Entry Level Curriculum Update – Chemistry

The *Entry Level Curriculum* was created to provide guidance as to the knowledge and skills a new graduate at the MLT or MLS level should possess upon entry into the workforce. In this session, we will discuss changes to the chemistry sections of these recently published documents and how best to utilize them in your curriculum.

Learning Objectives

1. Discuss the usefulness of the Entry Level Curriculum (ELC).
2. Explain changes that occurred in the recent update.
3. Identify and evaluate ways in which the ELC can be incorporated into your curriculum.

Development Process

The first Entry Level Curriculum (ELC) was published in 2002 and created by educators and practitioners using the Body of Knowledge (BOK) published by ASCLS. The ELC was revised during the 2015-16 year by a sub-committee of the Education Scientific Assembly (ESA), the Committee for Educational Programs and Initiatives (CEPI). The two main goals with the revision were:

- Use the recently updated (2014 version) ASCLS Body of Knowledge (BOK) and personal expertise in entry level practice to update the curriculum by removing dated topics and adding new items.
- Ensure differentiation of the MLT and MLS curriculum based on the level of education required for each.

There were 4 rounds of revisions in 2015-16:

- 1st revision reviewed at CLEC 2016 and from educators who could not attend
- 2nd revision reviewed by ASCLS members
- 3rd revision to BOD and 2016 House of Delegates
- 4th revision to ASCLS for publication

ELC committee members finalized all documents by applying the Beck/Moon algorithm introduced at CLEC 2016. The algorithm included three basic questions:

- Is it current practice?
- Is it entry level?
- Is it foundational?

In situations where conflicting comments were received, this algorithm provided the criteria for removing information from the documents.

Format

The curriculum format is delineated by discipline area within the MLS and MLT levels. Each discipline area is further delineated by major topics using a learning objective format which includes a sequence of concepts, principles/theories, and skills. Taxonomic levels (cognitive, psychomotor, affective) were included to assist new instructors and new programs.

It is understood that all listed technical items may not be available at each educational institution so that in some programs, only cognitive aspects (state, explain, describe) will be taught and at others the psychomotor may also be taught (perform or observe). The committee also expects that some

programs will teach beyond what may be included, based upon regional needs of their graduates and availability of resources.

What's New/What Changed?

Molecular diagnostics is a new addition to the 2016 version of the ELC. Other changes included **moving body fluids** from the Chemistry section to create a new Urinalysis and Body Fluids section.

Where there is overlap in some discipline areas, it is **cross-referenced** to another section within the ELC disciplines. For example, microscopic analysis in Hematology, Urinalysis & Body Fluids, and Microbiology are all cross-referenced to the more detailed microscope section in the General Practice document.

Differentiation in MLT vs MLS curriculum was based on the background knowledge (pre-requisite and/or core courses). Different cognitive levels were reflected in the verbs used to elucidate the tasks or knowledge. For example:

MLT version – Identify basic concepts of spectrophotometry

MLS version - Recognize and explain basic concepts of spectrophotometry

In many instances, the verb levels and expectations were the same, for example in performing tests or identifying abnormal results. A specific example is provided on page 3.

Finally, to assist educators in knowing which **items were deleted from the previous edition of the ELCs and which items were added**, **a summary list is included at the end of each discipline section**. This information could be useful when revising and updating course material. The addition/deletion lists for MLS Chemistry are listed on pages 4-7 and for MLT on pages 7-9 of this document.

Uses

The ELC is designed to

- help develop the curriculum for a new program
- assist the new instructor/professor with course development
- update a current program or course

In addition, the document can provide guidance to other organizations for entry level knowledge and skills of the MLS a or MLT graduate.

See example of differences in verb levels between MLS and MLT levels on next page:

MLS Level	MLT Level
General Clinical Chemistry: Carbohydrates	General Clinical Chemistry: Carbohydrates
Define and explain carbohydrate structures and classifications Level 1 Monosaccharide Disaccharide Polysaccharide Glycosidic linkage Aldose Ketose Hexose Pentose Isomer	Define the following terms Level 1 Monosaccharide Disaccharide Polysaccharide Glycosidic linkage Aldose Ketose Hexose Pentose Isomer
State the components of the disaccharides Level 1 Lactose Maltose Sucrose	State the components of the disaccharides Level 1 Lactose Maltose Sucrose
State the composition and function of each of the following polysaccharides Level 1 Starch Glycogen Proteoglycans (mucopolysaccharides) Glycoproteins	State the composition and function of each of the following polysaccharides Level 1 Starch Glycogen
Discuss carbohydrate metabolism Level 1 Explain the process of digestion and absorption of dietary carbohydrates Explain the main transport routes and uptake of carbohydrates State the main physiologic functions of carbohydrates Explain the following glucose pathways: Insulin and non-insulin routes of entry to cells Glycolysis (aerobic and anaerobic) Glycogenolysis Glycongenesis Gluconeogenesis Kreb's cycle (citric acid or TCA cycle) Pentose phosphate pathway (hexose monophosphate shunt)	Discuss carbohydrate metabolism Level 1 State the purpose of digestion and absorption of dietary carbohydrates State how glucose is transported in the blood State the main physiologic functions of carbohydrates State the purpose of the following glucose pathways Glycolysis Gluconeogenesis Glycogenesis Glycogenolysis

