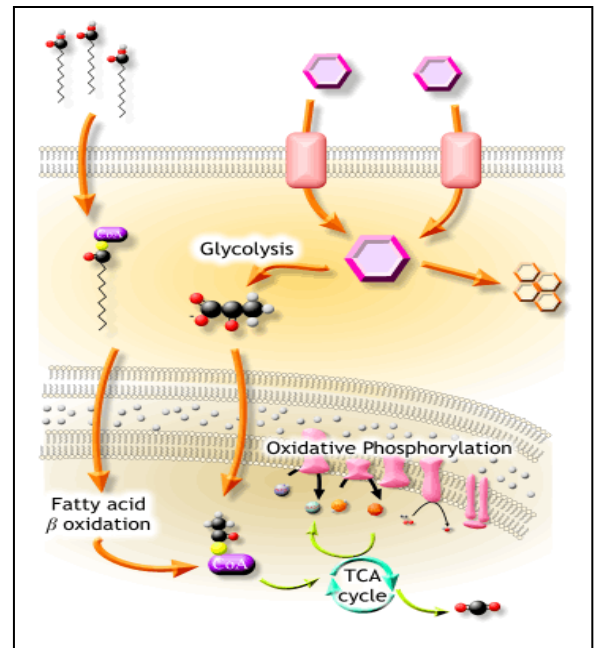
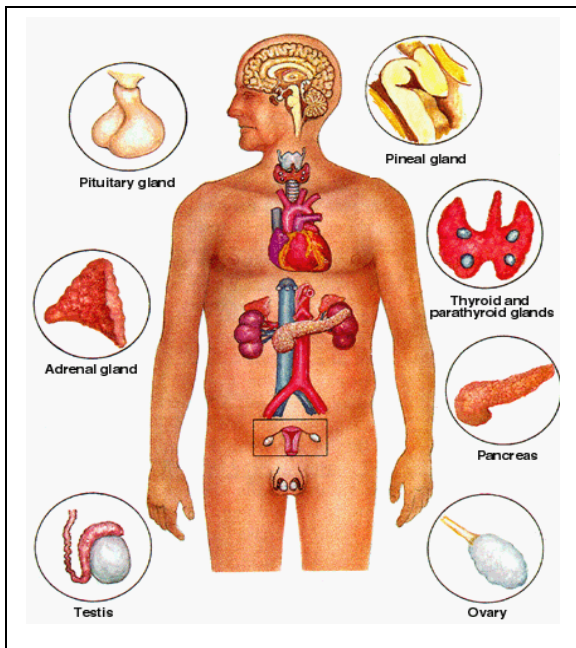


ENDOCRINE, METABOLISM & NUTRITION MODULE PHASE 1



Faculty of Medical Sciences
University of Sri Jayewardenepura



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Introduction

A sound knowledge of hormones and the state of nutrition on general metabolism is essential to have a good understanding of the health and diseases in humans. This in turn will help in providing effective treatments for diseases in medical practice. This is especially so as Sri Lanka is a country where malnutrition is highly prevalent.

The Endocrine Metabolism & Nutrition module under the Phase 1 medical curriculum is a six week module. During these six weeks, students will learn about the function of hormones, gross anatomy of neck, histology of endocrine glands, metabolic disorders, intermediary metabolism and their regulation in health. This module also deals with nutritional needs throughout life, diseases arising as a result of nutritional deficiencies, effects of processing and preparation on the nutritive value of foods, principles of diet formulation for healthy and in the management of disease.

Basically, three departments (Anatomy, biochemistry and Physiology) with members of the Department of Medicine will be involved in teaching and assessing the module. The following codes have been used in the content areas to categorize the curriculum in the module.

A - Must know

B - Good to know

C - Nice to Know

The reference reading material pertaining to the course module is also listed. Students may contact the chairperson or the convenor for any clarifications regarding the module.

Teaching of this module will be in the form of lectures, tutorials, small group discussions, fixed learning sessions, practicals, audio visual presentations, seminars and clinical scenarios. There will also be sessions in the skills laboratory to acquire skills relevant to the module.

Members of the Module Committee

Chairperson	Prof. Hemantha Peiris	Dept. of Biochemistry
Convener	Dr. P. P. Rasika Perera	Dept. of Biochemistry
Members	Prof. Narada Warnasuriya	Dept. of Paediatrics
	Prof. E.R. Jansz	Dept. of Biochemistry
	Dr. Ajith Fernanado	Dept. of Obstetrics & Gynaecology
	Dr. Himansu Waidyasekara	Dept. of Physiology
	Dr. K. M. N. Kumarasinghe	Dept. of Anatomy

Members of the Module Implementation Committee (2009-Batch 18)

Chairperson	Prof. Hemantha Peiris	Dept. of Biochemistry
Convener	Dr. P. P. Rasika Perera	Dept. of Biochemistry

General objectives

At the end of the module the students should be able to

1. Apply basic scientific knowledge regarding the metabolism of carbohydrates, proteins, lipids and nucleic acids and show how defects can lead to disease.
2. Describe how various pathways of metabolism can be integrated differently under varying physiological and pathological circumstances.
3. Describe the normal structure and function of endocrine glands, the role of hormones in metabolism and how they change in selected endocrine and metabolic diseases.
4. Apply the basic scientific knowledge to identify and assess the nutritional status of individuals and communities and to plan out appropriate intervention programmes.

Skills to be acquired

At the end of the module the students should be able to

1. Calculate the BMI of an individual and interpret the nutritional status.
2. Calculate the energy and protein content of food by using food composition tables.
3. Draw up a suitable diet for a healthy adult.
4. Identify the plant and animal foods rich in energy, protein, vitamins (fat and water soluble) and minerals available in Sri Lanka.
5. Perform and interpret an Oral Glucose Tolerance Test (OGTT).
6. Perform and interpret blood and urinary tests for glucose.
7. Perform a thyroid examination.

