澳門理工大學
Universidade Politécnica de Macau
Macao Polytechnic University

FACULTY OF HEALTH SCIENCES AND SPORTS

BACHELOR OF SCIENCE IN BIOMEDICAL TECHNOLOGY

(MEDICAL LABORATORY TECHNOLOGY)

LEARNING MODULE OUTLINE

Academic Year	2024 / 2025	Semester	1
Module Code	BSCC2101		
Learning Module	Clinical Chemistry		
Pre-requisite(s)	BSBC1102 Biochemistry		
Medium of Instruction	Chinese / English		
Credits	6	Contact Hours	90
Instructor	Veng Meng ,Richard Lo	Email	vmlo@mpu.edu.mo
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MODULE DESCRIPTION

The aim of this module is to introduce basic knowledge in clinical chemistry, including: Basic Operation principles, handling experimental data, quality assurance, and reference values.

The relationship between experimental quantity and pathological condition will be discussed. Methods in analysis of different samples will be demonstrated.

Students will learn routine work in a clinical chemistry laboratory.

MODULE INTENDED LEARNING OUTCOMES (ILOS)

On completion of this learning module, students will be able to:

M1.	Understand background knowledge of clinical chemistry
M2.	Understand the basic technical skills used in Clinical Chemistry
M3.	Understand the principle of clinical tests
M4.	Understand how to handle experimental data
M5.	Understand the application of clinical tests

These ILOs aims to enable students to attain the following Programme Intended Learning Outcomes (PILOs):

PILOs	M1	M2	M3	M4	M5
P1. To demonstrate understanding of a range of subjects, fields, principles and approaches relevant to medical laboratory technology	✓	✓	✓	✓	✓
P2. To demonstrate understanding of theories, analytical approaches and practices that underpin medical laboratory operations and management	✓	✓	✓	✓	✓
P3. To demonstrate understanding of major trends and issues related to medical laboratory technology	✓	✓	✓	✓	✓
P4. To apply professional knowledge and skills to analyse, interpret and solve problems, challenges and risks in medical laboratory practice	✓	✓	✓	✓	✓
P5. To critically appraise and interpret scientific and clinical literature and apply evidence-based practice	✓	✓	✓	✓	✓
P6. To acquire and apply research skills in medical laboratory technology	✓	✓	✓	✓	✓
P7. To demonstrate effective communication and teamwork skills	✓			✓	✓
P8. To maintain professional and ethical standards in medical laboratory practice and research	✓				✓

MODULE SCHEDULE, COVERAGE AND STUDY LOAD

Content

Theory	Contact Hours
1. **Basic concept** ● Areas of clinical chemistry, General Laboratory Techniques and Procedure	**1 hr**
2. **Laboratory Techniques** 2.1 Sampling: ● Blood, Urine and different type of clinical specimens collection. ● Sample handling and treatment. 2.2 Clinical assays: ● Spectroscopic methods; multiple wavelength assay, ● End point methods and kinetic methods; ● Electrochemical methods; ● Chromatographic methods and electrophoresis methods; ● Immunochemical techniques 2.3 Automation in Clinical chemistry ● Instruments in clinical chemistry laboratories; ● Auto analyzer; Total Laboratory Automation (TCA); ● Laboratory Information System (LIS).	**4 hrs**