MLS ELC Clinical Chemistry
Added and Deleted items

Additions

Math and Instrumentation

Perform basic calculations – normality

Define predictive statistics: True positive and negative, False positive and negative, Clinical sensitivity and specificity, Positive predictive value (PPV), Negative predictive value (NPV)

Calculate and utilize statistical data for method verification and comparison studies

- Precision - Coefficient of variation (CV); F test
- Accuracy - T-test, Linear regression- slope(m), - y intercept(b); Correlation coefficient(*r*)

Identify basic components of atomic absorption- Burner assembly, Gas regulators, Light source (hollow cathode lamp), Monochromator, Light detector, Signal conversion electronics, Read-out systems

Identify basic concepts and principles of fluorescent polarization

Identify basic concepts of a luminometer: Principles, Components, Operation, Maintenance/quality assurance

- Correctly operate luminometer
- Perform routine maintenance checks on the luminometer

Calibrate an osmometer following established laboratory procedure & perform test procedures on standards, controls, and unknowns

Identify/explain basic concepts of refractometer/light refraction; calibrate; perform testing

Identify basic concepts of mass spectrometry

- Principles
- Components
- Operation
- Maintenance/quality assurance

Correctly operate (if available) and perform routine maintenance checks

Carbohydrates:

State the components of the disaccharides: Lactose, maltose, sucrose

State the composition and function of each of the following polysaccharides: starch, glycogen, proteoglycans (mucopolysaccharides), glycoproteins

Explain the following glucose pathways:

- Insulin and non-insulin routes of entry to cells
- Glycolysis
- Glycogenolysis
- Glycongenesis
- Gluconeogenesis
- Kreb's cycle (citric acid or TCA cycle)
- Pentose phosphate pathway (hexose monophosphate shunt)

Explain diagnostic criteria for Type 1, 2 (impaired glucose tolerance and provisional diabetes mellitus), and GDM

Explain the difference between adrenergic and neuroglycopenic symptoms

Explain the usefulness of estimated average glucose (eAG)

Lipids:

Given serum appearance, and cholesterol and triglyceride levels, classify the lipoprotein disorder according to familial lipoprotein disorders nomenclature and explain the most likely defect

State most common disorders/causes associated with secondary hyperlipidemia

State National Cholesterol Expert Panel (NCEP) lipid levels associated with an increased risk for coronary heart disease (CHD) or cerebrovascular accident (CVA)
Explain the usefulness of the ASCVD (atherosclerotic cardiovascular disease) risk calculator (ACC/AHA recommendations); identify the six variables used in the ASCVD calculation

Proteins:

Explain the role of fetal fibronectin in preterm delivery

Congestive heart failure (beta-natriuretic peptide)

New Disease Markers:

Explain the origin and the usefulness in the detection of and risk assessment for an MI
- hs-CRP
- Lp(a)
- Homocysteine

Non-protein nitrogen:

Discuss the advantage and disadvantages of cystatin for determination of renal clearance

Differentiate eGFR and GFR

Electrolytes and Trace Elements:

Explain the role of atrial natriuretic peptide (ANP) in sodium regulation

State the most common methods of analysis - nuclear magnetic resonance (NMR), mass spectroscopy

Genetic disorders:

Describe tests used to evaluate the risk of fetal chromosomal abnormalities
- Human chorionic gonadotropin (hCG)
- Estrogens
- Alpha fetoprotein (AFP)
- Pregnancy-associated plasma protein-A (PAPP-A)

Deletions

Math and Instrumentation

Perform basic calculations –specific gravity

Define units of systems of measurement – nonmetric

Define conversions between and among systems of measurement – metric to nonmetric, nonmetric to metric and SI, SI to nonmetric

Calculate and utilize statistical data for quality control and statistical analyses – sampling

Discuss principles of basic electronics: Components, Voltage, current, resistance concepts-OHM's law