Main content areas

Section 1: Metabolism

1. Introduction to metabolism & concepts of regulation.
2. Carbohydrate metabolism.
3. Lipid metabolism.
4. Amino acid metabolism.
5. Oxidative phosphorylation.
6. Protein biosynthesis.
7. Catabolism & excretion of N compounds.
8. Regulation of metabolism.
9. Cell cycle and its control.
10. Integration of Metabolism.

Section 2: Endocrine System

11. Introduction to Hormones.
12. Anterior Pituitary Hormones – Growth Hormone.
13. Posterior Pituitary Hormones – Anti Diuretic Hormone.
14. Pituitary Hormones – GH/ ADH secretary abnormalities
15. Anterior Pituitary Hormones – Adrenocorticotrophic Hormone/ Thyrotropin.
16. Adrenocortical Hormones.
17. Adreno-Medullary Hormones.
18. Gross Anatomy of neck.
19. Thyroid Gland.
20. Endocrine Pancreas.
21. Diabetes mellitus.

Section 3: Nutrition

22. Energy and protein requirement.
23. Vitaminology – Introduction.
24. Vitaminology – Fat soluble Vitamins.
25. Vitaminology – Water soluble Vitamins.
26. Mineral Nutrition.
27. Nutritive value of commonly consumed foods of plant origin.
28. Nutritive value of selected foods of animal origin.
29. Principles of diet formulation.

Section 1

Metabolism

1. Introduction to Metabolism

Intermediate objectives At the end of the course learner will be able to	Content Areas	Teaching Technique	Duration	Department
1.1 Outline energy aspects of metabolism	NADH ₂ , ATP and high energy compounds (A)	Lecture	2 hours	Biochemistry
1.2 Outline metabolic pathways	General scheme for flow of a biochemical pathway (B) Anabolism, Catabolism (A)			
1.3 State principles of regulation of pathways	Points of control – significance (B)			

2. Carbohydrate metabolism

Intermediate objectives At the end of the course learner will be able to	Content Areas	Teaching Technique	Duration	Department
2.1 Outline Glycolysis & Gluconeogenesis	Biochemical pathways with control points (A)	Lecture	3 hours	Biochemistry
	Reversible and irreversible reactions (B)	Tutorial	1 hour	
	Points of control and principle functions (B)			
2.2 Outline Glycogenolysis & Glycogenesis	Significant points of entry of fructose, glucose, galactose and glycogen (A)			
	Biochemical reactions (A)			
	Reciprocal control (A)			
	Functions and significance (A)			
2.3 Outline TCA cycle	Biochemical pathway (A)			
	Control points (B)			
	Functions (A)			
2.4 Outline Lactose metabolism	Biochemical reaction (B)			
	Control during lactation (A)			
2.5 Outline HMP pathway	Function of G6P dehydrogenase (A)			
	Important intermediates from the pathways (A)			

3. Lipid metabolism

Intermediate objectives At the end of the course learner will be able to	Content Areas	Teaching Technique	Duration	Department
3.1 Outline Glyceride metabolism	Synthesis and hydrolysis of Mono, Di & triglycerides (C)	Lecture	2 hours	Biochemistry
3.2 Outline fatty acid metabolism	Outline β oxidation pathway (A) Fatty acid biosynthesis (B) Multi enzyme complexes (C)			
3.3 Outline biosynthesis of prostaglandins, cholesterol	Lipoygenase and cyclooxygenase pathways (A) Control point (A) Cholesterol from Mevalonate and control (A)			
3.4 Outline catabolism of bile salts	Conversion of cholesterol to primary, secondary bile salts (B)			
3.5 Outline biosynthesis of phospholipids	Attachment of PO_4^{3-} / base to C- 3 of compound (C)			

4. Amino acid metabolism

Intermediate objectives At the end of the course learner will be able to	Content Areas	Teaching Technique	Duration	Department
4.1 Outline biosynthesis of non-essential amino acids	Transamination of C-skeleton (A)	Lecture	1 hour	Biochemistry
4.2 Outline glucogenic and ketogenic amino acids	Points of entry to C –catabolism (B)			
4.3 List bioactive amino acid derivatives and their actions	Serotonin, histamine, dopamine and their effects (A)			

5. Energy Extraction

Intermediate objectives	Detailed Content Areas	Teaching Technique	Duration	Department
At the end of the course learner will be able to				
5.1 Outline oxidative phosphorylation	The “Complex” scheme for oxidative phosphorylation (B) Electron flow and ATP formation – coupling (B)	Lecture	1 hour	Biochemistry
5.2 Explain function of adipose tissue	Explain nature and role of BAT (A)			
5.3 Introduction to disorders of carbohydrate and lipid metabolism		Guided Learning Session	3 hours (x2)	Biochemistry Paediatrics
NOTE: Lipid & amino acid metabolism and Energy extraction	Covering all areas	Tutorial	1 hour	Biochemistry

6. Protein biosynthesis

Intermediate objectives At the end of the course learner will be able to	Content Areas	Teaching Technique	Duration	Department
6.1 Outline replication, transcription, translation	Semi conservative mechanism, enzymes, cofactors (B) Okazaki fragments (C) RNA template strand and enzymes, cofactors (B) Exons, introns (A) Role of ribosomes, t-RNA, m- RNA in translation (A) Genetic code (A)	Lecture	3 hours	Biochemistry
6.2 Explain mutations, and principles of genetic disorders	Types of mutation (A) Mutations and genetic diseases (A)			
6.3 Explain mechanism of action of Selected antibiotics	Antibiotics affecting protein biosynthesis – Mechanism (A)			

