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JOHANNESBURG
ACADEMIC OFFICE

FC Path(SA) Chem Curriculum

SECTION 1- BASIC PRINCIPLES AND PRACTICE OF CLINICAL CHEMISTRY

1.0 Basic Principles and Practices

1.1 UNITS OF MEASURE: Electronic Reporting of Results
1.2 REAGENTS: Chemicals, Reference Materials, Water Specifications, Solution Properties
1.3 CLINICAL LABORATORY SUPPLIES: Thermometers & Temperature, Glassware and Plastic ware, Desiccators and Desiccants, Balances
1.4 BASIC SEPARATION TECHNIQUES: Centrifugation, Filtration, Dialysis
1.5 LABORATORY MATHEMATICS AND CALCULATIONS: Significant Figures, Concentration, Dilutions, Hydration of Water, Graphing and Beer's Law, Mean, SD, CV, Z-score, RCV, Analytical and Diagnostic Sensitivity, Specificity , Predictive value, Diagnostic efficiency, Enzyme kinetics
1.6 SPECIMEN CONSIDERATIONS: Types of Samples, Sample Processing, Sample Variables, Chain of Custody

2.0 Phlebotomy and Specimen Considerations

2.1 PUBLIC RELATIONS AND CLIENT INTERACTION: Professionalism, Patient Consent, Confidentiality
2.2 BASIC INFECTION CONTROL
2.3 SOURCE AND COMPOSITION OF BLOOD SPECIMENS; TYPES OF BLOOD SPECIMENS; VENIPUNCTURE EQUIPMENT: Tourniquet, Needles, Evacuated Tube System, Syringe System, Butterfly System, Tube Additives, Trace Element–Free Tubes
2.4 ORDER OF DRAW AND ADDITIVE CARRY-OVER; VENIPUNCTURE PROCEDURES:
2.5 CAPILLARY PUNCTURE PROCEDURES:
2.6 SPECIMEN HANDLING AND PROCESSING: Routine Handling, Special Handling
2.7 SPECIMEN PROCESSING: Processing Safety, Specimen Suitability, Centrifugation, Stopper Removal, Aliquot Preparation

3.0 Basic Laboratory Safety and Regulations

3.1 LABORATORY SAFETY AND REGULATIONS: Occupational Safety and Health Act (OSHA), Other Regulations and Guidelines
3.2 SAFETY AWARENESS FOR CLINICAL LABORATORY PERSONNEL: Safety Responsibility, Signage and Labelling
3.3 SAFETY EQUIPMENT: Chemical Fume Hoods and Biosafety Cabinets, Chemical Storage Equipment, Personal Protective Equipment
3.4 BIOLOGIC SAFETY: General Considerations, Spills, Bloodborne Pathogens, Airborne Pathogens, Shipping
3.5 CHEMICAL SAFETY: Hazard Communication, Material Safety Data Sheet, OSHA Laboratory Standard, Toxic Effects from Hazardous Substances, Explosive and Inflammable Chemicals / Gases, Storage and Handling of Chemicals
3.6 RADIATION SAFETY: Environmental Protection, Personal Protection, Nonionizing Radiation
3.7 BASIC FIRE SAFETY:

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3.8 CONTROL OF OTHER HAZARDS: Electrical Hazards, Compressed Gases Hazards, Cryogenic Materials, Mechanical Hazards, Ergonomic Hazards
3.9 DISPOSAL OF HAZARDOUS MATERIALS: Chemical Waste, Radioactive Waste, Biohazardous Waste
3.10 ACCIDENT DOCUMENTATION AND INVESTIGATION

