**Chemistry Rotations Goals and Objectives**

**Rotation Directors:** Donald Giacherio, Ph.D., and Lee Schroeder, M.D., Ph.D.

The goal of the **First Chemistry Rotation** is for the resident to move from being a

**Novice**  (A novice knows little about the subject, and rigidly adheres to rules with little situational perception. He/she does not feel responsible for outcomes. )

To

**Advanced Beginner** (The advanced beginner is still dependent on rules, but can adapt rules to changing circumstances. However, all attributes of a situation tend to be given equal importance, and there is still little feeling of personal responsibility for outcomes.)

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| **First Rotation Goals** | **First Rotation Objectives** |
| **Medical Knowledge**Acquires knowledge of pathophysiology and laboratory manifestations of routinely-encountered conditions; knows where to access information to fill gaps in knowledge. | The resident will acquire knowledge about (please see Chemistry Section outline on web-based learning archive):* Menu of tests performed in the laboratory and the analytical techniques used
* Thyroid function testing
* Hemoglobinopathy and thalassemia evaluations
* Diabetes diagnostic criteria and test methods
* Cardiac biomarkers and risk factors
* Drug metabolism and drug screening
* Quality control and quality assurance
 |
| **Patient Care**Is able to perform procedures necessary to generate laboratory information, gather clinical information needed to establish a diagnosis, and make observations relevant to the clinical situation. | With appropriate supervision (see below), the resident will * Become proficient at identifying hemoglobin variants, thalassemias, and iron deficiency anemia as part of the daily signout of hemoglobinopathy evaluations
* Interpret Quad Test prenatal screening results
* Review and investigate unusual drug screen results
* Obtain relevant clinical history from the EMR
* Learn the approach to investigating unusual or unexpected laboratory results
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| **Practice-based Learning and Improvement**Uses feedback and evaluations to generate or modify learning plan and improve skills. | The resident will:* Access standard textbooks available in the laboratory and residents’ room, and will review relevant online learning modules
* Use faculty feedback to refine and improve their ability to recognize hemoglobin variants and related findings at hemoglobinopathy signout
* Ask questions and seek guidance from faculty and lab supervisory staff when presented with problem cases
* Present interesting cases at CP Case Conference and as continuing education talks for laboratory staff
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| **Interpersonal and Communication Skills**Establishes collegial interactive and communication skills in dealing with others; structures reports that are clear, succinct, and follow templates; listens to and fulfills requests from other providers. | The resident will* Interact in a collegial way with laboratory technical staff and supervisory staff
* Volunteer his/her opinion of cases to faculty
* With direction, notify treating physicians of unexpected findings
 |
| **Professionalism**Is honest, compassionate, and respectful of others; complies with laws and regulations pertaining to medical practice; fulfills patient care and educational responsibilities faithfully. Understands professional responsibility to appear for duty rested and fit to provide service. | The resident:* Is present and ready for signout, lab rounds, and didactic sessions at the agreed time
* Admits errors or omissions and takes steps to correct them
* Observes HIPPA guidelines and protects patient privacy
* Is sensitive to issues of race, gender, ethnic background, religion, sexual orientation, and other social factors in dealing with patient care and in interactions with other providers and other learners
* Treats colleagues at all levels with respect
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| **Systems-based Practice**Identifies issues related to error, cost, and the need for interdisciplinary collaboration in the delivery of health care. Conducts handoff at the conclusion of rotation with care and thoroughness. | The resident:* Is vigilant regarding possible specimen identification errors and takes steps to investigate and resolve potential errors
* Discusses cost-effectiveness in the selection or recommendation of ancillary studies
* Participates in discussions of new tests evaluations and new equipment acquisition
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The goal of the **Second and Third Chemistry Rotations** is for the resident to move from being an

**Advanced Beginner** (The advanced beginner is still dependent on rules, but can adapt rules to changing circumstances. However, all attributes of a situation tend to be given equal importance, and there is still little feeling of personal responsibility for outcomes.)