7. Catabolism & Excretion of N. Compounds

Intermediate objectives	Content Areas	Teaching Technique	Duration	Department
At the end of the course learner will be able to				
7.1 Outline purine and pyrimidine catabolism	Uric acid formation (A)	Lecture	2 hours	Biochemistry
7.2 Explain production and trapping of ammonia	Trapping and Transport of NH ₃ (A) Detoxification (A)	Guided Learning Session	1 ½ hours (x2)	
7.3 Outline urea cycle	Key Enzymes and disorders, urea the production (A)			
7.4 Explain bilirubin metabolism and jaundice	Recall mode of bilirubin formation (A) <i>Tests and Types of jaundice and diagnostic characteristics will be covered in the Gastro-intestinal module</i>			
7.5 Formation and excretion of creatinine	Mode of creatinine formation (A) Mode of creatinine excretion (A)			
7.6 Outline the relationship between Hyperhomocysteinaemia and atherogenesis	Hyperhomocysteinaemia (A) Role of Hyperhomocysteinaemia in atherogenesis (A)			
NOTE: Protein biosynthesis and catabolism & excretion of N. compounds	Covering all areas	Tutorial	1 hour	Biochemistry

8. Regulation of metabolism

Intermediate objectives At the end of the course learner will be able to	Content Areas	Teaching Technique	Duration	Department
8.1 Explain function of Lac operon	Induction and repression by metabolites (B)	Lecture	2 hours	Biochemistry
8.2 Recall allosterism and list examples	Significant kinetics of allosterism (B) Examples at key points of pathways (B)			
8.3 Recall covalent modification and list examples	Examples of covalent modification (B) Role of hormones (A)			
8.4 Give examples of feed back inhibition	Role of feed back inhibition in control of pathways (A) Examples including down regulation (A)			
8.5 Outline the action of special inhibitors	Inhibition by Penicillin (A) Mechanism of action of Augmentin (A)			

9. Cell cycle

Intermediate objectives	Content Areas	Teaching Technique	Duration	Department
At the end of the course learner will be able to				
9.1 Draw the cell cycle	Phases of the cell cycle including G ₀ , biochemical activity in each phase (A)	Lecture	1 hour	Biochemistry
9.2 Explain check point mechanisms	Function and mechanism of check points. (B)			
9.3 List importance of check points in the cell cycle process	G ₀ phase, check points and cancer (A)			

10. Integration of metabolism

Intermediate objectives	Content Areas	Teaching Technique	Duration	Department
At the end of the course learner will be able to				
10.1 Explain how metabolism is integrated (a) within the same cells (b) between tissues and organs	How all biochemical actions are integrated (B) The importance of regulation, and transport (B)	Lecture	1 hour	Biochemistry
10.2 Explain how control is effected (Examples)	Cori cycle, Glucose alanine cycle (A)			
NOTE: Regulation of metabolism, cell cycle and integration of metabolism.	Covering all areas	Tutorial	1 hour	Biochemistry

Section 2

Endocrine System

11. Introduction to Hormones

Intermediate objectives At the end of the course learner will be able to	Content areas	Teaching Technique	Duration	Department
11.1 Describe types of hormones and their classification	Relationship between hormones and enzymes (B) Different types of Hormones (A) Classification of hormones (A)	Lecture	1 hour	Biochemistry
11.2 Explain how the hypothalamus acts as an endocrine gland and list its functions	Hypothalamic control of other endocrine glands (A) Control substances secreted by the Hypothalamus and their functions (A)			
11.3 Recall the mechanism of action of Hormones	Specific receptors (A) Second messengers and their action (B) Propagation of hormonal signal (B)			

12. Anterior Pituitary Hormones - Growth Hormone

Intermediate objectives At the end of the course learner will be able to	Content area	Teaching Technique	Duration	Department
12.1 Describe the anatomy of the pituitary gland	Location and important relations of the pituitary gland (A) Parts of the pituitary gland and their functions (A) Histology of the pituitary gland (A) Functional anatomy of the pituitary gland (A) Hormones secreted by the gland (A)	Lecture	1 hour	Anatomy
12.2 Describe the structure and regulation of secretion of Growth Hormone (GH)	Structure of Growth hormone and its similarity to other hormones (A) Regulation of GH secretion – Control/ stimulators/ inhibitors (A)	Lecture	1 hour	Biochemistry
12.3 List the metabolic effects of GH	Effects of GH on a). Skeletal muscle (A) b). Hepatocytes (A) c). Adipocytes (A) d). β -cells of the islets of Langerhans (A)			
12.4 Explain physiological actions of GH	Actions of GH on bone growth and metabolism (A) Role of IGF-1 (A) Stimuli affecting growth hormone secretion (A)	Lecture	1 hour	Physiology

13. Posterior Pituitary Hormones - Anti Diuretic Hormone

Intermediate objectives	Content area	Teaching Technique	Duration	Department
<p>At the end of the course learner will be able to</p> <p>13.1 Describe the synthesis, actions and regulation of Anti Diuretic Hormone (ADH)</p>	<p>Synthesis - site, transport, secretion (A)</p> <p>Actions (A)</p> <p>Role of receptors (B)</p> <p>Regulation - effect of osmotic stimuli and changes in ECF volume (A)</p> <p>Other stimuli affecting ADH secretion (A)</p>	<p>Self learning guided by a handout</p>	<p>-</p>	<p>Physiology</p>

14. Pituitary Hormones – GH/ ADH secretary abnormalities

Intermediate objectives At the end of the course learner will be able to	Content area	Teaching Technique	Duration	Department
14.1 Explain the pathophysiology of Pituitary hormone secretion abnormalities	<p>Hyposecretion of GH in children – dwarfism (outline) (A)</p> <p>Hypersecretion of GH in children – Gigantism (outline) (A)</p> <p>Acromegaly –physiological basis of clinical features and investigation findings (A)</p> <p><i>Pathophysiology of ADH /Diabetes insipidus will be covered in the Renal Module</i></p> <p>Hyposecretion of pituitary hormones – (hypopituitarism) (A)</p> <p>(physiological basis of clinical features and investigation findings seen in each condition)</p>	Tutorial	1 hour	Physiology

