MED 1208: Biochemical basis of cardiorespiratory functions, alimentation and nutrition Module - 2015/2016 Batch

Year 1 Semester 2

Credits: 5
Responsible Department: Biochemistry
Module Coordinator: Dr. B.L. Goonapienuwala

Topic	Time	Objectives	T/L activity	Comments
1. Exchange and transport of respiratory gases				
1.1 Alveolar surfactant	1 hr	1. Define surface tension and describe how it applies to lung mechanics, including the effects of alveolar size and the role of surfactants. 2. Describe the principal components of pulmonary surfactant and explain the roles of each. 3. Explain the biochemical basis of infant respiratory distress syndrome (IRDS), adult respiratory distress syndrome (ARDS) and chronic obstructive pulmonary diseases (COPD) based on the derangement of lung surfactant. 4. List the common toxicants which affect function of surfactant	Lecture (1hr)	
1.2 Transport of respiratory gases	7 hrs	1. Describe the modes of O_2 transport in blood 2. Draw and explain the O_2-haemoglobin dissociation curve 3. List the factors affecting O_2-haemoglobin dissociation	Lecture (2hrs) PD (3hrs) SGD (2hrs)	**Should be done after the lecture on Hb**

		curve 4. Explain how, temperature, pH, 2,3 DPG, variants of haemoglobin and CO affect the affinity of hemoglobin to O_2 based on O_2-haemoglobin dissociation curve 5. Describe the modes of CO_2 transport in blood 6. Describe the importance of the chloride shift in the transport of CO_2 by blood 7. Draw the carbon dioxide dissociation curves for oxy- and deoxy-hemoglobin		PD on respiratory gas transport SGD based on the lectures on surfactant and respiratory gas transport
1.3 Acid base balance	5 hrs	1. Define pH 2. Describe the importance of acid-base regulation in human body 3. List the important buffer systems of human body 4. Explain the buffering actions of bicarbonate buffer system, phosphate buffer system, protein buffer system and ammonia buffer system 5. Define acidaemia, acidosis, alkalaemia and alkalosis 6. List common causes for respiratory acidosis, respiratory alkalosis, metabolic acidosis and metabolic alkalosis 7. State the methods of assessing acid-base status 8. Interpret the arterial blood gas analysis report up to the level of diagnosis of respiratory acidosis, respiratory alkalosis, metabolic acidosis and metabolic alkalosis	Lecture (2hrs) PD (3hrs)	
2. Blood and circulation				
2.1 Haemoglobin	1 hr	1. Describe the basic structure of haemoglobin 2. Explain the importance of structure of haemoglobin for its function 3. State the different physiological types of haemoglobin and their functional significance	Lecture (1hr)	
2.2. Haem metabolism and	1 hr	1. Outline the synthesis of haem and its regulation 2. Describe the process of haem catabolism	Lecture (1hr)	Jaundice will be done in detail under

jaundice		3. Define jaundice 4. Explain hyperbilirubinaemia and jaundice based on haem metabolism		Alimentation - Liver
2.3. Abnormal haemoglobins	5 hrs	1. List the types of abnormal haemoglobin 2. Describe the structural abnormalities of haemoglobin S, hemoglobin C, methaemoglobin, alpha and beta thalassemia 3. Describe the molecular basis of hemoglobin S, hemoglobin C, alpha and beta thalassemia 4. Explain the functional defects of haemoglobin S, hemoglobin C, methaemoglobin, alpha and beta thalassemia	Lecture (2hrs) PD (3hrs)	
2.4. Plasma Proteins	7 hrs	1. List important plasma proteins (including lipoproteins) 2. Describe the functions of plasma proteins (overall) 3. State the tissues involved in synthesis of plasma proteins 4. Describe the role of serum albumin 5. Describe the basic steps in metabolism of chylomicrons, VLDL, TAG, HDL and LDL 6. Explain the basis of electrophoresis based on separation of plasma proteins 7. Apply the knowledge of electrophoresis in classification of plasma proteins 8. Describe the importance of assessing plasma proteins in disease diagnosis	Lecture (4hrs) PD (3hrs)	PD on plasma proteins and electrophoresis Lipoproteins will be done in detail in module MED 2112
2.5. Nutritional factors affecting erythropoiesis (Iron, Folate and Vit B_{12} metabolism)	2 hrs	1. Recall the basic steps of erythropoiesis 2. List the nutritional factors involved in erythropoiesis 3. Explain the role of iron, folate and vitamin B_{12} in erythropoiesis 4. Describe the consequences of iron, folate and vitamin B_{12} deficiency relating to erythropoiesis 5. Recall common causes for iron, folate and vitamin B_{12} deficiencies 6. Interpret the investigations of iron, folate and vitamin	Lecture (2hrs)	This lecture has to be done after the lecture on **erythropoiesis** by department of Physiology