3.	**Acquisition, Management and Application of Laboratory Data** 3.1 Quality Control(QC): • Accuracy and Precession; • Errors: Systematic and Random errors; • Internal and External Quality Control; • Quality control chart; Inspection methods; • Quality Assurance(QA); Analytical Method Evaluations. 3.2 Reference values: • Concepts of reference values; • statistic of reference values; • establish of reference values; • Interpretation of Laboratory Data; • Individual & Population based reference value; • Partitioning of Reference Values; • Multivariate Reference Region	**4 hrs**
4.	**Proteins and Amino Acid** 4.1 Serum protein: Classification of Serum protein. 4.2 Analytical methods of protein assay: Total protein and Albumin assay; blood, urine and CSF (cerebrospinal fluid) 4.3 Serum electrophoresis. 4.4 Interpretation of protein assay data. 4.5 Special protein: M protein and Bence-Jones protein (BJ protein), Microalbumin (MAU). 4.6 Amino acid: Causes of Aminoaciduria. Amino Acid Analysis.	**4 hrs**
5.	**Carbohydrates** 5.1 Structure of Carbohydrates 5.2 Important saccharides and their functions: Glucose, Fructose and Galactose. 5.3 Blood glucose level regulation. 5.4 Diabetes and glucose related disease: Origin of diabetes; Types of diabetes; Hypoglycemia. 5.5 Determination of Glucose in Body Fluids: Preparation of sampling; Assay methods. 5.6 Glucose Tolerance Test (GTT); Oral glucose test and Postprandial Two Hours Sugar test, Insulin Tolerance Test. 5.7 Glycosylated hemoglobin: Clinical application of HbA1c. Fructosamine 5.8 Some more sugar related parameters: 1,5-Anhydroglucitol (1,5-AG), C-peptide. 5.9 Ketone bodies 5.10 Other sugars: Galactose, Fructose, Xylose and glycogen.	**4 hrs**
6.	Midterm test	**2 hrs**
7.	**Nitrogen Metabolites and Renal Function** 7.1 Excretion of various materials: Water and electrolytes, Nitrogen containing compounds (Urea, Creatine, Creatinine, Uric acid), Glucose. 7.2 Non protein nitrogen compounds assay: Total non protein nitrogen assay,	**4 hrs**

Urea, Creationine, Uric acid.

	7.3 Urinalysis: Dipstick and Microscopic Analysis (Urine sediments)	
	7.4 Renal Function Tests (RFT): Measurement of Glomerular Filtration Rate GFR (Clearance tests), Tubular function tests (Concentration & Dilution tests, PSP test), Renal blood flow tests, Urine osmolality.	
	7.5 Some more test related to renal function: Microalbumin (MAU), N-acetylglucosamindase:NAG, b2 Microglobulin ($\beta2MG$), Cystatin C.	
	7.6 Renal Diseases.	
	7.7 Renal Stone.	
	7.8 Hemodialysis	
8. Lipid and Lipoprotein		**4 hrs**
	8.1 Function, structure and classification of serum Lipids.	
	8.2 Lipoproteins and their composition:CM – Chylomicrons, VLDL – very low density lipoproteins, IDL – intermediate lipoproteins, LDL – low density lipoproteins and HDL – High density lipoproteins.	
	8.3 Lipid Panel: Cholesterol (Chol.) or Total cholesterol (TC), Triglycerides (TG), High-density lipoprotein (HDL) or HDL-C, Low-density lipoprotein (LDL) or LDL-C	
	8.4 Measurement of lipoproteins: Utracentrifugation, Lipid Electrophoresis and Precipitation-based method Immunoassay, Gel membrane filtration.	
	8.5 Hyperlipoproteinmias classification (Frederick (WHO) classification) and Lipid disorder.	
	8.6 Some more tests: Phospholipids, Free fatty Acid (FFA), Steroids (hormones) and Apolipoprotein (rocket electrophoresis).	
9. Electrolytes, Minerals and Trace elements		**3 hrs**
	9.1 Elements in Body: major elements, bulk elements and trace elements.	
	9.2 Minerals: Trace elements and non trace elements. Distribution of elements. Common features of trace elements.	
	9.3 Some important elements: Calcium and Phosphorous, Magnesium, Iron.	
	9.4 Water balance	
	9.5 Electrolytes (Potassium, Sodium and Chloride)	
	9.6 Osmolality Measurement, Serum Osmolar Gap	
10. Blood gas and Acid _Base balance		**3 hrs**
	10.1 Acid _ Base disorder : Buffering system of the body, Metabolic and Respiratory acid_base disorder, Acid Base disorder compensation.	
	10.2 Basic panel of blood gas analysis (pH, PCO2, PO2)	
	10.3 Some more terms: Base excess(BE), Anion gap(AG), Oxygen saturation.	
	10.4 Clinical explanation of Laboratory data.	
11. Clinical Enzymology		**3 hrs**
	11.1 Basic concept (Naming of enzymes, classification, basic properties)	
	11.2 Enzyme Kinetics	
	11.3 Isoenzymes (definition, properties and measurement), Isoforms.	
	11.4 Serum enzymes.	
	11.5 Diagnostic Clinical Enzymology.	
12. Liver Function Test		**3 hrs**
	12.1 Liver function and related parameters.	
	12.2 Live function tests.	

