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**Department of MLT**

**College of Health Erbil**

**University of Erbil Polytechnic**

**Subject: Clinical Biochemistry**

**Course Book – (Year 3)**

**Lecturer's name: Dr. Burhan A. Salih**

**Academic Year: 2022/2023**

**Course Book**

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| **1. Course name** | **Burhan Ahmed Salih** | |
| **2. Lecturer in charge** |  | |
| **3. Department/ College** | **MLT** | |
| **4. Contact** | **e-mail: burhan.salih@epu.edu.iq**  **Tel: 07504511374** | |
| **5. Time (in hours) per week** | **Theory: 2**  **Practical: 2** | |
| **6. Office hours** | **10** | |
| **7. Course code** |  | |
| **8. Teacher's academic profile** | * Ph.D. degree in Biochemistry (2006-2007)- Chemistry Dept. , College of Science, Salahaddin University- Erbil. * M.Sc. degree in Organic Chemistry (1999-2000) – Chemistry Dept. , College of Science, Salahaddin University- Erbil. * B.Sc. degree in Chemistry (2004-2008) –Chemistry Dept., College of Education, Salahaddin University- Erbil. * **1994** Took Baccalaureate, balakean Secondary School, Soran, Erbil, Iraq.   **Teaching and supervising Experiences**   * **Post-graduate** * Supervising a PGD student in EPU University on Medical Lab. Technology. * **Undergraduate** * Working as instructor in the **Shaqlawa Technical Institute\_** Erbil for about 8 successive years. The main courses that I gave to undergraduate students were: * Biochemistry : (8 Courses from 2000 till 2008) * Clinical Chemistry ( 7 courses in 2001 and 2008) * General Chemistry : (3 courses in 2000 and 2004) * Medical Instrumentals : (2courses in 2003 and 2005) * Working as instructor in medical Lab. Technology Dept. in Erbil Medical technical Institute, Polytechnic University-Erbil for about 6 years. The teaching courses were: * Biochemistry : (6 Courses from 2008 till 2014) * Clinical Chemistry ( 6 courses in 2008 and 2014) * Organic Chemistry ( 6 courses in 2008 and 2014) * My current work as lecturer and Investigator is in the Medical Lab. Technology Dept. – Health Technical College – Erbil Polytechnic University. The teaching courses that I am teaching are: * Biochemistry for post-graduate students. * Clinical Chemistry for post-graduate students. * Biochemistry * Clinical Chemistry | |
| **9. Keywords** | **Body fluid, liver function test, Renal function test, vitamins, Hormones and tumor marker** | |
| **10. Course overview:**  This is a lecture and laboratory course covering most areas of Clinical Chemistry. General principles of chemical analysis and clinical utility are reviewed. Analyses performed in the clinical chemistry laboratory are grouped according to function or organ system. Major groupings include carbohydrates metabolism and its respective disorders, proteins and its respective disorders, lipid and its respective disorders, kidney function tests (KFT), liver function tests (LFT), clinical enzymology, biochemical markers of bone metabolism, cardiac markers, tumor markers, and body water, electrolytes, acid-base balance and blood gases. The principles of testing methods and the physiologic and biochemical changes that occur in disease states are covered. General laboratory principles, laboratory safety, laboratory quality assessment will also be applied to the course. The laboratory practical will include collection and processing of blood specimens, quality control and diagnostic tests for common clinical tests. | | |
| **11. Course objective:**  The course aims for the students are to:  1. Define the following terms: quality assurance, quality control, accuracy, precision, reference interval, compare and contrast the specificity and sensitivity of the most commonly used diagnostic markers.  2. Describe the biochemical structure and metabolism of carbohydrate, proteins and lipids, their functions and describe the patterns associated with protein abnormalities shown in serum protein electrophoresis.  3. Discuss the tissue sources, major properties, methods of analysis, diagnostic significance, clinical use and sources of error in the analysis for enzymes and tumor markers.  4. Demonstrate how to calculate different important parameters in the field of clinical chemistry.  5. Discuss the basic disorders of the different organs and define which laboratory tests may be performed to diagnose them.  6. Gain practical Skills and common source of errors in clinical chemistry laboratory.  7. Show professional behaviour and receives criticism graciously.  8. Enhance critical reasoning and analytical skills in analyzing cases studies.  9. Develop communication skills in the presentation of scientific material via poster presentation.  10. Apply principles of safety regulations.  11. Participate in the biomedical activities | | |
| **12. Student's obligation**  To expose you to a seeking mentality in a laboratory setting.  To expose you to an environment that will require you to problem solve when experimental failure occurs.  To produce an environment in which you collaborate with fellow students. | | |
| **13. Forms of teaching**  teaching by presentation; guided exploratory learning (class discussion); open learning;  individual teaching (symenar); learning in projects, online learning. | | |
| **14. Assessment scheme**  Assignment – seminar and other activity (10%), mid-term test (25%), 5 practical reports - (20%), practical exam - 3-hr (30%), final 3-hr exam (30%) ‌ | | |
| **15. Student learning outcome:**  Be able to demonstrate foundation knowledge in the areas of chemistry.  Be able to integrate knowledge learned in discipline specific courses.  Be able to access, search and use the chemical literature.  Be knowledgeable in classical laboratory techniques and be able to use modern instrumentation.  Be able to design and conduct scientific experiments and analyze the resulting data.  Be able to work as a member of a team.  Be knowledgeable in proper procedures and regulations in handling and disposal of chemicals.  Be able to communicate (written and oral) scientific information to chemists and non-­‐chemists.  Be knowledgeable of ethical practices in science. | | |
| **16. Course Reading List and References‌:**  Clinical Chemistry (technic, Principle, correlation) by Michael. Tietz Fundamentals of Clinical Chemistry.  Harper’s Biochemistry-Rober K. Murray, Daryl K. Grammer, McGraw Hill, Lange  Medical Books. 25th edition. | | |
| **17. The Topics:** | | **Lecturer's name** |