		B_{12} deficiencies (red cell morphology, serum iron, ferritin, transferrin, TIBC, transferrin saturation, serum vitamin B_{12}, serum folate, intrinsic factor etc.)		
2.6. Red cell metabolism & red cell structure	2 hrs	1. Recall the functions of erythrocytes 2. Describe the metabolic adaptations of erythrocytes (glycolysis, HMP shunt, production of 2,3-BPG) 3. Explain the importance of above metabolic adaptations for the functions of erythrocytes 4. Explain the importance of NADPH for erythrocytes 5. State the common enzyme defects of erythrocytes metabolism (pyruvate kinase deficiency and glucose 6-phosphate dehydrogenase deficiency) 6. Describe the consequences of glucose 6-phosphate dehydrogenase deficiency 7. Describe the structure of erythrocyte membrane and cytoskeleton 8. State the diseases associated with alterations of erythrocyte membrane and cytoskeleton 9. Describe the basis of hereditary spherocytosis, hereditary elliptocytosis and hereditary ovalocytosis based on the genetic defects of proteins associated with erythrocyte membrane	Lecture (2hrs)	
2.7. Haemolytic anaemia	1 hr	1. Define hemolytic anemia 2. Outline the causes of hemolytic anemia (intracorpuscular and extracorpuscular) 3. Explain the mechanisms of haemolysis based on above causes 4. Describe the fate of hemoglobin in excessive intravascular haemolysis (haemoglobinaemia, haemoglobinuria, jaundice etc) 5. Describe the general features of hemolytic anemia based on the excessive haemolysis and abnormal bilirubin metabolism (pallor, reduced haemoglobin, reticulocytosis, enlargement of spleen, increased	Lecture (1hr)	

		MCV, elevated lactate dehydrogenase, etc.)		
2.8. Role of the vascular endothelium in regulation of blood pressure/blood flow	2 hrs	1. State the functions of vascular endothelium 2. List vasodilators and vasoconstrictors produced by endothelial cells 3. State how NO is synthesized and describe the regulation 4. State the role of NO, prostacyclins, endothelins etc. 5. Outline the role of vascular endothelium in relations to rennin-angiotensin-aldosterone system in maintaining blood pressure 6. Explain the rationale for the use of ACE inhibitors in the regulation of blood pressure	Lecture (2hrs)	
3. Muscle and exercise				
3.1. Biochemical Effects of exercise on muscle and other tissues	5 hrs	1. Define oxygen debt 2. Describe the metabolic pathways in relation to the intensity of exercise 3. Describe the changes in the muscle following muscle fatigue after exercise and lactic acidosis 4. Describe the biochemical basis of the recovery of skeletal muscle after exercise 5. Describe energy cost of exercise in terms of BMR 6. State the receptor changes in exercise (LDL, insulin etc) and their impact 7. Explain the changes in blood lipid profile with exercise	Lecture (2hrs) PD (3hrs)	This lecture should be done after the **muscle lecture** by the department of Physiology
3.2. identification of muscle damage	5 hrs	1. Define “biomarker” 2. Describe the features of a good biomarker 3. List the biomarkers that are useful in identifying skeletal and cardiac muscle damage 4. Explain how skeletal muscle damage could be differentiated from cardiac muscle damage based on change of serum parameters 5. State the alteration in activity of the enzymes in serum following skeletal muscle damage	Lecture (2hrs) PD (3hrs)	