15. Anterior Pituitary Hormones - Adrenocorticotrophic Hormone / Thyrotropin

Intermediate objectives At the end of the course learner will be able to	Content area	Teaching Technique	Duration	Department
15.1 Explain the biochemistry and functions, regulation of secretion of Adreno Corticotrophic Hormone	Chemical class and half life (A) Biological functions (B) Regulation of secretion (A)	Lecture	1 hour	Biochemistry
15.2 Outline the events in adrenal cortex following administration of ACTH	Events in the Adrenal Cortex, following administration of ACTH that result in the secretion of corticosteroids (A)			
15.3 List the effects of TSH on the thyroid glands	Effects of TSH on the thyroid gland. - Immediate (A) - long-term (A)			
15.4 Explain the regulation of TSH secretion	Effect of thyroid hormones and TRH on TSH secretion. (A)			

16. Adrenocortical Hormones

Intermediate objectives At the end of the course learner will be able to	Content areas	Teaching Technique	Duration	Department
16.1 Identify the structural and functional anatomy of the adrenal gland	Location of the adrenal glands and their relations (A) Major parts of the adrenal gland and their functions (A) Histological features of each part (A)	Practical	1 hour (x2)	Anatomy
16.2 Outline the synthesis, transport, mechanism of action, degradation and regulation of secretion of adrenocortical hormones	Synthesis and the congenital defects due to deficiency of enzymes in the pathways (A) Transport, mechanism of action and degradation of cortisol, aldosterone and adrenocortical sex hormones. (A) Regulation of secretion (A)	Lecture	½ hour	Biochemistry
16.3 Describe the physiological actions of adrenocortical hormones	Actions of glucocorticoids (A) Actions of aldosterone (A) Actions of adrenocortical sex hormones on foetus and adult (A) Factors regulating secretion of glucocorticoids and aldosterone (A)	Lecture	2 hours	Physiology

17. Adrenal Medullary Hormones

Intermediate objectives At the end of the course learner will be able to	Content areas	Teaching Technique	Duration	Department
17.1 Outline the synthesis, transport, mechanism of action, degradation, and regulation of secretion of adrenal medullary hormones	Chemical class (B) Sites of origin, synthesis (A) Factors stimulating secretion & Mechanism of action (A) How adrenalin increases blood glucose and decreases glucose utilized by muscle (A) How epinephrine ensures an energy supply to muscle in times of stress (A) Degradation and excretion of Epinephrine & Nor-epinephrine (A)	Lecture	½ hour	Biochemistry
17.2 Explain the physiological actions of adrenal medullary hormones	Physiological actions of Epinephrine & Norepinephrine, Dopamine (A) Role of α , β - receptors (A)	SGD.	2 hours	Physiology
17.3 Explain pathophysiology of secretion abnormalities of adrenal hormones	Hypersecretion of glucocorticoids – Cushing’s syndrome (A) Hypersecretion of mineralocorticoids – Conn’s syndrome (A) Hyposecretion of adrenocortical hormones – Addison’s disease (A) Hypersecretion of catecholamines – Pheochromocytoma (A) (physiological basis of clinical features and investigation findings seen in each condition)			

18. Gross Anatomy of Neck

Intermediate objectives	Content areas	Teaching Technique	Duration	Department
At the end of the course learner will be able to				
18.1 Observe and identify the surface anatomy of the neck	<p>Surface anatomy of the neck</p> <ul style="list-style-type: none"> - Observation on swallowing and palpation of Hyoid bone, thyroid cartilage (Superior border), Cricoid cartilage (A) Events which occur at this level. (A) Thyroid Gland (Isthmus and lobes) (A) - Palpation of one common carotid artery against the carotid tubercle on C6 (A) - Observation of the jugular veins on straining and on lying down. (A) - Observation of each sternomastoid muscle when contracted against resistance (A) 	<p>Lecture</p> <p>Demonstration</p> <p>Self learning</p>	3 hours	Anatomy

18. Gross Anatomy of Neck contd.

Intermediate objectives At the end of the course learner will be able to	Content areas	Teaching Technique	Duration	Department
18.2 Observe and identify the surface anatomy of the neck Contd.	Palpation of the lymph nodes of the neck (and head) and outlining the area of drainage of each group. (A) :- The superficial groups, Deep groups Upper deep cervical nodes (including tonsillar), Lower deep cervical nodes (includes supraclavicular)	Self learning Audio visual Presentation (AVP)	1 hour	Anatomy
18.3 Outline the surface markings of important structures in the neck.	Surface markings of (A) :- Subclavian Artery Common carotid artery level of its bifurcation Subclavian vein External and internal jugular veins Brachial Plexus (ventral rami and trunks), Accessory nerve.	Lecture Demonstration Self learning		
18.4 Describe the lymph drainage of neck	Lymphatic drainage of neck	Lecture	1 hour	Anatomy

19. Thyroid Gland

Intermediate objectives At the end of the course learner will be able to	Content areas	Teaching Technique	Duration	Department
19.1 Identify the structural and functional anatomy and the development of the Thyroid gland	Structure of the thyroid gland - Parts of the thyroid gland and their functions (A) - The blood supply of the thyroid gland (A) - Relations of the thyroid gland (A) - Structures which may be compressed by thyroid enlargement (A) - Basis for the movement of the thyroid swelling on swallowing (A) - Perform a thyroid examination	Lecture SGD	1 hour 2 hours	Anatomy
19.2 Outline the synthesis, transport, mechanism of action, degradation, and regulation of secretion of thyroid hormones	Synthesis of thyroid hormones from plasma iodide. (A) Transport of thyroid hormones (A) Mechanism of action of thyroid hormones (A) L- isomer and the hormonal activity (B) Degradation of thyroid hormones (A) Regulation of thyroid hormone secretion (A) Differences between T ₄ , T ₃ and rT ₃ . (A)	Lecture	1 hour	Biochemistry