- Proteins: Total Protein (TP), Albumin (ALB) - Enzymes: AST (Aspartate aminotransferase), ALT (Alanine aminotransferase), ALP (Alk Phos, GGT (Gamma GT), LD (Lactate Dehydrogenase) - Bilirubins: Total Bilirubin, Direct bilirubin: - Clotting Studies (Prothrombin Time): 12.3 Liver Diseases (Jaundice, etc)	
13. Acute Phase Reactants & Cardiac Marker 13.1 Acute Phase Reactant(C-reactive Protein CRP, Procalcitonin PCT, Haptoglobin Hp, a1-Antitrypsin AAT) 13.2 Introduction to cardiac Marker (purpose, definition, type of cardiac markers) 13.3 Common Cardiac Markers: - Enzymes(CK, LD, AST), Protein(troponins, Myoglobin (Mb). 13.4 Some more test: - C Reactive Protein (CRP), Homocysteine, Heart Fatty Acid Binding Protein (H-FABP), Ischemia modified albumin (IMA), Myoperoxidase (MPO), etc. 13.5 Acute myocardial infarction AMI and the markers respond.	**3 hrs**
14. Tumor Marker 14.1 Introduction 14.2 Type of Tumors: hormone, protein, enzyme, oncifetal Antigens, carbohydrate Antigen, others[DNA, amines, ..etc] 14.3 The clinical uses of tumor markers. 14.4 Common Tumor Marker 14.5 Tumor Marker measurement	**2 hrs**
15. Hormone Analysis 15.1 Introduction (Endocrine) 15.2 Hormone classification and Mechanism of action. Hormone regulation 15.3 The Nervous and Endocrine Systems 15.4 Hormone measurement 15.5 Important Hormone examples (Thyroid Gland, Adrenal Gland [medulla and cortex]).	**3 hrs**
16. Therapeutic Drug Monitoring (TDM), Drugs of Abuse, Toxicology 16.1 Basic Concept of TDM. 16.2 TDM measurement. 16.3 Dug Abuse tests (screening tests and confirmation tests) 16.4 Basic concept of clinical toxicology (common toxicants and Pathway of toxic material enter the body) 16.5 Test related to clinical toxicology.	**3 hrs**
17. Pregnancy and Foetoplacental System 17.1 Physiological changes of pregnancy 17.2 Tests used to confirm pregnancy 17.3 Tests used to assess the health of the mother 17.4 Tests used to assess the foetoplacental system	**3 hrs**

18. Renal stone analysis and Stool Occult Blood test
    18.1 Renal stone analysis
    18.2 Occult Blood test
	2 hrs

19. Biochemical common reactions	**1 hr**
20. Oral Presentation	**3 hrs**
21. Final Examination	**2 hrs**
Total	**61 hrs**

Practice (Laboratory3-5 students per group)	**Duration**
1. Quality Control	**2 hrs**
2. Serum Protein analysis	**3 hrs**
3. Serum Albumin analysis	**3 hrs**
4. Serum Protein Electrophoresis	**3 hrs**
5. Carbohydrate Analysis	**3 hrs**
6. Non protein nitrogen Analysis	**3 hrs**
7. **Lipids Analysis**	**3 hrs**
8. Renal Stone Analysis	**1 hr**
9. Urine & Stool Analysis & HbA1c	**2 hrs**
10. Auto analyzer	**3 hrs**

11. Laboratory Examination	3 hrs
Total	**29 hrs**

Teaching and Learning Activities

In this learning module, students will work towards attaining the ILOs through the following teaching and learning activities:

