Expectations for Student Conceptual Understanding in Biochemistry and Molecular Biology.

Formulated by the American Society for Biochemistry and Molecular Biology (ASBMB)

These expectations relate to concepts covered in prerequisite courses.

A) Students should be able to **recall** force laws and **apply** them in the context of molecular structure and molecular interactions.

B) Students should be able to **recall** principles and theories regarding waves, light, optics, and imaging, and **apply** them in the context of biochemical investigations.

C) Students should be able to **recall** concepts of energetics and order, and **apply** them in the context of biological macromolecules.

D) Students should be able to **recall** concepts of thermodynamics, and **apply** them in the context of thermal processes at the molecular level.

E) Students should be able to **recall** principles of chemical structure (*i.e.,* covalent bonds, polarity, the hydrophobic effect, hydrogen bonds and other non-covalent interactions), and **apply** them in the context of the dynamic aspects of molecular structure.

F) Students should be able to **recall** theories that govern chemical reactions (*i.e.,* collision theory, transition state theory, rate laws and equilibria), and **apply** them in the context of biomolecular structure and reactivity.

G) Students should be able to **recall** a range of mathematical functional relationships (*i.e.,* linear, exponential, saturation, and sigmoidal functions), **apply** them in the context of the molecular life sciences, **assess** whether the function is appropriate, and **predict** biomolecular outcomes based on mathematical equations.

These expectations are based on skills acquired during or before the course.

A) Given an experimental observation, students should be able to **develop** a testable and falsifiable hypothesis.

B) Given a hypothesis, students should be able to **identify** the appropriate experimental observations to be measured, as well as appropriate control variables.

C) Students should be able to **use** appropriate equations to **analyze** experimental data and **calculate** parameter estimates.

D) Students should be able to **apply** equations and models to **predict** outcomes of experiments.

E) Students should be able to **find** and **use** the primary literature.

F) Students should be able to **use** databases and bioinformatics tools.

G) Students should be able to **use** visual and verbal tools to **explain** concepts and data.

H) Students should be able to **translate** science into everyday examples.

I) Given a case study, students should be able to **identify** and **evaluate** both scientific and societal ethical aspects.

J) Students should be able to **discuss** cross-disciplinary concepts such as modularity, energy, etc.

These expectations relate to material covered in the course.

A) Students should be able to **analyze** preexisting or novel data and **relate** the findings in light of the theory of evolution.

B) Students should be able to **describe** what a mutation is at the molecular level, and how it comes about, be able to **predict** how changes in a nucleotide sequence can influence the expression of a gene or the amino acid sequence of the gene product (protein) and be able to **translate** these findings into a conclusion about how said mutation would impact the general fitness of an organism or population.

C) Students should be able to **apply** their knowledge of basic chemical thermodynamics to biologically catalyzed systems, quantitatively **model** how these reactions occur, and **calculate** kinetic parameters from experimental data.

D) Students should be able to **discuss** the concept of Gibbs free energy, and how to apply it to chemical transformations, be able to **identify** which steps of metabolic pathways are exergonic and which are endergonic and **relate** the energetics of the reactions to each other.

E) Students should be able to **relate** the laws of thermodynamics to homeostasis and **explain** how the cell or organism maintains homeostasis (a system seemingly in equilibrium) using non- equilibrium mechanisms.

F) Students should be able to **summarize** the different levels of control (including reaction compartmentalization, gene expression, covalent modification of key enzymes, allosteric regulation of key enzymes, substrate availability and proteolytic cleavage), and **relate** these different levels of control to homeostasis.

G) Students should be able to **define** what a genome consists of, and how the information in the various genes and other sequence classes within each genome are used to store and express genetic information.

H) Students should be able to **illustrate** how DNA is replicated and genes are transmitted from one generation to the next in multiple types of organisms including bacteria, eukaryotes, viruses, and retroviruses.

I) Students should be able to **discuss** the diversity and complexity of various biologically relevant macromolecules and macromolecular assemblies in terms of the basic repeating units of the polymer and the types of linkages between them.

J) Students should be able to **compare** and **contrast** the potential ways in which the function of a macromolecule might be affected and be able to **discuss** examples of allosteric regulation, covalent regulation and gene level alterations of macromolecular structure/function.