19. Thyroid Gland contd.

Intermediate objectives At the end of the course learner will be able to	Content areas	Teaching Technique	Duration	Department
19.3 Describe the metabolic changes in secretion abnormalities of thyroid hormones	Metabolic changes in - Deficiency (A) - Hypersecretion (A)	Lecture	1 hour	Physiology
19.4 Describe the physiological actions of thyroid hormones	The physiological actions of thyroid hormones on a). Calorigenesis (A) b). Potentiation of action of Catecholamines. (A) c). Metabolism (A) d). Physical and mental growth (A) e). Reproductive system (A) f). Nervous system (A)			
19.5 Describe the effects of thyroid hormones under specific conditions	Pregnancy, foetus and thyroid hormones (A) Placental transfer of thyroid hormones rT ₃ as an indicator of active foetal thyroid Fasting and thyroid hormones (A) D-isomer and effect on blood cholesterol (B)	Fixed Learning Module	1 hour (X2)	Biochemistry
19.6 List the different methods of estimating activity of thyroid hormones and their interpretations	Methods of estimating thyroid activity (including immunoassay) (A)			

19. Thyroid Gland contd.

Intermediate objectives At the end of the course learner will be able to	Content areas	Teaching Technique	Duration	Department
19.7 Explain the pathophysiology of secretion abnormalities of thyroid hormones and their treatment	Pathophysiology of hypersecretion and hyposecretion of thyroid hormones – in children and adults (A) Use of anti-thyroid drugs and β - blockers in hyperthyroidism (A) Use of thyroxin in hypothyroidism (A) Physiological basis of Thyroid crisis in relation to aetiology, signs, symptoms and treatment. (A) Clinical importance of the thyroid gland and the potential complications of thyroid surgery (A)	SGD	2 hours	Physiology Anatomy
19.8 Outline the imaging methods of the thyroid gland	Available imaging methods (A) Their clinical significance (A)			

20. The Endocrine Pancreas

Intermediate objectives At the end of the course learner will be able to	Content areas	Teaching Technique	Duration	Department
20.1 Identify the structural and functional anatomy of the pancreas	Location and Relations of the pancreas (A) Parts of the pancreas (A) Blood supply, venous drainage, nerve supply of pancreas (A) Development of the pancreas (recall) (A) Histological features of the pancreas (A)	SGD	2 hours	Anatomy
20.2 Name the hormones with glucagon like activity, their sites of origin and list their stimulatory factors	Hormones with Glucagon like activity & their sites of origin (B) Stimuli that provoke secretion of pancreatic Glucagon and Enteroglucagon (A) Effect of food on Enteroglucagon levels in blood (A)	Lecture	1 hour	Biochemistry
20.3 Explain the actions of glucagon.	Effect of Glucagon on the β -cells of the Islets of Langerhans (A) Effect of Glucagon on Glycogen Phosphorylase (A) Effect of Glucagon on liver and adipocyte lipases, and on gluconeogenesis in liver. (A) Effect of Glucagon on movement of glucose from the liver to muscle and other tissue (A) How Glucagon brings about ketonaemia (A) Differences between the actions of glucagon and Adrenalin on metabolic pathways. (B)			

20. The Endocrine Pancreas contd.

Intermediate objectives At the end of the course learner will be able to	Content areas	Teaching Technique	Duration	Department
20.4 Describe the structure, synthesis and secretion, mode of action and the factors that regulate insulin secretion	Structure of Insulin (A) Similarity between human Insulin and porcine Insulin. (B) Synthesis storage and method of secretion of insulin (A) Mode of action of Insulin (A) Insulin receptor (A) Nutrients that provoke Insulin secretion (A) Effect of gastro-intestinal hormones on Insulin secretion (A) Effects of Glucagon, ACTH, GH, Adrenalin and neural stimulation on Insulin secretion (A) Role of cyclic AMP in insulin secretion (A) Mode of action of Insulin (A)	Lecture	1 hour	Biochemistry

20. The Endocrine Pancreas contd.

Intermediate objectives At the end of the course learner will be able to	Content areas	Teaching Technique	Duration	Department
20.5 Describe the metabolic actions and fate of insulin in the body	Metabolic actions of Insulin (A) Effects of glucose and Insulin on the metabolism of Adipocytes (A) Glucose-Alanine cycle and the effects of insulin and other hormones on the cycle (B) Effects of plasma NEFA on the action of Insulin (B) Degradation of Insulin in the body (A)	Lecture	1 hour contd.	Biochemistry
20.6 Explain the role of Insulin like growth factors and glucose transporters	Types and functions of Insulin Like Growth factors (A) Types of glucose transporters (A) Functions of glucose transporters and their defects (A)			
20.7 Describe blood glucose homeostasis	Factors that determine the blood glucose level. (A) Role of liver in blood glucose homeostasis. - in starvation (A) - in the fed state (A)	Lecture	1 hour	Physiology
20.8 Histology of the endocrine organs	Covering all areas	Practical	3 hours (X2)	Anatomy
NOTE: Covering the whole Endocrine system	Embryology and Histology of Endocrine Glands	Practical Discussion	2 hours	Anatomy

21. Diabetes mellitus

Intermediate objectives At the end of the course learner will be able to	Content areas	Teaching Technique	Duration	Department
21.1 Explain the types of Diabetes and how diabetes mellitus differs from the other type.	Types of Diabetes (A) Nomenclature of Diabetes Mellitus (DM) (A) Differences between Diabetes Mellitus and other types of diabetes. (B)	Lecture	1 hour	Biochemistry
21.2 List conditions that could give rise to deficiency of Insulin	Conditions that gives rise to total deficiency of Insulin (A) Conditions that gives rise to relative deficiency of Insulin (A)			
21.3 Describe the pathogenesis of Diabetes mellitus	Environmental factors associated with DM (A) Genetic factors associated with DM (A) Pathogenesis of Type I DM (Postulated mechanism) (A)			
21.4 List the metabolic disturbances in untreated DM	Metabolic disturbances in DM (A) <ul style="list-style-type: none"> - Carbohydrate metabolism - amino acid and protein metabolism - Lipid metabolism 			
21.5 List the major differences of Type I and Type II DM	Differences in Type I and Type II DM. (A)			