Teaching and Learning Activities	M1	M2	M3	M4	M5
T1. *Interactive lectures* ■ Lectures: PowerPoint slides is presented and other supplementary materials provided if necessary ■ • Q & As: Raising different questions can draw student interest to the lecture they learn.	✓	✓	✓	✓	✓
T2. *Laboratories* ■ Students learn technical skills through laboratory operations		✓	✓	✓	
T3. *Assignments* ■ In- depth knowledge learning can be attained by actively learning from students through their assignments	✓		✓		✓

Alignment of MILOS with Teaching and Learning Activities

Activities	M1	M2	M3	M4	M5
Interactive lectures	✓	✓	✓	✓	✓
Laboratories		✓	✓	✓	
Assignments	✓		✓		✓

Attendance

Attendance requirements are governed by the Academic Regulations Governing Bachelor's Degree Programmes of the Macao Polytechnic University. Students who do not meet the attendance requirements for the learning module shall be awarded an 'F' grade.

Asssessment

In this learning module, students are required to complete the following assessment activities:

Assessment Activities	Weighting (%)	ILOs to be Assessed
A1. Examination	55%	M1, M2, M3, M5
A2. Lab Examination	5%	M2, M3, M4
A3. Midterm Test	15%	M1, M2, M3, M5
A4. Oral Presentation (Topics in Clinical Chemistry)	5%	M1, M3, M5
A5. Report (Topics in Clinical Chemistry)	10%	M1, M3,M5
A6. Laboratory Report	10%	M2, M3, M4

Any students scoring less than 35% of the total mark in the final examination will be given an "F" grade for the module even if the overall grade is 50% or higher.

The assessment will be conducted following the University's Assessment Strategy (see www.mpu.edu.mo/teaching_learning/en/assessment_strategy.php). Passing this learning module indicates that students will have attained the ILOs of this learning module and thus acquired its credits.

MARKING SCHEME

Marks Ranges	Grade	Grade Point	Grade Definitions**
93–100 88 – 92	A A-	4.0 3.7	Excellent
83 – 87	B+	3.3	Very Good
78–82 73 – 77	B B-	3.0 2.7	Good
68–72 63–67 58 – 62	C+ C C-	2.3 2.0 1.7	Satisfactory
53 – 57 50 – 52	D+ D	1.3 1.0	Passed
0 – 49	F	0	Failed

Generic descriptions of each grade are given below:

Excellent: Strong evidence of original thinking; good organisation, capacity to analyse and systemise; superior grasps of subject matter; strong evidence of extensive knowledge base.

Very Good: Evidence of grasps of subject; strong evidence of critical capacity and analytical ability; good understanding of issues; evidence of familiarity with literature.

Good: Evidence of grasp of subject; some evidence of critical capacity and analytical ability; reasonable understanding of issues; evidence of familiarity with literature.

Satisfactory: Profiting from the study experience; understanding of the subject; ability to develop solutions to simple problems in the material.

Pass: Sufficient familiarity with the subject matter to enable the student to progress without repeating the learning module.

Fail: Little evidence of familiarity with the subject matter; weak in critical and analytical skills; limited, or irrelevant use of literature.

REQUIRED READINGS

1. Tietz Textbook of Laboratory Medicine, Nader Rifai PhD 7ed. 2022, Medicine, Weill Cornell Medicine, NewYork, New York

REFERENCES

1. Michael L. Bishop, Edward P. Fody, Larry Schoeff., 2005, Clinical chemistry::principles, procedures, correlations, 5th ed. , Philadelphia :Lippincott Williams & Wilkins

STUDENT FEEDBACK

At the end of every semester, students are invited to provide feedback on the learning module and the teaching arrangement through questionnaires. Your feedback is valuable for instructors to enhance the module and its delivery for future students. The instructor and programme coordinators will consider all feedback and respond with actions formally in the annual programme review.

ACADEMIC INTEGRITY

The Macao Polytechnic University requires students to have full commitment to academic integrity when engaging in research and academic activities. Violations of academic integrity, which include but are not limited to plagiarism, collusion, fabrication or falsification, repeated use of assignments and cheating in examinations, are considered as serious academic offenses and may lead to disciplinary actions. Students should read the relevant regulations and guidelines in the Student Handbook which is distributed upon the admission into the University, a copy of which can also be found at www.mpu.edu.mo/student_handbook/.