4.0 Method Evaluation and Quality Control

4.1 BASIC CONCEPTS: Descriptive Statistics, Measures of Centre, Spread, and Shape, Descriptive Statistics of Groups of Paired, Inferential Statistics
4.2 REFERENCE INTERVAL STUDIES: Establishing Reference Intervals, Preanalytic and Analytic Considerations, Determining Whether to Establish or Verify Reference Intervals, Analysis of Reference Values, Data Analysis to Establish a Reference Interval, Data Analysis to Verify a Reference Interval
4.3 DIAGNOSTIC EFFICIENCY: Measures of Diagnostic Efficiency
4.4 METHOD EVALUATION: Regulatory Aspects of Method Evaluation, Method Evaluation,: Determination of Imprecision and Inaccuracy, Measurement of Imprecision, Measurement of Inaccuracy, Recovery Studies, Interference Studies, Comparison-of-Methods Studies, Allowable Error
4.5 QUALITY CONTROL: Quality Control (QC) Control Charts, Operation of a Quality Control System, Multi-Rules and interpretation, Proficiency Testing

5.0 Principles of Analytical Techniques

5.1 SPECTROPHOTOMETRY AND PHOTOMETRY: Spectrophotometric Instruments, Components of a Spectrophotometer, Spectrophotometer Quality Assurance, Atomic Absorption Spectrophotometer, Flame Photometry, Fluorometry, Chemiluminescence, Turbidity and Nephelometry,
5.2 ELECTROCHEMISTRY: Galvanic and Electrolytic Cells, Half-Cells, Ion-Selective Electrodes, pH Electrodes, Gas-Sensing Electrodes, Enzyme Electrodes, Coulometric Chloridometers
5.3 ELECTROPHORESIS: Procedure, Support Materials, Treatment and Application of Sample, Detection and Quantitation, Electroendosmosis, Isoelectric Focusing, Capillary Electrophoresis,
5.4 CHROMATOGRAPHY: Modes of Separation, Chromatographic Procedures, High-Performance Liquid Chromatography, Gas Chromatography
5.5 MASS SPECTROMETRY: Sample Introduction and Ionization, Mass Analyzer, Detector, Applications of Mass Spectrometry in the Clinical Laboratory
5.6 OSMOMETRY: Freezing-Point Osmometer
5.7 BASIC ANALYTIC TECHNIQUES FOR DIPSTICKS, GLUCOMETERS
5.8 BASICS OF IMMUNOASSAYS: Unlabeled Immunoassays, Labeled Immunoassays, Competitive Immunoassays, Non-competitive Immunoassays

6.0 Principles of Clinical Chemistry Automation

6.1 BASIC APPROACHES TO AUTOMATION, STEPS IN AUTOMATED ANALYSIS: Specimen Preparation and Identification, Specimen Measurement and Delivery, Reagent Systems and Delivery, Chemical Reaction Phase, Measurement Phase, Signal Processing and Data Handling
6.2 BASIC COMPONENTS OF LABORATORY AUTOMATION: Preanalytic Phase (Sample Processing), Analytic Phase (Chemical Analyses), Postanalytic Phase (Data Management)

7.0 Principles of Molecular Techniques

7.1 NUCLEIC ACID–BASED TECHNIQUES: Nucleic Acid Chemistry, Hybridization Techniques, DNA Sequencing, DNA Chip Technology, Target Amplification, Probe Amplification, Signal Amplification, Nucleic Acid Probe Applications, Genomes and Nucleic Acid variation. Epigenetics, Flow Cytometry, Microarrays, miRNA and RNA Interferences

SECTION 2 – BASIC BIOCHEMISTRY AND CLINICAL CORRELATIONS

8.0 Basic Biochemistry

Biochemical pathways of intermediary metabolism, molecular biochemistry as well as special applied biochemistry such as:

- The biochemistry of haemoglobin
- mmunoglobulins)
- Bilirubin metabolism
- Purine metabolism
- Haem biosynthesis
- Steroid synthesis (glucocorticoids, mineralocorticoids, androgens, oestrogens, progestogens)
- Pathways typically involved in metabolic disease (glycogen synthesis and lysis, urea cycle, fatty acid oxidation, branch chain amino acid oxidation, phenylalanine catabolism).
- Glucose metabolism; Glycogenesis, Gluconeogenesis
- Protein metabolism
- Bilirubin
- Purines
- Fatty acid oxidation
- Galactose metabolism
- Bile acids