To

**Competent** (The competent learner grasps the relevant facts, can sort information by relevance, can bring his/her own judgment to each case, and solve problems. Guidelines are adapted to unexpected events. He/she feels accountable for outcomes because of increasing decision-making.)

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| **Second and Third Rotation Goals** | **Second and Third Rotation Objectives** |
| **Medical Knowledge**Acquires knowledge of less commonly-encountered conditions and laboratory techniques; critically evaluates knowledge sources and uses evidence-based approach to acquire new knowledge. | The resident will acquire knowledge about * New biomarkers of disease being added to diagnostic algorithms
* Evidence-based approaches to optimize resource allocation (e.g., how and when to offer tests)
* Ranking the diagnostic value of one test or biomarker over another
* The prenalytical, analytical, and postanalytical factors that can affect test results or their medical interpretation
 |
| **Patient Care**Uses laboratory data and own observations to generate accurate diagnoses and differential diagnoses; suggests appropriate ancillary studies as needed; responds to requests for consultation. | With appropriate supervision (see below), the resident will * Recognize inappropriate test requests or testing patterns
* Interact directly with medical staff to resolve patient care issues
* Be able to ask sophisticated questions of clinicians that gather the relevant information needed to solve the laboratory problem
* Independently investigate a quality assurance problem or other laboratory-based project of his/her choice
 |
| **Practice-based Learning and Improvement**Adapts practices based on literature review, case outcomes, peer reviews, and system demands; seeks and gives feedback to improve self and others. | The resident:* Uses feedback and questions from clinicians to guide continued learning
* Accesses learning sources (textbooks, medical literature, web-based resources) to answer questions before coming to faculty for guidance
* Serves as a resource to other learners (junior residents, medical students, clinical fellows).
 |
| **Interpersonal and Communication Skills**Effectively communicates in a variety of settings, including during conferences, while providing consultations, and teaching peers.  | The resident will* Interact in a collegial way with treating physicians, other learners who request information or attend signout or didactic sessions.
* Volunteer his/her opinion of cases to faculty, with explanations of rationale
* Recognize cases that indicate the need to notify treating physicians, and suggest this need to faculty.
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| **Professionalism**Manages patient care duties and interacts with other providers with compassion and respect for diversity; recognizes and responds to need for help from colleagues. | The resident:* Attends other clinical pathology conference as appropriate.
* Volunteers support to others to assure good patient care
 |
| **Systems-based Practice**Improves patient outcomes and promotes efficiency by making decisions based on best evidence of outcomes, and by involvement in quality initiatives. | The resident:* Is knowledgeable about and suggests the most efficient and effective ancillary studies in difficult cases.
* Calls attention to practices that may increase the risk of error.
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The goal of the **Final Chemistry Rotation** is for the resident to move from being

**Competent** (The competent learner grasps the relevant facts, can sort information by relevance, can bring his/her own judgment to each case, and solve problems. Guidelines are adapted to unexpected events. He/she feels accountable for outcomes because of increasing decision-making.)

To

**Proficient** ((Characterised by the progress of the learner from step-by-step analysis and task performance to a holistic perception of the entirety of the situation. Uses pattern recognition arising from experience to identify problems. Perceives deviations from what is expected.  Learns from the experience of others.   Sense of responsibility grows with increasing decision-making. )

