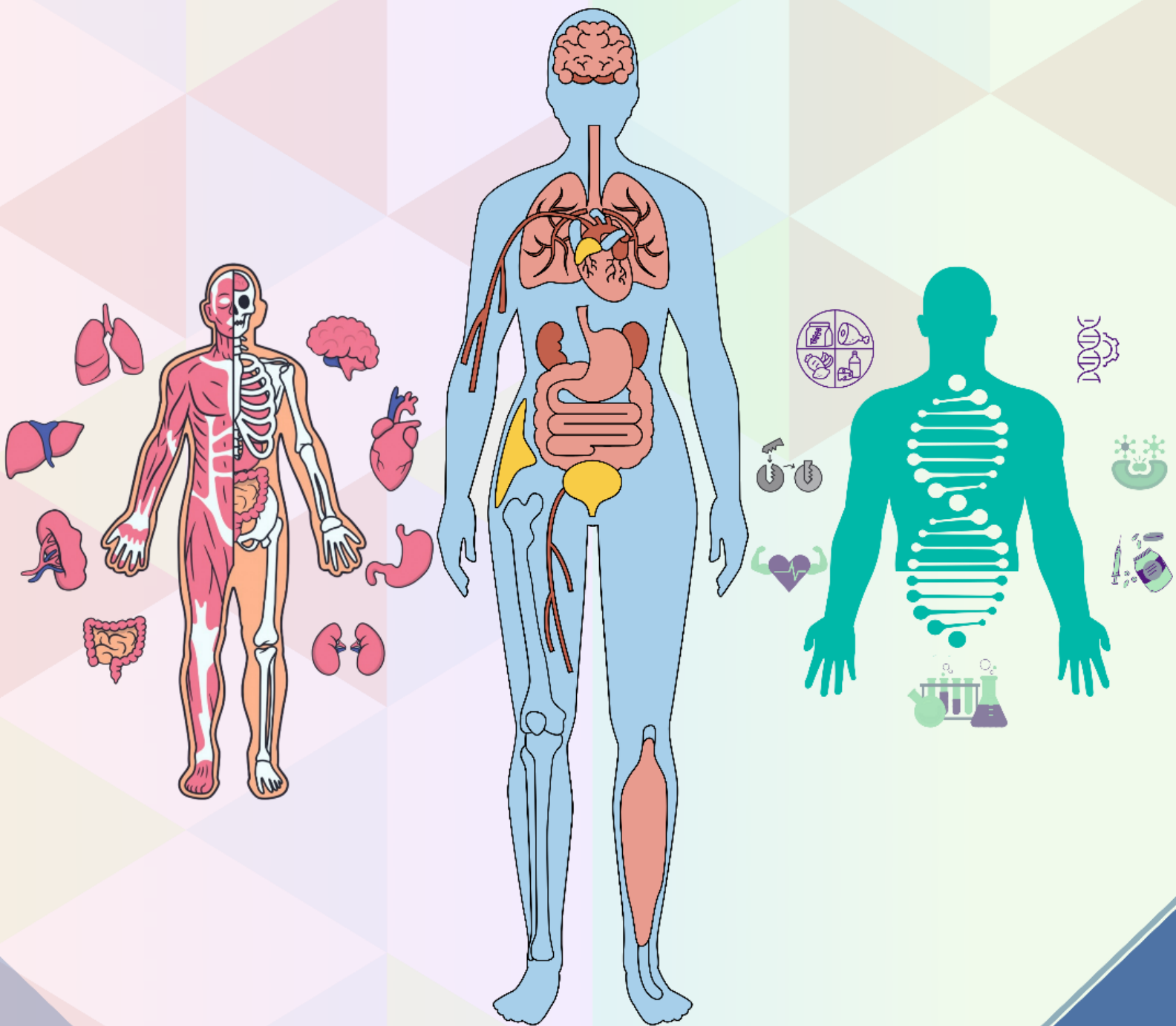


# STUDENT'S HANDBOOK

## BASIC SCIENCE STREAM



FACULTY OF MEDICINE  
SABARAGAMUWA UNIVERSITY OF SRI LANKA



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# 1. INTRODUCTION

## 1.1 Basic Science Stream: Anatomy, Biochemistry, and Physiology

The Basic Science curriculum in Anatomy, Biochemistry, and Physiology forms the foundation for your medical education, providing essential knowledge that connects structure, function, and biochemical processes in the human body. These subjects are integral to understanding health and disease, laying the groundwork for clinical practice.

Anatomy will help you explore the human body's structure, from organs and tissues to complex systems, offering a deep understanding of how the body is organized.

Physiology will explain how the body's systems function and interact, focusing on the mechanisms that maintain health and homeostasis.

Biochemistry will give you insight into the molecular processes that drive bodily functions, covering topics such as metabolism, enzymes, and cellular signaling.

The integrated approach to these disciplines ensures that you will gain a comprehensive, interconnected understanding of the human body, enhancing your ability to apply this knowledge in clinical settings. This curriculum is designed to build critical thinking, foster scientific inquiry, and prepare you for the challenges of patient care.

### 1.1.1. Anatomy

Anatomy is an essential component in foundation study of medicine. The human body is made up of a number of organs and systems that have their own unique function yet interact with one another to make up the machinery of a complex living individual. Anatomy is the study of body structure. It is an extensive field of study that has various subdivisions and specialties such as Histology, Embryology, Genetics and Radiological Anatomy. The gross structure of organs and systems studied as macroscopic and topographical anatomy deals with their morphological features, their arrangement within the body and their functions, with emphasis on their relevance to clinical medicine. It includes three-dimensional Anatomy together with its application in diagnostic and visual imaging procedures to understand how these organs and systems function in health and disease, it is necessary to study their structure at cellular, subcellular levels - microscopic anatomy and at the molecular level (molecular biology). The intricate process of human prenatal development – embryology, will be dealt with in its early stages as basic embryology and later as a part of the development of the organs and systems referred to as organogenesis. Embryology is essential not only to learn about the normal

process of development, but as a basis of understanding the various congenital defects that may occur the course in human genetics will cover the principles of basic medical genetics applicable to clinical medicine.

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## **Recommended Reading Material**

### **Gross and Clinical Anatomy**

- Gray's Anatomy for Students: with Student Consult Access by Richard Drake, A. Wayne Vogl, Adam W. M. Mitchell, 3rd edition
- Lasts Human Anatomy: Regional and Applied Chummy S Sinnatamby, 12th edition
- Clinical Anatomy: Applied Anatomy for Students and Junior Doctors 13th Edition by Harold Ellis, Vishy Mahadevan
- Clinical Neuroanatomy (Clinical Neuroanatomy for Medical Students, Richard S Snell, 7th edition
- Clinically Oriented Anatomy, Keith L. Moore, Arthur F. Dalley, A. M. R. Agur, 7th Edition
- Grants atlas by Anne M. R. Agur, Arthur F. Dalley, 13th edition

### **Embryology**

- Langman's Medical Embryology, Thomas W. Sadler, 13th edition

### **Histology**

- Wheater's Functional Histology: A Text and Colour Atlas, By Barbara Young, Phillip Woodford, Geraldine O'Dowd, (6th edition)

### **Human Genetics**

- Basic Medical Genetics 5th Edition by Rohan W. Jayasekara.

### **Supplementary Reading**

- BD Chaurasia's Handbook of General Anatomy, 4th Edition
- McMinns Clinical Atlas of Human Anatomy, Peter H Abrahams, 7<sup>th</sup> Edition
- ABC of Clinical Genetics, Helen M Kingston, 3<sup>rd</sup> Edition

### 1.1.2. Biochemistry

Biochemistry is the study of the chemical foundations of life. In essence, it applies the principles of chemistry to explore biological processes at the cellular, molecular, and sub-molecular levels. A strong understanding of biochemistry is crucial for comprehending the molecular origins of diseases, the mechanisms behind existing therapies, and the action of emerging drugs. In the future, medical treatments may shift from organ transplants to gene-based therapies. Fields like pharmacogenomics and nutritional genomics are paving the way for personalized medicine, with treatments tailored to an individual's genetic profile. To fully grasp these concepts, it's essential to understand the complex interactions between metabolic pathways, organs, and tissues.

This course is designed to focus on the biochemical principles most relevant to medicine. A solid foundation in biochemistry equips students with the knowledge to understand both the molecular mechanisms behind normal health and the alterations that lead to disease. To understand disease states, it is vital to first explore normal metabolic pathways—the biosynthesis and breakdown of molecules—and how different classes of biological molecules work together to capture energy, build complex molecular machines, utilize energy, and regulate metabolic pathways.

Additionally, this course introduces Clinical Biochemistry and Molecular Biology, providing insights into disease processes at the molecular level and modern diagnostic methods.

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#### Recommended Reading Material

- Lippincott's Illustrated Reviews – Biochemistry, Harvey RA (ed), 8th edition, 2013, Lippincott Williams & Wilkins, Philadelphia.

- Harper's Illustrated Biochemistry, Murray R, Rodwell V, Bender D, Botham KM, Weil AP, Kennelly PJ 30th/31st edition
- Textbook of Biochemistry with Clinical Correlations, Devlin TM, 7th edition, 2010, John Wiley & Sons, New York
- Lehninger principles of biochemistry (6th Edition) Nelson, D., and Cox, M.
- Biochemistry. Jeremy M. Berg, John L. Tymoczko, Lubert Stryer 7th Edition
- Molecular Biology of the Cell (Sixth Edition) by Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter.
- Nutritional Biochemistry 2nd Edition by Tom Brody.
- Nutritional Biochemistry and Metabolism: With Clinical Applications by Maria C. Linder.

### **1.1.3. Physiology**

Physiology is the study of the normal functions of the body, explored through cellular, tissue, and systemic levels. It focuses on understanding the mechanisms that maintain the environment surrounding cells, known as homeostasis. Regulatory mechanisms at both cellular and systemic levels ensure the proper functioning of the body. A deep understanding of these processes is achieved by the end of the course.

Propaedeutics introduces students to the art and science of clinical medicine, serving as a bridge between preclinical and clinical disciplines. Students will acquire knowledge in fundamental sciences, enabling them to understand the normal structure and function of the human body, as well as the pathological basis of disease, and apply this knowledge in clinical practice.

In terms of skills, students will learn how to obtain relevant information, perform clinical examinations, investigate appropriately, carry out essential clinical procedures, treat patients, and discuss management plans with patients, relatives, and caregivers. They will also learn the importance of obtaining informed consent and encouraging patients to play an active role in their own care. Furthermore, students will apply their knowledge to provide effective, compassionate care and actively contribute to healthcare teams, offering leadership when necessary. Effective communication with patients and their families, with consideration for psychosocial aspects, will be



emphasized, alongside a commitment to education and promoting behaviors that prevent disease and its complications.

Students will cultivate an attitude of high moral and ethical standards, ensuring they are courteous, respectful, and maintain confidentiality in doctor-patient relationships. They will also respect staff members and work collaboratively in multidisciplinary teams. Practicing within their competencies, students will seek expert advice or make referrals when needed. A commitment to lifelong learning and continuous skill development will also be encouraged.

Finally, students will develop wisdom, strengthening their problem-solving abilities and honing their judgment to determine the correct course of action in challenging situations.

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## **Recommended Reading Material**

1. Ganong's Review of Medical Physiology,  
Barrett KE, Barman SM, Boitano S, Hedderley BL 26<sup>th</sup> edition, 2019, McGraw-Hill. New York.
2. Guyton and Hall Textbook of Medical Physiology,  
Hall JE, 14<sup>th</sup> edition, 2021, Elsevier Science Health Science division.  
Philadelphia.

## **1.2 Teaching/Learning (T/L) Activities and Learning Materials**

- **Lectures**

Lectures are designed to give students a broad understanding of the basic concepts of the topic. They are conducted by the senior staff senior lecturers and are further augmented by the relevant small group discussions (SGD) and dissections.

- **Small Group Discussion (SGD) / Tutorial**

Small group discussions consist of groups of students of about 20 in number involved in detailed discussion of a topic or subtopic. Led by a junior staff member, the students are encouraged to develop and present their own ideas and observations. Interactive lectures are also conducted by the junior lecturers on specific topics along with cadaver demonstrations. Lesson plans and learning outcomes are given to the students prior to the lecture and SGD.

- **Cadaveric Learning Sessions**

Cadaveric learning is essential components of anatomical learning, providing students with hands-on exposure to the structural organization of the human body. Under faculty supervision, students engage in systematic dissections that align with ongoing anatomy topics. These sessions reinforce anatomical knowledge and enhance spatial understanding. Cadaver demonstrations further highlight key structures, offering a guided learning experience that aids in the identification and interpretation of anatomical relationships. Through these activities, students cultivate teamwork, critical thinking, and a deep appreciation for the contributions of body donors to medical education.

- **Self-Directed Learning (SDL)**

Students are also allotted time for self-study. Materials such as soft tissue specimens, prosected cadavers, latex models and work sheets are available to students for self-directed learning. These sessions are under staff guidance. Study space is also available in Anatomy museum, which houses a wide array of prosected specimens and students are encouraged to examine the specimens during self-study sessions or any free time.

- **Laboratory sessions**

The practical sessions in Anatomy, Physiology, and Biochemistry are integral components of the preclinical curriculum, offering students essential hands-on experience to complement theoretical learning. These lab sessions are designed to enhance understanding of the human body's structure, functions, and biochemical processes, providing a solid foundation for clinical studies. These sessions bridge theory with practice, helping students develop essential skills for clinical application. Lab sessions are designed to provide hands-on experience and deepen students' understanding of fundamental medical sciences.

- **Online learning management system (LMS system)**

The Learning Management System (LMS) serves as a centralized platform for lecture materials, recorded sessions, study guides, assignments, and assessments. It enables students to access resources, participate in discussions, and track their progress conveniently.

- **Learning material**

A variety of learning materials are provided to support students' academic progress, including:

- Anatomical Resources: Bones, anatomical models, and museum specimens.
- Textual and Digital References: Atlases, textbooks, study guides, and handouts.
- Visual Aids: Lecture presentations, radiological images, and fixed learning modules.

These resources ensure a comprehensive and multimodal learning experience, allowing students to reinforce their understanding through different formats.

- **Case-Based Learning (CBL)**

Case-Based Learning (CBL) is an interactive approach that encourages students to apply theoretical knowledge to real-life clinical scenarios. Through structured case discussions, students analyze patient presentations, correlate symptoms with anatomical and physiological principles, and develop problem-solving skills. This method fosters critical thinking, collaboration, and clinical reasoning, bridging the gap between foundational sciences and medical practice. CBL sessions are facilitated by faculty members who guide discussions, ensuring that students integrate knowledge across different disciplines while honing their diagnostic and decision-making abilities.

### 1.3 Integrated Curriculum

In the context of the basic science stream for medical students, an integrated curriculum refers to the blending of the three disciplines; Anatomy, Physiology and Biochemistry. By combining various scientific disciplines and linking them to clinical practice, this approach fosters students with the knowledge, skills, and critical thinking necessary to excel as future healthcare professionals.

When complemented by integrated assessments, it ensures that students are not only learning but are also able to apply their knowledge effectively in clinical scenarios. The integrated approach benefits students by promoting a holistic understanding of medical science, improving retention, fostering critical thinking, and better preparing them for clinical practice. Subjects are taught together to highlight their links. Students engage in case-based learning, group discussions, and practical exercises, making their learning relevant to clinical situation. Integrated learning is directly linked to clinical application, with students encouraged to understand how basic science concepts are applied in diagnosing, managing, and treating patients. Assessment in an integrated curriculum focuses on evaluating students' ability to integrate knowledge across disciplines.

The table below shows the modules in each semester with their credit values. The entire BSS is 48 credits.

**Table 1. Basic Science Stream Structure.**

Semester	Module	Module code	Credits*
Semester 1	Foundation (F1)	MEBS-1-1-1-7	7
	Blood & Immune System (B & I)	MEBS-1-1-2-3	3
	Cardiovascular System (CVS)	MEBS-1-1-3-4	4
	Respiratory System (RS)	MEBS-1-1-4-2	2
	Total		16
	End Semester 1 Examination (ESE 1)		
Semester 2	Endocrine System (ENDO)	MEBS-1-2-1-2	2
	Gastrointestinal System & Metabolism (GIM)	MEBS-1-2-2-9	9
	Renal System (RENAL)	MEBS-1-2-3-2	2
	Reproductive System (REPR)	MEBS-1-2-4-3	3
	Total		16
	End Semester 2 Examination (ESE 2)		
Semester 3	Nutrition (NUTR)	MEBS-2-1-1-2	2
	Musculoskeletal System (MSK)	MEBS-2-1-2-6	6
	Nervous System (NS)	MEBS-2-1-3-6	6
	Molecular & Precision Medicine (MP)	MEBS-2-1-4-2	2
	Total		16
	End Semester 3 Examination (ESE 3)		
2MBBS examination [Main]			
2MBBS examination [Subsequent]			

## 2. ASSESSMENTS

### 2.1 Assessment Tools and Types

- A. Multiple choice questions [TRUE/FALSE]
- B. Multiple choice questions [One Best Answer] [OBA]
- C. Multiple choice questions [Extended Matching] [EMQ]
- D. Structured essay questions [SEQ]: SEQs are integrated and consist of more than one discipline.
- E. Objective Structured Practical Examinations [OSPE]: OSPE would be based on the practical classes, guided learning sessions and small group discussions conducted.
- F. Objective Structured *Viva Voce* Examination [OSVE]: Only to award subject distinctions at the completion of 2MBBS examination.

#### 2.1.1 Formative assessments [FA]

There are TWO [2] Formative Assessments in each module; one at the middle and another at the end of the module. Formative assessments are mapped to the T/L activities so that by attempting the FAs, students can self-assess their learning progress. Group feedback is given at the end of each FA. Formative Assessments also will familiarize the learner with different assessment tools including *viva voce*.

#### 2.1.2 Summative assessments [SA]

##### End Semester Examinations (ESEs)

- These are held at the end of each semester. The End Semester Examinations will not be repeated.
- Based on the number of credit in a semester, a percentage from each ESE is added to the 2MBBS [main] examination as follows.

**Table 2. Contribution of the ESE for the 2MBBS [main] examination**

Semester	Credits	End Semester Examination	Method of Assessment	Contribution to 2MBBS [main] (%)
1	16	ESE1	MCQ and OSPE	13
2	16	ESE2	MCQ, SEQ and OSPE	14
3	16	ESE3	MCQ and OSPE	13
				40 [Total]

- Each ESE question paper is discussed with the students and group feedback is given at the end of each ESE.
- ESE marks are not added to the 2MBBS [subsequent examination] examination.

## **End of Stream Assessment**

### **2MBBS [main] and [subsequent] examinations:**

- 2MBBS [main] examination is held at the end of the BSS. Those who defer or fail the 2MBBS [main] examination shall sit for the 2MBBS [subsequent] examination which shall be held 6 weeks following the release of the 2MBBS [main] examination results.
- 2MBBS [main and subsequent] have two units, based on equal credit distribution.

**BSS Part 1:** Contents in Foundation, Blood and immune, Cardiovascular, Respiratory, Endocrine, Reproductive and Renal modules are assessed.

**BSS Part 2:** Contents in Gastrointestinal and Metabolism, Nutrition, Musculoskeletal, Neurology and Precision Medicine modules are assessed.

- The theory component of each Part (BSS Part 1 and BSS Part 2) has MCQs and SEQs, and the practical component of each part has OSPEs.

## **2.2 Assessment Framework**

The following table provides an overview of the different question types used in the assessments, along with their respective time and marks allocation

**Table 3. Marks and Time Allocation for Different Question Types**

Type of question	Time per question (min)	Marks per question
MCQ TRUE/FALSE	3	5 (minus marks for incorrect answer within the question)
OBA	3	3

<b>EMQ</b>	3 min per scenario	3 marks per scenario
<b>SEQ</b>	30 min	25
<b>OSPE</b>	3	10

The tables below show the assessment frameworks for

- ESE1, ESE2 and ESE3
- 2MBBS [main] and 2MBBS [subsequent] examinations



## End Semester Examination 1 (ESE1)

**Table 4. ESE1 assessment format**

Modules	Assessment Tool	Duration	Number of Questions	Contribution to 2MBBS [13%]
Foundation B & I CVS RS	MCQ Paper 1 [F+RS]	2 hrs 15 min	80 MCQs • T/F: 61 • OBA: 13 • EMQ: 2 (each from Anatomy and Physiology) with 3 scenarios; total 6 Qs)	8
	MCQ Paper 2 [CVS+B & I]	1 hrs 45 min		
	OSPE	75 min	25 OSPEs	5

## End Semester Examination 2 (ESE2)

**Table 5. ESE2 assessment format**

Modules	Assessment tool	Duration	Number and type of questions	Contribution to 2MBBS [14%]
ENDO REPRO RENAL GIM	MCQ Paper 1 [ENDO+REPRO+RENAL]	1 hr 45 min	80 MCQs • T/F: 60 • OBA: 8 • EMQs: 4 (2 from ANA, 1 from PHY and 1 from BCH) with 3 scenarios (so total is 12 Qs)	8
	MCQ Paper 2 [GIM]	2 hrs 15 min		
	SEQ	1 hr	2 SEQs SEQ1- [ENDO/REPRO/RENAL] SEQ2- GIM	2
	OSPE	1 hr	20 OSPEs	4

## End Semester Examination 3 [ESE3]

**Table 6: ESE3 assessment format**

Modules	Assessment tool	Duration	Number of Questions	Contribution to 2MBBS [13%]
NUT MSK NEURO MP	MCQ Paper 1 [NUT+MSK]	2 hrs	80 MCQs • T/F: 61 • OBA: 13 • EMQ: 2 (each from ANA and PHY) with 3 scenarios (so total is 6 Qs)	9
	MCQ Paper 2 [NEURO+MP]	2 hrs		
	OSPE	1 hr	20	4

## 2MBBs Examination [MAIN / SUBSEQUENT]

The 2MBBS Examination [MAIN / SUBSEQUENT] is comprised of two independent PARTs:

- Basic Science Stream PART 1 (BSS PART 1)
- Basic Science Stream PART 2 (BSS PART 2)

**Table 7: 2MBBS [Main & Subsequent] BSS Part 1 Format**

End of BSS Assessment [ 2MBBS Main & Subsequent] BSS Part 1			
Modules	Assessment tool	Duration	Number and type of questions
Foundation B & I CVS RS ENDO REPRO RENAL	MCQ	2 hrs	T/F 28 OBA 6 EMQ 2
	SEQ	2 hrs 30 min	5
	OSPE	1 hr	20

**Table 8: 2MBBS [Main & Subsequent] BSS Part 2 Format**

End of BSS Assessment [ 2MBBS Main & Subsequent] BSS Part 2			
Module	Assessment tool	Duration	Number and type of questions
GIM NUT MSK NS PM	MCQ	2 hrs	T/F 28 OBA 6 EMQ 2
	SEQ	2 hrs 30 min	5
	OSPE	1 hr	20

The following table outlines the weightage of various assessment components for the 2MBBS main and subsequent examinations

**Table 9: Weightage of Assessment Components in 2MBBS [Main and Subsequent] Examinations**

Assessment	Contribution for 2MBBS [main] examination (%)	Total (%)	Assessment	Contribution for 2MBBS [subsequent] examination (%)	Total (%)
ESEs	13+14+13	40	ESEs	No contribution	
<b>2MBBS [main]</b>			<b>2MBBS [subsequent]</b>		
BSS Part 1	MCQ 12.5 SEQ 12.5 OSPE 5	30	BSS Part 1	MCQ 12.5 SEQ 12.5 OSPE 5	30
BSS Part 2	MCQ 12.5 SEQ 12.5 OSPE 5	30	BSS Part 2	MCQ 12.5 SEQ 12.5 OSPE 5	30
		<b>100</b>			<b>60</b>
			<b>Convert marks out of 60 to out of 100</b>		

### **Eligibility to sit for the 2MBBS [main] examination**

- A student must achieve a minimum of 80% attendance for lectures, tutorials, practical, small group discussions (SGD), and case-based learning (CBL) sessions, and any defined T/L activity defined by Basic Science Stream.
- Failure to achieve the 80% attendance the student will not be eligible to sit the 2MBBS examination. He / She will be permitted to sit with the subsequent examination and this attempt will be considered as a repeat attempt.

### **Criteria for Determining the Pass/Fail Status, Distinctions, and Honours in the 2MBBS [Main and Subsequent] examinations**

#### **1. Criteria for passing the 2MBBS [main] examination**

**Criterion 1.1:** Student should obtain a minimum of 45% or above for **EACH** BSS PART 1 and PART 2 in the 2MBBS [main] examination.

**Criterion 1.2:** In order to 'Pass' the 2MBBS examination, student should obtain a minimum of 50% in the Final Examination (Refer Table 9).

- In the 2MBBS [main] Examination, BSS PART 1 and PART 2, students must complete all components of PART 1 AND/OR PART 2 in a single attempt (in one sitting). If a student fails to do so, they will be required to repeat the entire PART 1 AND/OR PART 2.
- Students are not permitted to skip the 2MBBS [main] examination BSS PART 1 AND/OR PART 2, under any circumstances. If a student presents a valid reason, they may be permitted to sit for the next available attempt, which will be considered their first attempt.

#### **2. Criteria for passing the 2MBBS [subsequent] examination**

**Criterion 2.1:** Student should obtain a minimum of 45% or above for the BSS PART 1 AND/OR PART 2 in the 2MBBS [subsequent] examination.

**Criterion 2.2:** In order to 'Pass' the 2MBBS examination, student should obtain a minimum of 50% in the Final Examination (Refer Table 9).

- Thus, a student has to **resit ONLY for the PART he/she has referred** based on the above criteria 2.1. The student has to sit for MCQ, SEQ and OSPE components of the referred PART(S).
- In the 2MBBS [subsequent] Examination, BSS PART 1 and PART 2, students must complete all components of PART 1 AND/OR PART 2 in a single attempt (in one sitting). If a student fails to do so, they will be required to repeat the entire PART 1 AND/OR PART 2.

#### **3. Criteria for failing 2MBBS [main and subsequent] examinations**

**Criterion 3.1:** Student is UNABLE to obtain a minimum of 50% or above for the **2MBBS** [main and subsequent] examination.

**OR**

**Criterion 3.2:** Student is UNABLE to obtained a minimum of 45% or above for the **BSS PART 1 AND/OR PART 2** in the **2MBBS** [main and subsequent] examination.

#### 4. Criteria for Distinction *Viva Voce* Examination

**Criterion 4.1:** Students who have obtained a minimum cumulative average of 60% or above at the ENTIRE 2MBBS [BSS PART 1 and PART 2] examination are eligible to apply for the distinction *viva voce*.

**Criterion 4.2:** Students who have obtained a minimum cumulative average of 65% or above for the respective subject component at the 2MBBS [BSS PART 1 and PART 2] examination are selected for the *viva voce* to offer a 'Distinction in the corresponding subject'.

#### 5. Award of Distinctions

**Criterion 5.1:** Students who have obtained cumulative average of 70% or above for *viva voce* and the respective subject component at the 2MBBS [BSS PART 1 and PART 2] examination are awarded the Distinction in the respective subject.

#### 6. Criteria for Honours

- A candidate shall not be eligible for Honours unless he/she has sat the examination on the earliest occasion on which he/she is qualified to do so, provided that it shall be within the power of the Senate to declare, for some specified reason, that he/she is eligible for Honours at a subsequent attempt.
- A candidate shall not be eligible for Honours unless he/she has passed the examination at his/her first scheduled attempt.
- Who passes the 2<sup>nd</sup> MBBS Examination at the first scheduled attempt and obtains total of (BSS PART 1 and BSS PART 2) 70% or above shall be eligible for First Class (Honours).
- Who passes the 2<sup>nd</sup> MBBS Examination at the first scheduled attempt and obtains total of (BSS PART 1 and BSS PART 2) 65% to 69% at that examination, shall be eligible for Second Class Upper Division (Honours).
- Who passes the 2<sup>nd</sup> MBBS Examination at the first scheduled attempt and obtains total of (BSS PART 1 and BSS PART 2) 60% to 64% at that examination shall be eligible for Second Class Lower Division (Honours).

#### 7. Other Conditions

- In the End Semester Examination students should complete all components of the examination within one attempt (in one sitting).
- A student can be absent only for one End Semester Examination, even with a valid reason.
- In case of a validly absent candidate for End semester examination, 40% from the cumulative marks are taken from the participated two End semester examinations for calculation of the final marks in the 2MBBS proper examination.
- Student who is unable to obtain a minimum of 25% in **EACH** BSS PART 1 OR PART 2 should resit the **ENTIRE 2MBBS** [BSS PART 1 and PART 2] examination.
- Student (s) who failed the subsequent examination has/have to resit PART 1 AND/OR PART 2 with the next available attempt.
- A total of FOUR (4) attempts are allowed to complete 2MBBS examination.

### 3. MODULES

Module	Coordinator(s)
1.Foundation	Dr I.H.V. Nicholas
2.Cardio vascular system	Dr. N.D. Amal Wageesha
3.Blood and Immune	Dr. K.M.G.M.K.K. Kulathunga
4.Respiratory system	Dr. Y.D Kolambage
5. Endocrine system	Dr. I.H.V. Nicholas
6.Reproductive system	Dr. T.C.S. Weerakoon
7.GI and metabolism	Dr. N.D. Amal Wageesha Dr. Sumeth Perera
8.Renal system	Dr. T.C.S. Weerakoon
9. Nutrition	Ms. K. Nadeesha Nilmini Dr. I.H.V. Nicholas
10. Musculo skeletal system	Dr. Y.D. Kolambage
11. Nervous system	Dr. K.M.G.M.K.K. Kulathunga
12. Molecular and precision medicine	Dr. Sumeth Perera

## 3.1 Foundation Module

Module code	Year	Semester	Credit
MEBS-1-1-1-7	01	01	07

### Introduction

During this module we aim to cover some aspects of basic medical science, primarily in the subject of Cell biology, Metabolism, Homeostasis, Structure and function of basic tissues, Early embryology and Principles of human Genetics integrated in the three basic sciences. The module will cover the fundamental principles of human Anatomy, Physiology and Biochemistry as well as familiarize yourself with medical terminology. The basic science concepts you learn during this module will lay the foundation for the upcoming modules of the basic sciences stream. The mode of teaching will center on lectures, tutorials/small group discussions (SGD), fixed learning modules (FLM), self-learning activities and practical.

