Promoting Concept-Driven Teaching Strategies in Biochemistry and Molecular Biology through Concept Assessments

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5 Core Concepts

Evolution
Structure and Function
Information Flow
Transformation of Energy and Matter
Systems

6 Core Competencies

Apply Science Process
Quantitative Reasoning
Modeling and Simulation
Interdisciplinary Nature of Science
Communicate and Collaborate
Science and Society
Vision and Change - Recommendations

• Integrate Core Concepts and Competencies throughout the Curriculum
• Focus on Student-Centered Learning
• Promote Campuswide Commitment to Change.
• Engage the Biology Community in the Implementation of Change.
NSF-Funded ASBMB Project: Background and Overview

Preparation: ASBMB Education Committee responds to need for core concept inventories linked to assessment.

Realization that (1) biochemistry core concepts need to vetted by a variety of experts, (2) core concepts of preparatory areas are needed, (3) core concepts need to be integrally linked to pedagogy and assessment.

RCN-UBE Project

Plan the development of Central Resource of core concepts, pedagogical approaches, assessment and network building.

Bring together experts in concept inventories, pedagogy, and education research.

Develop, launch, disseminate and assess effectiveness of central resource.

Provide educators and education researchers with relevant resource to biochemistry education. Increase participation of faculty in new and ongoing projects in education research.
These objectives will be addressed in the following four specific aims of this project:

• **Specific Aim 1:** Identify foundational concepts in terms of core knowledge and foundational principles, research, and skills.

• **Specific Aim 2:** Create a taxonomy of these foundational concepts and skills, and link them to topics outlined in the undergraduate curriculum recommendations of ASBMB.

• **Specific Aim 3:** Develop and evaluate appropriate assessment tools for the topics identified in Specific Aim 1.

• **Specific Aim 4:** Create a toolkit that can be easily accessed by the academic community.
How People Learn
Brain, Mind, Experience, and School

Should be required reading for all STEM teaching faculty
A large body of evidence shows that humans achieve greater conceptual understanding and retain information longer when they are actively involved—a process that enables them to construct knowledge. For a majority of students, lecturing is not the most effective mode of instruction.
Perception Filter in the Learning Process
How do we breach it when we teach?

How do we find out what is here?

How can students correct it, if it is wrong?

Long-Term Memory
An “infinite” expandable long-term storage space

What Do Our Students Need to Know?

Chemistry
Provides the methods and molecular perspective

Biochemistry
Molecular Biology
Provides the means to evaluate and predict

Mathematics

Biology
Provides the relevance

Physics
Provides physical models

\[ M = \frac{2RT \ln \frac{C_1}{C_2}}{\omega^2(1-V\rho)(x_2^2-x_1^2)} \]
Classic Hemoglobin Articles
Read Before Spring Break

Stokes (1864)
Spectroscopy
Solvent Extraction

Zinoffsky (1886)
Elemental Analysis

Bohr et al (1904)
Gas Laws
Peters (1912)
Stoichiometry
Herrick (1910)
Medical Case
Diggs et al (1934)
Epidemiology

Conant (1923)
Electrochemistry
Pauling & Coryell (1936)
Magnetic Properties
Svedberg & F. (1926)
Sedimentation Equilibrium

Adair (1925)
Osmometry

“Jigsaw” Groups

Produce

Concept Maps
Home Groups

Individual and Group MidTerm Exam
Classic Hemoglobin Articles 
Read After Spring Break

Group Work
- Pauling et al (1949) 
  Electrophoresis
- Ingram (1958/59) 
  Peptide Sequencing
- Dintzis (1961) 
  Direction Protein Syn
- Allison (1954) 
  Malaria Resistance

Individual Project
- Hemoglobinopathy 
  Assignment
- Genetic Mutations 
- Protein Structure

Individual and Group Final Exam
Course Timeline

Before Midterm

1850
- Stokes

1900
- Zinoffsky
- Bohr
- Herrick
- Peters
- Conant
- Adair
- Svedberg

After Midterm

1950
- Diggs
- Pauling
- Svedberg

2000
- Dintzis*
- Ingram*
- Allison*
- Pauling et al.
- Shemin

Course Website:
http://www.udel.edu/chem/white/CHEM342.html