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| **Final Rotation Goals** | **Final Rotation Objectives** |
| **Medical Knowledge**Exercises judgment in application of evidence-based knowledge to patient and to patient population; assists junior residents and other learners in accessing sources of medical knowledge. | The resident will* Fill in any gaps in knowledge based on prior rotations
* Gain knowledge about any new tests added since prior rotations , their medical use, why they added, how they are performed)
* Follow up on a previous quality assurance problem or other laboratory-based project to evaluate long term effectiveness and propose any future action
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| **Patient Care**Recognizes clinical cases and circumstances that are rare or unique and selects appropriate additional studies; initiates consultant role in unusual cases; directs other providers and learners in challenging situations. | The resident will * Act in a medical director role, serving as the primary contact for answering questions from cliniclans and staff, and learning from the problems that arise
* Serve as a resource to help junior residents solve clinical problems.
* Learn how to cross-cover multiple pathology areas to appreciate real world practice
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| **Practice-based Learning and Improvement**Facilitates collaboration and teamwork to improve patient care and promote learning.  | The resident:* Work with other learners, such as other residents and medical students, to share tasks related to gathering knowledge
* Recognize gaps in others’ learning (residents, students, and faculty) and contribute to filling the gaps.
* Recognize circumstances in which the current state of clinical and scientific evidence is lacking.
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| **Interpersonal and Communication Skills**Demonstrates skill in dealing with conflicting opinions or perspectives; responds independently to questions from other providers, patients, and families; generates sophisticated reports that relay information about complex cases. | The resident will* Manage conflicting opinions or perspectives in such a way that optimal patient care is protected.
* Independently handle inquiries for clarification or additional information, and initiate tasks necessary to provide this.
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| **Professionalism**Recognizes impairment in themselves and peers and takes steps to address this. Mentors others in use of inter-professional and multi-disciplinary collaboration; Is a role model to other learners regarding accountability to self and others. | The resident:* Can be viewed as a role model in understanding and managing the strengths and weaknesses of him/herself and others.
* Can serve as a mentor for junior residents
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| **Systems-based Practice**Identifies sources of error and inefficiency and initiates action to assess and fix; acts as a consultant in conducting cost benefit analysis  | The resident:* Identifies processes that lead to inefficiencies and potential errors, is able to analyze the relevant components of the process, and suggests improvements.
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**Plan for Training**

This CP rotation includes the Automated Chemistry, Special Chemistry, and Drug Analysis/Toxicology sections of the Chemical Pathology Laboratory. Time will also be devoted while on this rotation to Point of Care testing administered by the Chemical Pathology Laboratory, as well as to the Central Distribution and Sendout areas. The areas and topics to be emphasized within the block will depend on the training level and experience of an individual house officer.

 The Chemistry Section rotation includes didactic sessions with the laboratory directors, hands on demonstrations from laboratory supervisors and senior technologists, observation of procedures performed at the bench, participation in weekly clinical pathology conferences, presentation of cases or review topics to other residents and faculty of the section, participation in laboratory management meetings, independent study/review time, and the handling of problems/questions that arise daily. The goal is to have the resident become knowledgeable about 1) instrumentation and analytical techniques utilized in the laboratories, 2) the concepts of quality control and quality assurance, 3) regulatory accreditation requirements for the lab, 4) instrumentation and new test evaluation requirements, 5) basic laboratory management issues, 6) approaches to resolving potential interferences and or problems with laboratory assays, 6) why and how clinical tests are ordered for patient care, and 7) interpretation of clinical assays in the context of patient management.

 Specific goals and objectives depend on the experience of the house officer, and whether the rotation is the first or subsequent rotation through the laboratory. These goals and objectives are highlighted on a separate document.

### Daily/Weekly Activities and Duties

Within the group of laboratories there are a variety of daily and weekly activities that are available for participation by house officers. These include 1) departmental and clinical pathology weekly conferences (3/week), 2) the scheduled didactic sessions with the faculty from the laboratories (typically daily), 3) weekly administrative staff meetings, 4) presentations by residents of interesting cases or special topic review, 5) review and interpretation of hemoglobinopathy evaluations (daily), 6) observation of special chemistry and toxicology testing at the bench, and 7) attendance at biweekly endocrine division case conference.

### Problem Handling

While participating in this CP rotation, the house officers will be contacted by laboratory staff to handle calls, questions, and problems. In addition to issues within the laboratory, the Chemistry section resident will also handle calls for mislabeled sample issues in Central distribution and sendout test questions and problems.

Please see **Areas and Topics of Special Focus** at the end of this document.