### Module Committee

<b>Module Coordinator</b>	Dr. Irosha Nicholas – Basic Sciences Stream Coordinator, Head/Department of Biochemistry
<b>Committee members</b>	Dr. Joachim Perera – Consultant for Department of Anatomy Prof. M.N. Wickramaratne - Professor/Department of Biochemistry Dr. Kaushalya Kulathunga – Head/Department of Physiology Dr. Chamalika Weerakoon - Head/Department of Anatomy Dr. Amal Wageesha – Senior Lecturer/Department of Biochemistry Dr. Sumeth Perera - Senior Lecturer/Department of Biochemistry Dr. Yasas Kolambage – Lecturer/Department of Anatomy Ms. Nadeesha Nilmini – Lecturer/Department of Biochemistry

### Module Learning Outcomes

At the end of the foundation module, the student should be able to:

1. describe the structures and functions of animal cell and sub-cellular organelles, and recognize their roles in cellular processes.
2. explain methods of transport across cell membranes and their contribution to cellular function.
3. describe the microscopic structure of nerve and muscle tissues, and their physiological processes.
4. explain the role of pH and physiological buffers in cellular homeostasis.
5. analyze body fluids, electrolytes, and acid-base balance, and evaluate the consequences of imbalances on physiological processes.
6. describe and apply principles governing the structures of biomolecules and analyze their role in molecular recognition and interactions.
7. analyze the principles of enzyme catalysis and evaluate their significance in regulating metabolic pathways and cellular activities.
8. explain the mechanisms of hormone action in regulating biochemical pathways, and evaluate the impact of hormones on physiological functions.

9. describe the storage, transfer, and inheritance of genetic information, and evaluate its implications for inheritance patterns and cellular function.

## Course details with Intended Learning Outcome (ILOs)

Intended Learning Outcomes [ILOs]	Content Outline	T/L Activity	Duration (Hours)	Department
1.1. Describe the microscopic structure and functions of the human cell and cellular organelles.	<b>Cell structure and functions</b> <ul style="list-style-type: none"> <li>Structural and chemical constituents of the cell.</li> <li>Functional organization of the cell.</li> <li>Structure and functions of cell junctions.</li> </ul>	Lecture	2	Anatomy
1.2. Describe mitosis and meiosis  1.3. Discuss the abnormalities in cell division  1.4. Differentiate between mechanisms of cell death and its significance in health and disease	<b>Cell Division &amp; Cell Death</b> <ul style="list-style-type: none"> <li>Cell division: Mitosis and Meiosis</li> <li>Special features of meiosis and the importance</li> <li>Abnormalities in cell division.</li> <li>Apoptosis and necrosis</li> </ul>	Lecture	2	Anatomy
1.5. Explain the molecular structure of the cell membrane.	<b>Cell Membrane and Receptors</b> <ul style="list-style-type: none"> <li>Molecular structure of the cell membrane.</li> <li>Importance of proteins, carbohydrates and cholesterol in cell membrane.</li> </ul>	Lecture	2	Biochemistry
1.6. Describe the mechanisms of membrane transport systems.  1.7. Demonstrate the clinical significance related to transport mechanisms.	<b>Transport across membranes</b> <ul style="list-style-type: none"> <li>Transport mechanisms across membranes.</li> <li>Active, passive and secondary active transport.               <ol style="list-style-type: none"> <li>simple diffusion- voltage gated channels and ligand gated channels</li> <li>Endocytosis &amp; exocytosis - Primary active and secondary active</li> <li>Na<sup>+</sup>/ K<sup>+</sup>ATPase pump and its importance</li> <li>Ionophores</li> </ol> </li> <li>The biochemical importance of the composition of the oral rehydration solution.</li> <li>Clinical applications of transport systems and inhibitors of transport systems.</li> </ul>	Lecture	4	Biochemistry

1.8.Describe the structure and functions of cytoskeletal filaments	<b>Cytoskeleton</b> <ul style="list-style-type: none"> <li>Structure and functions of actin filaments, intermediate filaments and microtubules.</li> <li>Clinical significance in cytoskeleton defects.</li> </ul>	Lecture	2	Biochemistry
1.9.Outline the methods of intracellular communications.  1.10.Explain the mechanism of intra/inter cellular communications.	<b>Functional anatomy of cell</b> <ul style="list-style-type: none"> <li>Endocytosis and Exocytosis and contribution to the cellular function.</li> <li>Forms of intercellular communication</li> <li>Effect of chemical messengers (including second messengers) for cellular physiology.</li> </ul>	Lecture	2	Physiology
1.11.Demonstrate the mechanisms of physiological buffering systems	<b>pH and buffers</b> <ul style="list-style-type: none"> <li>Significance of buffering action, buffering capacity and buffering range</li> <li>Henderson-Hasselbalch equation and its applications</li> <li>Iso-electric pH</li> <li>Biological buffering systems</li> </ul> Histidine in buffering action, proteins/hemoglobin buffer system, bicarbonate buffer system, ammonia buffer system and phosphate buffer system <ul style="list-style-type: none"> <li>Metabolic and respiratory acidosis and alkalosis</li> </ul>	Lecture  Practical	2  2	Biochemistry  Biochemistry
1.12.Discuss cellular homeostasis and importance of maintenance.	<b>Homeostasis</b> <ul style="list-style-type: none"> <li>Internal environment and homeostasis</li> <li>Components of a control system and their function.</li> <li>Negative feedback mechanisms and positive feedback mechanisms.</li> </ul>	Lecture	2	Physiology
1.13.Discuss basics of conducting Physiology experiments in human subjects and common measurements	<b>Basic measurements used in physiological experimentation</b> <ul style="list-style-type: none"> <li>Height, weight and BMI measurement</li> <li>Skin fold thickness measurement</li> <li>Bio impedance technique- upper body and lower body</li> <li>Waist/Hip ratio</li> </ul>	Practical	2	Physiology
1.14.Outline the principles of calculating different body fluid compartments and changes with age.  1.15.Explain the mechanism of	<b>Body fluids</b> <ul style="list-style-type: none"> <li>Body fluid compartments.</li> <li>Substances and methods used to measure the fluid compartments.</li> <li>The mechanism of formation of interstitial fluid (starling forces).</li> <li>Definitions of osmolality and osmolarity.</li> <li>Concept of tonicity.</li> </ul>	Lecture	2	Physiology



<p>formation of interstitial fluid.</p> <p>1.16. Discuss the processes that maintain the volume, pH, composition of different body fluid compartments.</p> <p>1.17. Outline the fluid, electrolyte &amp; acid-base imbalance that occur in different body compartments and explain the compensatory mechanisms to maintain homeostasis.</p> <p>1.18. Analyze the metabolic changes in volume and composition in body fluid compartments in diarrhea &amp; vomiting.</p>	<p><b>Clinical applications of body fluids</b></p> <ul style="list-style-type: none"> <li>• Distribution of body fluids with age.</li> <li>• Volume, electrolyte and pH changes occur in fluid compartments in diarrhoea and vomiting.</li> <li>• Regulation of ECF volume and composition.</li> <li>• Homeostatic mechanisms in dehydration, overhydration, hypernatremia, hyponatremia, hyperkalaemia, hypokalaemia, acidosis and alkalosis.</li> <li>• Isotonic, hypotonic, hypertonic solutions with examples.</li> <li>• Importance of rehydration and the fluids used for rehydration.</li> <li>• Clinical conditions related to Dehydration, overhydration, hypernatremia, hyponatremia, hyperkalaemia, hypokalaemia, acidosis and alkalosis</li> </ul>	<p>Lecture</p>	<p>2</p>	<p>Physiology</p>
<p>1.19. Describe the chemical properties and functions of carbohydrates.</p> <p>1.20. Discuss the clinical importance of carbohydrates.</p>	<p><b>Carbohydrates</b></p> <ul style="list-style-type: none"> <li>• Monosaccharides, disaccharides and polysaccharides. - structural properties</li> <li>• Types of glycosidic linkages and their significance to humans.</li> <li>• Clinical significance of carbohydrate derivatives (sugar alcohols, sugar acids, glycoproteins and proteoglycans).</li> <li>• Reducing and non-reducing properties of sugars and its clinical applications.</li> </ul>	<p>Lecture</p>	<p>4</p>	<p>Biochemistry</p>
<p>1.21. Describe the chemical properties and functions of amino acids and proteins.</p> <p>1.22. Evaluate the clinical importance of proteins.</p>	<p><b>Amino acids and proteins</b></p> <ul style="list-style-type: none"> <li>• Classification of amino acids based on their chemical properties.</li> <li>• Zwitterions and iso electric point (pI) of amino acids.</li> <li>• Reactions of amino acids and their clinical importances.</li> <li>• Describe the levels of organization of proteins and forces that stabilize these structures and denaturation of proteins</li> <li>• Structure – function relationship of collagen, myoglobin and haemoglobin.</li> </ul>	<p>Lecture</p>	<p>6</p>	<p>Biochemistry</p>
		<p>Practical</p>	<p>2</p>	<p>Biochemistry</p>

	<ul style="list-style-type: none"> <li>Protein purification and separation and principles of separation methods.</li> </ul>			
1.23. Describe the chemical properties and functions of fatty acids and lipids.	<b>Lipids</b> <ul style="list-style-type: none"> <li>Classification of lipids.</li> <li>Fats and oils</li> <li>Saturated and unsaturated fatty acids</li> <li>Essential fatty acids and their biological importance.</li> <li>Structure, function and clinical significance of lipids derivatives.</li> <li>Structure, function and clinical significance of cholesterol and its derivatives.</li> <li>Lipids in blood grouping.</li> </ul>	Lecture	4	Biochemistry
1.24. Evaluate the clinical importance of fatty acids and lipids.		Practical	2	Biochemistry
1.25. Describe the chemical properties and functions of nucleotides and nucleic acids.	<b>Nucleic acids</b> <ul style="list-style-type: none"> <li>Structures, functions and properties nucleic acids.</li> <li>DNA replication and packaging.</li> <li>DNA repair mechanisms and the function and importance of telomerase.</li> <li>Explain connection of telomerase to cellular aging and apoptosis.</li> <li>Nucleotides as drugs.</li> </ul>	Lecture	6	Biochemistry
1.26. Evaluate the clinical importance of nucleotides and nucleic acids.				
1.27. Describe the central dogma of life.	<b>Storage and Expression of Genetic information</b> <ul style="list-style-type: none"> <li>Gene, genetic code gene expression and regulations.</li> <li>Protein biosynthesis process.</li> <li>Post transcriptional and post translational modifications and their significance.</li> <li>Amino acyl tRNA-synthetase consider as the 2nd genetic code.</li> <li>Chaperones in protein folding.</li> <li>Genetic mutations, protein misfolding and their clinical significance.</li> </ul>	Lecture	6	Biochemistry

<p>1.28. Define the basic terms used in human genetics</p> <p>1.29. Identify the clinical applications in genomic medicine</p>	<p><b>Introduction to Human Genetics</b></p> <ul style="list-style-type: none"> <li>• Basic terminology used in human genetics</li> <li>• Clinical applications of genomic technologies in genomic medicine.</li> </ul>	Lecture	1	Anatomy
<p>1.30. Describe the structure and organization of a chromosome</p> <p>1.31. Identify types of cytogenetic tests and the genetic basis for key laboratory steps</p>	<p><b>Structure &amp; Function of Chromosome</b></p> <ul style="list-style-type: none"> <li>• Structure and organization of a chromosome.</li> <li>• Types of cytogenetic tests.</li> <li>• Procedure in chromosome culture and karyotyping.</li> </ul>	Lecture	2	Anatomy
<p>1.32. Evaluate the clinical features and underlying karyotypic abnormalities associated with numerical and structural chromosomal disorders.</p>	<p><b>Chromosome Abnormalities</b></p> <ul style="list-style-type: none"> <li>• Clinical features and the karyotypes of abnormalities in chromosome number. (Polyploidy, Aneuploidy, Monosomy, Trisomy, Mosaicism)</li> <li>• Clinical features and the karyotypes of abnormalities in chromosome structure (Translocations, Inversions, Deletions, Duplications, Ring chromosomes, Isochromosomes)</li> </ul>	Lecture	2	Anatomy
<p>1.33. Describe the organization of a gene and the human genome</p> <p>1.34. Outline types of molecular genetic tests</p>	<p><b>Genes &amp; Human Genome</b></p> <ul style="list-style-type: none"> <li>• Organization of a gene (Intron, Exon)</li> <li>• Organization of the human genome</li> <li>• Structure and function of mitochondrial DNA.</li> <li>• Types of molecular genetic tests</li> </ul>	Lecture	2	Anatomy

<p>1.35.Describe the types of inheritance patterns and additional genetic mechanisms that have implications on inheritance patterns</p> <p>1.36.Construct pedigrees to interpret inheritance patterns</p>	<p><b>Patterns of Inheritance</b></p> <ul style="list-style-type: none"> <li>Terminology: Homozygous, Heterozygous, Dominant Trait, Recessive Trait, Intermediate Trait</li> <li>Pedigree drawing</li> <li>Features of patterns of inheritance types <ul style="list-style-type: none"> <li>i. Autosomal dominant inheritance</li> <li>ii. Autosomal recessive inheritance</li> <li>iii. X-Linked dominant inheritance</li> <li>iv. X- Linked recessive inheritance</li> <li>v. Y-Linked inheritance</li> <li>vi. Mitochondrial inheritance</li> </ul> </li> <li>Additional genetic mechanisms and their implications in inheritance patterns <ul style="list-style-type: none"> <li>i. Triplet Repeat Expansions</li> <li>ii. Anticipation</li> <li>iii. Imprinting</li> <li>iv. Uni-parental Disomy</li> <li>v. Multifactorial or Polygenic Inheritance</li> </ul> </li> </ul>	Lecture	2	Anatomy
<p>1.37.Describe the enzyme structure, function, mechanisms, and factors affecting activity, including inhibition and regulation.</p> <p>1.38.Apply enzyme knowledge in drug development and clinical diagnosis.</p> <p>1.39.Analyze enzyme kinetic data.</p>	<p><b>Enzymes</b></p> <ul style="list-style-type: none"> <li>Properties of enzyme.</li> <li>Mechanisms of enzymes actions (lock and key and induced fit models).</li> <li>Factors that affect enzyme activity (cofactors and coenzymes).</li> <li>Enzyme kinetics.</li> </ul> <p>Km and Vmax values and different types of inhibitions using Michaelis- Menten and Line-Weaver and Burkplots.</p> <ul style="list-style-type: none"> <li>Enzyme inhibition and types of inhibitions. (competitive, non- competitive, uncompetitive and suicide inhibition).</li> <li>Regulation of enzyme activities (induction, repression, allosteric modulation and covalent modification).</li> <li>Use of enzymes and inhibitors as drugs.</li> <li>Enzymes in clinical diagnosis.</li> </ul>	<p>Lecture</p> <p>Practical</p>	<p>6</p> <p>4</p>	<p>Biochemistry</p> <p>Biochemistry</p>
<p>1.40.Classify hormones by chemical structure and function, and explain their mechanisms of action and receptor interactions.</p> <p>1.41.Analyze the role of second messengers in hormone signaling and their clinical significance.</p>	<p><b>Hormones</b></p> <ul style="list-style-type: none"> <li>Classification of hormones based on their chemical structure and functions.</li> <li>Hormone receptors, their mechanism of action and clinical importance.</li> <li>Second messengers in hormone signal transduction and clinical importance.</li> </ul>	Lecture	4	Biochemistry

1.42. Describe the structure and function of epithelial tissue and glandular tissue	<b>Epithelia &amp; Glands</b> <ul style="list-style-type: none"> <li>• Microscopic structure of the epithelial tissue.</li> <li>• Basis of classification of epithelia and the functions.</li> <li>• Structure of basement membrane and its functions.</li> <li>• Basic components of exocrine glandular tissue.</li> <li>• Nature and mechanism of secretions of glandular tissue secretion.</li> <li>• Features of endocrine tissue.</li> </ul>	Lecture	2	Anatomy
1.43. Discuss the elements of the connective tissues.  1.44. Describe structural features of connective tissues and their function.  1.45. Explain the formation of connective tissue elements and connective tissues.	<b>Connective Tissue</b> <ul style="list-style-type: none"> <li>• Basic organization of connective tissue</li> <li>• Types of cells in connective tissue and their function</li> <li>• Components of Intercellular matrix and supporting framework</li> <li>• Types of fibres and synthesis of collagen</li> </ul> <b>Bone &amp; Cartilage</b> <ul style="list-style-type: none"> <li>• Types of skeletal tissue and functions</li> </ul> <b>Cartilage</b> <ul style="list-style-type: none"> <li>• Constituents of cartilage.</li> <li>• Cartilage formation</li> <li>• Types of cartilage, and their distribution histological differences and functions.</li> </ul> <b>Bone</b> <ul style="list-style-type: none"> <li>• Types of bone.</li> <li>• Macroscopic structure of a long bone.</li> <li>• Types of lamellar bone and their features.</li> <li>• Cells of bone.</li> <li>• Structure of an osteone.</li> <li>• Stages in bone formation.</li> <li>• Ossification -types of ossification, difference between intramembranous and endochondral ossification</li> <li>• In growth of a long bone -- Primary ossific centre, Secondary (epiphyseal) centre, Epiphyseal plate and its layers, Diaphysis, Epiphyseal line, Growing end.</li> </ul>	Lecture	2	Anatomy
1.46. Explain the structure and function of joints.  1.47. Demonstrate the clinical and functional relevance of joints in movement and stability.	<b>Joints of the Human Body</b> <ul style="list-style-type: none"> <li>• Classification of joints based on their structure and function.</li> <li>• Characteristic features of each type of joint, including their anatomical structure, range of motion, and mechanical properties.</li> <li>• Clinical and functional relevance of joints in movement and stability.</li> </ul>	Lecture	1	Anatomy

<p>1.48. Describe the body planes and types of movements</p> <p>1.49. Analyze the importance of body planes in movements and their clinical applications.</p>	<p><b>Body Planes &amp; Type of Movements</b></p> <ul style="list-style-type: none"> <li>Types of body planes and movements</li> <li>Clinical significance of body planes</li> </ul>	Lecture	1	Anatomy
<p>1.50. Describe the microscopic structure of a neuron, relating to its function in the central and peripheral nervous tissue.</p>	<p><b>Microscopic Anatomy of the Nerve Tissue</b></p> <ul style="list-style-type: none"> <li>Organization of the nervous system.</li> <li>Microscopic structure and functions of neuron.</li> <li>Types of neurons.</li> <li>Structure and functions of other cells in nerve tissue.</li> <li>Form and structure of a synapse.</li> <li>Structure of a nerve fibre -myelinated and non-myelinated</li> <li>Formation of myelin sheath.</li> <li>Organization of a peripheral and the fascial coverings.</li> <li>Structure and function of a ganglion.</li> </ul>	Lecture	2	Anatomy
<p>1.51. Distinguish between chemical and electrical transmissions at synapses.</p> <p>1.52. Describe structure and function of the neuromuscular junction.</p> <p>1.53. Describe the chemical &amp; electrical mechanism of synaptic transmission.</p>	<p><b>Excitable tissue - Nerve</b></p> <ul style="list-style-type: none"> <li>Resting membrane potential.</li> <li>Changes in ionic channels that underlie the action potential.</li> <li>Impulse propagation in unmyelinated and myelinated neurons.</li> <li>Orthograde and retrograde axonal transport.</li> <li>Chemical and electrical transmissions at synapses.</li> <li>Describe the neuromuscular junction, and explain how action potentials in the motor neuron at the junction</li> </ul> <p><b>Neurotransmitters</b></p> <ul style="list-style-type: none"> <li>Major types of neurotransmitters</li> <li>Steps involved in the biosynthesis, release, action and removal from the synaptic cleft of the major neurotransmitters</li> <li>Types of receptors for amino acids, acetylcholine monoamines, ATP, opioids, nitric oxide, and cannabinoids</li> <li>Endogenous opioid peptides, their receptors, and their functions</li> </ul>	<p>Lecture</p> <p>Lecture</p>	<p>2</p> <p>2</p>	<p>Physiology</p> <p>Physiology</p>
<p>1.54. Describe the location and pathways of sympathetic and parasympathetic neurons, including neurotransmitter release and receptor</p>	<p><b>Autonomic nervous system.</b></p> <ul style="list-style-type: none"> <li>Sympathetic and parasympathetic neurons. <ul style="list-style-type: none"> <li>Location of the cell bodies and axonal trajectories of preganglionic and postganglionic neurons.</li> <li>Neurotransmitters released by the preganglionic autonomic neurons, postganglionic neurons and adrenal</li> </ul> </li> </ul>	Lecture	2	Physiology

types on autonomic ganglia.  1.55. Analyze the functions of the sympathetic and parasympathetic nervous systems and how drugs can alter autonomic transmission.	<p>medullary cells.</p> <ul style="list-style-type: none"> <li>- Types of receptors on autonomic ganglia.</li> <li>• Drugs to alter the transmission.</li> <li>• Functions of the sympathetic and parasympathetic nervous systems.</li> </ul>			
1.56. Describe the microscopic features of the muscle tissue and relate to its function.	<p><b>Microscopic Structure of the Muscle Tissue</b></p> <ul style="list-style-type: none"> <li>• Structure and functions of muscle tissue.</li> <li>• Adaptation for contraction and movement.</li> <li>• Muscle types</li> <li>• Structure of skeletal muscle. <ul style="list-style-type: none"> <li>- Arrangement of fascia</li> <li>- Microscopic structure of a muscle fibre and the arrangement of myofibrils and myofilaments.</li> <li>- Tubular system and its function.</li> </ul> </li> <li>• Structural and functional unit of a muscle.</li> <li>• Innervation of muscle.</li> <li>• Structure of the motor end plate and the muscle spindle</li> <li>• Structure of the smooth muscle</li> <li>• Structure of the cardiac muscle and adaptation to its function.</li> </ul>	Lecture	2	Anatomy
1.57. Discuss the excitation, contraction coupling of skeletal muscle.  1.58. Analyze the electrical and mechanical events in muscle tissues.	<p><b>Muscle contraction</b></p> <ul style="list-style-type: none"> <li>• Molecular and electrical makeup of the muscle cell excitation-contraction coupling</li> <li>• Elements of the sarcomere that underlie striated muscle contraction.</li> <li>• Role(s) of <math>\text{Ca}^{2+}</math> in skeletal, cardiac and smooth muscle contraction.</li> <li>• Muscle cell diversity and function.</li> </ul>	Lecture	2	Physiology
1.59. Describe the process of fertilization 1.60. Explain the process of implantation and identify its abnormal sites	<p><b>Fertilization &amp; Implantation</b></p> <ul style="list-style-type: none"> <li>• Structure of a mature ovum and sperm.</li> <li>• Fertilization and subsequent embryological events</li> <li>• Site of fertilization and abnormal sites</li> <li>• Process of implantation</li> <li>• Abnormal sites of implantation and the possible clinical complications</li> </ul>	Lecture	2	Anatomy
1.61. Describe the embryological development during the second week after fertilization.	<p><b>Second Week of Development</b></p> <ul style="list-style-type: none"> <li>• Bilaminar embryo.</li> <li>• Position of the amniotic cavity and yolk sac.</li> <li>• Changes in the trophoblast</li> <li>• Formation of the extraembryonic mesoderm, the extraembryonic coelom and the connecting stalk.</li> </ul>	Lecture	2	Anatomy
1.62. Describe the	<b>Third Week of Development</b>	Lecture	2	Anatomy

embryological development during the third week after fertilization.	<ul style="list-style-type: none"> <li>• Formation of the three germ layers.</li> <li>• Distribution of the mesoderm in various parts of the embryonic disc</li> <li>• Cardiogenic area, the septum transversum, the lateral mesoderm, the prechordal plate, cloacal membrane.</li> <li>• Formation of the notochord.</li> <li>• Formation of the neural tube.</li> <li>• Differentiation of the mesoderm into paraxial, intermediate and lateral plate mesoderm and the formation of the intraembryonic coelom.</li> <li>• Early differentiation of blood vessels and the establishment of a primitive circulation</li> <li>• Differentiation of the trophoblast and identify the stages in the formation of the chorionic villi</li> <li>• Formation of the placenta</li> <li>• Connecting stalk between the developing placenta and the embryo.</li> </ul>			
1.63. Describe the embryological development during the embryonic period	<b>Embryonic Period</b> <ul style="list-style-type: none"> <li>• Formation of the curved embryo</li> <li>• Changes result from the head fold, tail folds and lateral folds.</li> <li>• Formation of the primitive umbilicus, primitive gut and the extraembryonic coelom.</li> <li>• Somites and notochord and the formation of the axial skeleton</li> <li>• Derivatives of the three germ layers.</li> <li>• Extent of the foregut, midgut and hindgut</li> <li>• Neural tube and derivatives of the neural crest cells.</li> <li>• Abnormalities associated with the development of the central nervous system.</li> </ul>	Lecture	2	Anatomy
1.64. Explain the embryological development of the chorion and placenta  1.65. Apply the knowledge on foetal membranes to understand twin pregnancies	<b>Chorion &amp; Placenta</b> <ul style="list-style-type: none"> <li>• Chorion and the chorionic cavity</li> <li>• Chorionic villi and the formation of the early placenta</li> <li>• Early changes in the trophoblast.</li> <li>• Formation and functions of the placenta. <ul style="list-style-type: none"> <li>- Blood circulation, external appearance and abnormalities.</li> </ul> </li> <li>• Chorionic villi and the placental barrier- intervillous space decidua, decidual septa, cotyledons, villus tree, stem villi</li> <li>• Foetal membranes, their development and functions.</li> <li>• Twinning: monozygotic twins, dizygotic twins</li> </ul>	Lecture	2	Anatomy



## 3.2 Blood and Immune Module

Module code	Year	Semester	Credit
MEBS-1-1-2-3	01	01	03

### Introduction

The blood and immune system module is designed to provide you with a comprehensive understanding of the fundamental concepts surrounding the blood and immune systems, essential areas in medical practice. Mastering these topics will equip the students with the knowledge needed to recognize, diagnose, and manage a variety of haematological and immunological conditions. Throughout this module, you will explore the structure and function of blood, its components, and the complex mechanisms involved in haemostasis. You will also delve into the immune system's defense mechanisms, learning how the body protects itself from infections and other threats. By engaging with theoretical content, practical sessions, and diagnostic techniques, you will develop the skills necessary to interpret haematological tests, perform blood groupings, and understand the clinical implications of blood and immune system disorders. This module aims not only to build a solid foundation in these areas but also to cultivate your ability to apply this knowledge in clinical practice, ensuring your preparedness for real-world healthcare scenarios.

### Module Committee

<b>Module Coordinator</b>	Dr. Kaushalya Kulathunga – Head/ Department of Physiology
<b>Committee members</b>	Dr. Joachim Perera – Consultant for Department of Anatomy Prof. M.N. Wickramaratne - Professor/Department of Biochemistry Dr. Irosha Nicholas – Basic Sciences Stream Coordinator, Head /Department of Biochemistry Dr. Chamalika Weerakoon - Head/ Department of Anatomy Dr. Amal Wageesha – Senior Lecturer / Department of Biochemistry Dr. Sumeth Perera - Senior Lecturer / Department of Biochemistry Dr. Yasas Kolambage – Lecturer / Department of Anatomy Ms. Nadeesha Nilmini - Lecturer / Department of Biochemistry

### Module Learning Outcomes

At the end of the Blood and Immune Module, the student should be able to:

1. explain the structure and function of blood and its components.
2. outline the mechanisms of haemostasis in the body.
3. conduct and interpret basic haematological tests.
4. perform a blood grouping test and understand the consequences of mismatched blood.
5. describe the microscopic structure of lymphatic organs.
6. describe the functions of a normal immune system.
7. apply the knowledge acquired to explain the altered physiology, biochemistry, and anatomy associated with common hematological disorders.