9.0 Amino Acids and Proteins

9.1 AMINO ACIDS: Overview, Basic Structure, Metabolism, Essential Amino Acids, Nonessential Amino Acids,

9.2 PROTEINS: Importance, Molecular Size, Synthesis, Catabolism and Nitrogen Balance, Structure, Nitrogen Content, Charge and Isoelectric Point, Solubility, Classification

9.3 PLASMA PROTEINS:Acute Phase Reactants, Albumin, Globulins

9.4 OTHER PROTEINS OF IMPORTANCE: Myoglobin, Troponin (cTn), Brain Natriuretic Peptide and N-Terminal–Brain Natriuretic Peptide, Haemoglobin, Immunoglobulins Cystatin C, Amyloid

9.5 TOTAL PROTEIN ABNORMALITIES: Hypoproteinaemia, Hyperproteinaemia,

9.6 PROTEINS IN OTHER BODY FLUIDS: Urinary Protein, Cerebrospinal Fluid Proteins

10.0 Nonprotein Nitrogen Compounds

Physiology and biochemistry, Clinical Application, Specimen Requirements and Interfering, Substances, Pathophysiology of:

10.1 UREA:

10.2 URIC ACID:

10.3 CREATININE/CREATINE:

10.4 AMMONIA:

11.0 Enzymes

11.1 GENERAL PROPERTIES AND DEFINITIONS, ENZYME CLASSIFICATION AND NOMENCLATURE, ENZYME KINETICS: Catalytic Mechanism of Enzymes, Factors That Influence Enzymatic Reactions, Measurement of Enzyme Activity, Calculation of Enzyme Activity, Measurement of Enzyme Mass, Enzymes as Reagents

11.2 THE CLINICAL SIGNIFICANCE OF THE FOLLOWING ENZYMES: Creatine Kinase, Lactate Dehydrogenase, Aspartate Aminotransferase, Alanine Aminotransferase, Alkaline Phosphatase, Acid Phosphatase, γ- Glutamyltransferase, Amylase, Lipase, Glucose-6-Phosphate Dehydrogenase, Drug-Metabolizing Enzymes, Cholinesterase

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12.0 Carbohydrates

12.1 GENERAL DESCRIPTION OF CARBOHYDRATES: Classification of Carbohydrates, Stereoisomers, Monosaccharides, Disaccharides, and Polysaccharides, Chemical Properties of Carbohydrates, Glucose Metabolism, Fate of Glucose, Regulation of Carbohydrate Metabolism

12.2 HYPERGLYCAEMIA: Diabetes Mellitus, Pathophysiology of Diabetes Mellitus, Criteria for Testing for Prediabetes and Diabetes, Criteria for the Diagnosis of Diabetes Mellitus, Criteria for the Testing and Diagnosis of Gestational Diabetes Mellitus

12.3 HYPOGLYCAEMIA: Approach to hypoglycaemia

12.4 Insulin Resistance and metabolic syndrome

12.5 ROLE OF LABORATORY IN DIFFERENTIAL DIAGNOSIS AND MANAGEMENT OF PATIENTS WITH GLUCOSE METABOLIC ALTERATIONS: Methods of Glucose Measurement, Glucose Tolerance and 2-Hour Postprandial Tests, Glycosylated Haemoglobin/Haemoglobin A1c, Ketones, Albuminuria

13.0 Lipids and Lipoproteins

13.1 LIPID CHEMISTRY: Fatty Acids, Triglycerides, Phospholipids, Cholesterol

13.2 GENERAL LIPOPROTEIN STRUCTURE: Chylomicrons, Very Low Density Lipoproteins, Low-Density Lipoproteins, Lipoprotein(a),High-Density Lipoproteins

