# I. BIOLOGY

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**ANIMAL DEVELOPMENT**

*Flowering Plant Growth and Development (13 two-tiered MC items)*
Lin SW. 2004. Development and application of a two-tier diagnostic test for high school students' understanding of flowering plant growth and development. *International Journal of Science and Mathematics Education* 2: 175–199.

**BIOCHEMISTRY**

*Threshold concepts in Biochemistry*: Loertscher, J. (2011). *Biochemistry and molecular biology education*, *39*(1), 56-57.https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4152212/

**BREATHING AND RESPIRATION**

*Breathing and Respiration (12 two-tiered MC items)*
Mann M, Treagust DF. 1998. A pencil and paper instrument to diagnose students' conceptions of breathing, gas exchange and respiration. *Australian Science Teachers Journal* 44: 55–59.

**DEVELOPMENTAL BIOLOGY**

*Developmental Biology Content Survey (15 MC items)*
Knight JK, Wood WB. 2005. Teaching more by lecturing less. *Cell Biology Education* 4: 298-310. doi:10.1187/05-06-0082. https://www.lifescied.org/doi/abs/10.1187/05-06-0082

**ENERGY AND MATTER**

(total of 16 Diagnostic Question Clusters of 6-8 items each; some items appear in more than one DQC)
*Diagnostic Question Clusters on Energy and Matter (DQCs)*
Wilson CD, Anderson CW, Heidemann M, Merrill JE, Merritt BW, Richmond G, Silbey DF, Parker JM. 2006. Assessing students' ability to trace matter in dynamic systems in cell biology. *CBE Life Sciences Education* 5: 323–331.
https://www.lifescied.org/doi/abs/10.1187/cbe.06-02-0142

Hartley LM, Wilke BJ, Schramm JW, D'Avanzo C, Anderson CW. 2011. College students' understanding of the carbon cycle: contrasting principle-based and informal reasoning. *BioScience* 61: 65-75.

*Thinking like a biologist: Using diagnostic questions to help students to reason with biological principles (16 DQC sets of ~7 items each, MC, TF, open-ended)*

D'Avanzo C, Anderson CW, Griffith A, Merrill J. 2011. Thinking like a biologist. Using diagnostic questions to help students reason with biological principles. [The site at http://www.biodqc.org/ has Diagnostic Question Clusters (DQC's) organized by three ecological topics (Carbon Cycling, Energy Flow in Ecosystems, Climate Change), and by three biological processes; (Photosynthesis, Biosynthesis, Cellular Respiration) - with two DQCs each; plus one each DQC under topics Gasoline, Biofuels, Carbon in Nature, and Carbon Balance. Some items appear in more than one DQC.

**ECOLOGY & EVOLUTION**

EcoEvo-MAPS: An Ecology and Evolution Assessment for Introductory through Advanced Undergraduates https://www.lifescied.org/doi/abs/10.1187/cbe.17-02-0037

*EvoDevoCI (MC and open ended items for 3 Exploratory Surveys and 6 Interview Question sets)*

Hiatt A, Davis GK, Trujillo C, Terry M, French DP, Price RM, Perez KE. 2013. Getting to Evo-Devo: Concepts and challenges for students learning evolutionary developmental biology. *CBE Life Sciences Education* 12: 494-508. doi:10.1187/cbe.12-11- 0203. https://www.lifescied.org/doi/abs/10.1187/cbe.12-11-0203

*EvoDevoCI (11 MC items, 4 scenarios)*

Perez KE et al 2013. The EvoDevoCI: A Concept inventory for gauging students' understanding of evolutionary developmental biology. *CBE Life Sciences Education* 12: 665-675. doi:10.1187/cbe.13-04-0079. https://www.lifescied.org/doi/abs/10.1187/cbe.13-04-0079

*Basic Tree Thinking Assessment (two tests, 10 MC items each, diagrams)*: Baum DA, Smith SD, Donovan SSS. 2005. The tree-thinking challenge. *Science* 310: 979-980.

*Conceptual Inventory of Natural Selection (CINS) (20 MC items, scenarios)*

Anderson DL, Fisher KM, Norman JG. 2002. Development and validation of the conceptual inventory of natural selection. *Journal of Research in Science Teaching* 39: 952-978.