## Course details with Intended Learning Outcome (ILOs)

Intended Learning Outcomes [ILOs]	Content Outline	T/L Activity	Duration (Hours)	Department
<p>2.1. Describe the components of blood and lymph, their origins, and the role</p> <p>2.2. Outline the functions of blood</p> <p>2.3. Analyze the role of colony-stimulating factors and growth inducers in blood cell formation and regulation.</p>	<p><b>Introduction to Blood</b></p> <ul style="list-style-type: none"> <li>Major components of blood</li> <li>Functions of blood</li> <li>Constituents of plasma and functions of plasma proteins</li> <li>Origin of blood cells from the pluripotent stem cell</li> <li>Function of colony stimulating factors and growth inducers</li> <li>Sites of production of blood cells in the fetus and adult</li> </ul>	Lecture	2	Physiology
<p>2.4. Describe main plasma proteins, their functions, and diagnostic value.</p> <p>2.5. Interpret serum electrophoretic patterns in clinical conditions.</p>	<p><b>Plasma Proteins</b></p> <ul style="list-style-type: none"> <li>Main plasma proteins.</li> <li>The diagnostic values of plasma proteins.</li> <li>Serum electrophoretic patterns in diagnosing clinical conditions and interpret laboratory reports.</li> </ul>	Lecture	2	Biochemistry
<p>2.6. Describe iron absorption, transport, and loss in the body.</p> <p>2.7. Apply knowledge of iron metabolism to understand the stages of anemia and the biochemical markers used to diagnose it.</p>	<p><b>Iron Metabolism</b></p> <ul style="list-style-type: none"> <li>Iron sources Exogenous Endogenous</li> <li>Factors that influence the absorption of dietary iron and explain their mode of action.</li> <li>Iron absorption, transport and loss.</li> <li>Diseases related to iron overload and deficiency.</li> <li>Biochemical markers (TIBC, BI, PS, ferritin) and normal values.</li> </ul>	Lecture	2	Biochemistry
<p>2.8. Discuss Hemoglobin Structure and Function</p>	<p><b>Hemoglobin Synthesis and Porphyrin</b></p> <ul style="list-style-type: none"> <li>Structure and distribution of heme in the body</li> <li>Hemoglobin metabolism.</li> </ul>	Lecture	2	Biochemistry
<p>2.9. State the sites of synthesis of erythropoietin and explain its role in the production of RBC's</p> <p>2.10. Explain the regulation of erythropoiesis</p> <p>2.11. Explain the Structure and Function</p>	<p><b>Hematopoiesis and Red blood cell</b></p> <ul style="list-style-type: none"> <li>Erythropoiesis</li> <li>Role of nutrients (Fe, Vit B12, Folate) and hormones in erythropoiesis</li> <li>Role of erythropoietin</li> <li>Regulation of erythropoiesis including role of hypoxia</li> <li>Structure and function of RBC</li> <li>Haemoglobin molecule and its functions</li> <li>RBC Count (A)</li> <li>RBC indices (MCV, MCH, MCHC) (A)</li> </ul>	<p>Lecture</p> <p>Practical</p>	<p>2</p> <p>2</p>	<p>Physiology</p> <p>Physiology</p>

<p>of RBCs and Hemoglobin</p> <p>2.12. Conduct a RBC count</p> <p>2.13. Discuss what RBC calculate these from given blood count results</p>				
<p>2.14. Define anaemia and classification</p> <p>2.15. List the common symptoms and signs of anaemia</p> <p>2.16. Explain the physiological basis of anemias of different origins</p> <p>2.17. Analyze the changes in commonly used haematological and other laboratory investigations in the different types of anaemia</p>	<p><b>Anaemia</b></p> <ul style="list-style-type: none"> <li>• Definition of anaemia</li> <li>• Anaemia Classification- Morphological &amp; etiological Classification</li> <li>• Clinical features of anaemia</li> <li>• Basic investigations of anaemia</li> <li>• Red cell parameters in a complete blood count</li> <li>• Classify anaemia morphologically with CBC and blood picture</li> <li>• Reticulocyte count in relation to anaemia</li> <li>• Peripheral blood film(draw)</li> <li>• ESR (A)</li> <li>• Osmotic fragility test and haemoglobin electrophoresis</li> </ul>	<p>Lecture</p> <p>Practical</p>	<p>2</p> <p>2</p>	<p>Physiology</p> <p>Physiology</p>
<p>2.18. Discuss Red Cell Catabolism and Jaundice</p> <p>2.19. Apply the principles of diagnostic techniques to interpret clinical manifestations related to the Red Cell Catabolism</p>	<p><b>Red Cell Catabolism and Jaundice</b></p> <ul style="list-style-type: none"> <li>• Different types of jaundice (hemolytic, intra and extra-hepatic cholestasis).</li> <li>• Transport, hepatic uptake, conjugation and excretion of bilirubin</li> </ul> <p><b>Clinical correlations</b></p> <ul style="list-style-type: none"> <li>• Biochemical basis of <ul style="list-style-type: none"> <li>- Jaundice seen in tissues in hyperbilirubinemia.</li> <li>- Pale colour stool in extra hepatic cholestasis.</li> <li>- Tea coloured urine in hepatitis.</li> <li>- Physiological jaundice.</li> <li>- Bilirubin profile and clinical correlations.</li> </ul> </li> </ul>	Lecture	2	Biochemistry
<p>2.20. Explain the molecular basis of blood groups</p> <p>2.21. Explain the cross matching in blood transfusion</p> <p>2.22. Discuss the clinical significance/applications</p>	<p><b>Blood Grouping</b></p> <ul style="list-style-type: none"> <li>• The physiological basis of blood grouping</li> <li>• The procedure of testing a sample of blood for grouping</li> <li>• The differences between the different blood types</li> <li>• The principles of direct testing and compatibility between blood samples</li> </ul>	Lecture	2	Physiology



<p>2.33.Describe the microscopic structure of lymphoid tissue and organs</p> <p>2.34.Compare and contrast the differences of a primary and secondary lymphoid follicles in the lymph node.</p> <p>2.35.Analyze the features of the red pulp and white pulp of the spleen with its function</p>	<p><b>Microscopic anatomy of the lymphatic system</b>  <b>Cells of the immune system</b></p> <ul style="list-style-type: none"> <li>• Appearance of lymphocytes in peripheral blood.</li> <li>• Lymphocyte subtypes - list the types and the functions of each sub-type.</li> <li>• T and B lymphocyte surface antigens / markers.</li> </ul> <p><b>Lymphatic organs</b></p> <ul style="list-style-type: none"> <li>• The microscopic anatomy of lymphoid organs. <ul style="list-style-type: none"> <li>- Lymph node, Spleen, Tonsils, Mucosa associated lymphoid tissue (MALT) and Thymus (childhood and adult)</li> </ul> </li> <li>• Differences of a primary lymphoid follicle and a secondary lymphoid follicle in the lymph node. <ul style="list-style-type: none"> <li>- Types of lymphocytes.</li> <li>- Histological appearance with H&amp;E stain.</li> <li>- The functional differences.</li> </ul> </li> <li>• Features of the red pulp and white pulp of the spleen <ul style="list-style-type: none"> <li>- Macroscopic appearance.</li> <li>- Microscopic anatomy (histology) in H&amp;E stained sections</li> </ul> </li> </ul>	<p>Lecture</p> <p>Practical</p>	<p>4</p> <p>2</p>	<p>Anatomy</p> <p>Anatomy</p>
<p>2.36.Define immunity</p> <p>2.37.Explain components of innate body defenses</p> <p>2.38.Explain the components of acquired body defenses</p> <p>2.39.Explain primary and secondary immune response</p> <p>2.40.Describe active and passive immunity</p> <p>2.41.Define hypersensitivity and explain briefly type I hypersensitivity reactions</p>	<p><b>Immunity</b></p> <ul style="list-style-type: none"> <li>• Significance of immunity, with respect to defending the body against microbial invaders</li> <li>• Circulating and tissue cell types that contribute to immune and inflammatory responses</li> <li>• Functions of hematopoietic growth factors, cytokines and chemokines</li> <li>• Roles and mechanisms of innate, acquired, humoral and cellular immunity</li> <li>• Basis of inflammatory responses and wound healing</li> </ul>	<p>Lecture</p>	<p>2</p>	<p>Physiology</p>
<p>2.42.Define the structure and function of immunoglobulins</p>	<p><b>Immunoglobulins</b></p> <ul style="list-style-type: none"> <li>• Function and the structure of immunoglobulins.</li> <li>• Variable (V) domains, constant (C) domains, Fc region</li> </ul>	<p>Lecture</p>	<p>2</p>	<p>Biochemistry</p>

<p>2.43.Describe isotype switching in immunoglobulins</p> <p>2.44.Apply knowledge of immunoglobulin structure to understand its function in immune responses.</p>	<ul style="list-style-type: none"> <li>• Structure with the function - antibody-antigen relation.</li> <li>• Isotypes-IgA, IgD, IgE, IgG, and IgM, and different biological properties of the isotypes.</li> <li>• Isotype switching.</li> <li>• Importance of immunoglobulins and their applications.</li> </ul>			
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## 3.3 Cardio-Vascular Module

Module code	Year	Semester	Credit
MEBS-1-1-3-4	01	01	04

### Introduction

The Cardiovascular Module is designed to provide medical students with a comprehensive and integrated understanding of the cardiovascular system, combining key concepts from Anatomy, Physiology, and Biochemistry. As a vital system responsible for maintaining homeostasis and ensuring the circulation of blood, the cardiovascular system plays a crucial role in sustaining organ function and overall health.

Through this module, students will develop a thorough understanding of the heart's structure, including its muscular composition, coverings, blood supply, nerve supply, and embryological development. They will also explore the anatomical relationships between the heart and surrounding thoracic structures, such as major blood vessels and surface landmarks, which are essential for physical examination and diagnostic imaging.

Beyond anatomical knowledge, students will integrate physiological principles to explain normal cardiovascular function and assess how the system responds to physiological demands. Additionally, they will explore the biochemical foundations of atherogenesis, emphasizing the role of lipoproteins in cardiovascular health. By combining these disciplines, the module prepares students to apply foundational science to clinical practice, fostering a deeper understanding of cardiovascular diseases and their management.

### Module Committee

<b>Module Coordinator</b>	Dr. Amal Wageesha – Senior Lecturer/Department of Biochemistry
<b>Committee members</b>	Dr. Joachim Perera – Consultant for Department of Anatomy Prof. M.N. Wickramaratne - Professor/Department of Biochemistry Dr. Irosha Nicholas – Basic Sciences Stream Coordinator, Head /Department of Biochemistry Dr. Kaushalya Kulathunga – Head/Department of Physiology Dr. Chamalika Weerakoon - Head/Department of Anatomy Dr. Sumeth Perera - Senior Lecturer/Department of Biochemistry Dr. Yasas Kolambage – Lecturer/Department of Anatomy Ms. Nadeesha Nilmini – Lecturer/Department of Biochemistry

### Module Learning Outcomes

At the end of the cardiovascular module, the student should be able to:

1. describe the normal structure of the heart, including its musculature, coverings, blood supply, nerve supply, and development.
2. explain the surrounding thoracic structures, surface markings of the heart, and major blood vessels.
3. explain the normal function of the cardiovascular system by integrating basic sciences.
4. analyze the contribution of the function of the cardiovascular system to overall circulatory health.

5. apply knowledge to analyze and explain the alterations in these systems in common clinical scenarios.

## Course details with Intended Learning Outcome (ILOs)

Intended Learning Outcomes [ILOs]	Content Outline	T/L Activity	Duration (Hours)	Department
3.1.Describe the anatomical structures of the mediastinum  3.2.Discuss the clinical relevance of the mediastinal structures	<b>Mediastinum</b> <ul style="list-style-type: none"> <li>Extent and boundaries of the mediastinum.</li> <li>Divisions of the mediastinum</li> <li>Arrangement of structures within each division.</li> <li>Mediastinal structures and their clinical importance.</li> </ul>	Lecture	2	Anatomy
3.3.Describe the gross anatomy of the pericardium and heart	<b>Heart &amp; Pericardium</b> <b>Pericardium</b> <ul style="list-style-type: none"> <li>Fibrous and serous pericardium and its nerve supply and basis of referred pain</li> <li>The basis of retrosternal pain referred to neck, arm, epigastrium</li> <li>The lines of continuity of parietal and serous pericardium</li> <li>The position of the transverse sinus and oblique sinus and major blood vessels in relation to them</li> <li>Locate the site for a pericardial tap in a pericardial effusion</li> </ul> <b>Heart</b> <ul style="list-style-type: none"> <li>Position of borders, surfaces and chambers of the heart</li> <li>Locate the site of palpation of apex beat</li> <li>Position of valves and site of auscultation of heart sounds</li> <li>The direction of enlargement of chambers</li> <li>The origin course and branches of the coronary arteries and areas supplied</li> <li>The effects of coronary artery occlusion to areas of myocardial damage, using case studies.</li> </ul>	Lecture	2	Anatomy
3.4.Describe the anatomy of the arterial and venous systems	<b>Anatomy of the Arterial &amp; Venous Systems</b> <ul style="list-style-type: none"> <li>Plan of the circulatory system</li> <li>The types of arteries, veins, and capillaries and their structural and functional differences.</li> </ul>	Lecture	2	Anatomy



	<ul style="list-style-type: none"> <li>• Collateral circulation, anastomoses, end arteries and their significance with examples</li> <li>• The parts of the aorta and their location in the mediastinum.</li> <li>• The arch of the aorta, including its levels, curvatures, and important relations.</li> <li>• Branches of the aortic arch</li> <li>• The relationship of the phrenic nerve and vagus nerve and recurrent laryngeal nerve to the arch of the aorta</li> <li>• The ligamentum arteriosum and explain the function of the ductus arteriosus in the fetus.</li> <li>• The pharyngeal arch arteries and their derivatives</li> <li>• The embryological basis of PDA, coarctation of aorta, retro-oesophageal right subclavian artery</li> </ul>			
<p>3.5.Describe the coronary circulation &amp; conduction system of the heart</p> <p>3.6.Discuss the clinical relevance of the coronary circulation and conduction abnormalities</p> <p>3.7.Interpret basic diagnostic findings related to the coronary and conduction system disorders</p>	<p><b>Coronary circulation &amp; conduction system of the heart</b></p> <ul style="list-style-type: none"> <li>• The coronary arteries, their branches, and areas of the heart they supply, along with the clinical implications of arterial occlusion.</li> <li>• The components of the heart's conduction system and their roles in maintaining cardiac rhythm.</li> <li>• The relationship between coronary circulation and conduction abnormalities in clinical scenarios.</li> <li>• Basic diagnostic findings (e.g., ECG, imaging) related to coronary and conduction system disorders.</li> </ul>	Lecture	2	Anatomy
3.8.Describe the conduction system of the heart and spread of cardiac excitation within the heart.	<p><b>Electrical Activity of the Heart</b></p> <ul style="list-style-type: none"> <li>• Function of the conduction system of the heart and compare the action potentials in each part</li> <li>• Common cardiac arrhythmias and the processes that produce them</li> </ul>	Lecture	2	Physiology
3.9.Explain the genesis of the ECG wave in relation to its cardiac electrophysiology	<p><b>ECG</b></p> <ul style="list-style-type: none"> <li>• Waves of the ECG, genesis and the relationship of the ECG to the electrical axis of the heart</li> <li>• Placing unipolar and bipolar leads in an adult</li> <li>• Appearance of the normal ECG recording from lead II and explain the waves.</li> <li>• Placing of electrodes and description normal ECG</li> <li>• Calculate heart rate, PR interval and determine the mean electrical axis.</li> </ul>	<p>Lecture</p> <p>Practical</p>	<p>2</p> <p>2</p>	<p>Physiology</p> <p>Physiology</p>

<p>3.10.Describe the surface anatomy of the heart, major arteries, and their clinical relevance.</p> <p>3.11.Apply knowledge of the peripheral vascular system to identify anatomical locations for peripheral pulsations</p> <p>3.12.Interpret radiographic images related to the heart.</p>	<p><b>Surface Marking of the Heart &amp; Peripheral Pulsation</b></p> <ul style="list-style-type: none"> <li>• The surface markings of the heart and major arteries, including their anatomical landmarks and clinical significance.</li> <li>• The areas for heart sounds and explain their relevance to surface anatomy.</li> <li>• Palpate and locate peripheral arterial pulsations and explain their clinical importance.</li> <li>• Radiographic images related to the heart and relate them to clinical practice.</li> </ul>	Lecture	2	Anatomy
		Cadaveric Learning	2	Anatomy
<p>3.13.Describe the microscopic structure of the heart and peripheral vascular system</p> <p>3.14.Compare and contrast the microscopic structures of arteries and veins</p>	<p><b>Microscopic Structure of Heart &amp; Peripheral Vascular System</b></p> <ul style="list-style-type: none"> <li>• Structural organization of the heart</li> <li>• Features of the endocardium</li> <li>• Features of cardiac muscle and their arrangement in the myocardium</li> <li>• Parts of the conducting system and their location</li> <li>• Histological features of the Purkinje fibres</li> <li>• Basic organization of tissue components of a blood vessel</li> <li>• Basis of differentiation of arteries into elastic, muscular and arterioles</li> <li>• Microscopic features of the different types of arteries</li> <li>• The special features of an arteriole and relate them to its function</li> <li>• Capillary circulation</li> <li>• Basis on which capillaries are classified into three types</li> <li>• Structural features of the different types of capillaries</li> <li>• Sites at which these capillaries are found and give their functions</li> <li>• Microscopic structure of the different types of veins</li> <li>• Significance of arterial anastomoses, end arteries, arteriovenous anastomoses</li> </ul>	Lecture	2	Anatomy
		Practical	2	Anatomy
<p>3.15.Explain the Sequential Contraction and Relaxation of the Heart and Its Role in Normal Blood Flow</p> <p>3.16.Discuss the Hemodynamic Changes and Physiological Basis of Cardiac Output</p> <p>3.17.Describe pathophysiology of Heart</p>	<p><b>The Heart as a Pump</b></p> <ul style="list-style-type: none"> <li>• Sequential pattern of contraction and relaxation in the heart results in a normal pattern of blood flow</li> <li>• The pressure, volume and flow changes occur during the cardiac cycle</li> <li>• The basis of arterial pulse</li> <li>• Regulation of cardiac output based on specific physiologic demands</li> <li>• Pumping action of the heart in specific disease states.</li> <li>• Heart failure</li> <li>• Physiological basis</li> </ul>	Lecture	2	Physiology

<p>Failure and Its Clinical Manifestations</p> <p>3.18. Discuss the Hemodynamic, Neuroendocrine, and Cellular Changes in Heart Failure</p>	<ul style="list-style-type: none"> <li>Common clinical manifestations</li> <li>Types - Left/right heart failure - Systolic/diastolic HF - Acute/chronic HF</li> <li>Haemodynamic, neuroendocrine &amp; cellular changes in heart failure</li> </ul>			
<p>3.19. Explain the mechanism of the production of heart sounds</p> <p>3.20. Describe the function of the heart valves and genesis of murmurs &amp; state the timing of the murmurs produced by valvular defects &amp; congenital heart diseases</p>	<p><b>Heart sounds and murmurs</b></p> <ul style="list-style-type: none"> <li>Heart sounds</li> <li>Function of the heart valves &amp; murmurs</li> <li>The timing of the murmurs produced by valvular defects &amp; congenital heart disease</li> </ul>	Lecture	2	Physiology
<p>3.21. Describe the types of blood flow</p> <p>3.22. Describe the relationship between flow, pressure &amp; resistance in the vascular system</p> <p>3.23. Define systolic blood pressure, diastolic blood pressure and mean arterial pressure.</p> <p>3.24. List the variations in blood pressure</p> <p>3.25. Perform a physical examination of the cardiovascular system</p> <p>3.26. Describe the physiological basis of measuring blood pressure</p>	<p><b>Circulatory physiology</b></p> <ul style="list-style-type: none"> <li>Dynamics of blood and lymph flow</li> <li>Biophysical consideration for circulatory physiology</li> <li>Flow, pressure, resistance, viscosity and radius</li> <li>Changes in blood pressure physiological/pathological</li> <li>Artery, capillary and venous circulation</li> </ul>	Lecture	2	Physiology
	<ul style="list-style-type: none"> <li>Physical examination of the cardiovascular system</li> <li>Measuring blood pressure using a sphygmomanometer</li> </ul>	Practical	2	Physiology
<p>3.27. Explain the effects of altered blood flow</p> <p>3.28. Describe the importance of regulation of cardiovascular system and the factors affecting it</p>	<p><b>Cardiovascular Regulatory Mechanisms</b></p> <ul style="list-style-type: none"> <li>The neural regulation of arterial blood pressure and heart rate involves receptors, afferent and efferent pathways, central integration, and effector mechanisms. the effects of CO<sub>2</sub> and hypoxia on the rostral ventrolateral medulla</li> <li>The process of autoregulation contributes to control of vascular caliber</li> </ul>	Lecture	2	Physiology



	<ul style="list-style-type: none"> <li>• Interpretation of lipid profiles.</li> </ul> <p><b>Atherosclerosis and cardiac markers</b></p> <ul style="list-style-type: none"> <li>• Biochemical basis of atherogenesis.</li> <li>• Risk factors for atherosclerosis.</li> <li>• Uses of cardiac markers in the diagnosis of myocardial infarction.</li> <li>• Relationship between homocysteine and atherosclerosis</li> <li>• Interpret laboratory reports.</li> </ul>			
<p>3.36.Explain the oxidative stress and action of anti-oxidants</p> <p>3.37.Describe the impact on balancing the oxidative stress for healthy lifestyle</p>	<p><b>Reactive Oxygen and Nitrogen Species (ROS &amp; RONS)</b></p> <ul style="list-style-type: none"> <li>• ROS and RONS generated within the body.</li> <li>• Neutralizing RONS and role of anti-oxidants. (Vitamin C and E, glutathione)</li> <li>• Effects of RONS to the body and their clinical significances.</li> <li>• Role of RONS against bacteria.</li> </ul>	Lecture	2	Biochemistry
<p>3.38.Define hypertension</p> <p>3.39.List the causes of hypertension</p> <p>3.40.Describe the pathophysiology of hypertension</p> <p>3.41.Explain the physiological basis of the treatment principles in hypertension</p> <p>3.42.List the complications of hypertension</p>	<p><b>Hypertension</b></p> <ul style="list-style-type: none"> <li>• Definition</li> <li>• Causes</li> <li>• Pathophysiology</li> <li>• Treatment principles</li> <li>• Complications</li> </ul>	Lecture	2	Physiology
<p>3.43.Define shock</p> <p>3.44.Describe the major causes of shock and pathophysiology of each one.</p> <p>3.45.Explain the physiological basis of signs and symptoms of shock</p> <p>3.46.Describe the physiological basis of treatment</p> <p>3.47.Explain the short and long-term physiological compensation of shock</p>	<p><b>Shock</b></p> <ul style="list-style-type: none"> <li>• Shock – definition</li> <li>• Causes of shock with examples</li> <li>• Physiological basis of clinical features</li> <li>• Physiological basis of treatment</li> <li>• Physiological compensation</li> </ul>	Lecture	2	Physiology

## 3.4 Respiratory Module

Module code	Year	Semester	Credit
MEBS-1-1-4-2	01	01	02

### Introduction

The Respiratory Module offers a comprehensive exploration of the respiratory system, emphasizing its critical role in gas exchange, homeostasis, and maintaining life. The focus will be on understanding the structural and functional aspects of the lungs, airways, and associated components that enable efficient respiration. You will start with an overview of the anatomy of the respiratory system, exploring the upper and lower airways, the alveoli where gas exchange occurs, and the supportive structures such as the diaphragm and intercostal muscles. We will examine how these components work together to facilitate the mechanics of breathing and ensure oxygen delivery and carbon dioxide removal.

This module places particular emphasis on the gross and microscopic anatomy of the lungs, pleura, and thoracic cavity. Through interactive sessions, group activities, and dissections, you will gain practical insights into the intricate relationships between these structures. Active participation in these activities will enhance your understanding of the respiratory system's dynamic nature. To support your learning, we have integrated diverse resources, including clinical scenarios, imaging techniques, and IT tools that demonstrate real-life applications of respiratory anatomy and physiology. This module also highlights clinical correlations, linking foundational knowledge to its application in diagnosing and managing respiratory conditions.

We aim to inspire your curiosity and deepen your understanding of the respiratory system, equipping you with the knowledge and skills for future clinical practice.

### Module Committee

<b>Module Coordinator</b>	Dr. Yasas Kolambage – Lecturer/Department of Anatomy
<b>Committee members</b>	Dr. Joachim Perera – Consultant for Department of Anatomy Prof. M.N. Wickramaratne - Professor/Department of Biochemistry Dr. Irosha Nicholas –Basic Sciences Stream Coordinator, Head /Department of Biochemistry Dr. Kaushalya Kulathunga – Head/Department of Physiology Dr. Chamalika Weerakoon - Head/Department of Anatomy Dr. Amal Wageesha – Senior Lecturer/Department of Biochemistry Dr. Sumeth Perera - Senior Lecturer/Department of Biochemistry Ms. Nadeesha Nilmini – Lecturer/Department of Biochemistry

### Module Learning Outcomes

At the end of the respiratory module, the student should be able to:

1. describe the normal structure, function and embryological development of the respiratory system

2. apply basic anatomical knowledge to explain the clinical relevance of respiratory health and disease.
3. describe the physiological basis of signs and symptoms of altered structure & function of the respiratory system.
4. interpret the respiratory function test results in the normal and disease states.
5. outline the physiological principles of managing common respiratory disorders.

## Course details with Intended Learning Outcome (ILOs)

Intended Learning Outcome (ILO)	Content Outline	T/L Activity	Duration (Hours)	Department
4.1. Describe the anatomy of the thoracic wall and its role during respiration  4.2. Explain the clinical significance of intercostal space	<b>Thoracic Wall and Its Movements</b> <ul style="list-style-type: none"> <li>• Features of bony thoracic cage and the arrangement of component bones</li> <li>• Features of typical rib</li> <li>• Boundaries of the inlet and outlet</li> <li>• Joints and ligaments of the thoracic cage</li> <li>• Mechanisms of increase in diameters of thoracic cage during respiration</li> <li>• Intercostal space and its clinical significance</li> <li>• Groups of muscle attached to the thoracic cage</li> </ul>	Lecture	1	Anatomy
4.3. Describe the anatomy of the diaphragm and its role during respiration	<b>Diaphragm</b> <ul style="list-style-type: none"> <li>• Attachments of the diaphragm and its nerve supply</li> <li>• Origins of the diaphragm from the vertebrae, ribs and lumbar fascia</li> </ul>	Lecture	1	Anatomy
4.4. Describe the basic anatomical structure of the nasal cavity and paranasal sinuses  4.5. Interpret the radiographs of the paranasal sinuses	<b>Basic Structure of the Nasal Cavity</b> <ul style="list-style-type: none"> <li>• Structure of the external nose, nasal cavity, paranasal sinuses and adaptation to their functions</li> <li>• Bony walls and the related structures</li> <li>• Appearance of the lateral wall and the openings of the paranasal sinuses</li> <li>• Olfactory region</li> </ul>	Lecture	2	Anatomy
4.6. Describe the basic anatomical structure of the larynx	<b>Basic Structure of the Larynx</b> <ul style="list-style-type: none"> <li>• Cartilages of the larynx, the membranes, muscles, Rima glottis and its function in respiration and phonation</li> </ul>	Lecture	2	Anatomy
4.7. Describe the gross anatomy of the trachea, bronchial tree, lungs and plural cavity.  4.8. Explain the clinical relevance of the trachea, bronchial tree, lungs and plural cavity.	<b>Trachea, Lungs and Pleura</b> <b>Trachea and bronchi</b> <ul style="list-style-type: none"> <li>• Trachea in neck and thorax</li> <li>• Level of bifurcation and direction and length of bronchi</li> <li>• Plan of the bronchial tree and the structural and related functional changes in the wall</li> </ul>	Lecture	2	Anatomy

	<ul style="list-style-type: none"> <li>• Clinical relevance of the tracheal bifurcation</li> </ul> <p><b>Lungs</b></p> <ul style="list-style-type: none"> <li>• External features of the lungs, the fissures and the lobes</li> <li>• Location of the lobes in pleural cavity on the basis which to choose the site of auscultation of breath sounds of each lobe</li> <li>• Structures related to each lung</li> <li>• Bronchopulmonary segment and its significance in postural drainage resection of lung and diagnostic procedures</li> <li>• Microscopic structure of the conducting and respiratory parts</li> <li>• Structure of an alveolus and the layers of the alveolar membrane</li> <li>• Movements of the thoracic cage in respiration</li> <li>• X - ray of the chest</li> <li>• Embryological basis of tracheoesophageal fistulae</li> <li>• Arrangement of lymph nodes</li> <li>• Development of pleural cavity and lung</li> <li>• Functional differentiation of lung</li> </ul> <p><b>Pleural cavity</b></p> <ul style="list-style-type: none"> <li>• Extent of pleural cavity and lines of pleural reflection and the surface projection of pleura and lungs</li> <li>• Pleural recesses</li> <li>• Anatomical relations of the pleural cavity</li> <li>• Nerve supply of parietal and visceral pleura and the sites of referred pain</li> <li>• X-ray appearance of a normal lung and pleural cavity</li> <li>• Radiological appearance in a pleural effusion, pneumothorax and haemothorax</li> <li>• Anatomical basis for choice of a site for pleural tap</li> <li>• <i>Case report – pleural effusion</i></li> </ul>			
<p>4.9. Discuss the lung mechanics involved in respiration</p> <p>4.10. Compare and contrast pulmonary and systemic circulations</p> <p>4.11. Outline the basic defence and metabolic functions of the lungs.</p>	<p><b>Lung Mechanics</b></p> <ul style="list-style-type: none"> <li>• Passages through which air passes from the exterior to the alveoli and the cells that line each of them</li> <li>• Major muscles involved in respiration and state the role of each</li> <li>• Lung compliance and airway resistance</li> <li>• Pulmonary and systemic circulations, and some major differences between them</li> </ul>	Lecture	2	Physiology



	<ul style="list-style-type: none"> <li>Basic lung defense and metabolic functions</li> </ul>			
<p>4.12. Define the basic lung volumes, capacities, and partial pressures</p> <p>4.13. To identify the volumes &amp; capacities on a spiograph</p>	<p><b>Lung Volumes and Capacities</b></p> <ul style="list-style-type: none"> <li>Basic measures of lung volume and approximate values for each in a normal adult</li> <li>FEV1 / FVC ratios in differentiating obstructive from restrictive airway diseases</li> <li>Normal flow volume loop</li> <li>Volume time curve and its changes in obstructive and restrictive airway diseases</li> </ul>	Lecture	2	Physiology
4.14. Describe the microscopic structure of the respiratory tract	<p><b>Microscopic Structure of Respiratory Tract</b></p> <ul style="list-style-type: none"> <li>Plan of the respiratory system</li> <li>Principal structural features</li> <li>Features of the respiratory epithelium and its relation to function</li> <li>Structural framework</li> <li>Mechanism for conditioning of inspired air</li> <li>Wall of the trachea</li> <li>Structure from the main bronchus to terminal bronchiole and its adaptation to function</li> <li>Structure of an alveolus and the features of the alveolar epithelium</li> <li>Components of the alveolar membrane</li> <li>Structural adaptation of the cells to its function</li> <li>Respiratory distress syndrome</li> <li>Capillary endothelial cells</li> </ul>	<p>Lecture</p> <p>Practical / Demonstration</p>	<p>2</p> <p>2</p>	<p>Anatomy</p> <p>Anatomy</p>
<p>4.15. Explain the mechanisms of gas exchange and transport of oxygen and carbon dioxide in the body.</p> <p>4.16. Discuss different types of hypoxia and factors affecting haemoglobin affinity for oxygen.</p> <p>4.17. Describe acid-base imbalances, their causes, compensatory responses, and the effects of altered CO2 levels.</p>	<p><b>Gas Exchange and Transport</b></p> <ul style="list-style-type: none"> <li>Manner in which O2 flows “downhill” from the lungs to the tissues and CO2 flows downhill from the tissues to the lungs</li> <li>Important factors affecting the affinity of haemoglobin for O2 and the physiologic significance of each</li> <li>Reactions that increase the amount of CO2 in the blood and draw the CO2 dissociation curve for arterial and venous blood</li> <li>Alkalosis and acidosis and list typical causes and compensatory responses to each</li> <li>Hypoxia and differences in different types of hypoxias</li> <li>Effects of hypercapnia and hypocapnia, and give examples of conditions that can cause them</li> </ul>	Lecture	2	Physiology

<p>4.18. Describe the development of the respiratory system</p> <p>4.19. Discuss the embryological basis of congenital defects related to respiratory system.</p>	<p><b>Development of the respiratory system</b></p> <ul style="list-style-type: none"> <li>• Formation of respiratory diverticulum and their branching</li> <li>• Airway formation and vascularisation</li> <li>• Alveolar formation and surfactant production</li> <li>• Lung maturation</li> <li>• Oesophageal Atresia and Tracheoesophageal Fistula</li> </ul>	Lecture	2	Anatomy
<p>4.20. Outline the surface markings related to the lungs and pleura</p>	<p><b>Surface Marking of the Lungs and Pleura</b></p> <ul style="list-style-type: none"> <li>• The technique of counting ribs</li> <li>• Surface markings of the lungs and their lobes</li> <li>• Surface markings of the pleural cavity</li> </ul>	Lecture	1	Anatomy
<p>4.21. Identify the important anatomical structures in the respiratory system and their relationships</p> <p>4.22. Demonstrate a comprehensive understanding of the anatomy of the respiratory system</p>	<p><b>Anatomy of the Respiratory System</b></p> <ul style="list-style-type: none"> <li>• Thoracic wall and intercostal space</li> <li>• Nasal cavity and paranasal sinuses</li> <li>• Lungs, airways and pleural cavity</li> <li>• Larynx and vocal cords</li> </ul>	Cadaveric Learning	2	Anatomy
<p>4.23. Identify normal radiological anatomy of the respiratory system</p> <p>4.24. Interpret imaging features of common respiratory system pathologies and their clinical significance.</p>	<p><b>Thoracic Imaging</b></p> <ul style="list-style-type: none"> <li>• Radiological techniques commonly used for thoracic imaging.</li> <li>• Normal Imaging Appearance of lungs, airways, mediastinum, and diaphragm in standard projections</li> <li>• Common Pathological Findings: Pneumonia, tumours, pneumothorax, pleural effusions etc.</li> </ul>	Lecture	2	Anatomy
<p>4.25. Describe the neural regulation of respiration</p> <p>4.26. Discuss ventilatory responses to changes in CO<sub>2</sub> and O<sub>2</sub> concentrations and nonchemical factors affecting respiration.</p> <p>4.27. Analyse the effects of exercise on ventilation and oxygen exchange in tissues.</p> <p>4.28. Explain the phenomenon of periodic breathing and its relevance in disease states.</p>	<p><b>Regulation of Respiration</b></p> <ul style="list-style-type: none"> <li>• Pre-Botzinger complex and describe its role in producing spontaneous respiration</li> <li>• Location and probable functions of the dorsal and ventral groups of respiratory neurons, the pneumotaxic center, and the apneustic center in the brainstem</li> <li>• Specific respiratory functions of the vagus nerves and the respiratory receptors in the carotid body, the aortic body and the ventral surface of the medulla oblongata</li> <li>• Ventilatory responses to increased CO<sub>2</sub> concentrations in the inspired air</li> <li>• Ventilatory responses to decreased O<sub>2</sub> concentrations in the inspired air</li> </ul>	Lecture	2	Physiology