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| **Week** | **Unit** | **Outline** | **No. of Hours** |
| **1-3** | **1** | Electrolyte and body fluid  a.List examples of electrolytes found in plasma water, interstitial fluid, and intracellular water.  b. Identify the analysts required to calculate anion gap and osmolality.  c. State the specific fluid compartments that make up total body water.  d. Distinguish between serum and plasma.  e. State the principle differences between interstitial fluid and plasma.  f. List five examples of body fluids that are assayed for electrolyte composition.  g. Select the electrolyte associated with each of the following:  h. major intracellular cation i. major extracellular cation  j. major extracellular anion  k. Identify four methods used to measure chloride in sweat.  l. Identify methods and instrument techniques used to measure electrolytes in body fluids.  m. Name the four colligative properties of solutions. | **6** |
| **4-7** | **2** | No protein Nitrogen and Renal Function  a.List and briefly describe the major parts of the urinary system.  b. Trace the ultrafiltrate (urine) flow through the major parts of the nephron.  c. Trace the blood flow in the kidney from the renal artery to the renal vein.  d. Summarize the three major renal processes; glomerular filtration, tubular reabsorption, and tubular secretion, including where they occur in the nephron and constituents involved.  e. Explain the difference between active transport and passive transport in relation to renal concentration.  f. List the major components of nonprotein nitrogen (NPN).  g. Identify the source of blood urea nitrogen (BUN) and the major organ of the urea cycle.  h. Review the most common BUN methodologies including chemical reactions and specificity.  i. State the reference range for BUN.  j. Convert BUN to urea and urea to BUN. k. Define azotemia and uremia.  l. Outline common causes of prerenal, renal, and postrenal azotemia. m. Identify causes of a decreased BUN.  n. Explain the source of creatinine (CR). o. Review the Jaffe reaction and creatinase procedures.  p. Cite the reference range for creatinine.  q. Classify sources of increased creatinine.  r. Calculate the BUN:CR ratio and discuss its clinical significance.  s. Summarize the formation and excretion of uric acid.  t. Review the major uric acid methodologies. u. Explain primary hyperuricemia (gout), including causes (precipitating factors) and treatment.  v. Outline causes of secondary hyperuricemia. 6 w. Review the renal clearance tests, including creatinine, the protein:creatinine ratio, and inulin clearance.  x. Calculate a creatinine clearance given the relevant data. y. Summarize the etiology and clinically significant laboratory findings of major renal diseases. | **8** |
| **8-9** | **3** | - Blood Gases, pH, and Acid–Base Balance  a.State the Henderson–Hasselbalch equation and identify the respiratory and metabolic components.  b. Calculate various blood gas parameters given the appropriate equation(s).  c. Identify the four major body buffer systems. d. Identify the five ways in which carbon dioxide is carried in blood.  e. Identify appropriate calibration materials to use for pH, PCO2, and PO2 measurements.  f. Describe the proper control material to use for blood pH, PCO2, and PO2 measurements.  g. Identify preanalytical sources of errors in blood-gas analysis.  h. Identify the specimen of choice discuss the proper handling of specimen for blood-gas analysis | **4** |
| **10-11** | **4** | - Mineral and Bone Metabolism  a.Identify three forms of calcium as they exist in circulation.  b. List three distinct methods for measuring total serum calcium.  c. Identify two chemical compounds used to measure inorganic phosphate in serum.  d. Identify three compounds used to measure magnesium in serum. e. Identify two main causes of hypercalcemia.  f. Indicate the source of parathyroid hormone.  g. Discuss the feedback effects of PTH on calcium and phosphorus levels in circulation.  h. List three functions of vitamin D in humans.  i. Describe the structure, tissue source(s), and function of calcitonin.  j. Identify biochemical markers specific for bone formation and resorption. k. List several methods used to measure biochemical markers for bone. | **4** |
| **12-14** | **5** | The Endocrine System  a.Identify three major types of hormones.  b. State which of the three classes of hormones characterizes the following compounds: i. thyroxine ii. cortisol iii. parathyroid hormone iv. epinephrine v. estrogen  c. Define negative feedback.  d. List five examples of hormones found in the anterior pituitary gland.  e. List two examples of hormones found in the posterior pituitary gland. 7  f. Know the location of the thyroid gland, adrenal glands, pituitary, and hypothalamus.  g. Identify the hormones released by the thyroid gland.  h. Identify the mineralocorticoids and the glucocorticoids.  i. Identify the hormones produced by the adrenal medulla.  j. List example(s) of target tissues for each of the following hormones: i. thyroxine ii. prolactin iii. testosterone iv. antidiuretic hormone v. oxytocin vi. growth hormone vii. aldosterone viii. cortisol ix. epinephrine x. luteinizing hormone  k. Associate abnormal laboratory results with a disease or syndrome.  l. Know the functions of the hormones presented.  m. State the methods used to quantitate the amount of hormones in blood. | **6** |
| **15-16** | **6** | Gastrointestinal Function  a.Review the gross anatomy of the gastrointestinial (GI) tract from the mouth to the anus.  b. Outline the functions of each significant component of the GI tract.  c. Identify three examples of GI regulatory peptides.  d. Define the following terms: peptic ulcer, gastrinoma, and protein-losing enteropathy.  e. Explain the principal pathological condition associated with each of the following GI tract disorders: Zollinger–Ellison’s syndrome, peptic ulcer, celiac disease, protein-losing enteropathy, lactase deficiency, and carcinoid tumors.  f. Identify five nonclinical laboratory diagnostic tests or procedures used to assess patients with disorders of the GI tract. | **4** |