**Supervision**

The following activities are to be conducted with **Direct Supervision** (the supervising physician is physically present with the resident):

Sign out of interpretative results (hemoglobinopathy evaluations)

The following activities may be conducted with **Indirect Supervision** (direct supervision immediately available either within the hospital of by telephonic or electronic communication):

Clinical consultations

The following activities may be conducted with **Oversight** (the supervising physician is available to review with feedback after activity is completed):

Quality assurance and other laboratory management projects

Evaluation

* Electronic (MedHub) evaluation completed by faculty at the conclusion of each rotation
* 360 evaluation completed by fellows and technical staff semi-annually
* Resident Inservice Examination (annually)

**Areas and Topics of Specific Focus**

**Chemistry Section**

***I. Principles of Laboratory Medicine***

*1. Interpretation of Laboratory Assays in Clinical Management*

* Understand the principles of sensitivity, specificity, positive and negative predictive value on the clinical significance of laboratory testing
* Understand the meaning and limitations of reference ranges and the factors affecting these ranges in populations
* Understand the concepts of analytical and clinically reportable range.

*2. Method Evaluation*

* Understand the goals of method evaluation (imprecision, accuracy, linearity, comparison with a reference method, analytical sensitivity, and interferences) and apply these to appropriate laboratory undertakings
* Understand and be able to establish and validate a reference range
* Be knowledgeable about the documentation requirements of an analytical procedure manual

*3. Total Quality Management (TQM)*

* Understand the fundamental principles of TQM, quality assurance, lean management
* Understand the functions of calibrators and controls

• Understand common statistical concepts used in quality control programs such as precision and accuracy, Levey-Jennings control chart, Westgard multirule QC application, and delta checks and be able to apply these to appropriate laboratory undertakings

• Be familiar with external quality assessment and proficiency testing programs such as CAP. Understand the Clinical Laboratory Improvement Act (CLIA) criteria governing laboratory testing

***II. Laboratory Techniques and Instrumentation***

• Understand the principles and operation of techniques such as photometric, electrochemical and electrophoretic methods. In addition, understand the analytical aspects of immunoassays(including competitive & and noncompetitive immunoassay design, homogenous vs. heterogeneous assays, nephelometric vs turbidimetric) and various signal generation and detection systems such as chemiluminescence, direct fluorescence, and fluorescence polarization.

• Understand different types of random-access automated analyzers and the measurement principles employed in these systems including spectrophotometric, ion-selective electrode and electrochemical methods, as well as immunoassays (EMIT, CEDIA, FPIA, MEIA II, electrochemiluminescence)

• Understand the principles of performance for common point-of-care devices such as glucometer, urine drugs of abuse, and activated clotting time devices. Know the issues surrounding specimen preparation and transport.

• Understand the principles behind mass spectrometry, high-performance liquid chromatography, and gas chromatography. Become knowledgeable about when these instruments are most effective for laboratory testing.

#### III. Chemical Pathology Pathophysiology

*1. Blood Gases, Acid-Base Disorders, Electrolytes*

* Be familiar with principle of integrated blood gas, electrolyte and CO-Oximetry systems
* Be able to define the Henderson-Hasselbach equation. Understand categories of clinical disorders of acid-base balance (metabolic & respiratory acidosis, metabolic & respiratory alkalosis, mixed disorders)
* Be familiar with direct versus indirect ion-selective measurement of electrolytes and the problems that arise with indirect measurements

*2. Renal Function Testing*

* Know the basic physiology of renal function*.* Understand broad knowledge of renal diseases (e.g., pre-renal azotemia, obstructive azotemia, glomerulonephritis, acute vs chronic renal failure, uremic syndrome) and be familiar with National Kidney Foundation practice guidelines for these conditions. Know the laboratory analytical methods (e.g., Jaffe vs enzymatic methods for creatinine) for the assessment of renal function and proteinuria
* Know the limitations and reporting issues with the estimated GFR.
* Understand the definition of osmolality, molecules in serum that contributes to osmolality and calculation of osmolal gap, as well as the principle of the osmometer