		6. Define the term 'myoglobinuria' 7. State the effects of myoglobin on nephrons 8. Outline the basis for selection of biomarkers used in the identification of muscle damage 9. List the enzymes used in diagnosis of myocardial damage 10. Describe the place of troponin, LDH, CK levels in relation to diagnosis of myocardial damage 11. Describe how myoglobinuria is detected in urine		
4. Digestion and absorption				
4.1. Liver and bile	11 hrs	1. Describe the functions of the liver 2. State the constituents of exocrine secretion and its importance 3. Explain the metabolic functions of the liver (Carbohydrate metabolism, synthesis and secretion of proteins, lipid metabolism, cholesterol catabolism, haem metabolism) 4. State the constituents of bile and its importance 5. Describe the factors that promote the formation of gall stones 6. State the composition of different types of gall stones commonly found 7. Describe the role of liver in metabolism of xenobiotics 8. State the liver enzymes and other plasma parameters (plasma proteins) useful in diagnosis of liver dysfunction 9. Correlate the degree of cell damage with change in the serum enzyme levels and plasma proteins	Lecture (2hrs) PD (2x3hrs) SGD (2hrs)	PD 1 on objectives 4, 8 & 9 PD 2 on objectives 10 – 14 SGD on all objectives
4.2. Jaundice		10. Describe the types of jaundice 11. Differentiate pre-hepatic, hepatic and post-hepatic jaundice based on etiology 12. Explain the biochemical changes that occur in each type	Lecture (1hr)	

		13. Describe the biochemical basis of clinical features and laboratory investigations of jaundice 14. Interpret the laboratory investigations of jaundice		
4.3. Digestion & absorption of carbohydrates	8 hrs	1. State the constituents that are important in the digestion of carbohydrate in saliva, pancreatic juice and brush border 2. Explain carbohydrate digestion in the GI tract 3. State the products of carbohydrate digestion and explain their absorption.	Lecture (1hr)	Lecture 1 from objectives 1 – 3
4.4. Digestion & absorption of proteins		4. Name the important constituents of GI and pancreatic secretions involved in protein digestions and explain their functions in protein digestion 5. Explain the importance of secreting proteolytic enzymes in their pro-forms and explain how the gut wall is protected from the activated proteolytic enzymes 6. Outline the process of protein digestion 7. State the products of protein digestion and explain how they enter the absorptive cell	Lecture (1hr)	Lecture 2 from objectives 4 – 7
4.5. Digestion and absorption of lipids		8. Recall the constituents of bile and explain their role in lipid digestion 9. Explain the importance of emulsification process and micelle formation in the digestion process of lipids 10. Name the enzymes involved in lipid digestion and explain their functions 11. Describe the absorption of digestive products of lipids (including fat soluble vitamins) 12. Explain the chylomicron formation in the enterocyte 13. Describe the enterohepatic circulation and its importance in fat digestion	Lecture (1hr) PD (3hrs) SGD (2 hrs)	Lecture 3 from objectives 8 – 13 PD from objectives 1,2,6,9 and 10

		14. State the changes that occur in the large intestine with respect to Fiber, Vitamin B_{12} and Vitamin K		
4.6. Digestive disorders	4 hrs	1. Explain how the following conditions affect digestion and absorption ***Digestive disorders*** • Achlorhydria • Intrinsic factor deficiency • Biliary insufficiency • Lactose intolerance • Pancreatic exocrine insufficiency • Coeliac disease • Chronic diarrhoea • Chronic alcoholism ***Nutritional deficiencies*** • Protein energy deficiency • Folate and B12 deficiency 2. Explain the mechanism of Cholera 3. State the alteration of the compositions that can occur in blood, urine and faeces due to the disorders stated in 1 4. Correlate the clinical features of the conditions mentioned in no 1 with their biochemical derangements 5. State the biochemical tests that can be performed to assess the disorders stated in 1	Lecture (2hrs) PD (2hrs)	PD on objective No. 4
5. Nutritional Biochemistry – 2				
5.1. Healthy diet	1 hr	1. State what is healthy diet 2. State what is “MyPlate” 3. State the characteristic features of healthy diet and MyPlate 4. Describe Sri Lankan “healthy plate”	Lecture (1hr)	