| **17-18** | **7** | Pancreas  a.Review the location and anatomy of the pancreas.  b. Identify the islets of Langerhans and the major cells found in the islets of Langerhans.  c. Summarize the endocrine and exocrine functions of the pancreas.  d. Explain the major invasive test for assessing exocrine pancreatic function secretin– cholecystokinin (CCK).  e. Summarize the most common noninvasive tests for assessing pancreatic exocrine insufficiency: pancreatic elastase-1, pancreatic chymotrypsin, pancreatic serum enzymes, breath test (C-mixed triglyceride test), urinary amylase, fecal fat, phospholipase A2, NBTPABA, and fecal elastase.  f. Review the two major tests for monitoring the endocrine function of the pancreas: insulin and C-peptide. g. Summarize briefly diabetes mellitus, the major endocrine pancreatic disease.  h. List the two primary causes of acute pancreatitis.  i. Outline Ranson’s indicators of severity in acute pancreatitis.  j. Briefly review the etiology and prognosis of chronic pancreatitis.  k. Summarize the etiology of cystic fibrosis. | **4** |
| **19-20** | **8** | - Cardiac Function  a.Explain the inflammatory response associated with atherosclerosis.  b. Define acute coronary syndrome (ACS).  c. List five factors that define an ideal cardiac biomarker.  d. Identify two biomarkers used to evaluate each of the following events associated with vascular inflammation: i. Proinflammatory cytokine release ii. Plaque destabilization 8 iii. Plaque rupture iv. Acute-phase reactant response v. Ischemia vi. Necrosis  e. Define hs-CRP relative to cardiac usefulness.  f. Identify the clinical usefulness of the following cardiac biomarkers:  i. Lipoprotein (a) ii. Lipoprotein-associated phospholipase A2 iii. Glycogen phosphorylase isoenzyme BB iv. Omega-3 fatty acids v. Matrix metalloproteinases vi. Placental growth factor vii. Oxidized low-density lipoprotein (LDL) viii. Myeloperoxidase ix. Cardiac troponin I and T x. Brain-type natriuretic peptide and NT-proBNP xi. Ischemia-modified albumin (IMA)  g. Discuss the advantages of point-of-care testing (POCT) for cardiac biomarkers.  h. Discuss the temporal relationship and concentration of each the following relevant to acute myocardial infarction (AMI): i. Myoglobin ii. CK-MB iii. Cardiac troponin I | **4** |
| **21-22** | **9** | - Liver Function  a.Diagram a hepatic lobule and identify the major vessels and cell types.  b. Review major liver functions and list examples of each category.  c. Summarize the main steps of bilirubin metabolism from the breakdown of hemoglobin to excretion as urobilin.  d. Differentiate conjugated and unconjugated bilirubin, including composition and solubility in water and alcohol.  e. Review the clinical significance of bilirubin, including levels of total, direct, and indirect bilirubin.  f. Define jaundice, and identify and list examples of the three major categories of jaundice.  g. Explain the enzyme deficiency or metabolic defect involved in Crigler–Najjar, Gilbert, Dubin–Johnson, and Rotor syndromes.  h. Identify type of virus, route of transmission, at risk populations, incubation period, and recovery rate for the following types of viral hepatitis: A, B, C, and D.  i. Briefly examine the progression in alcoholics from alcoholic fatty liver to alcoholic hepatitis to alcoholic cirrhosis.  j. Review the Jendrassik–Grof methodology, including reagents and the direct bilirubin procedure.  k. Summarize the clinical significance of increased ammonia.  l. Briefly outline other liver function tests: enzymes, albumin, urinary and fecal urobilinogen, and prothrombin time. m. Review common ammonia methodologies. | **4** |
| **23-24** | **10** | Iron, Porphyrins, and Hemoglobin  a.Explain the biochemistry of iron in humans.  b. Explain how iron is transported in the human body.  c. Outline the metabolism of iron and iron-containing compounds.  d. Cite examples of specific diseases associated with iron deficiency and iron overload.  e. Identify methods used to measure iron in serum or plasma.  f. Identify types of instrumentation used to measure iron, porphyrins, and porphobilinogen.  g. Identify examples of types of specimens used for laboratory assessment of iron, porphyrins, and hemoglobin. 9  h. List the two classes of porphyrias and outline specific porphyrias within each class.  i. Diagram the metabolic pathway of heme.  j. Draw the basis structure of a porphyrin. k. Define the following terms: porphyrins, porphyrias, ferritin, transferrin, heme, hemin, | **4** |
| **25-27** | **11** | - Nutrition and Vitamins  a.List the fat-soluble vitamins.  b. Identify methods used to measure selected vitamins.  c. Identify types of instrumentation used to measure vitamins.  d. Cite biological uses of selected vitamins.  e. State food sources of selected vitamins. f. Identify examples of types of specimens used for laboratory assessment of vitamins.  g. Identify selected vitamins by both their common and trivial chemical names.  h. Define the following terms: functional assay, direct assay, hypervitaminosis, and hypovitaminosis. 10  i. Associate selected vitamins with disease.  j. Define the following terms: nutrition, nutrients, dietary reference intakes, anthropometry, enteral feeding, and parenteral feeding.  k. Identify four parameters that are a significant part of an individual’s nutritional assessment.  l. Name six clinical laboratory tests that may yield significant information for a health-care provider to properly assess the nutritional status of a patient.  m. Name five high-risk factors associated with the development of nutritional deficiencies | **6** |
| **28-29** | **12** | Tumor Markers  a.List five roles of tumor markers in the assessment of cancers.  b. Describe four different methodologies that may be used to detect markers associated with malignancy.  c. List commonly used tumor markers and state their clinical significant in relation to cancer.  d. Identify several laboratory tests used to evaluate the following: i. Prostate disease ii. Ovarian cancer iii. Breast cancer iv. Bladder cancer v. Pancreatic cancer | **4** |
| **30** | Overview | | **2** |
| **Total** | | | **56** |