	<ul style="list-style-type: none"> <li>• Effects of each of the main nonchemical factors that influence respiration</li> <li>• Effects of exercise on ventilation and O<sub>2</sub> exchange in the tissues</li> <li>• Periodic breathing and explain its occurrence in various disease states</li> </ul>			
4.29. Describe the - Physiological adjustments at high altitudes, Space. Physiological adjustments in diving	<b>Respiratory System Adjustments in health and disease</b> <ul style="list-style-type: none"> <li>• Ventilatory changes in acid-base balance</li> <li>• Physiological and respiratory changes that occur in high altitude</li> <li>• Compensatory mechanisms in hypoxia</li> <li>• Respiratory changes in pregnancy</li> <li>• Changes in respiration with diving and drowning</li> <li>• Respiratory physiology of decompression sickness, asphyxia and periodic breathing</li> </ul>	Lecture	2	Physiology
4.30. Explain the types and causes of hypoxia  4.31. Explain the compensatory mechanisms in the body in hypoxia  4.32. Define apnoea	<b>Hypoxia and oxygen therapy</b> <ul style="list-style-type: none"> <li>• Define hypoxia</li> <li>• Types &amp; causes of hypoxias</li> <li>• Compensatory mechanisms of acute &amp; chronic hypoxias</li> <li>• Diffusion of O<sub>2</sub> to the tissues</li> <li>• Types &amp; causes of apnoea</li> <li>• Oxygen therapy in different types of hypoxia</li> <li>• Hyperbaric Oxygen Therapy (HBOT)</li> <li>• Complications of HBOT</li> </ul>	Lecture	2	Physiology
4.33. Conduct a basic systematic respiratory examination, demonstrating inspection, palpation, percussion, and auscultation.	<b>Respiratory System Examination</b> <ul style="list-style-type: none"> <li>• Prepare the clinical setting for a respiratory examination</li> <li>• Margins and demarcations of thoracic cavity and its organs</li> <li>• Respiratory rate and recognize breathing patterns</li> <li>• Palpation techniques to any signs of abnormality</li> <li>• Perform percussion of the chest</li> <li>• auscultate the lungs using a stethoscope</li> </ul>	Practical/ Demonstration	2	Physiology
4.34. Interpretation of LFT with reference to the deranged lung functions/ underlying diseases of the lung	<b>Lung Function Test</b> <ul style="list-style-type: none"> <li>• Tests used in the assessment of <ul style="list-style-type: none"> <li>- Ventilatory functions</li> <li>- Gas exchange of the lungs</li> </ul> </li> <li>• Volumes &amp; capacities on spiograph</li> <li>• Calculate the FEV<sub>1</sub> / FVC ratio on a vitalograph</li> <li>• To interpret the results of LFT</li> <li>• Use a peak flow meter to measure &amp; interpret the results of PEFR</li> </ul>	Practical/ Demonstration	2	Physiology

4.35.Enumerate & define the tests used in the assessment of - Blood gas	<b>ABG Analysis</b> <ul style="list-style-type: none"> <li>• Interpretation of blood gas report</li> </ul>	Practical/ Demonstration/ FLM	2	Physiology
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## 3.5 Endocrine Module

Module code	Year	Semester	Credit
MEBS-1-2-1-2	01	02	02

### Introduction

This Endocrine Module is designed to provide students with a comprehensive understanding of the endocrine system, focusing on its structure, function, and role in maintaining homeostasis within the body. The endocrine system plays a critical role in regulating a wide range of physiological processes, including metabolism, growth and development, mood, and reproductive functions, through the secretion of hormones. Throughout this module, you will explore the anatomy and physiology of endocrine glands such as the pituitary, thyroid, adrenal glands, pancreas, and reproductive organs. You will also delve into how hormones are synthesized, released, and interact with target cells to influence bodily functions. Additionally, we will examine common disorders related to endocrine dysfunction and their clinical implications. By the end of this module, students will have a solid foundation in the principles of endocrinology, equipping them with the knowledge to appreciate the complexities of hormonal regulation and its impact on health and disease. We encourage you to engage actively with the content, as a thorough understanding of the endocrine system is essential for anyone pursuing a career in medicine, healthcare, or related fields.

### Module Committee

<b>Module Coordinator</b>	Dr. Irosha Nicholas – Module Coordinator, Basic Sciences Stream Coordinator, Head /Department of Biochemistry
<b>Committee members</b>	Dr. Joachim Perera – Consultant for Department of Anatomy Prof. M.N. Wickramaratne - Professor/Department of Biochemistry Dr. Kaushalya Kulathunga – Head/Department of Physiology Dr. Chamalika Weerakoon - Head/Department of Anatomy Dr. Amal Wageesha – Senior Lecturer/Department of Biochemistry Dr. Sumeth Perera - Senior Lecturer/Department of Biochemistry Dr. Yasas Kolambage – Lecturer/Department of Anatomy Ms. Nadeesha Nilmini – Lecturer/Department of Biochemistry

### Module Learning Outcomes

At the end of the endocrine module, the student should be able to:

1. describe the structure and function of the major endocrine glands and their associated hormones.
2. explain the mechanisms of hormone action, including receptor binding, signal transduction pathways, and feedback loops, and their role in maintaining homeostasis.
3. identify the physiological processes regulated by hormones, such as metabolism, growth, reproduction, and stress response, and understand how these processes interact.
4. analyze common endocrine disorders and their clinical presentations, diagnostic methods, and treatment options.

## Course details with Intended Learning Outcome (ILOs)

Intended Learning Outcome (ILO)	Content area	T/L Activity	Duration (Hours)	Department
<p>5.1.Explain the role of hormones in maintaining whole-body homeostasis</p> <p>5.2.Discuss the principles of feedback control (negative and positive feedback) and the significance of hormonal secretion rhythms</p>	<p><b>Introduction to endocrine physiology</b></p> <ul style="list-style-type: none"> <li>Contribution of hormones to whole-body homeostatic mechanisms. process of synthesis and secretion of hormones by endocrine glands.</li> <li>Ways of transport of hormones in the blood. principles of feedback control and its relevance for homeostasis. rhythms of hormone secretion.</li> </ul>	Lecture	2	Physiology
<p>5.3.Describe the gross anatomy and functional role of the hypothalamus in regulating homeostasis.</p> <p>5.4.Describe the hypothalamo-hypophyseal portal and tract system and its role in neuroendocrine control.</p>	<p><b>Hypothalamus</b></p> <ul style="list-style-type: none"> <li>Location, structural components, and</li> <li>Role of the hypothalamus.</li> <li>Hormones released from the hypothalamus and their effects on the anterior and posterior pituitary.</li> <li>Hypothalamic control of neuroendocrine function through the hypothalamo-hypophyseal portal and tract systems.</li> </ul>	Lecture	1	Anatomy
<p>5.5.Describe the gross anatomy of the pituitary gland.</p> <p>5.6.Compare the differences between the anterior and posterior pituitary</p> <p>5.7.Explain pituitary hormones, their regulation, and hypothalamic connections.</p>	<p><b>Pituitary Gland</b></p> <ul style="list-style-type: none"> <li>Location, components, and relationships of the pituitary gland.</li> <li>Structural, functional and embryological differences between the anterior and posterior pituitary</li> <li>Hormones secreted by each part of the pituitary gland</li> <li>Neuronal connections with the hypothalamus</li> <li>Mechanisms for control of secretion</li> <li>Structure and significance of the hypothalamo-hypophyseal portal circulation.</li> </ul>	Lecture	1	Anatomy
<p>5.8.Describe the microscopic anatomy of the hypothalamus and pituitary glands.</p>	<p><b>Microscopic Structure of Hypothalamus and Pituitary</b></p> <p><b>Hypothalamus</b></p> <ul style="list-style-type: none"> <li>Cellular components and functional organization of the hypothalamus related to endocrine regulation.</li> <li>Role of hypothalamic nuclei in hormone synthesis and secretion.</li> </ul> <p><b>Pituitary gland (Hypophysis cerebri)</b></p> <ul style="list-style-type: none"> <li>Gross anatomy of the hypophysis including its blood supply</li> </ul>	Lecture	1	Anatomy

	<ul style="list-style-type: none"> <li>Development of the hypophysis cerebri</li> </ul> <p><b>A. Anterior pituitary / Adenohypophysis / Pars distalis</b></p> <ul style="list-style-type: none"> <li>Types of cells in anterior pituitary</li> <li>Functions of hormones secreted by the acidophils and basophils</li> <li>Mechanisms that control the secretion of hormones by the anterior pituitary</li> <li>Arrangement of blood vessels in the hypothalamohypophyseal portal circulation and its mechanism of control</li> </ul> <p><b>B. Posterior Pituitary / Neurohypophysis / Pars posterior</b></p> <ul style="list-style-type: none"> <li>Microscopic appearance of the posterior pituitary</li> <li>The predominant cell type in the neurohypophysis</li> <li>The hypothalamohypophyseal tract</li> <li>Posterior pituitary hormones, cells that secrete these hormones and their location</li> <li>Herring bodies</li> <li>Features of neurosecretory cells</li> </ul>			
<p>5.9.Describe the structure and anatomical connections of the pituitary gland with the hypothalamus and their functional significance.</p> <p>5.10.Explain the regulation and physiological roles of pituitary hormones.</p> <p>5.11.Discuss abnormalities in pituitary function, growth hormone secretion, and potential treatments.</p>	<p><b>Pituitary Gland</b></p> <ul style="list-style-type: none"> <li>Anatomical connections between the hypothalamus and pituitary gland and their functional significance.</li> <li>Structure of the pituitary gland and its functional relationship.</li> <li>Cell types in the anterior pituitary and how their numbers adjust to physiological demands.</li> <li>Role of proopiomelanocortin-derived hormones in pigmentation regulation.</li> <li>Effects of growth hormone on growth and metabolism, and the role of IGF-I in mediating these effects.</li> <li>Stimuli regulating growth hormone secretion and their mechanisms.</li> <li>Regulation and relevance of gonadotropins and prolactin secretion.</li> <li>Abnormal pituitary function and growth hormone secretion, and potential treatments.</li> </ul>	Lecture	2	Physiology

<p>5.12.Describe the gross anatomy of the thyroid and parathyroid glands.</p> <p>5.13.Outline the development, cellular structure, and functions of the thyroid and parathyroid glands.</p>	<p><b>Thyroid</b></p> <ul style="list-style-type: none"> <li>• Basic structure</li> <li>• Structural unit of the thyroid gland.</li> <li>• Blood supply, lymph drainage and nerve supply</li> <li>• Functions of thyroid gland</li> <li>• Development of thyroid gland</li> <li>• Important anatomical relations.</li> </ul> <p><b>Parathyroid</b></p> <ul style="list-style-type: none"> <li>• Form and location</li> <li>• Types of cells, their secretions, and their functions.</li> <li>• Blood supply and lymphatic drainage</li> <li>• Embryological development</li> </ul>	Lecture	2	Anatomy
<p>5.14.Describe the microscopic anatomy of the thyroid and parathyroid glands.</p>	<p><b>Microscopic Structure of Thyroid and Parathyroid Glands</b></p> <p><b>Thyroid</b></p> <ul style="list-style-type: none"> <li>• Gross anatomy of the thyroid gland</li> <li>• Functions of the follicular cells</li> <li>• Follicle cells function in the synthesis, storage and secretion of thyroid hormone</li> <li>• The appearance of the follicle varies with activity</li> <li>• Mechanisms that control the secretions of the thyroid gland</li> <li>• Parafollicular cells their location and secretions</li> </ul> <p><b>Parathyroid</b></p> <ul style="list-style-type: none"> <li>• Location of the parathyroid gland, the main types of cells, their secretions and functions</li> <li>• Role of these cells in regulating calcium levels.</li> </ul>	Lecture	1	Anatomy
<p>5.15.Describe function, and regulation of the thyroid gland and its hormones.</p> <p>5.16.Explain the role of thyroid hormones in homeostasis, development, and disorders, including their treatment.</p>	<p><b>Thyroid Gland</b></p> <ul style="list-style-type: none"> <li>• Functions of the thyroid gland</li> <li>• The chemical nature and synthesis of thyroid hormones.</li> <li>• The role of protein binding in thyroid hormone transport and metabolism.</li> <li>• Hypothalamic and pituitary regulation of thyroid function.</li> <li>• Effects of thyroid hormones on homeostasis and development.</li> <li>• Thyroid dysfunction and its treatment</li> </ul>	Lecture	2	Physiology
<p>5.17.Discuss the clinical outcome of the endocrine abnormality of pituitary and thyroid hormones</p>	<p><b>Pituitary and Thyroid Glands</b></p> <ul style="list-style-type: none"> <li>• Clinical presentations and physiological basis for endocrine abnormality of pituitary and thyroid hormones</li> </ul>	Practical / Demonstration	2	Physiology



<p>5.18.Describe the regulation of calcium and phosphate homeostasis, including key organs and hormonal control.</p> <p>5.19.Explain bone cell functions, calcium and phosphate metabolism, and their physiological significance.</p>	<p><b>Hormonal Control of Calcium and Phosphate</b></p> <ul style="list-style-type: none"> <li>• Role of calcium and phosphate homeostasis and it's regulation.</li> <li>• Calcium pools, turnover, and the organs involved in their regulation.</li> <li>• Mechanisms of calcium and phosphate absorption, excretion, and hormonal control.</li> <li>• Functions of cells involved in bone formation and resorption.</li> </ul>	Lecture	2	Physiology
<p>5.20.Describe the gross anatomy of the adrenal gland, including cortical layers and their functions.</p> <p>5.21.Outline the development, cellular structure, and functions of the adrenal gland</p>	<p><b>Adrenal Gland</b></p> <ul style="list-style-type: none"> <li>• Form, location, and topographical relationships</li> <li>• Layers of the adrenal cortex and structural and functional differences of cells in each layer.</li> <li>• Blood supply and arrangement of vessels in the adrenal cortex and medulla.</li> <li>• Functions of hormones secreted by the adrenal cortex and medulla.</li> <li>• Development of the adrenal gland</li> </ul>	Lecture	2	Anatomy
<p>5.22.Describe the microscopic anatomy of the adrenal gland and endocrine pancreas</p>	<p><b>Microscopic Structure of Adrenal / Suprarenal gland and endocrine pancreas</b></p> <ul style="list-style-type: none"> <li>• Features of a steroid secreting cell</li> <li>• Arrangement, structure and functions of cells in adrenal cortex layers</li> <li>• Arrangement of blood vessels in the cortex and medulla</li> <li>• Cells of the adrenal medulla and their features</li> <li>• Sites of extra adrenal chromaffin cells</li> <li>• Why the adrenal medullary cells are comparable to preganglionic sympathetic neurones</li> <li>• Significance of the diffuse endocrine system (APUD) and the distribution of these cells</li> <li>• Endocrine part of the pancreas</li> </ul>	Lecture	1	Anatomy
<p>5.23.Describe the biosynthesis, function, and regulation of adrenal medullary catecholamines and cortical steroids.</p> <p>5.24.Explain the physiological and pathological effects of adrenal hormones, including their metabolism and clinical relevance.</p>	<p><b>Adrenal medulla and cortex</b></p> <ul style="list-style-type: none"> <li>• Catecholamines secreted by the adrenal medulla and their biosynthesis, metabolism, and function.</li> <li>• Stimuli that increase adrenal medullary secretion.</li> <li>• Role of plasma proteins in binding adrenocortical steroids.</li> <li>• Difference between C18, C19, and C21 steroids.</li> <li>• Adrenal cortex steroid biosynthesis.</li> <li>• Major site of adrenocortical hormone metabolism and key metabolites.</li> </ul>	Lecture	4	Physiology

	<ul style="list-style-type: none"> <li>• Effect of glucocorticoids and aldosterone on cellular function and their physiological and pharmacological effects.</li> <li>• Physiological and pathological effects of adrenal androgens.</li> <li>• Regulation of glucocorticoid and adrenal sex hormone secretion and diseases caused by excess or deficiency of adrenal hormones</li> </ul>			
5.25. Discuss the clinical outcome of the endocrine abnormality of parathyroid and adrenal hormones	<b>Parathyroid and adrenal glands</b> <ul style="list-style-type: none"> <li>• Clinical presentations and physiological basis for endocrine abnormality of parathyroid and adrenal hormones</li> </ul>	Practical / Demonstration	2	Physiology
5.26. Describe the synthesis and secretion, mode of action and the factors that regulate insulin secretion  5.27. Describe blood glucose homeostasis	<b>Endocrine pancreas</b> <ul style="list-style-type: none"> <li>• Synthesis storage and method of secretion of insulin</li> <li>• Mode of action of Insulin</li> <li>• Metabolic actions of Insulin</li> <li>• Factors that determine the blood glucose level.</li> <li>• Role of liver in blood glucose homeostasis in starvation and in the fed state</li> </ul>	Lecture	2	Physiology
5.28. Discuss the clinical outcome of the endocrine abnormality of endocrine pancreatic hormones	<b>Endocrine pancreas</b> <ul style="list-style-type: none"> <li>• Clinical presentations and physiological basis for endocrine abnormality of endocrine pancreatic hormones</li> </ul>	Practical / Demonstration	2	Physiology

## 3.6 Gastro-Intestinal and Metabolism Module

Module code	Year	Semester	Credit
MEBS-1-2-4-9	01	02	09

### Introduction

The Gastrointestinal (GI) Module provides medical students with an integrated understanding of the structure, function, and biochemical processes of the digestive system. This module covers the detailed anatomy of the GI tract and its accessory organs, including their histological features and spatial relationships, which are essential for understanding both normal function and pathological conditions. Students will discuss the mechanisms underlying digestion, absorption, and motility, as well as the regulation of these processes through neural and hormonal control. The module examines the biochemical foundations of nutrient metabolism, including carbohydrate, protein, and lipid digestion, as well as the role of enzymes and bile acids in these processes. Students will also gain insights into the pathophysiology of common gastrointestinal disorders.

By integrating anatomical, physiological, and biochemical concepts, this module equips students with a strong foundation for GI-related conditions in their future medical practice. It nurtures a holistic understanding of gastrointestinal health and disease.

### Module Committee

<b>Module Coordinator</b>	Dr. Amal Wageesha – Senior Lecturer/Department of Biochemistry
<b>Committee members</b>	Dr. Joachim Perera – Consultant for Department of Anatomy Prof. M.N. Wickramaratne - Professor/Department of Biochemistry Dr. Irosha Nicholas –Basic Sciences Stream Coordinator, Head/Department of Biochemistry Dr. Kaushalya Kulathunga – Head/Department of Physiology Dr. Chamalika Weerakoon - Head/Department of Anatomy Dr. Sumeth Perera - Senior Lecturer/Department of Biochemistry Dr. Yasas Kolambage – Lecturer/Department of Anatomy Ms. Nadeesha Nilmini – Lecturer/Department of Biochemistry

### Module Learning Outcomes

At the end of the reproductive module, the student should be able to:

1. discuss the structure and function of the gastrointestinal tract and its accessory organs.
2. examine the processes of digestion, absorption, and metabolism, focusing on how the body processes nutrients and eliminates waste.
3. acquire basic knowledge for diagnostic imaging and clinical examination to assess gastrointestinal health.
4. apply the basic scientific knowledge to explain clinical significance of gastrointestinal related disorders.

## Course details with Intended Learning Outcome (ILOs)

Intended Learning Outcome (ILO)	Content Outline	T/L Activity	Duration (Hours)	Department
<p>6.1.Describe the structure and function of the gastrointestinal (GI) tract</p> <p>6.2.Explain the processes of digestion, absorption, and motility, focusing on the role of enzymes, hormones, and neural regulation.</p> <p>6.3.Analyze the physiological mechanisms involved in GI disorders</p>	<p><b>Overview of the GI Physiology</b></p> <ul style="list-style-type: none"> <li>• Key functions: digestion, absorption, and elimination</li> <li>• The role of accessory organs (liver, pancreas, gallbladder)</li> <li>• The process of mechanical and chemical digestion</li> <li>• Digestive enzymes and their functions (e.g., amylase, lipase, pepsin)</li> <li>• Role of bile in fat digestion</li> <li>• Mechanisms of nutrient absorption in the small intestine</li> <li>• Transport systems for carbohydrates, proteins, and lipids</li> <li>• Role of the large intestine in water and electrolyte absorption</li> <li>• Peristalsis, segmentation, and migrating motor complex</li> <li>• Neural control: enteric nervous system, vagus nerve</li> <li>• Hormonal regulation: gastrin, secretin, cholecystokinin (CCK)</li> <li>• Common gastrointestinal disorders (e.g., GERD, IBS, celiac disease)</li> <li>• Pathophysiology and symptoms of GI conditions</li> <li>• Treatment options and management strategies</li> </ul>	Lecture	2	Physiology
<p>6.4.Describe the structure and components of the oral cavity, including the features of the hard palate, gingiva, and tongue, and their adaptations for masticatory function, as well as the distribution and types of papillae and taste buds.</p> <p>6.5.Explain the features of the salivary glands, including their nature of secretion, duct system, and the role of lymphoid tissue in the wall of the pharynx, with a focus on the palatine tonsil.</p> <p>6.6.Outline the general tissue arrangements in the wall of the gastrointestinal system, describe the structure and layers of the esophagus, and</p>	<p><b>Oral cavity and salivary glands</b></p> <ul style="list-style-type: none"> <li>• The parts of the oral cavity, the features of the hard palate and gingiva, and how they are adapted to their masticatory function.</li> <li>• The components of the tongue, including variations in the anterior and posterior parts, the epithelium of the dorsum, and the types and distribution of papillae and taste buds.</li> <li>• The structure and function of the salivary glands, including their nature and mode of secretion, as well as the features of the duct system and the location of lymphoid tissue in the pharynx.</li> </ul>	Lecture	2	Anatomy

explain the distribution of nerve plexuses and the location of esophageal glands.				
<p>6.7. Identify and describe the divisions, layers, and musculature of the pharynx, including the constrictors, fascia, and other muscles, and explain the lymphatic collections and epithelial lining.</p> <p>6.8. Outline the blood supply, nerve supply, and lymphatic drainage of the pharynx, and discuss the mechanism of deglutition.</p> <p>6.9. Describe the anatomy of the esophagus, including its course, relations, and constrictions, sphincter mechanisms, and blood supply, and explain the clinical relevance of esophageal varices and its microscopic structure.</p>	<p><b>Pharynx and oesophagus</b></p> <ul style="list-style-type: none"> <li>• The divisions of the pharynx, the layers of its wall, and the muscles (constrictors and others), including their communication with surrounding structures.</li> <li>• The lymphatic collections and epithelial lining of the pharynx, and outline the blood supply, nerve supply, and lymphatic drainage.</li> <li>• The anatomy of the esophagus, including its course and relations, sphincter mechanisms, sites of constrictions, and the esophageal plexus, along with the blood supply and gastric nerves.</li> <li>• The tissue arrangement of the gastrointestinal system, describe the walls of the esophagus, and explain the distribution of nerve plexuses and the location of glands within the esophagus.</li> <li>• The clinical significance of esophageal varices, the microscopic structure of the esophagus, and the mechanism of deglutition in the context of swallowing.</li> </ul>			Anatomy
<p>6.10. Describe the structure and function of the mouth and oesophagus</p> <p>6.11. Explain the processes of chewing, salivation, and the initiation of swallowing</p>	<p><b>Physiology of Mouth and Oesophagus</b></p> <ul style="list-style-type: none"> <li>• The structure and the function of mouth</li> <li>• Functions and regulation of salivation</li> <li>• Physiological process and regulation of swallowing</li> <li>• Functional anatomy of oesophagus</li> <li>• Disorders associated with salivation and deglutition</li> </ul>	Lecture	2	Physiology
<p>6.12. Describe the embryological origins of the face, oral cavity, pharynx, and esophagus, focusing on the role of branchial (pharyngeal) arches in their development.</p> <p>6.13. Explain the processes of facial development, including the fusion of facial prominences, and their clinical relevance, such as in conditions like cleft lip and palate.</p> <p>6.14. Outline the development of the pharynx and esophagus, including the differentiation of associated structures, and</p>	<p><b>Development of the Face, Oral Cavity, Pharynx and Oesophagus</b></p> <ul style="list-style-type: none"> <li>• Recognize the key structures involved in the development of the face, oral cavity, pharynx, and esophagus, with an emphasis on the role of the branchial arches in shaping these regions.</li> <li>• Describe the sequence of events leading to facial development, including the fusion of facial prominences, and understand the clinical relevance of abnormalities like cleft lip and palate.</li> <li>• Outline the developmental processes of the pharynx and esophagus, including the formation of associated structures, and discuss the embryological basis of congenital anomalies such as esophageal atresia and tracheoesophageal fistula, along with their clinical implications.</li> </ul>	Lecture	2	Anatomy

discuss the embryological basis of congenital anomalies.				
<p>6.15.Outline the arrangement of muscles and aponeurosis in the anterolateral abdominal wall, including their roles in abdominal movement and support.</p> <p>6.16.Define the inguinal ligament and describe the structural arrangement of the walls of the inguinal canal.</p> <p>6.17.Discuss the inguinal canal's anatomy, its clinical significance, and its relevance to conditions such as inguinal hernias.</p>	<p><b>Anterior Abdominal Wall &amp; Inguinal Region</b></p> <ul style="list-style-type: none"> <li>• The muscles and aponeurosis in the anterolateral abdominal wall, and explain their functional roles in movement and support.</li> <li>• The structure and function of the inguinal ligament and outline the arrangement of the walls of the inguinal canal.</li> <li>• The anatomy of the inguinal canal and explain its clinical significance, including common conditions like inguinal hernias.</li> <li>• The clinical relevance of the inguinal region in relation to surgical procedures and hernia management.</li> </ul>	Lecture	2	Anatomy
<p>6.18.Describe the structure, function, and development of the peritoneum and peritoneal folds</p> <p>6.19.Recognize intraperitoneal and retroperitoneal structures.</p> <p>6.20.Identify key peritoneal spaces within the peritoneal cavity and their clinical relevance</p>	<p><b>Peritoneum and Peritoneal Cavity</b></p> <ul style="list-style-type: none"> <li>• Peritoneum</li> <li>• Peritoneal folds and their development</li> <li>• Intraperitoneal and retroperitoneal structures</li> <li>• Peritoneal spaces</li> </ul>	Lecture	1	Anatomy
<p>6.21.Describe the anatomical location, morphological features, and posterior relations of the stomach, including the extent of the lesser sac, the lesser and greater omenta, and their attachments.</p> <p>6.22.Outline the blood supply, lymphatic drainage, and nerve supply of the stomach, and discuss their functional significance.</p> <p>6.23.Recall the microscopic structure of the stomach and explain its development, including the fate of the dorsal and ventral mesogastrium.</p>	<p><b>Stomach</b></p> <ul style="list-style-type: none"> <li>• The anatomical location and morphological features of the stomach, including its divisions and posterior relations, with a focus on the lesser and greater omenta and their attachments.</li> <li>• The structure and functional role of the lesser sac, its extent, and its significance in relation to the stomach and surrounding structures.</li> <li>• The blood supply, lymphatic drainage, and nerve supply to the stomach, and describe how these systems support its functions.</li> <li>• The microscopic structure of the stomach and summarize its embryological development, specifically the fate of the dorsal and ventral mesogastrium.</li> </ul>	Lecture	1	Anatomy

<p>6.24. Describe the structure and function of the stomach</p> <p>6.25. Explain the physiological processes of gastric motility, gastric acid secretion, and enzyme activity.</p> <p>6.26. Analyze the regulation of gastric function through neural, hormonal, and paracrine mechanisms</p>	<p><b>Physiology of Stomach</b></p> <ul style="list-style-type: none"> <li>• Functional anatomy and functions of stomach.</li> <li>• Composition and regulation of gastric secretions.</li> <li>• Mechanism and regulation of gastric acid secretion.</li> <li>• Gastric mucosal barrier.</li> <li>• Gastric motility and emptying.</li> </ul>	Lecture	2	Physiology
<p>6.27. Describe the parts, development, and anatomical features of the liver and biliary system, including the liver's position, morphology, lobes, surfaces, peritoneal attachments, and vascular segments, as well as the structure and function of the gallbladder and bile duct system.</p> <p>6.28. Explain the anatomical relations of the pancreas, including its position, parts, blood supply, and the course of its ducts, alongside the development of the pancreas and the role of the islets of Langerhans in hormone secretion.</p> <p>6.29. Discuss the structure and function of the spleen, identifying its position, surfaces, blood supply, and peritoneal relations, and recognize signs of splenic enlargement.</p>	<p><b>Liver, Biliary system, Pancreas</b></p> <ul style="list-style-type: none"> <li>• Components of the liver and biliary system, including the liver's lobes, surfaces, peritoneal attachments, and vascular segments, and explain their significance in liver function.</li> <li>• Understanding of the anatomical structure of the pancreas, including its parts, blood supply, ducts, and the difference between endocrine and exocrine functions, particularly the role of the islets of Langerhans.</li> <li>• Structure of the spleen, recognize its surface relations and blood supply, and identify clinical signs of splenic enlargement.</li> </ul>	Lecture	2	Anatomy
<p>6.30. Describe the microscopic anatomy of the liver, gallbladder and pancreas</p>	<p><b>Microscopic Structure of the Liver, Gallbladder and Pancreas</b></p> <p><b>Liver</b></p> <ul style="list-style-type: none"> <li>• Hepatic lobules and arrangement of hepatocytes</li> <li>• Portal triad components and their functions</li> <li>• Sinusoids and their role in exchange</li> <li>• Kupffer cells and immune function</li> <li>• Space of Disse and hepatocyte interaction</li> <li>• Stellate cells and their role in fibrosis</li> </ul> <p><b>Gallbladder</b></p> <ul style="list-style-type: none"> <li>• Simple columnar epithelium and microvilli</li> </ul>	Lecture	2	Anatomy