*3. Cardiac Biomarkers for the assessment of coronary artery diseases*

• Be familiar with the current definition of myocardial infarction (MI) by European Society of Cardiology / American College of Cardiology (ESC/ACC) 2000, New York Heart Association (NYHA) classification and understand the interaction of diagnostic modalities (ECG, laboratory testing, imaging)

• Be familiar with the diagnostic & prognostic significance as well as the limitations of current coronary artery disease biomarkers (Troponins I and T, creatinine kinase, CK-MB index & isoforms, myoglobin, myeloperoxidase, PLAC, and cobalt-bound albumin)

• Know the analytical issues with assays used to measure cardiac markers (e.g., preferred specimen [serum vs plasma], interferences compounds [e.g., rheumatoid factor, human anti-mouse monoclonal antibodies], lack of standardization of Troponin assays, analytical false positives)

• Know the pathophysiology and evaluation of congestive heart failure (CHF). Be familiar with the markers of CHF (BNP and NT-proBNP) and their biological and technical limitations

*4. Assessment of Liver Status*

* Understand the dynamics and mechanisms of liver enzyme release and clinical utilities of the enzymes (e.g., AST, ALT, ALP, GGT, LDH)
* Know the biochemical assessment of liver function by non-enzyme analytes such as albumin, ammonia, bile acids, bilirubin, BUN, cholesterol, total protein, triglycerides
* Be familiar with bilirubin metabolism, fractionation of bilirubin (conjugated, unconjugated, δ-bilirubin, direct vs indirect) and unique aspects of neonatal bilirubin. Also, understand the conditions and genetic defects that affect bilirubin metabolism, transport and clearance (e.g., Gilbert syndrome, Dubin- Johnson)
* Be familiar with methods to measure alkaline phosphatase isoenzymes.

*5. Assessment of Thyroid Function*

* Understand the structure, biosynthesis, secretion, and metabolism of thyroid hormones (T4, T3, rT3). Be familiar with thyroid physiology and control of thyroid function (thyrotropin-releasing hormone, TRH, thyrotropin ,TSH)
* Know the common causes of hypothyroidism and hyperthyroidism
* Be familiar with laboratory tests for evaluation of thyroid disorders and be able to interpret the results
* Be familiar with current analytical methodologies for thyroid testing (TSH methods: 1st, 2nd, 3rd generation assays, isotopic and nonisotopic methods, T4, free T3 methods, T uptake methods, antimicrosomal/antithyroid peroxidase antibodies assay, thyrotropin-receptor antibodies assay, TSH suppression and stimulation tests.

*6. Assessment of Pituitary Function*

* Be familiar with physiological action, biochemistry and regulation of anterior pituitary hormones (ACTH, GH, PRL, LH, FSH) and of posterior pituitary hormones (ADH and Oxytocin)
* Be familiar with endocrine tests of hypothalamic-pituitary function (cosyntropin test/rapid ACTH stimulation test, insulin hypoglycemia test, metyrapone test, levodopa test, arginine infusion test, glucose-growth hormone suppression test, TRH test, GnRH test, clomiphene test, CRH test, gonadotropin-releasing hormone test, water deprivation test, saline infusion test and water loading test)

*7. Assessment of* *Adrenal Cortex Function Testing*

* Be familiar with physiological action, biochemistry, biosynthesis, chemical structure and metabolism of glucocorticoids and mineralocorticoids.
* Understand clinical conditions associated with excess and deficiency of adrenal cortex hormones. Be familiar with testing the functional status of the adrenal cortex (basal levels vs stimulation tests & suppression tests, circadian rhythm of corticosteroids, morning ACTH, cortisol [urinary, random and free], rapid ACTH Cortisol stimulation test, multi-day ACTH stimulation, metyrapone stimulation, CRH stimulation).