21. Diabetes Mellitus contd.

Intermediate objectives At the end of the course learner will be able to	Content areas	Teaching Technique	Duration	Department
21.7 Describe, perform and interpret an Oral Glucose Tolerance Test (OGTT)	Procedure of performing an OGTT (A) Significance of the a). The fasting blood glucose level. (A) b). The peak level and time of peak. (A) c). The level at two hours, in the diagnosis of Diabetes Mellitus. (A) Interpretation of a Diabetic curve(A) Features and conditions that could give rise to a lag storage curve, a flat curve and an impaired glucose tolerance curve (A)	Practical	3 hours (x2)	Physiology Biochemistry
21.8 Perform interpret blood and urinary tests for glucose	Benedict's test for reducing substances (A) Clinistix Test (A) Measurement of blood glucose (A)	Practical	3 hours (x2)	Biochemistry
21.9 Describe the biochemical tests that could be utilised to monitor blood glucose control	HbA _{1c} in monitoring blood glucose control (A) Fructosamine in monitoring blood glucose control (A) Advantage of using HbA _{1c} and fructosamine over fasting blood sugar in monitoring therapy. (A)	GLS	3 hours (x2)	Biochemistry

Section 3

Nutrition

22. Energy and Protein Requirement

Intermediate objectives At the end of the course learner will be able to	Content areas	Teaching Technique	Duration	Department
22.1 Describe the energy and protein requirements in individuals and deviations from normal.	Energy content of food and calculate energy value of food, BMR, BMI (A) Assessing the Nutritive Value of proteins (A) Energy and protein requirements in an (A) infant/child/adult/elderly/pregnancy & lactation Protein homeostasis (A) Nutritional assessment (A) Energy Protein Malnutrition (A)	Lecture Tutorial	5 hours 1hour	Biochemistry Biochemistry
22.2 Assess the nutritional status of a child by using anthropometric measurements given.	Weight for height/ Weight for age (A) Height for age (A) Occipito-frontal circumference (A)	Skills Lab	1 ½ hours (x3)	Physiology Biochemistry Anatomy
22.3 Assess the BMI of a person	BMI calculation (A)			

23. Vitamins as nutrients - Introduction

Intermediate objectives At the end of the course learner will be able to	Content area	Teaching Technique	Duration	Department
<p>23.1 Recall the discovery of vitamins</p> <p>23.2 Define the nomenclature of Vitamins</p> <p>23.3 Define the terms vitamin, provitamin and vitamer and how a vitamin differs from a hormone and an enzyme</p>	<p>Water soluble and fat soluble vitamins (A)</p> <p>Biological active forms of vitamins (A)</p>	Lecture	1 hour	Biochemistry

24. Vitamins as nutrients – Fat Soluble Vitamins

Intermediate objectives At the end of the course learner will be able to	Content area	Teaching Technique	Duration	Department
<p>24.1 Vitamin A</p> <p>24.1.1 Explain the sources of vitamin A, Bioavailability and RDA requirement.</p> <p>24.1.2 State how the digestion, absorption and transport of Vitamin A occur</p> <p>24.1.3 List the main biochemical and physiological functions of vitamin A</p>	<p>Sources of vitamin A (A)</p> <p>Define the terms Provitamin A, retinol requirement (A)</p> <p>Bioavailability of vitamin A (A)</p> <p>RDA requirement for (a) infant (b) school child (c) adult (d) pregnancy and lactation (A)</p> <p>Factors which aid / hinder the digestion and absorption of vitamin A (A)</p> <p>Transformation of provitamin A to vitamin A (A)</p> <p>Mechanism of transport of vitamin A from intestine to liver and extra hepatic tissues (A)</p> <p>How vitamin A influence the genomic expression of cells (A)</p> <p>Relationship between retinoids and cancer (A)</p> <p>Vitamin a deficiency, symptoms (A)</p>	Lecture	1 hour	Biochemistry

24. Vitamins as nutrients – Fat Soluble Vitamins contd.

Intermediate objectives	Content area	Teaching Technique	Duration	Department
At the end of the course learner will be able to				
<p>24.2 Vitamin D</p> <p>24.2.1 Explain the sources of vitamin D, bioavailability and RDA requirement.</p> <p>24.2.2 State how synthesis of vitamin D in the skin and absorption from intestine.</p> <p>24.2.3 List the biochemical and physiological functions</p>	<p>Sources of vitamin D (A)</p> <p>Bioavailability of vitamin D (A)</p> <p>RDA requirements for (a) infant (b) children (c) adult (d) pregnancy and lactation (A)</p> <p><i>Synthesis of vitamin D/ calcitriol will be covered in the gastro-intestinal tract module</i></p> <p>Deficiency symptoms (A)</p> <p>Relationship between calcium and vitamin D (A)</p> <p>Effects of excessive intake (A)</p>	Lecture	1 hour	Biochemistry

24. Vitamins as nutrients – Fat Soluble Vitamins contd.

Intermediate objectives	Content area	Teaching Technique	Duration	Department
At the end of the course learner will be able to				
<p>24.3 Vitamin E</p> <p>24.3.1 Indicate the sources and chemical characteristics of substances with vitamin E activity.</p> <p>24.3.2 Assess the RDA of vitamin E</p> <p>24.3.3 Explain the main biochemical and physiological functions.</p>	<p>Sources of vitamin E (A)</p> <p>Types of tocopherol (A)</p> <p>Activity of tocopherols (A)</p> <p>How the requirement is influenced by vitamin A, intake of polyunsaturated fatty acids, and advancing age (A)</p> <p>Dietary sources (A)</p> <p>Role of antioxidants (A)</p> <p>Antioxidants in preventing diseases (A)</p>	Lecture	1 hour	Biochemistry
<p>24.4 Vitamin K</p> <p>24.4.1 Explain the sources of vitamin K</p> <p>24.4.2 List the biochemical and physiological functions</p>	<p>Sources of vitamin K (A)</p> <p>Analogues of vitamin K (A)</p> <p>Vitamin K dependent proteins and functions of γ-carboxylase (A)</p> <p>Effects of dicumerol and warfarin (A)</p>			