	<ul style="list-style-type: none"> <li>• Lamina propria and connective tissue support</li> <li>• Muscularis layer and bile expulsion</li> <li>• Serosa and external structural support</li> </ul> <b>Pancreas</b> <ul style="list-style-type: none"> <li>• Exocrine pancreas – acini and ductal system</li> <li>• Endocrine pancreas – Islets of Langerhans</li> <li>• Alpha, beta, delta, and PP cells and their functions</li> </ul>			
<p>6.31. Describe the structure and function of the liver and gallbladder</p> <p>6.32. Explain the processes involved in bile synthesis, the composition of bile, and its role in fat emulsification and absorption in the small intestine.</p> <p>6.33. Analyze the regulation of bile secretion and the impact of liver and gallbladder disorders on digestion and overall health.</p>	<b>Physiology of liver and Gallbladder</b> <ul style="list-style-type: none"> <li>• Functional anatomy and physiological aspects of the <ul style="list-style-type: none"> <li>- Liver</li> <li>- The bile</li> <li>- Gall bladder</li> <li>- Common disorders</li> </ul> </li> </ul>	Lecture	2	Physiology
<p>6.34. Describe the structure and function of the pancreas, including its dual role in endocrine and exocrine secretion.</p> <p>6.35. Explain the processes involved in the secretion of digestive enzymes (amylase, lipase, proteases) and bicarbonate, and their role in digestion in the small intestine.</p> <p>6.36. Analyze the regulation of pancreatic secretion by</p>	<b>Exocrine pancreas</b> <ul style="list-style-type: none"> <li>• Structure of the pancreas, including exocrine and endocrine components (acini, islets of Langerhans)</li> <li>• Role in digestion (enzyme secretion) and metabolic regulation (insulin, glucagon)</li> <li>• Components of pancreatic juice: digestive enzymes (amylase, lipase, proteases) and bicarbonate</li> <li>• Function of pancreatic juice in neutralizing stomach acid and aiding digestion in the small intestine</li> <li>• Mechanism of secretion: acinar and ductal cells involved in enzyme and bicarbonate production</li> <li>• Regulation of secretion by hormones (secretin, CCK) and neural pathways during digestion</li> </ul>	Lecture	2	Physiology
<p>6.37. Outline the parts of the small intestine, including its length, and describe the anatomy of the duodenum, jejunum, and ileum, with a focus on their peritoneal relations, blood supply, and related structures.</p> <p>6.38. Describe the appearance of the inner wall of the duodenum at the openings of</p>	<b>Small Intestine</b> <ul style="list-style-type: none"> <li>• The components and structure of the small intestine, focusing on the duodenum, jejunum, and ileum, along with their blood supply, peritoneal relations, and related structures.</li> <li>• The functional aspects of the duodenum's inner wall, particularly at the openings of the pancreatic and bile ducts, and describe the mesentery's role in attaching the small intestine to the posterior abdominal wall.</li> </ul>	Lecture	1	Anatomy



<p>the pancreatic and bile ducts, and explain the features of the mesentery, its attachment to the posterior abdominal wall, and the superior mesenteric artery and vein.</p> <p>6.39. Recall the development of the small intestine, the stages of rotation of the gut, and potential anomalies, and discuss the microscopic structure of the different parts of the small intestine and their adaptations to their functions.</p>	<ul style="list-style-type: none"> <li>The blood supply to the jejunum and ileum, including the superior mesenteric artery and vein, and describe their course, tributaries, and termination.</li> </ul>			
<p>6.40. Describe the structure and function of the small intestine, including the roles of the duodenum, jejunum, and ileum in digestion and nutrient absorption.</p> <p>6.41. Explain the processes of enzyme secretion, bile involvement, and nutrient absorption in the small intestine</p> <p>6.42. Analyze the regulatory mechanisms involved in small intestine motility</p>	<p><b>Physiology of Small intestine</b></p> <ul style="list-style-type: none"> <li>Describe the functions of small intestine</li> <li>Outline the structural adaptations of SI to suit its functions</li> <li>Describe the composition and functions of small intestinal secretions</li> <li>Describe the process of absorption of digestive products</li> <li>Describe the small intestinal motility types</li> </ul>	Lecture	2	Physiology
<p>6.43. Outline the different parts of the large intestine, including the caecum, appendix, ascending, transverse, descending, and sigmoid colon, and describe the external features and peritoneal relations of each part.</p> <p>6.44. Describe the attachments of the transverse and sigmoid mesocolon, and explain the blood supply to the large intestine, including the superior mesenteric artery, its branches, and the inferior mesenteric artery and its branches.</p> <p>6.45. Explain the nerve supply and nerve plexuses within the walls of the large intestine, the normal position of the appendix, and its variations, along with the anatomical basis of pain in appendicitis and the attachment of the</p>	<p><b>Large Intestine</b></p> <ul style="list-style-type: none"> <li>The components and structure of the large intestine, including the caecum, appendix, ascending, transverse, descending, and sigmoid colon, along with their external features and peritoneal relations.</li> <li>The attachment of the transverse and sigmoid mesocolon, and describe the blood supply of the large intestine, including the superior and inferior mesenteric arteries and their branches.</li> <li>The nerve supply and nerve plexuses in the walls of the large intestine, and describe the attachment of the mesoappendix and the course of the appendicular artery.</li> <li>The normal position of the appendix, variations in its location, and the anatomical basis of pain in appendicitis.</li> </ul>	Lecture	1	Anatomy

mesoappendix and the appendicular artery.				
<p>6.46. Describe the epithelial lining of the stomach, the arrangement of glands in its different parts, and the features of various secretory cells found in these glands, relating their functions to the secretions produced.</p> <p>6.47. Explain the transition from the stomach to the small intestine at the gastroduodenal junction and how the structure of the small and large intestines varies from the basic anatomical plan to accommodate their functions.</p> <p>6.48. Discuss the structural adaptations of the small intestine, including the villus and crypt structures, the types of cells present in these regions, their functions, the location of endocrine cells, and the distribution and role of lymphatic tissue in the intestine.</p>	<p><b>Microscopic Structure of Stomach, Small Intestine and Large Intestine</b></p> <ul style="list-style-type: none"> <li>• The epithelial lining of the stomach and the arrangement of the glands in different regions of the stomach, explaining the functions of various secretory cells found within these glands.</li> <li>• The transition from the stomach to the small intestine, specifically at the gastroduodenal junction, and discuss how the structural features of the small and large intestines adapt to their functional roles.</li> <li>• Describe the structure of villi and crypts in the small intestine, the types of cells within them, their functions, the role of endocrine cells, and the distribution of lymphatic tissue in the intestinal lining.</li> </ul>	Lecture	2	Anatomy
<p>6.49. Describe the structure and function of the large intestine,</p> <p>6.50. Explain the process of fermentation in the colon, the role of gut microbiota in digestion, and the production of short-chain fatty acids (SCFAs).</p> <p>6.51. Analyze the regulation of motility and the clinical significance of disorders affecting the large intestine,</p>	<p><b>Physiology of Large intestine</b></p> <ul style="list-style-type: none"> <li>• Describe the functions of large intestine</li> <li>• List the composition of faeces</li> <li>• Outline the effects of intestinal bacteria</li> <li>• Describe the motility of large intestine</li> <li>• Describe defaecation reflex</li> </ul>	Lecture	2	Physiology
<p>6.52. Describe the neural regulation of the GIT.</p> <p>6.53. Explain the hormonal regulation of the GIT,</p> <p>6.54. Analyze the integrated regulation of the GIT during digestion</p>	<p><b>GI Regulation</b></p> <ul style="list-style-type: none"> <li>• Overview of the neural and hormonal regulation of the GIT</li> <li>• Role of the enteric nervous system, autonomic nervous system, and central nervous system in coordinating digestion</li> <li>• Key hormones: gastrin, cholecystokinin (CCK-PZ), secretin, gastric inhibitory</li> </ul>	Lecture	2	Physiology

	<p>peptide (GIP), and vasoactive intestinal peptide (VIP)</p> <ul style="list-style-type: none"> <li>• The role of each hormone in regulating gastric acid secretion, enzyme release, bile secretion, motility, and nutrient absorption</li> <li>• Types of motility: peristalsis, segmentation, and the migrating motor complex (MMC)</li> <li>• Mechanisms of motility regulation by neural and hormonal signals to facilitate digestion and absorption</li> </ul>			
<p>6.55. Describe the position, curvatures, and peritoneal relations of the rectum, including the anorectal junction, levator ani, ischiorectal fossa, and the anal canal's length, direction, and sphincter arrangement.</p> <p>6.56. Explain the blood supply to the rectum and anal canal, and describe the internal appearance and structure of the anal canal, including the anal valves and anal columns.</p> <p>6.57. Recall the development of the anal canal, potential anomalies that may occur, and the histological structure of the anal canal lining.</p>	<p><b>Rectum and Anal Canal</b></p> <ul style="list-style-type: none"> <li>• The position, curvatures, peritoneal relations of the rectum, and the anorectal junction, along with the levator ani, ischiorectal fossa, and the anal canal's length and direction.</li> <li>• The arrangement of the sphincters in the anal canal and describe the blood supply to the rectum and anal canal.</li> <li>• The internal appearance of the anal canal, including the structure of the anal lining, and identify the anal valves and anal columns.</li> <li>• The development of the anal canal and understand potential anomalies that may occur.</li> </ul>	Lecture	1	Anatomy
<p>6.58. Describe the embryological development of the foregut, midgut, and hindgut, explaining their contributions to the gastrointestinal system and the significance of rotation and fixation processes.</p> <p>6.59. Explain the processes of rotation and fixation of the gut tube, their significance in normal anatomy, and the implications of congenital anomalies such as malrotation and volvulus.</p> <p>6.60. Discuss the development of the stomach, its orientation, the formation of associated mesenteries (greater and lesser omentum), and outline the development of the rectum and anal canal,</p>	<p><b>Development of the Stomach, Intestine, Rectum and Anal Canal</b></p> <ul style="list-style-type: none"> <li>• The embryological development of the foregut, midgut, and hindgut, and understand the significance of the rotation and fixation processes in normal anatomy and congenital anomalies such as malrotation and volvulus.</li> <li>• The processes of rotation and fixation of the gut tube and discuss their importance in the proper anatomical development of the gastrointestinal system, particularly in relation to congenital anomalies.</li> <li>• The formation of the stomach, its orientation, the development of associated mesenteries (greater and lesser omentum), and outline the development of the rectum and anal canal, including the role of the cloaca and its division by the urorectal septum.</li> </ul>	Lecture	2	Anatomy

including the role of the cloaca and its division by the urorectal septum.				
<p>6.61. Identify the embryological origins of the liver, pancreas, and biliary system, and explain the process of hepatic bud formation and its differentiation into the liver, gallbladder, and bile ducts.</p> <p>6.62. Outline the development of the pancreas, including the fusion of the dorsal and ventral pancreatic buds and the formation of the main and accessory pancreatic ducts.</p> <p>6.63. Discuss the embryological basis of congenital anomalies such as biliary atresia and annular pancreas, and their clinical implications.</p>	<p><b>Development of the Liver, Pancreas and Biliary System</b></p> <ul style="list-style-type: none"> <li>The process of hepatic bud formation, detailing its differentiation into the liver, gallbladder, and bile ducts, and how this contributes to the development of the biliary system.</li> <li>Development of the pancreas, including how the dorsal and ventral pancreatic buds fuse and how the main and accessory pancreatic ducts are formed.</li> <li>The embryological basis of congenital anomalies such as biliary atresia and annular pancreas, and evaluate their clinical implications and potential treatments.</li> <li>The embryological origins of the liver, pancreas, and biliary system, explaining how the hepatic bud differentiates into the liver, gallbladder, and bile ducts.</li> <li>The development of the pancreas, including the fusion of the dorsal and ventral pancreatic buds and the formation of the main and accessory pancreatic ducts.</li> <li>The embryological basis of congenital anomalies such as biliary atresia and annular pancreas, including their clinical relevance and potential implications.</li> </ul>	Lecture	2	Anatomy
<p>6.64. Explain the digestion and absorption of carbohydrates, including key enzymes and transport mechanisms.</p> <p>6.65. Describe the metabolic pathways involved in carbohydrate utilization for energy production.</p> <p>6.66. Differentiate between catabolic and anabolic processes in metabolism and their relevance to health.</p>	<p><b>Carbohydrate metabolism</b></p> <ul style="list-style-type: none"> <li>Mechanisms of digestion by salivary amylase, intestinal maltase, isomaltase, sucrase, and lactase.</li> <li>Identification and roles in the digestion process.</li> <li>Mechanisms of glucose and galactose absorption via SGLT and its operation.</li> <li>Role and distribution of different GLUT transporters.</li> <li>Mechanisms of fructose and pentose absorption.</li> <li>Overview of anabolism and catabolism.</li> <li>Role of ATP in energizing energy-requiring reactions.</li> <li>Disorders related to carbohydrate digestion (e.g., lactase deficiencies, lactose intolerance, sucrase deficiency) and their biochemical implications.</li> <li>Disorders associated with carbohydrate absorption.</li> </ul>	Lecture SGD	4 2	Biochemistry

<p>6.67. Describe the steps of glycolysis, including key enzymes, intermediates, and energy yield.</p> <p>6.68. Explain the regulation of glycolysis through allosteric enzymes, hormonal control, and feedback mechanisms.</p> <p>6.69. Analyze the significance of glycolysis in different physiological and pathological conditions, such as anaerobic metabolism and metabolic disorders</p>	<p><b>Glycolysis</b></p> <ul style="list-style-type: none"> <li>• Mechanisms of glucose transport across cell membranes.</li> <li>• Overview of the energy-investing and energy-harvesting phases of glycolysis.</li> <li>• Allosteric, covalent modifications, and induction/repression of the glycolytic pathway.</li> <li>• Reactions where reducing equivalents (e.g., NADH) are generated in glycolysis.</li> <li>• Reactions where ATP is synthesized during glycolysis.</li> <li>• Significance and mechanism of substrate-level phosphorylation.</li> <li>• Explanation and significance of aerobic vs. anaerobic glycolysis.</li> <li>• Comparison of energy output under aerobic and anaerobic conditions.</li> <li>• Importance and roles of intermediates in glycolysis.</li> <li>• Glycolytic enzyme deficiencies and their clinical significance.</li> <li>• Predominance of anaerobic glycolysis in malignant cells and its implications.</li> </ul>	Lecture	2	Biochemistry
<p>6.70. Describe the formation of Acetyl Co-A from carbohydrates, fats, and proteins, and its central role in metabolism.</p> <p>6.71. Explain the steps of the TCA (Krebs) cycle, including key enzymes, intermediates, and energy production.</p> <p>6.72. Analyze the regulation of the TCA cycle and its significance in energy metabolism and biosynthetic pathways.</p>	<p><b>Tricarboxylic Acid Cycle (TCA)</b></p> <ul style="list-style-type: none"> <li>• Reaction catalyzed by the pyruvate dehydrogenase complex.</li> <li>• Explanation of why it is called the pyruvate dehydrogenase complex.</li> <li>• List of coenzymes and vitamins required by the pyruvate dehydrogenase complex.</li> <li>• Mechanisms of regulation of the pyruvate dehydrogenase complex.</li> <li>• Pathway of citrate formation from acetyl-CoA.</li> <li>• Sites and reactions for the formation of NADH, FADH<sub>2</sub>, GTP, and CO<sub>2</sub> in the TCA cycle.</li> <li>• Comparison of the oxidative decarboxylation of pyruvate and alpha-ketoglutarate.</li> <li>• Overview of the regulation of the TCA cycle.</li> <li>• Explanation of the amphibolic (both catabolic and anabolic) nature of the TCA cycle.</li> <li>• Outline of anaplerotic reactions that replenish TCA cycle intermediates.</li> </ul>	Lecture	2	Biochemistry
<p>6.73. Explain the principles of bioenergetics, including free energy changes and ATP production.</p> <p>6.74. Describe the electron transport chain (ETC) and oxidative phosphorylation, highlighting the role of key</p>	<p><b>Electron Transport Chain (ETC)</b></p> <ul style="list-style-type: none"> <li>• Significance of malate and glycerol-phosphate shuttles in cellular metabolism.</li> <li>• Role of reduced coenzymes as an energy source for oxidative phosphorylation.</li> </ul>	Lecture	2	Biochemistry

<p>complexes and proton gradients.</p> <p>6.75. Analyze the regulation and significance of oxidative phosphorylation in energy metabolism and its implications in metabolic disorders.</p>	<ul style="list-style-type: none"> <li>• Entry points for electrons from NADH and FADH<sub>2</sub> in the electron transport chain and the final reduction of O<sub>2</sub> to H<sub>2</sub>O.</li> <li>• Explanation of Mitchell's chemiosmotic hypothesis for ATP generation.</li> <li>• Differences between substrate-level phosphorylation and oxidative phosphorylation.</li> <li>• Uncoupling of oxidative phosphorylation and its significance in brown adipose tissue.</li> <li>• Effects of inhibitors on the electron transport chain (ETC).</li> </ul>			
<p>6.76. Describe the metabolism of hexoses other than glucose, including fructose, galactose, and Sucrose.</p> <p>6.77. Explain the enzymatic pathways that convert these hexoses into glycolytic or other metabolic intermediates.</p> <p>6.78. Analyze the Biochemical significance and disorders associated with defects in hexose metabolism, such as hereditary fructose intolerance and galactosemia.</p>	<p><b>Metabolism of other hexoses</b></p> <ul style="list-style-type: none"> <li>• Overview of the catabolic pathways for lactose, galactose, and fructose.</li> <li>• Pathway of lactose synthesis in lactating mammary glands.</li> <li>• Consequences of known enzyme deficiencies in the catabolic pathways of lactose, galactose, and fructose.</li> <li>• Explanation of phosphate trapping due to excessive fructose consumption.</li> <li>• Why fructose is not a substitute for sugar in uncontrolled diabetes.</li> <li>• Biochemical basis for cataract development in diabetics due to excess glucose.</li> <li>• Why cataracts do not develop in healthy individuals.</li> </ul>	Lecture	2	Biochemistry
<p>6.79. Describe the key steps, enzymes, and substrates involved in gluconeogenesis.</p> <p>6.80. Explain the regulation of gluconeogenesis by hormonal and allosteric control mechanisms.</p> <p>6.81. Analyze the Biochemical significance of gluconeogenesis in maintaining blood glucose levels during fasting and metabolic stress.</p>	<p><b>Gluconeogenesis</b></p> <ul style="list-style-type: none"> <li>• Description of the five stages of glucose homeostasis in the fed and fasting states.</li> <li>• Indication of the entry points of gluconeogenic substrates into the gluconeogenesis pathway.</li> <li>• Explanation of the importance of gluconeogenesis in maintaining glucose levels.</li> <li>• Role of insulin and glucagon in the regulation of gluconeogenesis.</li> <li>• Recall that gluconeogenesis is a metabolically expensive pathway.</li> <li>• Stimulation of gluconeogenesis under stress.</li> <li>• Impact of excess ethanol consumption leading to fasting hypoglycemia.</li> <li>• Importance of the Cori cycle and glucose-alanine cycle.</li> </ul>	Lecture	2	Biochemistry
<p>6.82. Describe the key steps, enzymes, and products of the hexose monophosphate pathway.</p>	<p><b>Hexose Monophosphate Pathway (HMP)</b></p> <ul style="list-style-type: none"> <li>• Significance of Oxidative and Non-Oxidative Phases of the HMP Pathway</li> <li>• Predominance of Oxidative Pathway in Fat-Synthesizing Tissues</li> <li>• Predominance of Non-Oxidative Pathway</li> </ul>	Lecture	2	Biochemistry

<p>6.83.Explain the significance of NADPH production and ribose-5-phosphate generation in cellular metabolism.</p> <p>6.84.Analyze the regulation of the pathway and its role in redox balance, biosynthesis, and disease conditions such as G6PD deficiency.</p>	<p>in Rapidly Dividing Cells</p> <ul style="list-style-type: none"> <li>• Link Between HMP Pathway and Glycolysis</li> <li>• Importance of the HMP pathway in neutralizing strong oxidants.</li> <li>• Hemolysis in glucose-6-phosphate dehydrogenase deficiency and its biochemical implications.</li> </ul>			
<p>6.85.Describe the processes of glycogenesis and glycogenolysis, including key enzymes and regulatory steps.</p> <p>6.86.Explain the hormonal and allosteric regulation of glycogen metabolism, focusing on insulin, glucagon, and epinephrine.</p>	<p><b>Glycogen Metabolism</b></p> <ul style="list-style-type: none"> <li>• Synthesis and Breakdown of Glycogen</li> <li>• Reciprocal Control of Glycogen Metabolism</li> <li>• Muscle Glycogen and Blood Glucose Regulation</li> <li>• Muscle Contraction and Glycogenolysis</li> <li>• Glycogen storage diseases and their implications.</li> </ul>	Lecture	2	Biochemistry
<p>6.87.Describe the major pathways of lipid metabolism, including fatty acid oxidation, synthesis, and lipid transport.</p> <p>6.88.Explain the regulation of lipid metabolism by enzymes, hormones, and energy demands.</p> <p>6.89.Analyze clinical conditions related to lipid metabolism, such as obesity, hyperlipidemia, fatty liver disease, and metabolic syndrome.</p>	<p><b>Lipid digestion and absorption</b></p> <ul style="list-style-type: none"> <li>• Emulsification of Lipids</li> <li>• Lipolysis by Lipases</li> <li>• Hydrolysis of Cholesterol Esters</li> <li>• Lipid Absorption and Transport</li> <li>• Clinical Correlations in Lipid Digestion and Absorption</li> </ul>	Lecture	2	Biochemistry
<p>6.90.Describe the process of beta oxidation of fatty acids, including the steps, enzymes, and products formed.</p> <p>6.91.Explain the regulation of beta oxidation by hormonal control, substrate availability, and cellular energy status.</p> <p>6.92.Analyze the physiological significance of beta oxidation in energy metabolism and its role in conditions like ketogenesis and fatty acid oxidation disorders.</p>	<p><b><math>\beta</math>-oxidation</b></p> <ul style="list-style-type: none"> <li>• Description of how fatty acids are activated for metabolism.</li> <li>• Explanation of the transport process for long-chain fatty acids across the mitochondrial membrane.</li> <li>• Overview of the regulation mechanisms of <math>\beta</math>-oxidation.</li> <li>• Explanation of the reciprocal regulation between fatty acid synthesis and breakdown.</li> <li>• Statement of the biochemical significance of <math>\beta</math>-oxidation in energy production.</li> </ul>	Lecture	2	Biochemistry
<p>6.93.Describe the process of fatty acid biosynthesis, including key enzymes, intermediates, and energy requirements.</p>	<p><b>Fatty Acid Synthesis.</b></p> <ul style="list-style-type: none"> <li>• Explanation of acetyl-CoA as the precursor for fatty acid synthesis.</li> <li>• Explanation of how citrate contributes to fatty acid biosynthesis.</li> </ul>	Lecture	2	Biochemistry

6.94.Explain the regulation of fatty acid synthesis by hormones, allosteric control, and feedback mechanisms.	<ul style="list-style-type: none"> <li>• Role and function of acetyl-CoA carboxylase in fatty acid biosynthesis.</li> <li>• Explanation of how acetyl-CoA carboxylase is regulated during fatty acid biosynthesis.</li> <li>• Overview of the four types of reactions in the fatty acid synthase complex.</li> <li>• Importance of NADPH in fatty acid biosynthesis.</li> <li>• Indication that 16-carbon palmitate is the final product of fatty acid synthesis.</li> <li>• Human Desaturases and Essential Fatty Acids</li> <li>• Metformin and Weight Loss</li> </ul>			
<p>6.95.Describe the process of ketone body synthesis (ketogenesis), including key enzymes, intermediates, and conditions that promote its occurrence.</p> <p>6.96.Explain the utilization of ketone bodies as an alternative energy source, focusing on their transport and conversion in peripheral tissues.</p> <p>6.97.Analyze the clinical significance of ketone body metabolism in conditions such as diabetes, fasting, and ketogenic diets.</p>	<p><b>Ketone body metabolism</b></p> <ul style="list-style-type: none"> <li>• Production of Ketone Bodies</li> <li>• Renal Handling of Ketone Bodies</li> <li>• Liver and Ketone Body Utilization</li> <li>• Energy Utilization of Ketone Bodies</li> <li>• Clinical Correlations in Ketone Body Metabolism</li> </ul>	Lecture	2	Biochemistry
<p>6.98.Describe the biosynthesis of eicosanoids, including the role of arachidonic acid and key enzymes involved (e.g., cyclooxygenase and lipoxygenase).</p> <p>6.99.Explain the different classes of eicosanoids (prostaglandins, leukotrienes, thromboxanes) and their physiological functions in inflammation, immune response, and hemostasis.</p> <p>6.100.Analyze the clinical significance of eicosanoids in conditions such as inflammation, cardiovascular diseases, and the therapeutic implications of eicosanoid-targeting drugs (e.g., NSAIDs).</p>	<p><b>Eicosanoids</b></p> <ul style="list-style-type: none"> <li>• List of eicosanoids.</li> <li>• Cyclo-Oxygenase and Linear Pathways in Eicosanoid Synthesis</li> <li>• Enzyme Activities of Prostaglandin Synthase</li> <li>• Significance of Omega-3 and Omega-6 Fatty Acids in Eicosanoid Synthesis</li> <li>• Biological Effects of Eicosanoids</li> <li>• Effect of NSAIDs on Eicosanoid Synthesis</li> <li>• Clinical Correlations in Eicosanoid Metabolism</li> </ul>	Lecture	2	Biochemistry



<p>6.101.Describe the process of cholesterol biosynthesis, including key enzymes, intermediates, and regulation at different stages.</p> <p>6.102.Explain the conversion of cholesterol to bile acids, highlighting key enzymes and the role of bile acids in digestion and fat absorption.</p> <p>6.103.Analyze the clinical relevance of cholesterol biosynthesis and bile acid metabolism, including disorders like hypercholesterolemia, gallstones, and the use of statins.</p>	<p><b>Cholesterol Metabolism and Bile acids</b></p> <ul style="list-style-type: none"> <li>• Cholesterol Biosynthesis and Regulation</li> <li>• Effect of Statins on Cholesterol Synthesis</li> <li>• Intracellular Cholesterol Regulation</li> <li>• Bile Acid Synthesis and Regulation</li> <li>• Mechanism of Cholelithiasis</li> <li>• Clinical Correlations in Cholesterol Metabolism</li> </ul>	Lecture	2	Biochemistry
<p>6.104.Describe the processes of protein digestion and absorption, including key enzymes and transport mechanisms in the stomach and small intestine.</p> <p>6.105.Explain the metabolic fate of amino acids, focusing on their role in protein synthesis, energy production, and nitrogen disposal.</p> <p>6.106.Analyze the regulation of amino acid metabolism and its clinical relevance in conditions like phenylketonuria, maple syrup urine disease</p>	<p><b>Proteins and Amino Acids Metabolism</b></p> <ul style="list-style-type: none"> <li>• Enzymes for Protein Digestion</li> <li>• Absorption of Proteins and Peptides</li> <li>• Amino Acid Absorption from Intestinal Lumen</li> <li>• Transamination and Deamination in Amino Acid Metabolism</li> <li>• Central Role of Glutamate in Amino Acid Metabolism</li> <li>• Ketogenic and Glucogenic Amino Acids</li> <li>• Specialized Products from Amino Acids</li> <li>• Clinical Correlations in Amino Acid Metabolism</li> </ul>	Lecture	2	Biochemistry
<p>6.107.Describe the steps of the urea cycle, including key enzymes, intermediates, and the conversion of ammonia to urea.</p> <p>6.108.Explain the regulation of the urea cycle by substrate availability, allosteric control, and hormonal influences.</p> <p>6.109.Analyze the clinical significance of the urea cycle, including disorders such as urea cycle defects and their impact on nitrogen metabolism and overall health.</p>	<p><b>Urea Cycle</b></p> <ul style="list-style-type: none"> <li>• Urea Cycle and Its Regulation</li> <li>• Amino Acid Exchange Among Organs</li> <li>• Enzyme Deficiencies in the Urea Cycle</li> <li>• Toxicity of Excess Ammonia</li> <li>• Clinical relevance and implications of disorders related to the urea cycle and ammonia toxicity.</li> </ul>	Lecture	2	Biochemistry