Kalinowski, S. T., Leonard, M. J., & Taper, M. L. (2016). Development and validation of the conceptual assessment of natural selection (CANS). *CBE-Life Sciences Education*, *15*(4), ar64. https://www.lifescied.org/doi/10.1187/cbe.15-06-0134

**EXPERIMENTAL DESIGN**

Dasgupta, A. P., Anderson, T. R., & Pelaez, N. J. (2016). Development of the neuron assessment for measuring biology students' use of experimental design concepts and representations. *CBE-Life Sciences Education*, *15*(2), ar10. https://www.lifescied.org/doi/10.1187/cbe.15-03-0077

Deane, T., Nomme, K., Jeffery, E., Pollock, C., & Birol, G. (2014). Development of the biological experimental design concept inventory (BEDCI). *CBE-Life Sciences Education*, *13*(3), 540-551.https://www.lifescied.org/doi/10.1187/cbe.13-11-0218

**GENETICS**

*Genetics Literacy Assessment Instrument (GLAI) (31 MC items) FOUR in Bowling et al. Genetics 2008;*

Bowling BV, Acra EE, Wang L, Myers MF, Dean GE, Markle GC, Moskalik CL, Huether CA. 2008. Development and evaluation of a genetics literacy assessment instrument for undergraduates. *Genetics* 178: 15-22. [download PDF] from nku.edu

*Genetics Concept Assessment (GCA) (25 MC items, diagrams)*

Smith MK, Wood WB, Knight JK. 2008. The genetics concept assessment: A new concept inventory for gauging student understanding of genetics *CBE Life Science Education* 7: 422-430. https://doi.org/10.1187/cbe.08-08-0045

*Genetics Diagnostic (13 two-tiered MC items, diagrams)*

Tsui CY, Treagust D. 2009. Evaluating secondary students' scientific reasoning in genetics using a two-tier diagnostic instrument. *International Journal of Science Education* 32: 1073-1098.

*Genetic Drift Inventory (GeDI) (22 agree–disagree items)*

Price RM, Andrews TC, McElhinny TL, Mead LS, Abraham JK, Thanukos A, Perez KE. 2014. The Genetic Drift Inventory: A tool for measuring what advanced undergraduates have mastered about genetic drift. *CBE Life Science Education* 13: 65-75. doi: 10.1187/cbe.13-08-0159. https://www.lifescied.org/doi/abs/10.1187/cbe.13-08-0159

*Dominance Concept Inventory:* Abraham, J. K., Perez, K. E., & Price, R. M. (2014). The Dominance Concept Inventory: a tool for assessing undergraduate student alternative conceptions about dominance in Mendelian and population genetics. *CBE-Life Sciences Education*, *13*(2), 349-358. https://www.lifescied.org/doi/10.1187/cbe.13-08-0160

**GENERAL BIOLOGY**

*Gen-MAPS:* Couch, BA, Wright CD, Freeman S, Knight JK, Semsar K, Smith MK, Summers MM, Zheng Y, Crowe AJ, Brownell SE (2019). GenBio-MAPS: A programmatic assessment to

measure student understanding of Vision and Change core concepts across general biology programs. *CBE Life Sci. Educ. 18:arx 1–14, doi: 10.1187/cbe.18-07-0117*

**HOST-PATHOGEN INTERACTIONS**

*Host-Pathogen Interactions (HPI) (17 [18 noted in Marbach-Ad et al. 2009] two-tiered MC items) ITEMS NOT PROVIDED*

Marbach-Ad G, Briken V, El-Sayed NM, Frauwirth K, Fredericksen B, Hutcheson S, Gao L-Y, Joseph SW, Lee V, McIver KS, Mosser D, Quimby BB, Shields P, Song W, Stein DC, Yuan RT, Smith AC. 2009. Assessing student understanding of host pathogen interactions using a concept inventory. *Journal of Microbiology Education* 10: 43-50.

Marbach-Ad G, McAdams KC, Benson S, Briken V, Cathcart L, Chase M, El-Sayed NM, Frauwirth K, Fredericksen B, Joseph SW, Lee V, McIver KS, Mosser D, Quimby BB, Shields P, Song W, Stein DC, Stewart R, Thompson KV, Smith AC. 2010. A model for using a concept inventory as a tool for students' assessment and faculty professional development. *CBE Life Science Education* 9: 408-416. https://www.lifescied.org/doi/full/10.1187/cbe.10-05-0069

**INTRODUCTORY BIOLOGY**

*Biology Concept Inventory (BCI) (30 MC items) ON-LINE at http://bioliteracy.colorado.edu/*

Klymkowsky MW, Garvin-Doxas K, Zeilik M. 2003. Bioliteracy and teaching efficacy: What biologists can learn from physicists. *Cell Biology Education* 2: 155-161. doi: 10.1187/cbe.03-03-0014. https://www.lifescied.org/doi/abs/10.1187/cbe.03-03-0014

Garvin-Doxas K, Doxas I, Klymkowsky MW. 2008. Ed's Tools: A web-based software toolset for accelerated concept inventory construction. pp 130-140. In: Deeds, D & B Callen, editors; Proceedings of the National STEM Assessment Conference.