24. Vitamins as nutrients – Fat Soluble Vitamins contd.

Intermediate objectives At the end of the course learner will be able to	Content area	Teaching Technique	Duration	Department
<p>24.5 Vitamin F</p> <p>24.5.1 State the two essential fatty acids and explain why they are considered essential.</p> <p>24.5.2 State the relationship between EFA and atherosclerosis</p>	<p>EFA and their function (A)</p> <p>Effects of oxidants of PUFA (A)</p> <p>Foods rich in EFA (A)</p> <p>Role of EFA in the atherogenesis and thrombosis(A)</p> <p>Role of PUFA on serum cholesterol (A)</p>	Lecture	1 hour	Biochemistry

25. Vitamins as nutrients – Water Soluble Vitamins.

Intermediate objectives At the end of the course learner will be able to	Content area	Teaching Technique	Duration	Department
<p>25.1 Thiamin (vitamin B₁)</p> <p>25.1.1 State the sources of vitamin B₁ and requirement.</p> <p>25.1.2 List the biochemical and physiological functions.</p>	<p>Dietary sources (A)</p> <p>Requirement expressed in terms of energy intake (A)</p> <p>Effect of milling, extraction rate and cooking. (A)</p> <p>Biochemical consequence in thiamin deficiency (A)</p> <p>Criteria used to define thiamin status (A)</p> <p>Symptoms of B₁ deficiency (A)</p>	Lecture	1 hour contd.	Biochemistry
<p>25.2 Riboflavin (vitamin B₂)</p> <p>25.2.1 State the sources of and requirements.</p> <p>25.2.2 List the biochemical and physiological functions.</p>	<p>Dietary sources and recommended daily allowance (A)</p> <p>Effect of cooking (A)</p> <p>Biochemical and physiological role in cellular function (A)</p> <p>Deficiency symptoms (A)</p>			
<p>25.3 Niacin (B₃)</p> <p>25.3.1 Sources and recommended daily allowance</p> <p>25.3.2 List the biochemical and physiological functions</p>	<p>Dietary sources and recommended daily allowance (A)</p> <p>Amino acid composition and effect of long term consumption of maize and sorghum (A)</p> <p>Biochemical and physiological basis of mental depression in pellagra and fatty liver (A)</p> <p>Symptoms of niacin deficiency (A)</p>			

25. Vitamins as nutrients – Water Soluble Vitamins contd.

Intermediate objectives	Content area	Teaching Technique	Duration	Department
At the end of the course learner will be able to				
25.4 Pyridoxine (B ₆)		Lecture	1 hour	Biochemistry
25.4.1 State the sources and daily requirements	Naturally occurring pyridoxine derivatives (A)			
	Requirement and protein intake (A)			
25.4.2 List the biochemical and physiological functions	Effects of INAH in adults with tuberculosis (A)			
	Symptoms associated with deficiency (A)			
25.5 Folic acid (B ₉)				
25.5.1 List the sources and the factors affecting absorption	Dietary sources and factors affecting folate absorption. (A)			
25.5.2 List the Biochemical functions.	Serum folate status (A)			
	Laboratory tests in detection of folate deficiency (A)			
	Folate and vitamin B ₁₂ deficiency and erythropoiesis. (A)			
	Antifolates and principles of their action (A)			

25. Vitamins as nutrients – Water Soluble Vitamins contd.

Intermediate objectives	Content area	Teaching Technique	Duration	Department
At the end of the course learner will be able to				
25.6 Vitamin B ₁₂ 25.6.1 State the sources and factors affecting absorption of vitamin B ₁₂ 25.6.2 List the biochemical functions.	Foods rich in B ₁₂ (A) Requirements of B ₁₂ (A) Factors influencing the absorption and the role of GIF (A) Deficiency on cell cycle (A) Distinguish folate and B ₁₂ deficiency (A) Pernicious anemia and neurological symptoms (A)	Lecture	1 hour contd.	Biochemistry
25.7 Vitamin C 25.7.1 List the foods rich in ascorbic acid and factors affecting the absorption 25.7.2 List the biochemical and physiological functions	Sources of vitamin C (A) Effect of cooking and food processing on vitamin C (A) Recommended allowance (A) Hydroxylation mediated by vitamin C (A) Role of vitamin C in wound healing (A) Role in prevention of diseases (A)			
Note: Vitaminology (Fat soluble and water soluble)	Covering all content areas	Tutorial	1 hour	Biochemistry

26. Mineral Nutrition

Intermediate objectives At the end of the course learner will be able to	Content area	Teaching Technique	Duration	Department
26.1 Calcium 26.1.1 Explain the dietary sources requirements and homeostasis.	*Will be covered in the locomotor module			
26.2 Iron 26.2.1 List the foods rich in iron, RDA values, distribution in body and iron overload.	Foods rich in iron (A) Haem and non-haem iron (A) TIBC, percentage saturation of transferrin (A) Iron requirements of an adult man, an infant, child, menstruating woman and during pregnancy and lactation. (A) Deficiency diseases (A)	Lecture	1 hour	Biochemistry

26 Mineral Nutrition contd.

Intermediate objectives At the end of the course learner will be able to	Content area	Teaching Technique	Duration	Department
26.3 Iodine 26.3.1 State the dietary sources and requirement 26.3.2 Recall the physiological role of in thyroid hormone synthesis. 26.3.3 Explain the term iodine deficiency disorder and endemic goitre	Foods rich in iodine (A) Recommended daily allowance for children and adults (A) Iodide trapping (A) Oxidation of Iodide (A) Incorporation into thyroglobulin (A) Deficiency disorders (A) Endemic goitre (A) Tests for iodine in salts (A)	Lecture	1 hour contd.	Biochemistry
26.4 Fluorine 26.4.1 State the sources of fluorine and requirements. 26.4.2 Explain the function of fluorine in bone and teeth with special reference to prevention of dental caries.	Recommended concentrations of fluorine in drinking water and how this level changes with climate. (A) Toxicity, defluoridation of water (A) Dental fluorosis (A)	Lecture	1 hour	Biochemistry