<p>6.110.Describe the biosynthesis and degradation pathways of purines and pyrimidines, including key enzymes and intermediates involved.</p> <p>6.111.Explain the regulation of purine and pyrimidine metabolism and its role in nucleotide balance and DNA/RNA synthesis.</p> <p>6.112.Analyze the clinical significance of purine and pyrimidine metabolism, including disorders like gout, immunodeficiencies, and drug effects on metabolism (e.g., methotrexate).</p>	<p><b>Purine and pyrimidine metabolism</b></p> <ul style="list-style-type: none"> <li>• Description of the de novo synthesis pathways for purines and pyrimidines. <ul style="list-style-type: none"> <li>- Regulation of Purine Synthesis</li> <li>- Salvage Pathway for Purines</li> <li>- Role of Tetrahydrofolate (B9)</li> <li>- Effect of Enzyme Deficiencies on Purine Synthesis</li> </ul> </li> <li>- Purine Catabolism</li> <li>- Clinical Correlations in Nucleotide Metabolism</li> </ul>	Lecture	2	Biochemistry
<p>6.113.Describe the metabolic changes that occur during feeding and fasting, including shifts in insulin/glucagon ratios and the mobilization of energy stores.</p> <p>6.114.Explain the pathophysiology of diabetes, focusing on insulin resistance and impaired glucose metabolism.</p> <p>6.115.Analyze the impact of feeding, fasting, and diabetes on overall metabolism, and the role of therapeutic interventions like insulin therapy and dietary modifications in managing metabolic disorders.</p>	<p><b>Metabolism of Feeding /Fasting states and Diabetes</b></p> <ul style="list-style-type: none"> <li>• Understanding energy homeostasis</li> <li>• Metabolic pathway regulation</li> <li>• Glycogen metabolism</li> <li>• Gluconeogenesis and ketogenesis</li> <li>• Lipid metabolism</li> <li>• Protein and amino acid metabolism</li> <li>• Transition between feeding and fasting states</li> <li>• Role of the cori and glucose-alanine cycles</li> <li>• Energy substrate prioritization</li> <li>• Clinical relevance and biochemical diagnosis of diabetes</li> </ul>	Lecture	2	Biochemistry
<p>6.116.Describe how the major metabolic pathways (carbohydrate, lipid, protein metabolism) are integrated to maintain cellular energy homeostasis.</p> <p>6.117.Explain the role of key regulatory molecules (insulin, glucagon, AMP, ATP) in coordinating metabolic processes across different tissues and organs.</p> <p>6.118.Analyze the importance of metabolic integration in physiological states such as</p>	<p><b>Metabolic Integration</b></p> <ul style="list-style-type: none"> <li>• Metabolic Pathway Interconnections</li> <li>• Hormonal Regulation</li> <li>• Tissue-Specific Metabolic Roles</li> <li>• Fed and Fasting State Integration</li> <li>• Energy Substrate Shifts</li> <li>• Adaptations During Exercise</li> <li>• Pathophysiology of Metabolic Dysregulation</li> <li>• Interorgan Communication</li> <li>• Regulation of ATP Production</li> <li>• Clinical Relevance</li> </ul>	Lecture	2	Biochemistry

fed, fasting, and stress responses, and its relevance to metabolic disorders.				
<p>6.119.Describe the role of the liver in xenobiotic metabolism, including phase I (oxidation, reduction, hydrolysis) and phase II (conjugation) reactions, and the enzymes involved.</p> <p>6.120.Explain the significance of liver function tests (e.g., ALT, AST, bilirubin levels) in assessing liver health and detecting liver diseases.</p> <p>6.121.Analyze the clinical implications of impaired liver metabolism in drug interactions, toxicity, and liver diseases such as cirrhosis, hepatitis, and fatty liver disease.</p>	<p><b>Xenobiotic Metabolism</b></p> <ul style="list-style-type: none"> <li>• Definition and Significance of Xenobiotics</li> <li>• Liver's Role in Xenobiotic Metabolism</li> <li>• Toxicity Conversion and Phases of Drug Metabolism</li> <li>• Conjugation in Xenobiotic Metabolism</li> <li>• Role of Cytochrome P450 Enzyme</li> <li>• Metabolism of Specific Compounds</li> <li>• Liver Function Tests</li> <li>• Components of Liver Function Tests</li> <li>• Biochemical Changes in Liver Disorders</li> <li>• Differentiation of Jaundice Types</li> <li>• Understanding Liver Enzymes</li> <li>• Liver Protein and Bilirubin Dynamics</li> <li>• Impact of Liver Diseases</li> <li>• Clinical Correlations</li> <li>• Interpretation of Results</li> </ul>	Lecture	4	Biochemistry
<p>6.122.Describe the biochemical pathways involved in the regulation of body weight, including energy balance, adipogenesis, and lipid metabolism.</p> <p>6.123.Explain the role of hormones (e.g., leptin, ghrelin, insulin) in appetite regulation and fat storage in obesity.</p> <p>6.124.Analyze the biochemical factors contributing to obesity-related diseases, such as insulin resistance, metabolic syndrome, and cardiovascular disease.</p>	<p><b>Biochemical Basis of Obesity</b></p> <ul style="list-style-type: none"> <li>• Adipose Tissue as an Endocrine Organ</li> <li>• Body Mass Index (BMI)</li> <li>• Adipokines</li> <li>• Leptin and Adiponectin in Adipocyte Mass</li> <li>• Regulation of Body Mass by Leptin</li> <li>• Leptin's Effect on Neurons</li> <li>• Adiponectin and Metabolic Syndrome</li> <li>• Genetic Factors in Obesity</li> <li>• Obesity and Metabolic Syndrome</li> <li>• Clinical Conditions Related to Obesity</li> </ul>	Lecture	2	Biochemistry
<p>6.125.Recall the arrangement of the lower part of the thoracic cage and the lumbar vertebral column.</p> <p>6.126.Describe the layers of the lumbar fascia, their attachments, and the arrangement of muscles in the posterior abdominal wall</p>	<p><b>Posterior abdominal wall</b></p> <ul style="list-style-type: none"> <li>• The structural arrangement of the lower part of the thoracic cage and lumbar vertebral column, including their anatomical relationships to the posterior abdominal wall.</li> <li>• The layers of the lumbar fascia, including their attachments and the functional arrangement of muscles in the posterior abdominal wall.</li> </ul>	Lecture	2	Anatomy

<p>6.127. Recall the surface landmarks used for the abdominal surface marking of organs and structures.</p> <p>6.128. Outline and name the divisions of the abdomen into its nine regions, describing the layout of the viscera within these regions.</p> <p>6.129. Define the parietal and visceral peritoneum, and identify the peritoneal folds in relation to visceral structures.</p> <p>6.130. Recognize the viscera that are retroperitoneal and identify the significance of peritoneal spaces and recesses.</p>	<p><b>Surface Marking of the Abdomen</b></p> <ul style="list-style-type: none"> <li>• The ability to divide the abdomen into nine regions and describe the layout of the viscera within these regions, identifying key surface landmarks.</li> <li>• The distinction between parietal and visceral peritoneum, describing the peritoneal folds in relation to the abdominal viscera, and identifying the structures that are retroperitoneal.</li> <li>• The peritoneal spaces and recesses, discussing their clinical significance and the role they play in abdominal anatomy.</li> </ul>	Lecture	2	Anatomy
<p>6.131. Identify key abdominal organs and structures in various imaging modalities such as X-ray, CT, MRI, and ultrasound.</p> <p>6.132. Describe the normal anatomical relationships of abdominal organs as visualized in cross-sectional imaging.</p> <p>6.133. Correlate imaging findings with surface anatomy and internal landmarks.</p> <p>6.134. Explain the principles of abdominal imaging techniques and their clinical applications in diagnosing abdominal disorders.</p>	<p><b>Imaging Anatomy of the Abdomen</b></p> <ul style="list-style-type: none"> <li>• The abdominal organs and structures in various imaging modalities such as X-ray, CT, MRI, and ultrasound.</li> <li>• The normal anatomical relationships of abdominal organs as visualized through cross-sectional imaging techniques.</li> <li>• Correlate imaging findings with surface anatomy and internal landmarks.</li> <li>• The principles behind abdominal imaging techniques and their clinical applications in diagnosing abdominal disorders.</li> </ul>	Lecture	2	Anatomy
<p>6.135. Discuss the physiology of vomiting and antiemetics</p>	<p><b>Physiology of Vomiting</b></p> <ul style="list-style-type: none"> <li>• Physiological mechanisms behind vomiting</li> <li>• Role of antiemetics in preventing vomiting</li> </ul>	Lecture	1	Physiology
<p>6.136. Describe the pathophysiology of diarrhea</p> <p>6.137. Explain the common causes of diarrhea their effects on gastrointestinal function.</p> <p>6.138. Analyze the clinical management and treatment strategies for diarrhea.</p>	<p><b>Physiology of Diarrhea</b></p> <ul style="list-style-type: none"> <li>• Diarrhea and its classification based on frequency, consistency, and volume of stool</li> <li>• The types of diarrhea: osmotic, secretory, and inflammatory</li> <li>• Physiological mechanisms behind diarrhea, including altered motility, secretion, and absorption in the gastrointestinal tract</li> </ul>	Lecture	1	Physiology

	<ul style="list-style-type: none"> <li>• Role of pathogens, toxins, and underlying conditions in triggering diarrhea</li> <li>• Consequences of diarrhea, such as dehydration, electrolyte imbalances, and malnutrition</li> <li>• Role of Oral Rehydration Solution (ORS) in preventing dehydration and restoring electrolyte balance in diarrhea management</li> </ul>			
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## 3.7 Renal Module

Module code	Year	Semester	Credit
MEBS-1-2-3-2	01	02	02

### Introduction

Have you ever wondered which part of your body works tirelessly to keep everything in balance—managing fluid levels, electrolytes, pH, and even your blood pressure? It's amazing how one system does so much to maintain the stability your body needs to survive. If that sounds interesting, get ready to dive into the world of the kidneys and the urinary system.

Over the module we'll uncover how the kidneys and urinary tract work, from their structure to their incredible functions. Understanding this system is super important because kidney problems are surprisingly common and can affect people at any point in their lives. Plus, what you learn here will be key to understanding how to handle fluid and electrolyte issues and take care of patients with kidney and urinary tract conditions in the future.

### Module Committee

<b>Module Coordinator</b>	Dr. Chamalika Weerakoon - Head/Department of Anatomy
<b>Committee members</b>	Dr. Joachim Perera – Consultant for Department of Anatomy Prof. M.N. Wickramaratne - Professor/Department of Biochemistry Dr. Irosha Nicholas -Basic Sciences Stream Coordinator, Head/Department of Biochemistry Dr. Kaushalya Kulathunga – Head/Department of Physiology Dr. Amal Wageesha – Senior Lecturer/Department of Biochemistry Dr. Sumeth Perera - Senior Lecturer/Department of Biochemistry Dr. Yasas Kolambage – Lecturer/Department of Anatomy Ms. Nadeesha Nilmini – Lecturer/Department of Biochemistry

### Module Learning Outcomes

At the end of the renal module, the student should be able to:

1. explain the development of the kidney and the urinary system with the basis of common urinary tract abnormalities.
2. describe the structure and the relations of the kidney, ureter bladder and urethra in the male and the female.
3. describe the functions of the kidney and its role in homeostasis.
4. describe the basis of features (anatomical, physiological and biochemical) seen in common kidney disease.
5. describe the normal mechanism of micturition and the functional/structural abnormalities that produce common voiding dysfunction.

## Course details with Intended Learning Outcome (ILOs)

Intended Learning Outcome (ILO)	Content Outline	Activity	Duration (Hours)	Department
7.1.Describe the macroscopic structure of the renal system  7.2.Analyze how the structure of the renal system relates to its function.	<b>Anatomy of the Renal System</b> <b>Kidney</b> <ul style="list-style-type: none"> <li>Position, relations, poles, borders, and hilus of the kidney</li> <li>Clinical significance of renal fascia and perinephric fat</li> <li>Structure: cortex, medulla, pelvis and calyces</li> <li>Blood supply and lymphatic drainage</li> </ul> <b>Ureter</b> <ul style="list-style-type: none"> <li>Origin, course, and relations</li> <li>Mechanisms to prevent reflux</li> <li>Clinical significance of obstruction of the lumen</li> </ul> <b>Bladder</b> <ul style="list-style-type: none"> <li>Position, shape, peritoneal reflection, trigone and main relations</li> <li>Parts: apex, base, inferolateral surfaces, neck</li> <li>Blood, nerve and lymphatic supply</li> </ul> <b>Urethra</b> <u>Male: Urethra and Prostate</u> <ul style="list-style-type: none"> <li>Course, relations, and parts (prostatic, membranous and spongy)</li> <li>Blood supply, nerve supply and lymphatic drainage of the urethra.</li> </ul> <u>Female: Urethra (A)</u> <ul style="list-style-type: none"> <li>Course, relations, and parts</li> <li>Blood supply, nerve supply and lymphatic drainage of the urethra</li> <li>Structure, function and control of the sphincters in female and male</li> <li>Structural differences of the male and female urethra</li> </ul>	Lecture	2	Anatomy
		Dissection/ Demonstration/ FLM	2	Anatomy
7.3.Describe the microscopic structure of the renal system and analyse how its structure relates to its function.	<b>Histology of the Renal System</b> <ul style="list-style-type: none"> <li>Microscopic structure of the nephron (Bowman's capsule, PCT, LOH, DT, CD), ureter, bladder, and urethra</li> <li>Renal circulation</li> </ul>	Lecture	2	Anatomy
		Practical	2	Anatomy
7.4.Explain the development and developmental anomalies of the renal system	<b>Development of the renal system</b> <ul style="list-style-type: none"> <li>Development and developmental anomalies of the kidney, ureter, prostate, bladder and urethra (male and female)</li> </ul>	Lecture	2	Anatomy

<p>7.5. Describe the functional anatomy of the kidneys and explain the mechanisms of glomerular filtration</p> <p>7.6. Analyze the factors influencing renal blood flow GFR and autoregulation</p>	<p><b>Introduction to renal physiology</b></p> <ul style="list-style-type: none"> <li>• Functional anatomy of the kidneys including the ultrastructural appearance of the glomerular ultra-filtering membrane</li> <li>• Glomerular filtration rate (GFR) and its regulation</li> <li>• Renal blood flow and autoregulation: neural, and hormonal influences</li> <li>• Characteristics of a substance used to measure the GFR and explain the principle of using such a substance to measure GFR</li> <li>• Renal clearance of a substance</li> </ul>	Lecture	2	Physiology
<p>7.7. Discuss Tubular Functions and regulation of Ions by the Kidney</p> <p>7.8. Define the concepts of glucose reabsorption, renal threshold, and transport maximum</p> <p>7.9. Analyze how these processes contribute to renal physiology and homeostasis.</p>	<p><b>Tubular Functions and Regulation of Ions by the Kidney</b></p> <ul style="list-style-type: none"> <li>• Absorptive and secretory functions of different parts of the nephron</li> <li>• Transport mechanisms in relation to Na<sup>+</sup>, K<sup>+</sup>, glucose, H<sup>+</sup> and water</li> <li>• Glucose reabsorption, renal threshold, and transport maximum concepts</li> </ul>	Lecture	2	Physiology
<p>7.10. Describe the Processes involved in acid-base regulation</p> <p>7.11. Evaluate the role of urinary buffers in facilitating H<sup>+</sup> excretion</p>	<p><b>Renal Acid Base Balance</b></p> <ul style="list-style-type: none"> <li>• Role of kidneys in the <ul style="list-style-type: none"> <li>- Regulation of H<sup>+</sup> in the body.</li> <li>- Secretion of H<sup>+</sup></li> <li>- Reabsorption of filtered HCO<sub>3</sub><sup>-</sup></li> <li>- Synthesis of new HCO<sub>3</sub><sup>-</sup></li> </ul> </li> <li>• Using urinary buffers to facilitate H<sup>+</sup> excretion</li> </ul>	Lecture	2	Physiology
<p>7.12. Describe the regions and mechanisms of water reabsorption in the nephron, and explain the roles of the counter-current multiplier and exchanger</p> <p>7.13. Discuss the factors influencing urine dilution and concentration</p>	<p><b>Renal Water Homeostasis</b></p> <ul style="list-style-type: none"> <li>• Regions and mechanisms of water reabsorption in the nephron</li> <li>• Counter-current multiplier and exchanger role in concentration gradients</li> <li>• Factors influencing urine dilution and concentration</li> <li>• Mechanisms of tubular-glomerular feedback/ balance in maintaining homeostasis</li> </ul>	Lecture	2	Physiology



7.14.Evaluate how tubular-glomerular feedback mechanisms contribute to maintaining homeostasis in renal function				
7.15.Define of diuresis and the MoA of different classes of diuretics  7.16.Compare and contrast water diuresis and osmotic diuresis  7.17.Evaluate the use of different classes of diuretics in the clinical application	<b>Diuretics</b> <ul style="list-style-type: none"> <li>• Definition of diuresis and its physiological basis</li> <li>• Mechanisms and clinical implications of water diuresis vs osmotic diuresis</li> <li>• Mechanism of action of following diuretics: water, ethanol, mannitol and glucose, carbonic anhydrase inhibitors, thiazides, 'loop' diuretics, K<sup>+</sup> sparing diuretics</li> </ul>	Lecture	2	Physiology
7.18.Identify the normal and abnormal constituents of urine macroscopically, microscopically and biochemically.	<b>Urine analysis and Urine Full Report</b> <ul style="list-style-type: none"> <li>• Colour, appearance, pH, specific gravity</li> <li>• Cells, casts, crystals, calculi</li> <li>• Reducing substances, protein, ketone bodies, bile pigments &amp; bile salts</li> <li>• Assessment of renal function in clinical practice using, - Blood urea - Serum creatinine - Cystatin c - Creatinine clearance - Estimated GFR(eGFR)</li> </ul>	Practical	2.5	Physiology
7.19.Explain the physiological basis of clinical features of common renal diseases	<b>Renal Pathologies</b> <ul style="list-style-type: none"> <li>• Nephrotic syndrome-proteinuria, oedema</li> <li>• AKI - oliguria, oedema, hypertension,hyperkalaemia, metabolic acidosis</li> <li>• CKD -polyuria, hypertension, hyperkalaemia, metabolic acidosis, anaemia, mineral bone disease</li> </ul>	Practical	2.5	Physiology
7.20.Perform tests to identify some abnormal constituents of urine.	<ul style="list-style-type: none"> <li>• Benedict's test, Heat coagulation test, Rothera's test, Fouchet's test, Hay's test</li> <li>• Interpretation of laboratory reports related to renal function</li> </ul>	Practical  FLM*	2  2	Biochemistry  Biochemistry
7.21.Discuss the principles of imaging techniques  7.22.Apply the principles of imaging techniques to interpret clinical manifestations related to the renal system	<b>Imaging Anatomy of the Renal System</b> <ul style="list-style-type: none"> <li>• Imaging modalities utilized in the evaluation of the renal system</li> <li>• Linking imaging findings with clinical manifestations for accurate diagnosis</li> </ul>	Lecture	2	Anatomy

## 3.8 Reproductive Module

Module code	Year	Semester	Credit
MEBS-1-2-2-3	01	02	03

### Introduction

The Reproductive module provides an in-depth exploration of the gross anatomy, microscopic anatomy, physiology, and clinical aspects of the male and female reproductive systems. In this module, you will enhance your understanding of the complex structures and functions involved in human reproduction, from gamete production to fertilization, pregnancy, and parturition. The male reproductive system includes organs such as the testes, epididymis, vas deferens, prostate, and penis, all of which work together to produce, mature, and transport sperm. The female reproductive system, on the other hand, comprises the ovaries, fallopian tubes, uterus, and vagina, each playing a crucial role in ovulation, fertilization, and fetal development. Additionally, the module will cover the hormonal regulation of reproduction, detailing how hormones such as estrogen, progesterone, and testosterone influence reproductive processes.

This module also delves into the physiological changes that occur during puberty, pregnancy, lactation, and menopause, while emphasizing the clinical implications of common reproductive disorders, including infertility, sexually transmitted infections, and congenital anomalies. By examining the reproductive system from both an anatomical and functional perspective, you will gain a comprehensive understanding of human reproduction and its significance to overall health.

Throughout this module, you will explore the interrelationship between structure and function, understand the role of hormones in regulating reproductive cycles, and gain insights into the latest diagnostic and therapeutic approaches for reproductive health. The knowledge gained in this module is essential for understanding reproductive health, family planning, and addressing clinical challenges related to human reproduction.

### Module Committee

<b>Module Coordinator</b>	Dr. Chamalika Weerakoon - Head/Department of Anatomy
<b>Committee members</b>	Dr. Joachim Perera – Consultant for Department of Anatomy Prof. M.N. Wickramaratne - Professor/Department of Biochemistry Dr. Irosha Nicholas –Basic Sciences Stream Coordinator, Head /Department of Biochemistry Dr. Kaushalya Kulathunga – Head/Department of Physiology Dr. Amal Wageesha – Senior Lecturer/Department of Biochemistry Dr. Sumeth Perera - Senior Lecturer/Department of Biochemistry Dr. Yasas Kolambage – Lecturer/Department of Anatomy Ms. Nadeesha Nilmini – Lecturer/Department of Biochemistry

## Module Learning Outcomes

At the end of the reproductive module, the student should be able to:

1. describe the normal structure, function, and regulation of the male and female reproductive systems, including the processes of fertilization, pregnancy, parturition, puerperium, and lactation, by integrating and applying the basic sciences.
2. evaluate the clinical aspects of the reproductive system by integrating knowledge of its structure and function in relation to common reproductive disorders and congenital anomalies.
3. critically evaluate the hormonal regulation of the reproductive systems, applying knowledge of hormonal interactions to understand their impact on reproductive health, fertility, and related medical conditions
4. apply knowledge of imaging techniques for the reproductive system, critically assessing imaging findings to identify and interpret both normal and pathological conditions across various imaging modalities.

## Course details with Intended Learning Outcome (ILOs)

Intended Learning Outcome (ILO)	Content Outline	T/L Activity	Duration (Hours)	Department
8.1. Describe the anatomical structure and function of the bony pelvis and its associated joints  8.2. Analyze its role in movement, load-bearing, and clinical conditions	<b>Bony Pelvis and Joints of the Pelvis</b> <ul style="list-style-type: none"> <li>Genetic male and genetic female</li> <li>Sex chromosomal abnormalities</li> <li>Anatomical features of the bony pelvis</li> <li>Gender differences in the structure of the pelvis and their functional implications</li> <li>Classification of the pelvic joints</li> <li>Ligaments and muscles associated with the stability of the pelvic joints</li> <li>Clinical conditions to abnormalities in the bony pelvis and pelvic joints</li> </ul>	Guided Learning	2	Anatomy
8.3. Describe anatomy and function of the muscles of the pelvic wall, pelvic floor, and perineum.  8.4. Analyze the role of the pelvic floor muscles in supporting the pelvic viscera and maintaining pelvic stability.	<b>Pelvic Wall, Pelvic Floor and Perineum</b> <ul style="list-style-type: none"> <li>Muscles of the pelvic wall</li> <li>Importance of the muscles of the pelvic floor as a support to pelvic viscera</li> </ul>	Guided Learning	2	Anatomy
8.5. Describe anatomical boundaries of the perineum and the limits of the perineal pouches.	<b>Perineum</b> <ul style="list-style-type: none"> <li>Boundaries of the perineum</li> <li>Perineal pouches</li> </ul>	Lecture	1	Anatomy

8.6. Describe the anatomical structures of the bony pelvis, pelvic joints, pelvic wall, pelvic floor, and perineum,	<b>Bony Pelvis and Joints of the Pelvis, Pelvic Wall, Floor and Cavity, Perineum</b> <ul style="list-style-type: none"> <li>Anatomical features of the bony pelvis and its joints</li> <li>Muscles of the pelvic wall and their role in pelvic stability</li> <li>Structure and function of the pelvic floor muscles and their role in supporting pelvic viscera</li> <li>Boundaries and subdivisions of the perineum</li> <li>Clinical conditions to dysfunctions of the bony pelvis, pelvic joints, pelvic floor, and perineum</li> </ul>	Dissections/ Demonstration/ FLM	2	Anatomy
8.7. Describe the gross anatomy of the female reproductive system	<b>Gross Anatomy of Female Reproductive System</b> <p><b>Ovary</b></p> <ul style="list-style-type: none"> <li>Position of ovary in the pelvic cavity and its gross structure, its relations</li> <li>Blood supply and describe the course of the main arteries</li> <li>Ovarian cycle and its influence on the uterus</li> </ul> <p><b>Uterus and uterine tubes</b></p> <ul style="list-style-type: none"> <li>Anatomy of uterus and its position in the pelvic cavity</li> <li>Anteversion and anteflexion</li> <li>Supports of the uterus</li> <li>Internal os and external os</li> <li>Fornices in relation to the cervix</li> <li>Blood supply</li> <li>Uterine cycle and endometrial changes</li> <li>Parts of the uterine tube and its functions</li> <li>Process of fertilization and implantation</li> </ul> <p><b>Vagina</b></p> <ul style="list-style-type: none"> <li>Anatomy of the vagina and its direction</li> <li>Fornices and their important relations</li> <li>Blood supply</li> </ul>	Lecture	2	Anatomy
8.8. Explain the anatomy of the mammary gland  8.9. Analyze the anatomical changes that occur during pregnancy and lactation.	<b>Mammary Gland</b> <ul style="list-style-type: none"> <li>Location of the breast</li> <li>Components of the breast</li> <li>Fascial relations</li> <li>Mammary gland and the arrangement of the ducts</li> <li>Blood supply</li> <li>Lymphatic drainage</li> <li>Changes in the breast during pregnancy and lactation</li> </ul>	Lecture	1	Anatomy

8.10. Describe microscopic structure of the female reproductive system	<b>Histology of Female Reproductive System</b>  <b>Ovary</b> <ul style="list-style-type: none"> <li>• Microscopic structure of the ovary</li> <li>• Follicles in various stages of maturation</li> <li>• Process of oogenesis and the changes that take place in the oocyte</li> <li>• Process of ovulation</li> <li>• Microscopic structure of the corpus luteum</li> </ul> <b>Uterus and Vagina</b> <ul style="list-style-type: none"> <li>• Ovarian and uterine cycle</li> <li>• Microscopic structure of the uterine tube</li> <li>• Related to this structure to its function</li> <li>• Histological features of the walls of the uterus</li> <li>• Features of the endometrium at stages of the ovarian/uterine cycle</li> <li>• Significance of these changes in relation to implantation of the fertilized ovum</li> <li>• Microscopic structure of the cervix</li> <li>• Microscopic features of the vaginal wall</li> </ul> <b>Mammary gland</b> <ul style="list-style-type: none"> <li>• Microscopic structure of the mammary gland</li> <li>• Role of the epithelial and stromal components in the mammary gland</li> <li>• Changes in the mammary gland during different stages of life during puberty, pregnancy, lactation</li> <li>• Microscopic changes associated with clinical conditions of the mammary gland</li> </ul>	Lecture	2	Anatomy
		Practical	1	Anatomy
8.11. Describe the functions and the regulation of the female reproductive system	<b>Physiology of Female Reproductive System – Hormones</b> <ul style="list-style-type: none"> <li>• Key hormones secreted by Leydig cells and Sertoli cells of the testes and by the Graffian follicles and Corpora Lutea of the ovaries</li> <li>• Role of chromosomes, hormones and related factors in sex determination and development</li> <li>• Hormonal changes in the body at puberty in males and females</li> </ul>	Lecture	2	Physiology
8.12. Describe the functions and the regulation of the female reproductive system	<b>Physiology of Female Reproductive System Menstrual cycle</b> <ul style="list-style-type: none"> <li>• Physiologic changes that occur in the female reproductive organs during the menstrual cycle</li> </ul>	Lecture	2	Physiology

	<ul style="list-style-type: none"> <li>General structures of 17<math>\beta</math>- estradiol and progesterone and their biosynthesis, transport, metabolism and actions</li> <li>Roles of the pituitary and the hypothalamus in the regulation of ovarian function and the role of feedback loops in this process</li> </ul>			
8.13.Describe the physiology of puberty and menopause	<b>Puberty and Menopause</b> <ul style="list-style-type: none"> <li>Puberty and adolescence</li> <li>Male and female secondary sexual characteristics</li> <li>physiological changes that occur during puberty</li> <li>Menopause and climacteric</li> <li>Changes in reproductive hormones, reproductive organs and other systems in the body during and after menopause</li> </ul>			
8.14.Describe the physiology behind pregnancy and parturition	<b>Pregnancy and Parturition</b> <ul style="list-style-type: none"> <li>Formation of CL and Role of CL in Maintaining a pregnancy</li> <li>The hormones that are important in maintaining a pregnancy up to term</li> <li>The site of production, structure, function and the pattern of secretion of hCG, hPL, oestrogen and progesterone during a normal pregnancy</li> <li>The physiological changes that occur in the body during pregnancy including breasts</li> <li>The signs and symptoms of pregnancy</li> <li>The physiological basis of the pregnancy test</li> <li>The functions of the placenta</li> <li>The exchange of substances across the placenta</li> <li>Labour and the factors responsible for the onset of labour</li> <li>The hormonal regulation of labour</li> <li>Puerperium and the physiological changes that occur during puerperium</li> </ul>	Lecture	2	Physiology
8.15.Describe the physiology of lactation, including the processes involved in milk production and secretion	<b>Physiology of lactation</b> <ul style="list-style-type: none"> <li>The neuroendocrine regulation of milk production and milk ejection(A)</li> <li>Physiological basis of lactational amenorrhoea</li> </ul>	Lecture	2	Physiology
8.16.Describe the factors considered in prescribing a diet during pregnancy, lactation, and infancy	<b>Nutrition in Pregnancy, Lactation and Infancy</b> <ul style="list-style-type: none"> <li>Factors are considered in prescribing a diet for infants (principles of complementary feeding) /pregnancy/lactation</li> </ul>	Lecture	2	Biochemistry

8.17. Describe the neonatal physiology, including the.	<b>Neonatal Physiology</b> <ul style="list-style-type: none"> <li>Physiological adaptations and functions of organ systems in the newborn</li> <li>Mechanisms that support survival and development immediately after birth</li> </ul>	Lecture	2	Physiology
8.18. Describe the anatomy of the male reproductive system, including the structure, location, and relations of the scrotum, testes, epididymis, ductus deferens, prostate, and urethra  8.19. Discuss the development of the male genital ducts and external genitalia, the factors influencing their development, and the clinical significance of congenital anomalies and the spread of malignancy within the male reproductive system	<b>Anatomy of the Male Reproductive System</b> <ul style="list-style-type: none"> <li>Parts of the male reproductive system and the location of its parts</li> </ul> <b>Scrotum and testes</b> <ul style="list-style-type: none"> <li>Walls of the scrotum and recall its continuity with the anterior abdominal wall</li> <li>Gross anatomy of the testes, its blood supply and lymphatic drainage</li> <li>Structure of seminiferous tubule and process of spermatogenesis</li> <li>Anatomy of the inguinal canal- its location, position of the deep and superficial inguinal rings, its walls and contents</li> <li>Spermatic cord and its contents</li> <li>Descent of testes</li> <li>Parts of the epididymis and its microscopic structure</li> <li>Course of the ductus deferens</li> <li>Gross anatomy of the prostate</li> <li>Capsule of the prostate</li> <li>Sagittal and transverse section through the prostatic urethra</li> <li>Lobes of the prostate and the arrangement of the glandular tissue</li> <li>Venous drainage to spread of malignancy</li> <li>Microscopic structure of the ductus deferens, seminal vesicle and prostate gland</li> </ul> <b>Urethra</b> <ul style="list-style-type: none"> <li>Commencement and termination of the urethra</li> <li>Parts of the urethra and the location of these parts</li> <li>Sinuous course and varying dilatations and constrictions</li> <li>Sphincters</li> <li>Blood supply</li> <li>Development of the male genital ducts and external genitalia</li> <li>Factors that influence the development of these structures</li> <li>Congenital anomalies of the urethra</li> </ul>	Lecture	2	Anatomy

8.20. Describe the microscopic structure of the male reproductive system	<b>Histology of Male Reproductive System</b> <ul style="list-style-type: none"> <li>• Parts of the male genital system</li> <li>• Gross anatomy</li> <li>• Walls of the scrotum</li> </ul> <b>Testes</b> <ul style="list-style-type: none"> <li>• Tunica albuginea and the intermuscular septa and lobules</li> <li>• Seminiferous tubules</li> <li>• Cells lining the tubules, the rete testis and the vasa efferentia</li> <li>• Process of spermatogenesis and list the cells of the spermatogenic series</li> <li>• Morphological features of the cells of this series</li> <li>• Spermiogenesis</li> <li>• Changes that occur in the formation of a sperm from a spermatid</li> <li>• Structure of a mature sperm</li> <li>• Features of a Sertoli cells and discuss their function</li> <li>• Blood testes barrier</li> <li>• Location of the interstitial cells of the testes and discuss their functions</li> </ul>	Lecture	2	Anatomy
Practical		Practical	1	Anatomy
8.21. Describe the functions and the regulation of the male reproductive system	<b>Physiology of Male Reproductive System</b> <ul style="list-style-type: none"> <li>• Key hormones secreted by Leydig cells and Sertoli cells of the testes</li> <li>• Steps involved in spermatogenesis</li> <li>• Mechanisms that produce erection and ejaculation</li> <li>• General structure of testosterone and its biosynthesis, transport, metabolism and actions</li> <li>• Processes involved in the regulation of testosterone secretion</li> </ul>	Lecture	2	Physiology
8.22. Demonstrate the process of semen analysis	<b>Semen analysis</b> <ul style="list-style-type: none"> <li>• Techniques used to evaluate semen quality,</li> <li>• Interpretation of parameters such as sperm count, motility, morphology, and overall semen health in relation to male fertility</li> </ul>	Demonstration	2	Physiology
8.23. Describe the various contraceptive methods and the use	<b>Contraceptives</b> <ul style="list-style-type: none"> <li>• Mechanisms of action, efficacy, benefits, and potential side effects</li> <li>• Role in family planning and reproductive health</li> </ul>	Demonstration	2	Physiology
8.24. Describe the development of male and female reproductive system	<b>Development of the Male and Female Reproductive System</b> <ul style="list-style-type: none"> <li>• Embryological development of the male and female reproductive systems</li> </ul>	Lecture	2	Anatomy



	<ul style="list-style-type: none"> <li>• Roles of genetic and hormonal factors in the differentiation of male and female reproductive systems</li> <li>• Comparison of the development of the male and female reproductive systems</li> <li>• Role of the mesonephric and paramesonephric ducts in sexual differentiation</li> <li>• Congenital anomalies related to the development of the reproductive systems</li> <li>• Clinical implications of abnormal development</li> </ul>			
8.25.Describe the process of sexual differentiation  8.26.Evaluate the presentation of sex differentiation abnormalities	<b>Sex Differentiation and abnormalities</b> <ul style="list-style-type: none"> <li>• Genetic male and genetic female</li> <li>• Sex chromosomal abnormalities</li> <li>• Abnormalities of sexual differentiation</li> </ul>	SGD	2	Physiology
8.27.Describe the imaging anatomy of the reproductive system	<b>Imaging Anatomy of the Reproductive System</b> <ul style="list-style-type: none"> <li>• Anatomical features of reproductive organs in various imaging modalities</li> <li>• Principles and techniques used in imaging the reproductive system</li> <li>• Imaging findings of the reproductive system</li> <li>• Role of imaging in diagnosing reproductive system disorders</li> <li>• Limitations and advantages of different imaging techniques in reproductive system anatomy</li> <li>• Fetal imaging in the context of the reproductive system</li> </ul>	Lecture	2	Anatomy

\*FLM, Fixed Learning Module

## 3.9 Nutrition Module

Module code	Year	Semester	Credit
MEBS-2-1-1-2	02	01	02

### Introduction

The nutrition module provides a comprehensive overview of key concepts related to digestion, absorption, and the functions of macronutrients (proteins, carbohydrates, and fats) essential for energy and growth. It explores the importance of vitamins and minerals, categorizing them into fat-soluble and water-soluble groups, and highlights the nutritional value of foods from plant and animal sources. Additionally, it addresses energy and protein requirements, amino acid balance, and nutritional status assessment while emphasizing strategies to combat energy-protein malnutrition. The module concludes with the principles of diet formulation, including food group classifications and functional foods, offering a holistic approach to understanding nutrition.

