nature of genetic information in the cells of an organism. *J Bio Educ* **35**(1): 29-36, 2000. **[7] [G]**

Zeidan Q, Loertscher J, Wolfson AJ, Tansey, JT, Offerdahl EG, Kennelly PJ, Dries DR, Moore VD, Dean DM, Carastro LM, Villafañe SM, Tyler L. Development of a Certification Exam to Assess Undergraduate Students' Proficiency in Biochemistry and Molecular Biology Core. *CBE—Life Sci Educ* **20** (2), 2021. doi.org/10.1187/cbe.19-12-0265 **[4] [Q]**