**MACROEVOLUTION**

*Measure of Understanding of Macroevolution (MUM) (28 items: 27 MC items, plus one open-ended item, diagrams) PROVIDED*

Nadelson LS, Southerland SA. 2010. Development and preliminary evaluation of the Measure of Understanding of Macroevolution: Introducing the MUM. *The Journal of Experimental Education* 78: 151–190. [download PDF] from researchgate.net

**MICROBIOLOGY**

*Development, Validation, and Application of the Microbiology Concept Inventory*.Timothy D. Paustian, Amy G. Briggs, Robert E. Brennan, Nancy Boury, John Buchner, Shannon Harris, Rachel E. A. Horak, Lee E. Hughes, D. Sue Katz-Amburn, Maria J. Massimelli, Ann H. McDonald, Todd P. Primm, Ann C. Smith, Ann M. Stevens, Sunny B. Yung. (2017) *J. Microbiol. Biol. Educ.* 18(3): doi:10.1128/jmbe.v18i3.1320

*Development and Validation of the Microbiology for Health Sciences Concept Inventory*. Heather M. Seitz, Rachel E. A. Horak, Megan W. Howard, Lucy W. Kluckhohn Jones, Theodore Muth, Christopher Parker, Andrea Pratt Rediske, Maureen M. Whitehurst. (2017) *J. Microbiol. Biol. Educ.* 18(3): doi:10.1128/jmbe.v18i3.1322

**MOLECULAR BIOLOGY**

*Central Dogma:* Newman, D. L., Snyder, C. W., Fisk, J. N., & Wright, L. K. (2016). Development of the central dogma concept inventory (CDCI) assessment tool. *CBE-Life Sciences Education*, *15*(2), ar9. https://www.lifescied.org/doi/10.1187/cbe.15-06-0124

*Lac Operon:* Stefanski, K. M., Gardner, G. E., & Seipelt-Thiemann, R. L. (2016). Development of a Lac Operon Concept Inventory (LOCI). *CBE-Life Sciences Education*, *15*(2), ar24. https://www.lifescied.org/doi/10.1187/cbe.15-07-0162

*Introductory Molecular Biology: Introductory Molecular and Cell Biology Assessment (IMCA) (24 MC items, diagrams)* Shi J, Wood WB, Martin JM, Guild NA, Vicens Q, Knight JK. 2010. A diagnostic assessment for introductory molecular and cell biology. *CBE Life Sciences Education* 9: 453-461. doi: 10.1187/cbe.10-04-0055. https://www.lifescied.org/doi/abs/10.1187/cbe.10-04-0055

*Molecular Biology Capstone Assessment: Couch, B. A., Wood, W. B., & Knight, J. K. (2015). The Molecular Biology Capstone Assessment: a concept assessment for upper-division molecular biology students. CBE-Life Sciences Education, 14(1), ar10. https://www.lifescied.org/doi/10.1187/cbe.14-04-0071*

*Molecular Life Sciences Concept Inventory (MLS)* *www.lifescinventory.edu.au*

**OSMOSIS AND DIFFUSION**

*Diffusion and Osmosis Diagnostic Test (DODT) (12 two-tiered MC items, diagrams)*

Odom AL, Barrow LH. 1995. The development and application of a two-tiered diagnostic test measuring college biology students' understanding of diffusion and osmosis following a course of instruction. *Journal of Research in Science Teaching* 32: 45-61. [HTML] from wiley.com

Odom AL. 1995. Secondary and college biology students' misconceptions about diffusion and osmosis. *American Biology Teacher* 57: 409–415. [download PDF] from pbworks.com

*Osmosis and diffusion conceptual assessment (ODCA) (8 two-tiered MC items, diagrams)* Fisher KM, Williams KS, Lineback J. 2011. Osmosis and diffusion conceptual assessment. *CBE Life Sciences Education* 10:418-29. https://www.lifescied.org/doi/abs/10.1187/cbe.11-04-0038

**PHOTOSYNTHESIS AND RESPIRATION**

*Photosynthesis and Respiration (13 two-tiered MC items, plus open ended)* Haslam F, Treagust DF. 1987. Diagnosing secondary students' misconceptions of photosynthesis and respiration in plants using a two-tier multiple choice instrument. *Journal of Biological Education* 21: 203–211.