### Module Committee

<b>Module Coordinator</b>	Ms. Nadeesha Nilmini – Lecturer/Department of Biochemistry Dr. Irosha Nicholas – Basic Sciences Stream Coordinator, Head/Department of Biochemistry
<b>Committee members</b>	Dr. Joachim Perera – Consultant for Department of Anatomy Prof. M.N. Wickramaratne - Professor/Department of Biochemistry Dr. Kaushalya Kulathunga – Head/Department of Physiology Dr. Chamalika Weerakoon - Head/Department of Anatomy Dr. Amal Wageesha – Senior Lecturer/Department of Biochemistry Dr. Sumeth Perera - Senior Lecturer/Department of Biochemistry Dr. Yasas Kolambage – Lecturer/Department of Anatomy

### Module Learning Outcomes

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

1. Discuss the fundamental concepts of nutrition, including key terminologies, definitions, and foundational principles.
2. Explain the human requirements for micronutrients and analyze how inadequate intake leads to clinical conditions.
3. Describe and illustrate the structure, function, absorption, and synthesis of micronutrients within the human body.
4. Assess clinical indications and biochemical markers of micronutrient deficiencies and propose strategies to address them through appropriate nutritional interventions.
5. Evaluate the nutritional status of individuals and populations using scientific methodologies and design effective intervention programs based on identified needs.

6. Apply diet formulation principles to cater to varying life stages and develop nutritional strategies for managing metabolic diseases.

## Course details with Intended Learning Outcome (ILOs)

Intended Learning Outcomes [ILOs]	Content Outline	T/L Method	Duration (Hours)
9.1. Discuss the discovery, classifications, and roles of vitamins	<b>Introduction</b> <ul style="list-style-type: none"> <li>Discovery of vitamins.</li> <li>Definition of vitamin, pro-vitamin, vitamer, and how a vitamin differs from a hormone and an enzyme.</li> <li>The classification of vitamins.</li> <li>The roles of vitamins.</li> </ul>	Lecture	2
9.2. Discuss the sources, RDA requirement and metabolism of vitamins. 9.3. Analyze the biochemical and physiological roles of Vitamins. 9.4. Explain the impact of vitamin imbalances of health. 9.5. Evaluate the symptoms and biochemical assessments for vitamin imbalances. 9.6. Describe effective strategies and applications to address health implications.	<b>Fat soluble vitamins</b> <b>Vitamin A</b> <ul style="list-style-type: none"> <li>Sources of vitamin A, Bioavailability and RDA requirement</li> <li>Transformation of pro-vitamin A to Vitamin A, absorption and transport of vitamin A from the intestine to liver and extrahepatic tissues.</li> <li>The main biochemical and physiological functions vitamin A (role of vision cycle, influence of genomic expression of cell/protein synthesis, relationship between retinoids with cancer and immunity).</li> <li>Deficiency symptoms (Vitamin A imbalances )</li> </ul> <b>Vitamin D</b> <ul style="list-style-type: none"> <li>Sources of vitamin D, bioavailability and RDA requirement.</li> <li>Synthesis of Vitamin D in the skin and absorption from the intestine.</li> <li>The functions (calcium absorption and mineralization of bones, calcium and phosphate re-absorption).</li> <li>Deficiency symptoms (Vitamin D imbalances )</li> </ul> <b>Vitamin E</b> <ul style="list-style-type: none"> <li>Sources of vitamin E.</li> <li>The role of an anti-oxidant and sparing action.</li> <li>How the requirement is influenced by vitamin A, intake of polyunsaturated fatty acids and advancing age.</li> </ul>	Lecture	2

	<p><b>Vitamin K</b></p> <ul style="list-style-type: none"> <li>Sources of vitamin K</li> <li>The biochemical functions of vitamin K-dependent <math>\alpha</math> carboxylase derive proteins (homeostasis and role in bone).</li> <li>The actions of dicumarol and warfarin on vitamin K regeneration</li> </ul>		
	<p><b>Water soluble vitamins</b></p> <p><b>Thiamine (vitamin b1)</b></p> <ul style="list-style-type: none"> <li>Sources of vitamin b1 and RDA requirements</li> <li>Effect of milling, extraction rate and cooking of cereals on vitamin content.</li> <li>The biochemical functions (B1 dependent reactions in metabolism) and biochemical consequences in deficiency.</li> <li>Criteria are used to define thiamine states.</li> <li>The symptoms of B1 deficiency.</li> <li>The laboratory assessment of vitamin B1 deficiency.</li> </ul> <p><b>Riboflavin (vitamin b2)</b></p> <ul style="list-style-type: none"> <li>Sources of vitamin B2 and RDA requirements</li> <li>The biochemical functions (Biochemical role in cellular functions).</li> <li>The deficiency symptoms.</li> </ul> <p><b>Niacin (vitamin b3)</b></p> <ul style="list-style-type: none"> <li>Sources of vitamin B3 and RDA requirements</li> <li>The biochemical functions.</li> <li>The symptoms of Niacin deficiency and the basis of mental depression in Pellagra and fatty liver.</li> </ul> <p><b>Pyridoxine (vitamin b6)</b></p> <ul style="list-style-type: none"> <li>Sources of vitamin B6 and RDA requirements</li> <li>List naturally occurring pyridoxine derivatives.</li> <li>The biochemical functions.</li> </ul> <p><b>Folic acid (B9)</b></p> <ul style="list-style-type: none"> <li>Dietary sources and factors affecting folate absorption.</li> <li>The biochemical functions.</li> <li>Folate and vitamin B12 deficiency and erythropoiesis.</li> </ul>	Lecture	4

	<ul style="list-style-type: none"> <li>• Anti folates and principles of their action.</li> </ul> <p><b>Cobalamine (vitamin b12)</b></p> <ul style="list-style-type: none"> <li>• Sources of vitamin B9 and RDA requirements</li> <li>• The role of GIF on B12 absorption.</li> <li>• The biochemical functions and effect of deficiency on the cell cycle.</li> <li>• Deficiency symptoms (Pernicious Anaemia and Neurological symptoms).</li> <li>• Distinguish folate and B12 deficiency.</li> </ul> <p><b>Ascorbic acid (vitamin c)</b></p> <ul style="list-style-type: none"> <li>• The foods rich in ascorbic acid and factors affecting the absorption</li> <li>• The foods rich in ascorbic acid and factors affecting the absorption</li> <li>• The biochemical functions (Hydroxylation and other reactions, iron absorption and anti-oxidant functions).</li> <li>• Deficiency symptoms.</li> </ul>		
<b>B) MINERALS AS NUTRIENTS</b>			
<p>9.7.Discuss the sources, RDA requirement and metabolism of minerals</p> <p>9.8.Analyze the biochemical and physiological roles of minerals</p> <p>9.9.Explain the impact of imbalances of minerals on health.</p> <p>9.10.Evaluate the symptoms and biochemical assessments for mineral imbalances.</p> <p>9.11.Describe effective strategies and applications to address health implications.</p>	<p><b>Introduction</b></p> <ul style="list-style-type: none"> <li>• The mineral content of the body in terms of the fat-free body weight.</li> <li>• The seven “principle elements” and the “micro-nutrient elements” are essential to humans.</li> <li>• Factors that can affect the absorption, retention, and availability of mineral nutrients.</li> <li>• Good dietary source requirements (infants, children, adults pregnant and lactating women, vegetarians) and functions of minerals are stated below.</li> </ul> <p><b>Calcium</b></p> <ul style="list-style-type: none"> <li>• Dietary sources and requirements</li> <li>• The normal ranges for serum Ca and phosphate and the forms in which Ca is found in serum.</li> <li>• The factors that influence Ca<sup>2+</sup> absorption in the intestine and explain their mode of action.</li> <li>• The part played by calcitriol in “adaptation to a low Ca intake”.</li> <li>• The deficiency diseases (a) rickets (b) osteomalacia.</li> </ul>	Lecture	4

	<p><b>Iron</b></p> <ul style="list-style-type: none"> <li>• Dietary sources and requirements</li> <li>• The different tissues in which iron is found, and the functions performed by iron in these tissues.</li> <li>• The factors that influence the absorption of dietary iron and explain their mode of action.</li> <li>• Iron absorption, transport and loss.</li> <li>• The diseases related to iron overload.</li> <li>• The deficiency disease (stages of anaemia) &amp; clinical symptoms and biochemical markers (TIBC, BI, PS, ferritin) and normal values.</li> </ul> <p><b>Iodine</b></p> <ul style="list-style-type: none"> <li>• Dietary sources and requirements.</li> <li>• The steps in thyroid hormone synthesis and the role of iodine.</li> <li>• The factors that (a) stimulate or inhibit (b) trapping of iodine to release of T3 and T4.<sup>32</sup></li> <li>• The terms iodine deficiency disorder (IDD) and endemic goiter.</li> <li>• Recall that IDD should be prevented as early as possible in the reproductive life, preferably before conception, during pregnancy and early in infancy.</li> <li>• How iodized salt needs to be used, stored and distributed in Sri Lanka.</li> </ul> <p><b>Zinc</b></p> <ul style="list-style-type: none"> <li>• Dietary sources and requirements.</li> <li>• The biochemical roles of Zn</li> <li>• The deficiency disease &amp; clinical symptoms</li> </ul> <p><b>Fluorine</b></p> <ul style="list-style-type: none"> <li>• Dietary sources and requirements</li> <li>• The function of fluorine in bone and teeth with special reference to the prevention of dental caries.</li> <li>• The toxicity (dental fluorosis &amp; osteofluorosis) &amp; defluoridation of water.</li> </ul> <p><b>Selenium and Chromium</b></p> <ul style="list-style-type: none"> <li>• Dietary sources and requirements</li> <li>• The relationship between selenium and chromium.</li> <li>• Selenium is an essential component of glutathione peroxidase.</li> </ul>		
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	<ul style="list-style-type: none"> <li>The association between selenium and vitamin E</li> <li>The association between chromium and GTF.</li> </ul>		
<b>C) FOODS OF PLANT ORIGIN AND ANIMAL ORIGIN</b>			
<p>9.12. Analyze the nutritional composition and bioavailability of major food groups.</p> <p>9.13. Illustrate the health benefits of each food group.</p>	<ul style="list-style-type: none"> <li>Why your body needs food</li> <li>Major food groups origin in plant &amp; animal</li> </ul> <p><b>origin in plant</b></p> <ul style="list-style-type: none"> <li>Cereal grains and products</li> <li>Pulses</li> <li>Roots and tubers</li> <li>Fruits vegetables</li> <li>Nuts and seeds</li> <li>Plant-based fat &amp; oil</li> </ul> <p><b>origin in animal</b></p> <ul style="list-style-type: none"> <li>Fish &amp; seafood</li> <li>Meat &amp; poultry</li> <li>Eggs milk and milk products</li> <li>Animal-based fat &amp; oil</li> </ul> <ul style="list-style-type: none"> <li>Examples for each group</li> <li>Nutritional composition in major food groups of animal/plant</li> <li>Compare the bioavailability of plant foods vs animal foods</li> <li>The major health benefits which get from animal foods/plant foods</li> </ul>	<p>Lecture</p> <p>Students Seminar (Two student ppt sessions; one on 'plant origin foods' and the other on 'animal origin foods')</p>	<p>1</p> <p>4</p>
<b>D) ENERGY AND PROTEIN REQUIREMENT</b>			
<p>9.14. Discuss the fundamental concepts of nutrition</p> <p>9.15. Explain the principles of energy utilization in humans.</p> <p>9.16. Apply knowledge of energy values by calculating the energy content of foods</p>	<p><b>Introduction to nutrition and Energy of food</b></p> <ul style="list-style-type: none"> <li>The meaning of nutrition, nutrients, and food</li> <li>"Why is it important for medical students to learn about nutrition"</li> <li>How energy is used by humans (note; major protein Na/K pumps).</li> <li>The sources of dietary energy and units of energy (kcal and J).</li> <li>The term 'Recommended Dietary Allowance' (RDA).</li> <li>The terms 'gross energy' and 'metabolizable energy values of food'.</li> <li>"Atwater factors" and calculate the energy value of food using the different values for macronutrients and alcohol</li> </ul>	Lecture	2

<p>9.17. Define and explain key concepts of energy metabolism.</p> <p>9.18. Apply the methods to estimate energy needs.</p> <p>9.19. Describe the energy requirements across different life stages</p>	<p><b>Energy requirements</b></p> <ul style="list-style-type: none"> <li>• Respiratory quotient, specific dynamic action.</li> <li>• Basal/resting metabolic rate (BMR/RMR) and the conditions under which BMR are measured.</li> <li>• The effects of body size and composition, physical activity, hormones, gender and climate on energy expenditure.</li> <li>• The methods used in estimating the energy requirements of an individual (BMR multiples depending on activity/ physical activity factors or equations with activity factors).</li> <li>• The energy and protein requirements in infant, child, adult elderly, pregnancy and lactation. (WHO &amp; Sri Lanka recommended values)</li> </ul>	Lecture	2
<p>9.20. Analyze and compare the quality of proteins in foods</p> <p>9.21. Assess the mechanisms maintaining protein homeostasis</p> <p>9.22. Evaluate methods for assessing protein nutritive value.</p>	<p><b>Amino acids , Protein requirements and homeostasis</b></p> <ul style="list-style-type: none"> <li>• The differences between indispensable, dispensable, and conditionally indispensable amino acids based on their roles and sources in the body</li> <li>• The protein quality of commonly consumed foods in Sri Lanka by comparing their amino acid profiles and biological value</li> <li>• The WHO defines protein requirements for different demographic groups (adult men, pregnant women, lactating women, and pre-school children) and explains how these requirements differ.</li> <li>• The term “nitrogen balance” and the effect of energy intake on N balance.</li> <li>• The term “protein-sparing action” and the importance of this action and analyze its role in preserving protein stores during periods of caloric restriction or illness.</li> <li>• The mechanisms that regulate protein homeostasis during amino acid imbalance, protein deficiency, and starvation.</li> </ul>	Lecture	3
	<ul style="list-style-type: none"> <li>• The in vitro and in vivo methods ( i.e., biological value, true digestibility, net protein utilization, chemical score) used to assess protein nutritive value, and compare their respective advantages.</li> </ul>		



9.23.Describe methods of nutritional assessment, for evaluating the nutritional status of adults and children.	<b>Assessment of nutritional status</b> <ul style="list-style-type: none"> <li>• Methods of nutritional assessment (ABCD approach).</li> <li>• The anthropometric measurements used in assessing the nutritional status of adults (waist circumference, hip circumference, waist: hip, mid-upper arm circumference, BMI) and children (weight for height/weight for age/ height for age/ occipitofrontal circumference).</li> </ul>	Lecture  Practical	1  3
9.24.Analyze the stages of starvation and its effects on body food stores. 9.25.Compare and examine the clinical signs of kwashiorkor and marasmus, linking them to biochemical changes in EPM. 9.26.Assess EPM using clinical and biochemical tools	<b>Energy protein malnutrition (EPM)</b> <ul style="list-style-type: none"> <li>• The effects on the body's food stores and physiological changes in different stages of starvation, provide a detailed explanation of the during each stage.</li> <li>• The clinical signs and symptoms of kwashiorkor and marasmus, and evaluate the biochemical changes occurring in the body, specifically with Energy and Protein Malnutrition (EPM).</li> <li>• The changes in plasma <b>associated with (a) Kwashiorkor and (b) Marasmus, and interpret</b> these changes in the context of metabolic and nutritional alterations in EPM.</li> <li>• EPM uses various methods, integrating both clinical and biochemical tools to evaluate malnutrition severity and progression</li> </ul>	Lecture	2
<b>Food and diet formulation</b>			
9.27.Analyze the Sri Lankan food pyramid, including its six food groups, examples, and major nutrients.	<b>Food groups</b> <ul style="list-style-type: none"> <li>• The six food groups of the Sri Lankan food pyramid</li> <li>• The examples for each food group</li> <li>• Major nutrients in each food group</li> <li>• Know the meaning of “serving sizes”</li> </ul>	Lecture	1
9.28.Apply serving size knowledge to design a balanced meal diet based on the food pyramid	<ul style="list-style-type: none"> <li>• The recommended no. of daily servings from each food groups</li> </ul>		

<p>9.29. Apply the principles behind diet formulation for different life stages and manage metabolic diseases.</p>	<p><b>Diet and principles of diet formulation</b></p> <ul style="list-style-type: none"> <li>• Factors that influence the nutritional requirements of individuals.</li> <li>• The principles behind formulating diets.</li> <li>• Factors are taken into account when prescribing a diet for infants (principles of complementary feeding )/child/adult/pregnancy/lactation/elderly /athletes/</li> <li>• The dietary principles of managing metabolic diseases such as diabetes mellitus, CVD, CKD, and obesity.</li> </ul> <p><b>Diabetes mellitus</b></p> <ul style="list-style-type: none"> <li>• The standard dietary requirements of a diabetic diet</li> <li>• The dietary guidelines for diabetic patients</li> <li>• The meal planning with Glycemic Index (GI) and Glycemic Load (GL)</li> </ul> <p><b>Cardiovascular disease (CVD )</b></p> <ul style="list-style-type: none"> <li>• The standard dietary requirements of a diabetic diet</li> <li>• The dietary guidelines for diabetic patients</li> </ul> <p><b>Chronic kidney disease (CKD)</b></p> <ul style="list-style-type: none"> <li>• The standard dietary requirements of a diabetic diet</li> <li>• The dietary guidelines for diabetic patients</li> <li>• The principle behind the restriction of protein and certain minerals in the diet of CKD patients</li> </ul> <p><b>Obesity</b></p> <ul style="list-style-type: none"> <li>• The standard dietary requirements for weight management</li> <li>• The dietary guidelines for obesity condition</li> </ul>	<p>Lecture</p>	<p>3</p>
<p>9.30. Identify functional foods and their health roles.</p>	<p><b>Functional Food</b></p> <ul style="list-style-type: none"> <li>• What are functional foods, nutraceuticals, probiotics and prebiotics.</li> <li>• Functional foods and their role in promoting health</li> <li>• The functional foods commonly encountered in the diet, their bioactive compounds and their nutrition and health role.</li> <li>• Understanding of the basic scientific principles necessary to evaluate the benefits of and claims for nutraceuticals and functional foods</li> </ul>	<p>Lecture</p>	<p>1</p>

## 3.10 Musculoskeletal Module

Module code	Year	Semester	Credit
MEBS-2-1-2-6	02	01	06

### Introduction

This module provides an in-depth exploration of the musculoskeletal system, focusing on its essential components that enable movement, support, and protection. The primary emphasis will be on understanding the structural and functional aspects of bones, joints, muscles, and their interconnections, as well as the nerves and blood vessels that sustain them.

You will begin with an introduction to the skeletal framework, delving into the axial skeleton, which forms the core of the body, and the appendicular skeleton, which supports the limbs. We will explore the dynamic nature of joints that permit movement and the intricate muscle systems that generate the force required for locomotion and daily activities.

This module places significant focus on the gross anatomy of the vertebral column, upper limb, lower limb and head and neck. Through detailed dissections and group activities, you will gain hands-on experience, enabling you to appreciate the three-dimensional relationships between anatomical structures. We encourage you to actively participate in these sessions, as they are integral to mastering the complexity of the human musculoskeletal system.

To enrich your learning experience, we have incorporated various resources, including IT tools, clinical scenarios, and real-life applications of musculoskeletal anatomy. The module also highlights aspects of clinical and applied anatomy, bridging the gap between foundational knowledge and its practical implications in medical practice.

We hope this module will ignite your curiosity and deepen your understanding of the musculoskeletal system, preparing you for future clinical applications.

### Module Committee

<b>Module Coordinator</b>	Dr. Yasas Kolambage – Lecturer/Department of Anatomy
<b>Committee members</b>	Dr. Joachim Perera – Consultant for Department of Anatomy Prof. M.N. Wickramaratne - Professor/Department of Biochemistry Dr. Irosha Nicholas – Module Coordinator, Basic Sciences Stream Coordinator, Head /Department of Biochemistry Dr. Kaushalya Kulathunga – Head/Department of Physiology Dr. Chamalika Weerakoon - Head/Department of Anatomy Dr. Amal Wageesha – Senior Lecturer/Department of Biochemistry Dr. Sumeth Perera - Senior Lecturer/Department of Biochemistry Ms. Nadeesha Nilmini – Lecturer/Department of Biochemistry

## Module Learning Outcomes

At the end of the musculoskeletal module, the student should be able to:

1. Explain the structure and function of the vertebral column, emphasizing its role in stability, mobility, and protection of the spinal cord
2. Explain the gross anatomy of the upper limb, including bones, joints, muscles, nerves, and blood supply, with a focus on functional movements.
3. Explain the gross anatomy of the lower limb, including its skeletal framework, muscles, joints, and neurovascular structures, highlighting its role in weight-bearing, locomotion,
4. Explain the gross anatomy of the head and neck region, including muscles, bones, and neurovascular structures, with a focus on their functional roles in movement and mastication
5. Apply knowledge on the normal anatomy of the musculoskeletal system to interpret radiological images, clinical procedures, and recognize common pathological findings in the vertebral column, upper limb, lower limb, and head and neck.

## Course details with Intended Learning Outcome (ILOs)

Intended Learning Outcome (ILO)	Content Outline	T/L Activity	Duration (Hours)	Department
<b>A) VERTEBRAL COLUMN</b>				
10.1. Describe the parts of a typical vertebra and explain the regional characteristics of the vertebral column.	<b>Bones of the Vertebral Column</b> <ul style="list-style-type: none"> <li>• Parts of a typical vertebra</li> <li>• Regional characteristics in cervical, thoracic and lumbar vertebrae</li> </ul>	Guided Learning	2	Anatomy
10.2. Evaluate the contribution of the intervertebral discs, ligaments, joints, and muscular arrangement to the stability, mobility, and movement of the vertebral column.	<b>Vertebral Column and Muscles of the Back</b> <ul style="list-style-type: none"> <li>• Vertebral column, its adaptation to its function of weight bearing and support and the maintenance of erect posture</li> <li>• Location of the curvatures and their importance</li> <li>• Structure of an intervertebral disc and its functions</li> <li>• Ligaments and joints of the vertebral column and its movements</li> <li>• Arrangement of muscles in relation to the vertebral column and their nerve supply and their action</li> <li>• Movements of the vertebral column</li> <li>• Factors contributing to the stability of the column</li> <li>• Boundaries of an intervertebral foramen for the passages of spinal nerve</li> <li>• Possibility of a nerve being compressed by disease of a vertebra or by a prolapsed</li> </ul>	Lecture	2	Anatomy
10.3. Interpret the clinical significance of vertebral column anatomy.		Dissection/ Demonstration/ FLM	2	Anatomy

	intervertebral disc resulting in neurological symptoms <ul style="list-style-type: none"> <li>Deformities that are possible in the vertebral column</li> </ul>			
10.4. Describe the anatomy of the spinal cord and spinal nerves.	<b>Spinal Cord &amp; Spinal Nerves</b> <ul style="list-style-type: none"> <li>Location and extent of the spinal cord</li> <li>Coverings of the spinal cord</li> <li>Internal structure of the spinal cord</li> <li>Spinal nerve</li> <li>Arterial supply and venous drainage of the spinal cord</li> </ul>	Lecture	2	Anatomy
<b>B) UPPER LIMB</b>				
10.5. Describe the bones of the upper limb and their articulations	<b>Bones of the Upper Limb</b> <ul style="list-style-type: none"> <li>Bones of shoulder girdle- clavicle scapula and the upper end of the humerus as one functional unit</li> <li>The position of the clavicle and scapula</li> <li>The functions of the clavicle</li> <li>The sternoclavicular and acromioclavicular joints and the ligaments associated with these joints</li> <li>The bones of the arm and forearm and their articulations</li> </ul>	Guided Learning	2	Anatomy
10.6. Describe muscles of the shoulder girdle and arm	<b>Muscles of the Shoulder Girdle and Arm</b> <ul style="list-style-type: none"> <li>The muscles attached to the shoulder girdle and their actions</li> <li>The arrangement of the deep fascia of the arm and its division into functional muscular compartments with its nerve supply</li> <li>The muscles in these compartments and their actions</li> </ul>	Guided Learning	2	Anatomy
10.7. Describe the development of the limbs  10.8. Describe the embryological basis of congenital limb defects and deformities	<b>Development of the Limbs</b> <ul style="list-style-type: none"> <li>Mesoderm and Limb Bud Development</li> <li>Limb Specialization and Morphogenesis</li> <li>Development of bones</li> <li>Muscle and Dermis Development</li> <li>Congenital Limb Defects and Deformities</li> </ul>	Lecture	2	Anatomy
10.9. Describe the anatomy of the axilla and the brachial plexus  10.10. Discuss the clinical implications of brachial plexus nerve injuries	<b>Brachial Plexus</b> <ul style="list-style-type: none"> <li>The axilla             <ul style="list-style-type: none"> <li>its contribution to the functioning of the upper limb</li> <li>its walls, entrance from the neck and the arrangement of structures</li> </ul> </li> <li>Formation of the brachial plexus and the plan of distribution</li> <li>Clinical implications of brachial plexus nerve injuries</li> </ul>	Lecture	2	Anatomy

<p>10.11.Describe the anatomy of the shoulder and elbow joints, including its structure, supporting ligaments, and range of movements.</p> <p>10.12.Discuss clinical conditions affecting the shoulder and elbow joints.</p>	<p><b>Shoulder Joint and Elbow Joint</b></p> <ul style="list-style-type: none"> <li>• Scapula <ul style="list-style-type: none"> <li>- the movements of the scapula</li> <li>- the muscles involved, their attachments and nerve supply</li> <li>- the origin, course and distribution of the suprascapular nerve, subscapular nerves thoracodorsal nerve, axillary nerve and spinal accessory</li> <li>- the effects of injury to these nerves</li> <li>- the origin and course of arteries involved in the anastomoses around the scapula</li> <li>- the features of a long bone</li> <li>- the process of bone formation and growth in length of a bone</li> </ul> </li> <li>• Pectoral Girdle <ul style="list-style-type: none"> <li>- the muscles of the pectoral region and the shoulder and their nerve supply</li> <li>- the importance of joints of the pectoral girdle and movements of scapula in movements of the arm</li> </ul> </li> <li>• Shoulder Joint <ul style="list-style-type: none"> <li>- the shoulder joint in relation to its morphology and movement</li> <li>- the factors that control mobility and stability of the joint</li> <li>- the muscles of the rotator cuff and their action</li> <li>- the movements involved in abduction of the arm at the shoulder</li> <li>- the possible effects of a dislocation of the shoulder joint</li> <li>- the effects of paralysis serratus anterior, deltoid and trapezius with regard to movements of the shoulder</li> <li>- Clinical conditions affecting the shoulder joint</li> </ul> </li> <li>• Elbow Joint <ul style="list-style-type: none"> <li>- the elbow joint, articular surfaces, capsule, ligaments and movements</li> <li>- the region of the cubital fossa, its boundaries, contents and its important relations</li> <li>- Clinical conditions affecting the elbow joint.</li> </ul> </li> </ul>	Lecture	2	Anatomy
10.13.Describe the compartments and arrangement of muscles of the forearm	<p><b>Muscles of the Forearm</b></p> <ul style="list-style-type: none"> <li>• Muscular compartments - anterior flexor and posterior extensor</li> </ul>	Guided Learning	2	Anatomy