26. Mineral Nutrition contd.

Intermediate objectives At the end of the course learner will be able to	Content area	Teaching Technique	Duration	Department
<p>26.5 Copper (Cu)</p> <p>26.5.1. List the sources and requirements</p> <p>26.5.2 Discuss biochemical and physiological functions</p>	<p>Recommended daily allowance and sources (A)</p> <p>Biochemical role of copper and ceruloplasmin (A)</p> <p>Biochemical basis of Wilson's disease and treatment of Wilson's disease with penicillamine and zinc acetate (A)</p>	Lecture	1 hour contd.	Biochemistry
<p>26.6 Zinc (Zn)</p> <p>26.6.1 List the foods and RDA of zinc</p> <p>26.6.2 List the physiological and biochemical functions.</p>	<p>Food rich in zinc and RDA of zinc for infants, children and for pregnant and lactating women. (A)</p> <p>Zinc in enzyme systems (A)</p> <p>Role of zinc in acute phase response and wound healing. (A)</p> <p>Deficiency symptoms (A)</p>			
<p>26.7 Selenium and Chromium</p> <p>26.7.1. State the relationship between selenium and chromium</p>	<p>Selenium as an essential component of glutathione peroxidase (A)</p> <p>Association between selenium and vitamin E (A)</p> <p>Association between chromium and GTF (A)</p>			
Note: Mineral Nutrition	Covering all content areas	Tutorial	1 hour	Biochemistry

27. Nutritive value of commonly consumed foods of plant origin

Intermediate objectives At the end of the course learner will be able to	Content area	Teaching Technique	Duration	Department
27.1 Identify Plant foods and their composition	Food composition tables <ul style="list-style-type: none"> • Classifications (A) • Difference of table values (C) Cereals and their nutrients in <ul style="list-style-type: none"> • Processing (B) • Preparation (C) • Minimizing losses (B) Starchy, roots & tubers (B) Oil seeds and nuts (A) Pulses (A) Vegetables & fruits (A) Bioavailability (A) Glycaemic Index (A)	Lecture	3 hours	Biochemistry

28. Nutritive value of selected foods of animal origin

Intermediate objectives At the end of the course learner will be able to	Content area	Teaching Technique	Duration	Department
28.1 Identify Foods of animal origin & their composition	Milk and infant feeding (A) Nutritive value of colostrums & breast milk (A) Nutritive value of cows milk (A) Methods of processing of milk, advantages & disadvantages (B) Fermented milk and milk products (A) Milk replacement diet (A) Eggs, meat & fish (A) - composition, nutritive value (A) Processing of meat (C) ω-fatty acids, heaty fish (A)	Lecture	3 hours	Biochemistry
NOTE: Foods of plant and animal origin	Covering all areas	Tutorial	1 hour	Biochemistry

29. Principles of Diet Formulation

Intermediate objectives At the end of the course learner will be able to	Content area	Teaching Technique	Duration	Department
29.1 Understand the principles of formulating diets for normal persons and ones with metabolic diseases.	<p>Factors that influence nutritional requirements and principles of formulating diets. (A)</p> <p>Principles of complementary feeding (A)</p> <p>Factors taken into account when prescribing a diet for infant/ child/ adult/ pregnancy/ lactation/ elderly/ athletes/ metabolic diseases such as Diabetes Mellitus, atherosclerosis. (A)</p> <p>“Functional Foods” (List and functions) (A)</p>	<p>Lecture</p> <p>Tutorial</p> <p>GLS</p>	<p>3 hours</p> <p>1 hour</p> <p>1 ½ hours (x2)</p>	<p>Biochemistry</p>

Recommended Reading

Metabolism

1. Harper's Biochemistry, Robert K. Murray, Daryl K. Granner, Peter A. Mayes, Victor W. Rodwell, McGraw-Hill Companies, UK.
2. Lippincott's Illustrated Reviews: Biochemistry, Pamela C. Champe, Richard A., Ph.D. Harvey, Denise R., Ph.D. Ferrier, Lippincott Williams & Wilkins, USA.

Endocrine System

Anatomy:

1. Wheater's Functional Histology by, Barbara Young, Alan Stevens, James S. Lowe, Churchill Livingstone, UK.
2. Cunningham's Manual of Practical Anatomy by G. J. Romanes, Oxford Medical Publications, UK.
3. Last's Anatomy: Regional and applied by Chummy S. Sinnatamby (Editor) & R. J. Last (Editor), Churchill Livingstone UK.

Biochemistry:

1. Harper's Biochemistry, Robert K. Murray, Daryl K. Granner, Peter A. Mayes, Victor W. Rodwell, McGraw-Hill Companies, UK.
2. Lippincott's Illustrated Reviews: Biochemistry, Pamela C. Champe, Richard A., Ph.D. Harvey, Denise R., Ph.D. Ferrier, Lippincott Williams & Wilkins, USA.
3. Textbook of Biochemistry with clinical correlations, Thomas M. Devlin (Editor), Wiley-Liss, USA.
4. Clinical Chemistry, William J. Marshall, Stephen K. Bangert, Mosby, St. Louis, USA.

Physiology:

1. Review of Medical Physiology by William F Ganong, Mc Graw Hill Medical Publishers, UK.
2. Pathophysiology of disease by Stephen J. McPhee, Vishwanath R. Lingappa, William F. Ganong , McGraw Hill Medical Publishers, UK.

Nutrition

1. Food and Nutrition: T. W. Wickramanayake, ARTI, Sri Lanka.
2. Human Nutrition and Dietetics. J. S. Garrow, W. P. T. James, A. Ralph, Churchill Livingstone, UK.
3. Essentials of Nutrition and Diet Therapy, S. R. Williams, Mosby, St. Louis, USA.
4. Davidson and Passmore's Human Nutrition and Dietetics, R. Passmore, M. A. Eastwood, Churchill Livingstone, Edinburgh, UK.
5. Tables of Food Composition for use in Sri Lanka, W. A. D. Perera, P. M. Jayasekara, S. Z. Thaha, Colombo, Sri Lanka.
6. Principles of Nutrition, Hemantha Peiris, Sri Lanka.