*8. Assessment of* *Gastric, Pancreatic & Intestinal Function*

* Be familiar with clinical manifestations of gastric, pancreatic & intestinaldisease and diagnostic methodologies such as breath tests for H. pylori, fecal occult blood, lipase amylase (fractionation of amylase; pancreatic versus salivary and amylase/creatinine clearance ratio)

*9. Assessment of* *Glucose and Diabetic Testing*

* Understand the metabolism of carbohydrates (insulin, C-peptide, proinsulin, glucagons, and other regulatory hormones) and be familiar with the American Diabetes Association (ADA) definitions of impaired fasting glucose and diabetes mellitus Type I & Type II
* Be familiar with the laboratory assessment of diabetes and glucose metabolism (blood glucose, oral glucose tolerance test, Hemoglobin A1c, fructosamine and urinary microalbumin). Also, know the current analytical methodologies for these tests

*10. Assessment of* *Mineral And Bone Metabolism*

* Understand the biochemistry and physiology of calcium, phosphate, magnesium
* Know the physiological states of calcium, phosphate, magnesium (free ionized, protein-bound, complexed and total) and factors that affect them (pH, protein concentrations, etc)
* Be familiar with hormones that regulate mineral metabolism (parathyroid hormone (PTH)- calcitonin and vitamin D) as well as parathyroid hormone-related protein (PTHrP). Understand various PTH assays, including “bio-intact” PTH, intra-operative PTH
* Know the pathophysiology of laboratory evaluations of metabolic bone disease such as osteoporosis, osteomalacia and Paget’s disease

*11. Assessment of Porphyrins and Disorders of Porphyrin Metabolism*

* Be familiar with the chemistry, biochemistry and biosynthesis of heme and porphyrins. Know the enzymes involved in heme and porphyrins biosynthesis
* Be familiar with porphyrin disorders such as primary porphyrin disorders including neurological/psychiatric vs cutaneous photosensitivity as well as secondary or acquired porphyrin disorders

*12. Tumor Markers*

* Be familiar with the definition, classification, biochemistry and distribution of tumor markers, whether protein or carbohydrate, including prostate specific antigen (PSA), free and complexed PSA, alkaline phosphatase, neuron specific enolase, calcitonin, human chorionic gonadotropin, and adrencorticotropic hormone, α-fetoprotein, carcinoembryonic antigen, tissue polypeptide antigen, squamous cell carcinoma antigen,CA 15-3, CA 27 29, CA 125, and CA 19-9.

*13. Assessment of Fetal Lung Maturity*

* Understand the physiology of respiratory distress syndrome (RDS)
* Be familiar with fetal lung maturity testing (lecithin/sphingomyelin (L/S) ratio, phosphatidyl glycerol (PG), foam stability index (FSI or shake test), DSPC, Fluorescence polarization FLM test, Counting of lamellar bodies). Understand the biochemistry, physiology and diagnostic performance of fetal fibronectin

*14. Trace Elements*

* Understand biochemistry, physiology and metabolism of trace elements (iron, magnesium, zinc, copper, manganese, molybdenum, selenium, cobalt and fluoride) as well as ultratrace elements (nickel, vanadium, boron and silicon)
* Know the biochemistry and clinical significance of metal binding proteins such as transferrin, ferritin and ceruloplasmin
* Know the clinical assessments of trace elements (e.g., serum iron, iron binding capacity, transferrin, transferrin saturation, serum ferritin, zinc protoporphyrin, serum ceruloplasmin)
* Be familiar with specimen of choice (plasma, urine, hair, nail) and the analytical methods for the determinations of trace elements

*15. Vitamins*

* Know the definition and classification of vitamins: fat soluble vitamins (A, D, E, K) and water soluble vitamins (B1, B2, B6, B12 [cobalamin], C, niacin, nicotinamide, folic acid, biotin, panothenic acid)
* Understand the clinical disorders associated with the deficiency as well as toxicity of vitamins

*16. Cholesterol & Lipids Testing*

* Be familiar with chemical structures, biosynthesis, classification, functions and metabolism of lipids and lipoproteins
* Be familiar with Fredrickson classification and ATP III classification of hyperlipidemia (New features & shared features with ATP II, risk assessment, Framingham Point Scores)
* Understand the pathophysiology of lipid disorders
* Know the principles of analytical techniques for laboratory assessment of lipids