13.3 LIPOPROTEIN PHYSIOLOGY AND METABOLISM: Lipid Absorption, Exogenous Pathway, Endogenous Pathway, Reverse Cholesterol Transport Pathway

13.4 DIAGNOSIS AND TREATMENT OF LIPID DISORDERS: Arteriosclerosis, Hyperlipoproteinaemia, Hypercholesterolaemia, Hypertriglyceridaemia, Combined Hyperlipoproteinaemia, Lipoprotein(a) Elevation, Hypolipoproteinaemia, Hypoalphalipoproteinaemia,

14.0 Electrolytes

14.1 WATER BALANCE AND COLLIGATIVE PROPERTIES OF SOLUTES; Osmolality

14.2 THE ELECTROLYTES: Sodium, Potassium, Chloride, Bicarbonate, Magnesium, Calcium, Phosphate, Lactate

14.3 ANION GAP, Osmolar Gap, Corrected sodium, Adjusted calcium

14.4 ELECTROLYTES AND RENAL FUNCTION

15.0 Blood Gases

15.1 DEFINITIONS: ACID, BASE, BUFFER ACID-BASE BALANCE: Maintenance of H+, Buffer Systems: Regulation of H+, Regulation of Acid-Base Balance: Lungs and Kidneys

15.2 ASSESSMENT OF ACID-BASE HOMEOSTASIS: The Bicarbonate Buffering System and the Henderson-Hasselbalch Equation, Acid-Base Disorders: Acidosis and Alkalosis

15.3 OXYGEN AND GAS EXCHANGE : Oxygen and Carbon Dioxide, Oxygen Transport , Quantities Associated With Assessing a Patient's Oxygen Status, Hemoglobin–Oxygen Dissociation

15.4 QUALITY ASSURANCE: Preanalytic Considerations, Analytic Assessments: Quality Control and Proficiency Testing, Interpretation of Results

16.0 Iron and Trace Elements

16.1 IRON: Health Effects, Absorption, Transport, and Excretion, Deficiency, Toxicity, Evaluation of Iron Status, Total Iron Content (Serum Iron, Total Iron-Binding Capacity, Percent Saturation, Transferrin and Ferritin)

16.2 Copper

SECTION 3…/

SECTION 3 - ASSESSMENT OF ORGAN SYSTEM FUNCTIONS

17.0 Introduction to Hormones and Pituitary Function

17.1 FUNCTIONAL ASPECTS OF THE HYPOTHALAMIC– HYPOPHYSIAL UNIT
17.2 HYPOPHYSIOTROPIC OR HYPOTHALAMIC HORMONES
17.3 ANTERIOR PITUITARY HORMONES
17.4 PITUITARY TUMORS
17.5 GROWTH HORMONE: Actions of Growth Hormone, Testing, Acromegaly, Growth Hormone Deficiency
17.6 PROLACTIN; Prolactinoma, Other Causes of Hyperprolactinaemia, Clinical Evaluation of Hyperprolactinaemia, Management of Prolactinoma, Idiopathic Galactorrhea
17.7 HYPOPITUITARISM: Aetiology of Hypopituitarism, Treatment of Panhypopituitarism
17.8 POSTERIOR PITUITARY HORMONES: Oxytocin, Vasopressin