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| **18. Practical Topics (If there is any)** |  |

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| **Week** | **Outline** | **Number of hours** |
| **1-4** | Estimation of Electrolyte (Na, K, Ca, PO4,Cl) | 12 |
| **5-8** | Renal function test ( creatinine, uric acid, blood urea) | 12 |
| **9-12** | pH, PCO2, and PO2 measurements. | 12 |
| **13-15** | Estimation of PTH , calcium and phosphorus | 9 |
| **16-18** | major tests for monitoring the endocrine function of the pancreas: insulin and C-peptide. | 9 |
| **19-21** | Estimation of Insulin and IR homo. | 9 |
| **21-25** | Liver function test (bilirubin, enzymes) | 15 |
| **26-28** | Estimation of cardiac marker | 9 |
| **29-30** | Unknown sample and activity | 6 |
| **Total** | | **93** |

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| **19. Examinations:** | | |
| **Type of question** | **Example** | |
| **Multiple choice** | 1. Liver function tests includ 2. GOT b- ALP   c- Urea d- All of them | |
| **Short answer** | **what is normal blood glucose level? How it’s regulated?** | |
| **Definition** | **Define the following terms:**   1. Renal function   B- creatinine | |
| **Problem situation** | 1. Hyponatremia - too little sodium outside the cell or too much inside the cell and the cell will swell | |
| **Quiz** | **Read and complete: For each number 1-4 choose word A.B,C and D** | |

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| **20. Extra notes:** |
| **21. Peer review**  Assist.prof Dr.Najat Jabar |