*17. Proteins*

* Understand the principles of protein analysis in body fluids (e.g., Kjeldahl and Biuret methods, refractometry, qualitative dipstick). Be familiar with the principles of serum, urine, CSF and pleural fluid protein electrophoresis, and be able to identify various proteins and interpret the significance of findings (e.g., monoclonal gammopathy, light-chain diseases, Bence-Jones proteinuria, Oligoclonal banding, proteinuria, etc.). In addition, be familiar with the significance of CSF/serum albumin index, CSF IgG index, transudates versus exudates in peritoneal fluid and Pleural/serum protein ratio, pleural fluid LDH and protein, glucose, pH, lipids of pericardial fluid

*18. Clinical Enzyme Kinetics*

* Understand the principles of enzyme kinetics (Michaelis-Menten equation, concepts of Km, Vmax. Zero-order and 1st-order kinetics)and clinical enzymology including isoenzymes and isoforms
* Be familiar with the principles of analytical enzymology and know the concepts of activity vs. mass assays, e.g. CK versus CK-MB assays

*19. Therapeutic Drug Monitoring - General*

* Understand basic pharmacokinetic principles involving Vd, dose, peak and trough concentration of a drug, area under the curve (AUC), clearance, half-life, bioavailability and protein binding. Also be familiar with one compartmental and two compartmental models of drug distribution, first and second order elimination kinetics and effect of disease on K, the elimination rate constant. Understand the effects of disease such as uremia, hepatic disease on protein binding of drugs.
* Understand common drug-drug interactions with particular emphasis on effect of one drug on clearance of another drug, for example increased clearance of phenytoin in the presence of carbamazepine, an inducer of cytochrome P 450 enzymes.
* Understand which free/unbound drugs are frequently measured and why? What are the common factors affecting free/unbound drug concentrations?

# *20. Therapeutic Drug Monitoring of Specific Drugs*

* Analgesics/ Antipyretic: Familiar with toxic concentrations of acetaminophen and salicylate, and liver failure due to acetaminophen overdose and specific antidote for treatment.
* Antidepressants: (Tricyclic antidepressants, selective serotonin reuptake inhibitors).
* Anticonvulsants: Familiar with therapeutic drug monitoring of classical antidepressants such as phenytoin, carbamazepine, Valproic acid, Phenobarbital, primidone and ethosuximide. Understand clinical utility of monitoring free phenytoin, free valproic acid and free carbamazepine concentrations in patients with uremia, hepatic disorder, AIDS hypoalbuminemia, and other conditions. Understanding of need for therapeutic drug monitoring of newer anticonvulsant such as lamotrigine, gabapentene, oxcarbazepine and tiagabine.
* Cardiovascular drugs: Therapeutic drug monitoring of digoxin and effect of endogenous digoxin-like immunoreactive factors on various immunoassays used for monitoring serum digoxin concentrations.
* Antibiotics: Understand need for monitoring of peak and/or trough concentrations of aminoglycosides and vancomycin.
* Immunosuppressants: Proficiency in therapeutic drug monitoring of cyclosporine and tacrolimus with understanding of C0, C2 and AUC monitoring for cyclosporine. Be familiar with therapeutic drug monitoring of newer immunosuppressants such as sirolimus, mycophenolic acid, and everolimus. Compare immunoassay versus LC-MS/MS for immunosuppressant monitoring.

## *21. Clinical and Forensic Toxicology*

* Understand drug screening and confirmation (Immunoassays v GC/MS). Understand the strengths and limitations of each type of screen.
* Be familiar with alcohol poisoning using ethanol, methanol, isopropanol, and ethylene glycol. Understand DWI laws and legal limit of blood alcohol concentration (0.08% plasma in certain states and whole blood in others.
* Be familiar with atomic absorption or mass spectrometric technique for determination of heavy metals in body fluids such as lead, mercury, arsenic, and cadmium.
* Understand the pathophysiology of cyanide and carbon monoxide poisoning.