18.0 Adrenal Function

18.1 THE ADRENAL GLAND: AN OVERVIEW
18.2 THE ADRENAL CORTEX BY ZONE: Cortex Steroidogenesis, Congenital Adrenal Hyperplasia
18.3 DIAGNOSIS OF PRIMARY ALDOSTERONISM: Diagnosis Algorithm
18.4 ADRENAL CORTICAL PHYSIOLOGY
18.5 ADRENAL INSUFFICIENCY (ADDISON'S DISEASE: Diagnosis of Adrenal Insufficiency, Treatment of Adrenal Insufficiency
18.6 HYPERCORTISOLISM
18.7 CUSHING'S SYNDROME: Pituitary versus Ectopic Adrenocorticotropic Hormone Secretion, Diagnosis of Cushing's Syndrome, Diagnostic Workup
18.8 ANDROGEN EXCESS: Diagnosis of Excess Androgen Production
18.9 THE ADRENAL MEDULLA; Development, Biosynthesis and Storage of Catecholamines, Catecholamine Degradation, Urine and Plasma Catecholamine Measurements, Causes of Sympathetic Hyperactivity, Diagnosis of Phaeochromocytoma

19.0 Gonadal Function

19.1 THE TESTES: Physiology, Disorders of Sexual Development and Testicular Hypofunction, Diagnosis of Hypogonadism
19.2 THE OVARIES: Hormonal Production by the Ovaries, The Menstrual Cycle, Hormonal Control of Ovulation, Pubertal Development in the Female, Menstrual Cycle Abnormalities, Hirsutism

20. The Thyroid Gland

20.1 THE THYROID: Thyroid Hormone Synthesis, Protein Binding of Thyroid Hormone, Regulation of Thyroid Hormone production, Actions of Thyroid Hormone, Calcitonin
20.2 TESTS FOR THYROID EVALUATION
20.3 DISORDERS OF THE THYROID: Hypothyroidism, Thyrotoxicosis, Graves' disease, Toxic Adenoma and Multinodular Goiter, Thyroid malignancy
20.4 DRUG-INDUCED THYROID DYSFUNCTION: Amiodarone-Induced Thyroid Disease, Subacute Thyroiditis,
20.5 NONTHYROIDAL ILLNESS

21.0 Calcium, Phosphate, and Magnesium Homeostasis and Hormonal Regulation

21.1 CALCIUM HOMEOSTASIS
21.2 HORMONAL CONTROL OF CALCIUM METABOLISM: Vitamin D, Parathyroid Hormone, FGF-23
21.3 HYPERCALCAEMIA: Signs and Symptoms, Causes, Endocrine Causes, Organ System Causes, Medications That Can Cause Hypercalcaemia
21.4 HYPOCALCAEMIA: Signs and Symptoms, Causes, Endocrine Causes, Organ System Causes, Medications That Affect Calcium, Metabolism
21.5 HYPERPHOSPHATAEMIA: Signs and Symptoms, Causes
21.6 HYPOPHOSPHATAEMIA: Signs and Symptoms, Causes
21.7 HYPERMAGNESAEMIA: Signs and Symptoms, Causes
21.8 HYPOMAGNESAEMIA: Signs and Symptoms, Causes
21.9 METABOLIC BONE DISEASE: Rickets and Osteomalacia, Osteoporosis

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22.0 Liver Function

22.1 BIOCHEMICAL FUNCTIONS: Excretory and Secretory, Synthetic, Detoxification and Drug Metabolism,

22.2 LIVER FUNCTION ALTERATIONS DURING DISEASE: Jaundice, Cirrhosis, Tumors, Reye Syndrome, Drug- and Alcohol-Related Disorders

22.3 ASSESSMENT OF LIVER FUNCTION/LIVER FUNCTION TESTS: Bilirubin, Urobilinogen in Urine and Faeces, Serum Bile Acids, Enzymes, Tests Measuring Hepatic Synthetic Ability and Ammonia production, Urea synthesis

23.0 Cardiac Function

23.1 DIAGNOSIS OF HEART DISEASE: Laboratory Diagnosis of Myocardial Infarction, Markers of Inflammation, Markers of Congestive Heart Failure,

24.0 Renal Function

24.1 RENAL PHYSIOLOGY: Glomerular Filtration, Tubular Function, Elimination of Nonprotein Nitrogen Compounds, Water, Electrolyte, and Acid-Base Homeostasis, Endocrine Function, 1,25-Dihydroxy Vitamin D3