*Covalent Bonding and Photosynthesis test development ITEMS NOT PROVIDED* Treagust D. 1986. Evaluating students' misconceptions by means of diagnostic multiple choice items. *Journal of Research in Science Education* 16: 199-207.

**PHYSIOLOGY**

*Homeostasis:* Development and Validation of the Homeostasis Concept Inventory McFarland, JL, Price RM, Wenderoth MP, Marinkova P, Cliff W, Michael J, Modell J, Wright A CBE—Life Sciences Education Volume 16, Issue 201 Jun 2017

Phys-MAPS: Semsar K, Brownell SE, Couch BA, Crowe AJ, Smith MK, Summers MM, Wright CD, Knight JK (2018). Phys-MAPS: A programmatic physiology assessment for introductory and advanced undergraduates. Adv Physiol Educ 43: 15–27, 2019; doi:10.1152/advan.00128.2018.

**QUANTITATIVE/STATISTICAL REASONING**

Stanhope, L., Ziegler, L., Haque, T., Le, L., Vinces, M., Davis, G. K., ... & Umbanhowar, C. (2017). Development of a Biological Science Quantitative Reasoning Exam (BioSQuaRE). *CBE-Life Sciences Education*, *16*(4), ar66. https://www.lifescied.org/doi/full/10.1187/cbe.16-10-0301

Deane, T., Nomme, K., Jeffery, E., Pollock, C., & Birol, G. (2016). Development of the Statistical Reasoning in Biology Concept Inventory (SRBCI). CBE-Life Sciences Education, 15(1), ar5. https://www.lifescied.org/doi/10.1187/cbe.15-06-0131

**SCIENTIFIC LITERACY**

Gormally, C., Brickman, P., & Lutz, M. (2012). Developing a test of scientific literacy skills (TOSLS): Measuring undergraduates' evaluation of scientific information and arguments. *CBE-Life Sciences Education*, *11*(4), 364-377.https://www.lifescied.org/doi/full/10.1187/cbe.12-03-0026

**TRANSPORT IN PLANTS AND CIRCULATION IN HUMANS**

*Internal Transport in Plants and the Human Circulatory Systems (28 two-tiered MC items)* Wang JR. 2004. Development and validation of a two-tier instrument to examine

understanding of internal transport in plants and the human circulatory system. *International Journal of Science and Mathematics Education* 2: 131–157.

# II. ASTRONOMY

Astronomy Diagnostic Test (ADT) Hufnagel 2002
Lunar Phases Lindell and Olsen 2002
Light and Spectroscopy, Bardar et al., 2007

# III. COMPUTER SCIENCE

http://dbserc.pitt.edu/Assessment/Assessments-Computer-Science

# IV. CHEMISTRY

- **INORGANIC CHEMISTRY (VIPER)**

  Virtual inorganic pedagogical electronic resource: a community for teachers and students of inorganic chemistry https://www.ionicviper.org//

- **CHEMISTRY**

  Compiled in list of chemistry concept inventories:
  http://chemistry.miamioh.edu/bretzsl/cer/assessment.html

  DBER Resources - curated by Marilyne Stains -
  https://sites.google.com/site/marilynestains/useful-links-for-the-group

others
http://dbserc.pitt.edu/Assessment/Assessments-Chemistry
http://www.rsc.org/learn-chemistry/resource/res00001645/using-assessment-to-link-concepts#!cmpid=CMP00004906

# V. PHYSICS

The AAPT ComPADRE Digital Library is a network of free online resource collections supporting faculty, students, and teachers in Physics and Astronomy Education. https://www.compadre.org/

**Other Resources:**

**The Living Physics Portal-**Due for Beta release Fall 2018

The Living Physics Portal is an online environment for physics faculty to share and discuss free curricular resources for teaching introductory physics for life sciences (IPLS). The objective of the Portal is to improve the education of the next generation of medical professionals and biologists by making physics classes more relevant for life sciences students. http://livingphysicsportal.org/

**ALPhA**
The Advanced Laboratory Physics Association (ALPhA) was formed in 2007 to provide communication and interaction among the faculty and staff who are involved in advanced laboratory physics instruction at colleges and universities in the United States and the rest of the world. https://www.advlab.org/

# VI. STATISTICS

Statistics Concept Assessment
https://www.researchgate.net/publication/35439982_The_statistics_concept_inventory_development_and_analysis_of_a_cognitive_assessment_instrument_in_statistics
Research Methods and Statistics:
http://journals.sagepub.com/doi/abs/10.1177/0098628317711287