Activate and calibrate spectrophotometer following established laboratory procedure

Establish procedures to be used in the activation of a spectrophotometer

Identify basic concepts of coulometric amperometry

Instrumentation: pH meter (a stand-alone meter)

Develop a maintenance procedure for all balances

Develop a maintenance procedure for all centrifuges

Perform routine maintenance on a hot plate

Establish lab procedures for electrophoresis

Proteins:

Discuss the role of gene therapy in treating genetic disorders

Compare recent advances in the measurement and detection of analytes associated with the diagnosis or monitoring of protein disorders

Enzymes:

Discuss clinically significant enzymes – CK isoforms, Acid phosphatase

Ischemia modified albumin (IMA)

Electrolytes and Trace Elements:

Correlate UIBC with specific diseases or disorders or iron deficiency or iron excess

Endocrine:

Total T4, Total T3, T uptake, Free thyroxine estimate/index (FTE/FTI)

Genetic Disorders:

Perform laboratory screening procedures for the diagnosis of each metabolic disorder

Urine color
Urine odor

Urine crystals
Colorimetric tests on urine

MLT ELC Clinical Chemistry
Added and Deleted items

Additions

Instrumentation:
Turbidimetry and Nephelometry – basic concepts
AAS-basic concepts
Luminometer-basic concepts
Mass Spec-basic concepts

Carbohydrates:
Disaccharide components
Composition and function of starch and glycogen
Diagnostic criteria for Type 1, 2 (impaired glucose tolerance and provisional diabetes mellitus), and GDM

Lipids:
Lipemia
Saturated /Unsaturated fats
Atherosclerosis

Proteins:
Fetal fibronectin
Congestive heart failure (BNP)

Disease Markers:
Hs-CRP
Lp(a)
Homocysteine

TDM & Toxicology:
Drugs of abuse
Emergency toxicology
Chronic poisoning
Factors that influence toxicity

Hemoglobin:
Dubin-Johnson syndrome
Rotor's
Crigler-Najjar

Deletions:

Math and Instrumentation:
Calculations: Logarithms, Hydrates, Specific gravity
Non-metric units of measurement

Instrumentation: Electronics
Spectrophotometer calibration and maintenance
AAS basic components
Blood gas analyzer temperature maintenance and readout systems, electrode balance and slope adjustment with standard gases
Balance maintenance
RCF calculations
Centrifuge maintenance
Densitometer calibration
ELP maintenance
Establishment of lab procedures
Chromatography calculations and maintenance
Coulometric Amperometry

Carbohydrates:
Fructosuria
Hereditary fructose intolerance
Glucose dehydrogenase
Glycated serum protein/fructosamine
Lactic acid methodology
Insulin antibodies
Lactose tolerance
D xylose
Discuss recent advances

Lipids:
Steroids
Terpenes
Prostaglandins
Carotenoids
Fat-Soluble Vitamins
Detailed Lipid Pathway information
Urine fat methods (included in UA)
Fecal Fat analysis patient prep and procedure
Compare lipid results to non POC analyzer results
Discuss recent advances

Proteins:
Zwirtterion
Protein targeting
Regulatory hormones
Transamination, oxidative deamination, ketogenic and glycogenic amino acids
AFP (in Immunology-tumor markers)
Cause for elevated urine protein (in UA document)
Recent advances

Enzymes:
Metabolism
Enzyme calculations
Synthesis, catabolism and regulation

Plasma vs. non-plasma specific enzymes
Recent advances
Disease Markers:
Methods: CK-MB, Myoglobin, Troponin, hs CRP
Ischemia modified albumin (IMA)

NPN:
Creatinine chemical structure
Electrolytes and Trace Elements:
Zinc
Manganese
Chromium
Recent advances

Acid-Base:
Imidazole group of histidine
Disease states associated with ABG imbalance

TDM and Toxicology:
Pharmacokinetics
Metabolism, biotransformation, elimination
Toxicology terms
Mechanisms of toxicity
Toxicology analytic methods
Recent advances

Vitamins:
Deleted all EXCEPT correlation of disease states with vitamin deficiencies
Hemoglobin:
Heme synthesis (covered in Hematology)
Porphyrin disease states
Porphyrin analysis

Body Fluids:
Amniotic Fluid
Seminal Fluid (EXCEPT post-vasectomy)
Endocrinology:
Hormone structure and classification
Hormone synthesis, metabolism and mechanism of action
Non-thyroid illness causes of abnormal thyroid tests
Total T3, Total T4, T3 Uptake and FTE/FTI
Dexamethasone Suppression Test
Metyrapone Test
ACTH Stimulation Test