24.2 ANALYTIC PROCEDURES: Glomerular Filtration and Clearance Measurements, Urinalysis

24.3 PATHOPHYSIOLOGY: Acute Kidney Injury, Chronic Kidney Disease, Nephrotic Syndrome, Nephritic Syndrome, Renal Calculi

25.0 Pancreatic Function and Gastrointestinal Function

25.1 PHYSIOLOGY OF PANCREATIC FUNCTION

25.2 DISEASES OF THE PANCREAS: Acute Pancreatitis, Chronic Pancreatitis, Pancreatic Carcinoma, Cystic Fibrosis

25.3 TESTS OF PANCREATIC FUNCTION: Secretin/Cholecystokinin Test, Faecal Fat Analysis, Sweat Electrolyte Determinations, Serum Enzymes

25.4 PHYSIOLOGY AND BIOCHEMISTRY OF GASTRIC SECRETION

25.5 DISEASES OF THE STOMACH: Peptic Ulcer Disease

25.6 TESTS OF GASTRIC FUNCTION: Measuring Gastric Acid in Basal and Maximal Secretory Tests, Measuring Gastric Acid, Plasma Gastrin

25.7 INTESTINAL DISEASE: Malabsorption Syndromes, Coeliac Disease, Chron's Disease,

25.8 CLINICOPATHOLOGIC ASPECTS OF INTESTINAL FUNCTION

25.9 TESTS OF INTESTINAL FUNCTION: Lactose Tolerance Test, D-Xylose Absorption Test, Serum Carotenoids, Other Tests of Intestinal Malabsorption

26.0 Body Fluid Analysis In The Investigation of Disease

26.1 CEREBROSPINAL FLUID

26.2 SWEAT

26.3 SYNOVIAL FLUID

26.4 SEROUS FLUIDS: Pleural Fluid, Pericardial Fluid, Peritoneal Fluid

SECTION 4-OVERVIEW OF SPECIALTY AREAS

27.0 Introduction to Toxicology

27.1 TOXICOLOGY OF SPECIFIC AGENTS: Alcohol, Carbon Monoxide,

27.2 TOXICOLOGY OF THERAPEUTIC DRUGS: Salicylates, Acetaminophen

27.3 TOXICOLOGY OF DRUGS OF ABUSE: Amphetamines, Cannabinoids, Cocaine, Opiates, Phencyclidine, Sedatives-Hypnotics

28.0 Circulating Tumor Markers: Basic Concepts and Clinical Applications

28.1 TYPES OF TUMOR MARKERS

29.2 APPLICATIONS OF TUMOR MARKER DETECTION: Screening, Prognosis, Monitoring Effectiveness of Therapy and Disease Recurrence

Prescribed Books…/

Prescribed Books

Essential reading

1) Clinical Chemistry, 7th Edition, Marshall, Bangert and Lapsley, ISBN: 978-0-7234-3703-1
2) Undergraduate Chemical Pathology Notes-eg UCT notes or equivalent/any comprehensive set of notes from any South African University involved in registrar training
3) Clinical Chemistry, Principles Techniques and Correlations, 7th edition, Bishop, Fody and Schoeff ISBN 1451118694, 9781451118698 **AND/OR** Tietz Fundamentals of Clinical Chemistry, 2015; 7th edition Burtis and Bruns (ISBN-13: ISBN-13: 978-1455741656 ISBN-9: 1455741655)
5) Medical Statistics at a glance, 2009, 3rd edition Petrie and Sabin (ISBN: 978-1-4051-8051-1) (Wiley-Blackwell)
6) Medical Biochemistry at a Glance, 2012. 3rd edition. Salway JG **AND/OR** Essential Biochemistry for Medicine, 2010; 1st edition Fry M (Wiley & Blackwell) ISBN 978-0-470-74328-7

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