5.2. Components of diet and food processing	10 hrs	1. Explain the importance, state the types and their products, describe the nutritional value, antinutrient properties, processing methods and their effects on the nutritional value of the following in diet. a. cereals b. pulses c. vegetable, fruits and starchy foods d. oil seeds and nuts including coconut e. meat, fish and egg f. milk and milk products 2. Describe the nutritive value and the importance of colostrum and breast milk 3. Describe the methods used to minimize losses of nutrients during processing and increase the bio-availability of nutrients	 Lecture (1hr) Lecture (1hr) Lecture (1hr) Lecture (1hr) Lecture (1hr) Lecture (1hr) Lecture (1hr) PD (3hrs)	 PD on objective No 3
5.3. Dietary fibre	1 hr	1. Define the term dietary fibre 2. State the types of dietary fibre 3. State the food items rich in dietary fibre 4. Discuss the health benefits of dietary fibre	Lecture (1hr)	
5.4. Energy requirement	6 hrs	1. Recall why energy is needed for the body 2. Recall the sources of dietary energy 3. Define Resting Energy Expenditure (REE), Basal Metabolic Rate (BMR) and Specific Dynamic Action (SDA) 4. State factors influencing BMR 5. Compare and contrast BMR and the total energy requirement 6. Calculate total energy expenditure using BMR and BMR factor 7. Explain the FAO/WHO/UNU recommended intakes of energy in the various phases of life (newborn, infants, children and adolescents, adults and elderly, pregnancy, lactation)	Lecture (2hrs)	SGD on both energy and protein requirements

5.5. Protein requirement		1. Explain why protein is essential in the diet 2. Explain what is nitrogen balance (zero, positive and negative) 3. State the parameters for evaluating quality of proteins; Biological Value (BV), Net Protein Utilization (NPU), digestibility and amino acid score, protein digestibility corrected amino acid score (PDCAAS) etc. 4. Define and compare Biological Value (BV), Net Protein Utilization (NPU), digestibility and amino acid score and protein digestibility corrected amino acid score (PDCAAS) 5. Compare the quality of protein sources commonly used in Sri Lanka 6. Discuss the FAO/WHO/UNU recommended intakes of proteins in the various phases of life (newborn, infants, children and adolescents, adults and elderly, pregnancy, lactation)	SGD (2hrs) Lecture (2hrs)	
5.6. Protein energy deficiencies	1 hr	1. Define wasting and stunting 2. Explain kwashiorkor and marasmus 3. Explain the use of growth parameters on identifying wasting and stunting 4. Identify laboratory and clinical features associated with malnutrition including kwashiorkor, marasmus, wasting and stunting	Lecture (1hr)	
5.7. Free radicals & antioxidants	6 hrs	1. State what are free radicals and antioxidants 2. State the types of free radicals 3. State the sources of free radicals (exogenous and endogenous) 4. State the harmful effects of free radicals 5. Explain the antioxidant systems in the body (enzymatic / non enzymatic and dietary) 6. Explain the relationship of oxidative stress in ageing and human diseases; atherosclerosis, diabetes, haemolysis, neurodegenerative disorders, cancer etc..	Lecture (2hrs)	

5.8. Biochemical effects of alcoholism		1. Describe the metabolism of alcohol in chronic alcoholism 2. Describe the effects of alcohol on metabolism 3. State the possible organ failures in chronic alcoholism 4. Explain the consequences of chronic alcoholism (chronic pancreatitis, fatty liver, liver cirrhosis) 5. Explain the nutritional problems arising in chronic alcoholism (iron, vitamin B and protein) 6. Outline the management of nutritional deficiencies in chronic alcoholism	Lecture (2hrs) SGD (2hrs)	
5.9. Dietary management in diseases	1 hr	1. List the common diseases requiring special dietary management (acute and chronic renal failures, chronic liver failure, dyslipidemia, diabetes, chronic alcoholism, hepatitis, pancreatic insufficiencies, malabsorption etc.) 2. Explain the biochemical basis of dietary management of above diseases	Lecture (1hr)	
6. Student centered learning activity	6 hrs	Present and discuss the key areas that were learnt during the module	Student presentations (6hrs)	Holistic approach on the module. Revision of major topics by presentation and discussion to improve the student centered learning.

Lectures – 51 hours **SGD – 10 hours** **Practical – 32 hours** **Seminar – 6 hours**