# VII. Inventories for Assessing Students' Perceptions About Biology (College-level)

## ENGAGEMENT

Wiggins, B. L., Eddy, S. L., Wener-Fligner, L., Freisem, K., Grunspan, D. Z., Theobald, E. J., ... & Crowe, A. J. (2017). ASPECT: A survey to assess student perspective of engagement in an active-learning classroom. *CBE-Life Sciences Education*, *16*(2), ar32. https://www.lifescied.org/doi/10.1187/cbe.16-08-0244

Student Course Engagement Questionnaire
http://serc.carleton.edu/files/NAGTWorkshops/assess05/SCEQ.pdf
(Handelsman et al. 2005)
23 Likert items assessing perceived skills engagement, participation/interaction engagement, emotional engagement, and performance engagement

## LEARNING GAINS

Classroom Activities and Outcomes Survey (Terenzini et al. 2001)
24 Likert items rating progress in learning skills related to engineering or general scientific inquiry.

Student Assessment of Learning Gains (SALG) http://salgsite.org/(Seymour et al. 2000)
Multiple Likert items within 10 major categories rating gains in learning, skills, and attitudes due to components of a class

Survey of Undergraduate Research Experiences (SURE) (Lopatto 2004)
http://www.grinnell.edu/academic/csla/assessment/sure 20 Likert items assessing perceived learning gains as a result of participation in undergraduate research.

Undergrad Research Student Self-Assessment
http://www.colorado.edu/eer/research/undergradtools.html (Hunter et al. 2007)
Multiple Likert items assessing perceived gains in skills related to participation in research, yes/no questions categorizing specific experiences, and open response items.

## MOTIVATION

Achievement Goal Questionnaire
(Elliot and Church 1997, Finney et al. 2004)
18 Likert items rating performance approach and avoidance goals, and mastery goals.

Motivated Strategies for Learning Questionnaire (MSLQ)
http://www.indiana.edu/~p540alex/MSLQ.pdf (Pintrich Paul R. 1991, Pintrich P. R. et al. 1993)
31 Likert items assessing students' goals and value beliefs. 31 assessing use of learning strategies and 19 items concerning student management of learning resources.

Science Motivation Questionnaire (SMQ)
http://www.coe.uga.edu/smq/ ← not working
NEW LINK: https://coe.uga.edu/assets/downloads/mse/smqii-glynn.pdf
(Glynn et al. 2011)
30 Likert items comprising 6 components of motivation: intrinsic, extrinsic, relevance, responsibility, confidence, and anxiety.

## Self-Efficacy

College Biology Self Efficacy
(Baldwin et al. 1999)

## VIEWS/ATTITUDES

Biology Attitude Scale (Russell and Hollander 1975)
22 items: 14 Likert-type and 8 semantic differential measuring students' perceptions of liking or disliking biology

Colorado Learning Attitudes about Science Survey (CLASS)- Biology
https://www.lifescied.org/doi/abs/10.1187/cbe.10-10-0133
(Semsar et al. 2011) 31 Likert-type items for measuring novice-to-expert-like perceptions including enjoyment of the discipline, connections to the real world and underlying knowledge and problem-solving strategies.

Environmental Values Short Form (Zimmermann 1996)
31 Likert items assessing level of agreement with statements describing concern for different environmental issues

Survey of Teaching Beliefs and Practices for Undergraduates (STEP-U)
Marbach-Ad, G., Rietschel, C., & Thompson, K. V. (2016). Validation and Application of the Survey of Teaching Beliefs and Practices for Undergraduates (STEP-U): Identifying Factors Associated with Valuing Important Workplace Skills among Biology Students. CBE-Life Sciences Education, 15(4), ar59. https://www.lifescied.org/doi/10.1187/cbe.16-05-0164

Views About Sciences Survey (VASS)
http://modeling.asu.edu/R%26E/Research.html (Halloun and Hestenes 1996)
50 items: Students choose a value describing their position with regards to two alternate conclusions to a statement probing their views about knowing and learning science in three scientific and three cognitive dimensions.

Views on Science and Education (VOSE)
http://www.ied.edu.hk/apfslt/download/v7_issue2_files/chensf.pdf
(Chen 2006)
15 items for which several statements or claims are listed. Respondents choose their level of agreement to these series of predetermined statements/claims to provide reasoning behind their opinion.

Views on Science-Technology-Society (VOSTS) (Aikenhead and Ryan 1992)
http://www.usask.ca/education/people/aikenhead/