	<ul style="list-style-type: none"> <li>Arrangement of flexors in layers the names and origins of these muscles and their pattern of innervations</li> <li>Muscles involved in pronation and supination</li> <li>Classification of extensors into superficial and deep and their origins and their nerve supply</li> <li>Origin and insertion of the supinator muscle</li> <li>Actions of the extensor muscles of the forearm and give their nerve supply</li> </ul>			
10.14.Describe the anatomy and movements of the radio-ulnar and wrist joints, including key structures and their roles in pronation and supination	<b>Radio-Ulnar Joint and Wrist Joint</b> <ul style="list-style-type: none"> <li>Radio-Ulnar Joint <ul style="list-style-type: none"> <li>the superior radio-ulna joint, articular surfaces, capsule, ligaments and movements</li> <li>the arrangement of the articular surfaces, ligaments and cartilage (In distal joint) that would facilitate pronation &amp; supination</li> <li>the movements that occur in proximal and distal radioulnar joints to bring the arm from a supine to a prone position</li> </ul> </li> <li>Wrist Joint <ul style="list-style-type: none"> <li>the arrangement of structures at the wrist in a cadaver and relate this to a living person</li> <li>the arrangements of these tendons at the wrist</li> <li>the positions of the median nerve, ulnar nerve and radial artery in relation to the above tendons</li> <li>the site where radial pulse is palpable</li> <li>the effects of a cut injury at the wrist</li> <li>extensor retinaculum and the tendons that pass through the compartments on the dorsum of the wrist</li> <li>the arrangement of the tendons at the lateral margin of the wrist- anatomical snuff box</li> <li>the appearance of the articular surfaces and the attachments of ligaments of the wrist joint</li> <li>movements at wrist joint</li> </ul> </li> </ul>	Lecture	2	Anatomy
10.15.Discuss the clinical relevance of injuries to the radio-ulnar and wrist joints, including impacts on nerves, blood vessels, and joint functionality.		Dissection/ Demonstration	2	Anatomy
10.16.Describe the anatomical structures of the hand and their roles in hand movements and tactile functions.	<b>Hand</b> <ul style="list-style-type: none"> <li>Position of the hand during pronation and supination</li> <li>Extensor expansion, its attachments and the tendons inserted into it</li> <li>Thenar and hypothenar eminences</li> <li>Skin creases</li> <li>Prominences of the carpal bones</li> <li>Prominences of the heads of the metacarpals</li> <li>Attachments of the flexor retinaculum</li> <li>Factors that contribute to the tactile functions of the hand</li> </ul>	Lecture	2	Anatomy
10.17.Discuss the clinical significance of hand anatomy, including carpal tunnel syndrome				

	<ul style="list-style-type: none"> <li>• Fascial spaces in the hand and infections of the hand</li> <li>• Carpal tunnel <ul style="list-style-type: none"> <li>- the arrangement of deep fascia in the hand</li> <li>- the carpal tunnel and its contents</li> <li>- the symptoms that result from a progressive compression of the median nerve in a carpal tunnel syndrome</li> <li>- the insertion of the flexor tendons in the wrist</li> <li>- the arrangement and insertion of the flexor digitorum superficialis and profundus to the phalanges</li> <li>- the origins and insertions of the lumbricals and interossei and their actions and nerve supply</li> <li>- fibrous flexor sheaths, synovial bursa, fascial spaces (mid palmar and thenar) and their significance as sites of infection</li> <li>- the arrangement of fascia in the pulp of the fingers</li> </ul> </li> <li>• Joints and movements of fingers <ul style="list-style-type: none"> <li>- the appearance of the articular surfaces and the attachments of ligaments of the metacarpophalangeal joints and the interphalangeal joints</li> <li>- movements at these joints</li> </ul> </li> <li>• Movements of the thumb <ul style="list-style-type: none"> <li>- the articular surfaces, ligaments and movements at the carpometacarpal joint of the thumb</li> <li>- the position of rest of the thumb and the movements of flexion extension, abduction, adduction and opposition. state the nerves</li> </ul> </li> </ul>			
<p>10.18. Review the arterial supply, venous drainage and lymphatic drainage of the upper limb.</p> <p>10.19. Apply knowledge of the upper limb blood supply to comprehend clinical procedures and associated conditions.</p>	<p><b>Blood Supply of the Upper Limb</b></p> <ul style="list-style-type: none"> <li>• Axillary artery and its branches and the possible anastomoses</li> <li>• Course of brachial artery and the possible sites of compression</li> <li>• the vessels that take part in anastomoses around the shoulder and elbow and the significance of this anastomosis</li> <li>• Course and branches of the radial and ulnar arteries</li> <li>• Arrangement of arteries in the hand</li> <li>• venous drainage and lymphatic drainage of the upper limb.</li> </ul>	Guided Learning	2	Anatomy



<p>10.20. Review the nerve supply of the upper limb.</p> <p>10.21. Apply knowledge of the upper limb nerve supply to comprehend clinical conditions.</p>	<p><b>Nerve Supply of the Upper Limb</b></p> <ul style="list-style-type: none"> <li>• The main nerves of the brachial plexus that enter the arm</li> <li>• The peripheral nerves that enter the arm from the axilla and their course and branches</li> <li>• The positions of peripheral nerves at the elbow and their entry into the forearm</li> <li>• The nerves that lie in contact with the humerus and the sites of contact and its clinical significance</li> <li>• The course of radial nerve its branches at different levels and structures supplied, site of likely lesions</li> <li>• The course of the median, ulnar and radial nerves, their branches and the structures supplied</li> <li>• The course of the median nerve and ulnar nerve in the hand</li> <li>• The nerve supply to the skin of the hand</li> <li>• The intrinsic muscles of the hand and their nerve supply</li> </ul>	Guided Learning	2	Anatomy
<p>10.22. Identify the important anatomical structures in the upper limb and their relationships</p> <p>10.23. Demonstrate a comprehensive understanding of the anatomy of the upper limb</p>	<p><b>Upper Limb Demonstration and Dissection</b></p> <ul style="list-style-type: none"> <li>• Shoulder joint and axilla</li> <li>• Arm</li> <li>• Elbow joint and cubital fossa</li> <li>• Forearm</li> <li>• Wrist joint and carpal tunnel</li> <li>• Hand</li> </ul>	Dissection/ Demonstration	2	Anatomy
<b>C) LOWER LIMB</b>				
<p>10.24. Describe the bones of the lower limb and their articulations</p>	<p><b>Bones of the Lower Limb</b></p> <ul style="list-style-type: none"> <li>• Regions of the lower limb and bones of these regions</li> <li>• Each of these bones as part of the skeletal framework of the lower limb and their articulations and anatomical position</li> </ul>	Guided Learning	2	Anatomy
<p>10.25. Describe the anatomy of the lumbo-sacral plexus and its branches</p> <p>10.26. Discuss the clinical implications of femoral and sciatic nerve injuries</p>	<p><b>Lumbo-Sacral Plexus</b></p> <ul style="list-style-type: none"> <li>• Formation of lumbosacral plexus</li> <li>• Main branches of lumbosacral plexus</li> <li>• Course of femoral and sciatic nerves</li> <li>• Motor and sensory distribution of femoral and sciatic nerve</li> <li>• Main motor and sensory effects in cases of lesions of femoral and sciatic nerves</li> </ul>	Lecture	2	Anatomy

<p>10.27.Describe the anatomy of the gluteal muscles and muscles of the thigh, including its structure, supporting ligaments, and range of movements.</p> <p>10.28.Discuss clinical conditions affecting the gluteal muscles and muscles of the thigh.</p>	<p><b>Gluteal Muscles and Muscles of the Thigh</b></p> <ul style="list-style-type: none"> <li>• Gluteal Muscles <ul style="list-style-type: none"> <li>-the features of the hip bone and the femur</li> <li>-the origin of the gluteal muscles from the gluteal surface of the Ilium, their insertion to the region of the greater trochanter</li> </ul> </li> <li>• Muscles of the Thigh <ul style="list-style-type: none"> <li>-the arrangement of the deep fascia of the thigh and its functions</li> <li>-the saphenous opening, the iliotibial tract, the intermuscular septa</li> <li>-the function of the iliotibial tract</li> <li>-the muscular compartments in the thigh and each group of muscles with their own nerve supply</li> <li>-the muscles in the anterior and medial compartments and their attachments actions and nerve supply</li> <li>-the heads of origin of the quadriceps and its insertion and its action on knee joint</li> <li>-the boundaries of the femoral triangle and its contents</li> <li>-the course of the femoral artery through femoral triangle and adductor canal &amp; locate where pulsations can be felt, where it can be compressed</li> <li>-the fascial layers of femoral sheath and contents of the sheath</li> <li>-the location and boundaries of the femoral canal discuss the clinical significance</li> <li>-the iliopsoas muscle, its attachments and its action on the hip joint</li> <li>-the origin of the femoral and obturator nerve from the lumbar plexus its course into the thigh and muscular and cutaneous branches</li> <li>-the cutaneous nerves of the thigh</li> <li>-the anatomical basis Meralgia paresthetica</li> <li>-the origins and insertion of the flexor muscles in back of thigh- hamstrings and to their arrangement in relation to the popliteal fossa</li> <li>-the attachments, nerve supply and action of the adductor magnus muscle</li> <li>-the boundaries, and in order superior to inferior the structure that form the floor and the contents of the popliteal fossa</li> <li>-the course of the branches of the sciatic nerve from the fossa to the leg</li> </ul> </li> </ul>	<p>Guided Learning</p>	<p>2</p>	<p>Anatomy</p>
<p>10.29.Describe the anatomical structures and movements of the hip joint</p> <p>10.30.Discuss the clinical relevance of</p>	<p><b>Hip Joint</b></p> <ul style="list-style-type: none"> <li>• The articular surfaces, attachment of capsule and ligaments of the hip joint</li> <li>• What are the retinaculæ</li> <li>• The muscles in relation to the hip joint</li> <li>• Blood supply to the head of the femur</li> </ul>	<p>Lecture</p> <p>Dissection/ Demonstration</p>	<p>1</p> <p>2</p>	<p>Anatomy</p> <p>Anatomy</p>

<p>injuries related to the hip joint</p> <p>10.31.Compare the hip joint and shoulder joint with respect to their structural features, stability, and mobility.</p>	<ul style="list-style-type: none"> <li>• Possible sites of fracture of the neck of the femur and the possible effects</li> <li>• What are the nerves can be damaged in a posterior dislocation of the hip joint</li> <li>• The movements at the hip joint and the muscles involved</li> <li>• The attachments of sacrospinous and sacrotuberous ligaments and boundaries and communication of the foramina</li> <li>• The important structures that pass through these foramina</li> </ul>			
<p>10.32.Describe the compartments and arrangement of muscles of the leg and foot</p>	<p><b>Muscles of the Leg and Foot</b></p> <ul style="list-style-type: none"> <li>• The structural and functional muscular compartments extensor, peroneal and flexo</li> <li>• The muscles in each of these compartments, their attachments actions and their nerve supply</li> <li>• The origin and insertion of the gastrocnemius and Soleus and their insertion to the tendocalcaneus. what are the actions of theses muscles?</li> <li>• The location of the tendons of these groups of muscles in relation to the ankle joint</li> </ul>	Guided Learning	2	Anatomy
<p>10.33.Describe the anatomical structures and movements of the knee joint</p> <p>10.34.Discuss the clinical relevance of injuries related to the knee joint</p>	<p><b>Knee Joint</b></p> <ul style="list-style-type: none"> <li>• The functions of the knee joint</li> <li>• The articular surfaces -the femoral condyles, upper end of tibia and patella</li> <li>• The capsular attachment, the ligaments (extra and intracapsular), the menisci and outline their functional role</li> <li>• The extent of the synovial cavity and the location of the bursae as sites of infection(bursitis)</li> <li>• The mechanics of extension and flexion of joint and the muscles involved</li> <li>• The role of the quadriceps femoris and ligamentum patella, the patella and popliteus muscle</li> <li>• The mechanism of locking and unlocking of the joint</li> <li>• The nerve supply to the hip and knee joint with reference to referred pain</li> <li>• Knee jerk (significance will be explained later)</li> <li>• X rays</li> <li>• The aetiology of Sports injuries <ul style="list-style-type: none"> <li>- collateral, cartilages, cruciate 3 C's and their injuries</li> <li>- fracture of the patella</li> <li>- bursitis</li> </ul> </li> </ul>	Lecture	1	Anatomy

10.35.Describe the anatomical structures and movements of the ankle joint and joints of the foot  10.36.Discuss the clinical relevance of injuries related to the ankle joint and joints of the foot	<b>Ankle Joint and Joints of the Foot</b> <ul style="list-style-type: none"> <li>• The ligaments of the ankle joint, the spring ligament, the bifurcate ligament</li> <li>• The movements of inversion and eversion and the joints and muscles involved in this movement</li> <li>• The arrangement of muscles in the sole of the foot and their nerve supply</li> <li>• The arches of the foot</li> </ul>	Lecture	1	Anatomy
10.37.Describe the posture and gait cycle  10.38.Discuss the anatomical basis of common gait abnormalities.	<b>Posture and Gait</b> <ul style="list-style-type: none"> <li>• Gait cycle.</li> <li>• Movements of the lower limb joints concerning the gait cycle.</li> <li>• Common gait abnormalities.</li> </ul>	Lecture	1	Anatomy
10.39.Review the arterial supply, venous drainage and lymphatic drainage of the lower limb.  10.40.Apply knowledge of the lower limb blood supply to comprehend clinical procedures and associated conditions.	<b>Blood Supply and Venous Drainage of Lower Limb</b> <ul style="list-style-type: none"> <li>• The course of the anterior tibial artery and its continuation into the foot as the dorsalis pedis artery</li> <li>• The site of palpation of arterial pulse</li> <li>• The arrangement of veins in the lower limb and the mechanisms of venous drainage</li> <li>• Varicose veins and the basis of the appearance of varicose veins</li> </ul>	Guided Learning	2	Anatomy
10.41.Review the nerve supply of the lower limb.  10.42.Apply knowledge of the lower limb nerve supply to comprehend clinical conditions associated with nerve injuries	<b>Nerve Supply of the Lower Limb</b> <ul style="list-style-type: none"> <li>• Sciatic nerve <ul style="list-style-type: none"> <li>- the origin and course of the sciatic nerve, pudendal nerve, gluteal nerve, posterior cutaneous nerve of thigh, its main branches and the structures supplied</li> <li>- the possible causes of pain along the back of the thigh (sciatica) and on the lateral side of the thigh</li> <li>- the small muscles at the back of the hip joint and their nerve supply and action</li> <li>- the course of the common peroneal nerve and posterior tibial nerve from the popliteal fossa to the leg</li> <li>- sites where the nerve may be damaged and the possible effects</li> <li>- the course of the deep peroneal nerve in the leg and its continuation into the foot &amp; the structures supplied in the foot</li> </ul> </li> </ul>	Guided Learning	2	Anatomy
10.43.Identify the important anatomical structures in the lower limb and their relationships	<b>Lower Limb Demonstration and Dissection</b> <ul style="list-style-type: none"> <li>• Femoral triangle, hip joint and gluteal region</li> <li>• Thigh</li> <li>• Popliteal fossa and knee joint</li> <li>• Leg</li> <li>• Ankle joint and tarsal tunnel</li> </ul>	Dissection/ Demonstration	2	Anatomy

10.44.Demonstrate a comprehensive understanding of the anatomy of the lower limb	<ul style="list-style-type: none"> <li>Foot</li> </ul>			
<b>D) HEAD AND NECK</b>				
10.45.Describe the bones of the skull and face with their articulations	<b>Bones of the Skull and Face</b> <ul style="list-style-type: none"> <li>The bones of the vault, base, lateral aspect of the skull</li> <li>The bones of the face</li> </ul>	Guided Learning	2	Anatomy
10.46.Describe the anatomical arrangement of the scalp and face, including their blood and nerve supply.  10.47.Explain the clinical implications related to the scalp and face.  10.48.Compare the structural and functional differences between the skin of the face and the scalp.	<b>Scalp and Muscles of the Facial Expression</b> <ul style="list-style-type: none"> <li>The layers of the scalp</li> <li>why do scalp injuries bleed profusely, gape and heal easily?</li> <li>The extent of spread of infections, haemorrhage into the sub-aponeurotic and subperiosteal layers of the scalp</li> <li>The nerve supply of the muscles of the face and scalp and its embryological origin</li> <li>That is special about facial muscles and the attachments and action of the buccinators, orbicularis oculi, and occipitofrontalis</li> <li>The veins in the face and scalp and their communications with intracranial venous sinuses: emissary veins</li> <li>The course of arteries and sites where arterial pulsations</li> <li>The sites of anastomosis between branches of internal and external carotid arteries</li> <li>The differences between the skin of the face and of the scalp</li> </ul>	Lecture	2	Anatomy
10.49.Review the anatomical structures of the oral cavity and tongue.	<b>Oral Cavity and Tongue</b> <ul style="list-style-type: none"> <li>Anatomy of the oral cavity</li> <li>Muscles of the tongue</li> <li>Blood supply, lymphatic drainage, and nerve supply of the tongue</li> </ul>	Guided Learning	2	Anatomy
10.50.Review the anatomical structures in the parotid and submandibular region	<b>Parotid and Submandibular Region</b> <ul style="list-style-type: none"> <li>Anatomy of the parotid and submandibular glands and their ducts</li> <li>Blood and neural supply</li> </ul>	Guided Learning	2	Anatomy
10.51.Describe the anatomy of the infratemporal fossa, including its boundaries contents and connections.	<b>Infratemporal Fossa</b> <ul style="list-style-type: none"> <li>Location of the infratemporal fossa.</li> <li>Boundaries of the infratemporal fossa.</li> <li>Contents of the infratemporal fossa.</li> <li>Connections of the infratemporal fossa</li> </ul>	Lecture	2	Anatomy

<p>10.52. Describe the anatomy of the muscles of mastication and temporomandibular joint.</p> <p>10.53. Discuss clinical conditions related to the muscles of mastication and temporomandibular joint.</p>	<p><b>Muscles of Mastication and TM Joint</b></p> <ul style="list-style-type: none"> <li>• Muscles of mastication</li> <li>• Course of the maxillary artery</li> <li>• Pterygoid plexus of veins, its communication with veins of the face and dural venous sinuses</li> <li>• Temporomandibular joint its articular surfaces, intraarticular disc, capsular attachments, ligaments</li> <li>• Movements that take place in the joint during mastication</li> </ul>	Lecture	2	Anatomy
<p>10.54. Describe the anatomy of the nasal cavity and paranasal sinuses</p> <p>10.55. Interpret the radiological appearance of paranasal sinuses</p>	<p><b>Nasal Cavity and Paranasal Sinuses</b></p> <ul style="list-style-type: none"> <li>• Structure of the external nose, nasal cavity, paranasal sinuses and their adaptation to their functions.</li> <li>• Bony walls and structures related.</li> <li>• Appearance of the lateral wall and the openings of the paranasal sinuses.</li> <li>• Blood supply and innervation of the nose.</li> <li>• Radiological appearance of paranasal sinuses</li> </ul>	Lecture	2	Anatomy
<p>10.56. Describe the anatomy of the orbit and extraocular muscles</p> <p>10.57. Explain the clinical relevance of eye movements</p>	<p><b>Orbit and Extraocular Muscles</b></p> <ul style="list-style-type: none"> <li>• Structure and boundaries of the orbit and their functional relevance.</li> <li>• Contents of the orbit</li> <li>• Attachments, actions, and innervation of the extraocular muscles.</li> <li>• Functional significance of eye movements and the role of the extraocular muscles.</li> <li>• Blood supply and venous drainage of the orbit.</li> </ul>	Lecture	2	Anatomy
<p>10.58. Identify the important anatomical structures in the head and neck and their relationships</p> <p>10.59. Demonstrate a comprehensive understanding of the anatomy of the head and neck</p>	<p><b>Head and Neck Demonstration and Dissection</b></p> <ul style="list-style-type: none"> <li>• Scalp</li> <li>• Face</li> <li>• Infratemporal Fossa</li> <li>• Orbit</li> <li>• Nasal Cavity</li> </ul>	Dissection/ Demonstration	2	Anatomy
<p>10.60. Describe the cervical plexus and its supply</p>	<p><b>Cervical Plexus</b></p> <ul style="list-style-type: none"> <li>• Formation of the cervical plexus and its anatomical location.</li> <li>• Branches of the cervical plexus: Superficial (cutaneous) and deep (motor) branches.</li> <li>• Contribution to sensory innervation of the neck, scalp, and shoulders.</li> <li>• Motor supply to muscles such as the diaphragm via the phrenic nerve.</li> <li>• Communication with cranial nerves and sympathetic structures.</li> </ul>	Guided Learning	2	Anatomy

10.61. Describe the anatomy of the muscles of the neck	<b>Muscles of the Neck</b> <ul style="list-style-type: none"> <li>Sternomastoid and trapezius muscle –its origin, insertion, actions, nerve supply and its relations</li> <li>The location of the infrahyoid muscles and the prevertebral muscles</li> </ul>	Lecture	2	Anatomy
10.62. Describe the cervical fascia, fascial planes, neck triangles, and their contents.  10.63. Explain the anatomy and clinical relevance of major neurovascular structures in the neck.	<b>Root of the Neck</b> <ul style="list-style-type: none"> <li>Arrangement and extent of cervical fascia and the fascial planes</li> <li>External jugular vein, its formation, course, surface marking, and relation to the deep cervical fascia</li> <li>Triangles of the neck and their contents</li> <li>Branches of the external carotid artery and their course</li> <li>Structures encountered when approaching the trachea for a tracheotomy</li> <li>Course of the internal carotid artery and internal jugular vein, the arrangement of lymph nodes in the neck-deep structures in the neck</li> </ul>	Lecture	1	Anatomy
10.64. Describe the anatomy of the larynx and its clinical relevance.	<b>Larynx</b> <ul style="list-style-type: none"> <li>Cartilages of the larynx, the membranes, muscles, Rima glottis and its function in respiration and phonation</li> </ul>	Lecture	1	Anatomy
10.65. Explain the embryological development of the branchial arches.  10.66. Discuss the clinical significance of the derivatives of each branchial arch.	<b>Development of the Branchial Arches</b> <p>Development of the branchial arches, including their and neck structures.</p> <p>Branchial clefts, pouches, and membranes and their structures such as the tonsils, parathyroid glands, and</p> <p>Branchial arch and their clinical correlations.</p> <p>Link processes to clinical conditions such as branchial cysts.</p>	Lecture	2	Anatomy
10.67. Identify normal radiological anatomy of the neck, including soft tissues, bones, and vasculature.  10.68. Interpret imaging features of common neck pathologies and their clinical significance.	<b>Imaging Anatomy of Musculoskeletal System</b> <ul style="list-style-type: none"> <li>Radiological techniques: X-rays, CT, MRI, and ultrasound for MSK imaging.</li> <li>Normal imaging appearance of bones, joints, and soft tissues.</li> <li>Identification of key anatomical landmarks in the axial and appendicular skeleton.</li> <li>Imaging features of muscles, tendons, ligaments, and cartilage.</li> <li>Common pathological findings: Fractures, dislocations, degenerative changes, and soft tissue injuries.</li> <li>Interpretation of imaging findings in clinical scenarios.</li> </ul>	Lecture  Demonstration/ FLM	2  2	Anatomy  Anatomy

## 3.11 Neuroscience Module

Module code	Year	Semester	Credit
MEBS-2-1-3-6	02	01	06

### Introduction

The Neuroscience Module is the control center of the body, intricately coordinating sensory input, motor output, and higher cognitive functions. Understanding its structure, function, and the mechanisms that underlie both normal and abnormal states is fundamental to the practice of medicine.

In this module, you will explore the essentials of neuroanatomy, neurophysiology, and neurobiology, while gaining insights into how the brain and spinal cord work together to regulate bodily processes. From the way neurons communicate to how the higher functions like, memories, and emotions are formed, neuroscience connects biology with the human experience. You will also examine the role of the nervous system in disease, providing the foundation for diagnosing and managing neurological disorders.

The goal of this book is to provide a clear, structured, and engaging introduction to the topic of neuroscience. By the end of this module, you will have acquired a solid understanding of the basic principles of neuroscience, which will serve as the cornerstone for your future studies in clinical medicine.

### Module Committee

<b>Module Coordinator</b>	Dr. Kaushalya Kulathunga – Head/Department of Physiology
<b>Committee members</b>	Dr. Joachim Perera – Consultant for Department of Anatomy Prof. M.N. Wickramaratne - Professor/Department of Biochemistry Dr. Irosha Nicholas – Basic Sciences Stream Coordinator, Head Department of Biochemistry Dr. Chamalika Weerakoon - Head/Department of Anatomy Dr. Amal Wageesha – Senior Lecturer/Department of Biochemistry Dr. Sumeth Perera - Senior Lecturer/Department of Biochemistry Dr. Yasas Kolambage – Lecturer/Department of Anatomy Ms. Nadeesha Nilmini – Lecturer/Department of Biochemistry

### Module Learning Outcomes

At the end of the Neuroscience module, the student should be able to:

1. Explain the normal and abnormal development of the central nervous system (CNS).
2. Describe the anatomy of the head and neck region.
3. Discuss the different types of sensations (common and special) and their clinical significance.
4. Outline the anatomical and physiological foundations of the motor system and its clinical importance.
5. Discuss the physiological basis of higher brain functions and the impact of their dysfunction.



## Course details with Intended Learning Outcome (ILOs)

Intended Learning Outcomes [ILOs]	Content Outline	T/L Activity	Duration	Department
<p>11.1. Describe the coverings of the brain.</p> <p>11.2. Explain the structure and functions of the cranial venous sinuses.</p> <p>11.3. Identify the different spaces surrounding the brain (epidural, subdural, and subarachnoid).</p> <p>11.4. Describe the formation and circulation of cerebrospinal fluid (CSF).</p>	<p><b>Ventricular System, Meninges and CSF Circulation</b></p> <ul style="list-style-type: none"> <li>Coverings of the brain</li> <li>Arrangement of dura mater in relation to brain and spinal cord</li> <li>Arrangement of dura mater and its functions and venous sinuses in the cranial cavity</li> <li>Epidural, subdural, subarachnoid spaces</li> <li>Subarachnoid space and its contents</li> <li>Telachoroidea and choroid plexus</li> <li>Ventricular system</li> <li>Formation and circulation of cerebrospinal fluid in the brain</li> <li>Blood brain barrier</li> <li>Significance of the epidural, subdural, and subarachnoid spaces in relation to clinical conditions</li> </ul>	Lecture	2	Anatomy
<p>11.5. Describe the structural organization of the cerebral cortex.</p> <p>11.6. Explain the distribution and organization of grey matter and white matter in the brain.</p> <p>11.7. Outline commissural fibres, projection fibers, and their roles in neural connectivity and brain function.</p> <p>11.8. Describe the anatomy of the cerebral hemispheres, and locations of the main functional</p>	<p><b>Cerebral Cortex</b></p> <ul style="list-style-type: none"> <li>Describe the main fissures, lobes, and functional areas.</li> <li>Outline the two main sites of distribution of the grey matter - basal ganglia and cerebral cortex.</li> <li>Outline the functional areas in the cortex.</li> <li>Describe the neuronal layers in the different functional parts and their connections (review microscopic structure of the cerebral cortex).</li> <li>Describe the patterns of arrangement of the white matter.</li> <li>Describe the location of the internal capsule and the distribution of the fibres.</li> <li>Describe the corona radiata and the fibres contained in them.</li> <li>Describe the optic radiation.</li> <li>Define commissural fibres and association fibres.</li> <li>List the commissures.</li> <li>Describe the corpus callosum and fornix.</li> <li>Describe the anatomy of cerebral hemispheres - surfaces, borders, major sulci and gyri, lobes.</li> <li>Locate these sulci and gyri on the brain.</li> <li>Recognize:</li> </ul>	Lecture	2	Anatomy

areas in the cerebral cortex.	<ul style="list-style-type: none"> <li>• The distribution of grey matter in the cerebral cortex and basal ganglia.</li> <li>• The distribution of white matter in the corona radiata, internal capsule, and commissures.</li> <li>• The cavity – the lateral ventricle.</li> <li>• Grey matter.</li> <li>• Describe the location of the main functional areas in the cerebral cortex.</li> <li>• Describe the neuronal layers in the different functional parts and their connections (review microscopic structure of the cerebral cortex).</li> </ul> <p><b>White Fibres</b></p> <ul style="list-style-type: none"> <li>• Describe the corona radiata and the fibres contained in them.</li> <li>• Describe the internal capsule and the fibres contained in its parts.</li> <li>• Describe the optic radiation.</li> </ul> <p><b>Commissures</b></p> <p>Define commissural fibres and association fibres. List the commissures. Describe the corpus callosum Describe the fornix and its communications. Describe the lateral ventricle, its parts, its relations, n with the third ventricle.</p>			
<p>11.9.Discuss physiological basis of Memory &amp; learning.</p> <p>11.10.Describe the stages of memory &amp; neurological basis of memory, learning habituation &amp; sensitization.</p>	<p><b>Memory and learning</b></p> <ul style="list-style-type: none"> <li>• Forms of memory</li> <li>• Parts of the brain involved in memory processing and storage</li> <li>• Synaptic plasticity, long term potentiation (LTP), long term depression (LTD), habituation, and sensitization and their roles in learning and memory</li> </ul>	Lecture	2	Physiology
<p>11.11.Describe the anatomical organization of the diencephalon.</p> <p>11.12.Explain the structure and functional significance of the thalamus.</p> <p>11.13.Discuss the structural and functional</p>	<p><b>Thalamus &amp; Hypothalamus</b></p> <p><b>Diencephalon</b></p> <ul style="list-style-type: none"> <li>• Topography of the diencephalon, extent, its components, connections</li> <li>• Sagittal section of brain to illustrate the limits</li> <li>• Following in relation to the diencephalon</li> <li>• Optic chiasma and optic tract</li> <li>• Pineal body</li> <li>• Structure in interpeduncular fossa</li> <li>• Telachoroidea of the 3rd ventricle</li> <li>• Internal capsule</li> <li>• Thalamus and hypothalamus</li> <li>• Third ventricle</li> </ul>	Lecture	2	Anatomy

relationships of the hypothalamus.	<b>Thalamus</b> <ul style="list-style-type: none"> <li>• Thalamus as the main cell station (3rd order neuron) of the sensory system</li> <li>• Sensory nuclei it contains for all sensations and that it is divided into several parts</li> <li>• Anatomy and relations of the thalamus</li> <li>• Medial and lateral geniculate bodies</li> <li>• Functions of these two bodies (visual and auditory) and their connections</li> <li>• Regions of the epithalamus - and the pineal body</li> <li>• Region of the hypothalamus and its important relations</li> <li>• Relationship of the hypothalamus to the hypophysis cerebri structurally and functionally</li> <li>• Role of the limbic system and reticular formation, and their connections with the hypothalamus and thalamus.</li> <li>• Functions of the hypothalamus</li> </ul>			
11.14. Identify the location and connection of the hypothalamus.  11.15. Explain the Neuroendocrine functions	<b>Functions of Hypothalamus</b> <ul style="list-style-type: none"> <li>• Temperature regulation, thirst mechanism and appetite control.</li> <li>• Sleep awake cycle.</li> <li>• Neuroendocrine regulation</li> </ul>	Lecture	2	Physiology
11.16. Describe the nuclei of the basal ganglia, their arrangement.  11.17. Discuss the clinical relevance of basal ganglia dysfunction in relation to movement disorders.	<b>Basal Ganglia</b> <ul style="list-style-type: none"> <li>• Nuclei in the basal ganglia and describe their arrangement.</li> <li>• Key anatomical and functional relationships of the basal ganglia with other brain structures.</li> <li>• Clinical relevance of basal ganglia dysfunction.</li> </ul>	Lecture	2	Anatomy
11.18. Describe the external and internal anatomical features of the brainstem.  11.19. Explain the structural and functional relationships of the brainstem.  11.20. Discuss the	<b>Brain Stem</b> <ul style="list-style-type: none"> <li>• Grooves and elevations on anterior, posterior, and lateral surfaces.</li> <li>• Connections with the other parts of the brain.</li> <li>• Internal structures as seen in transverse sections of the brainstem at different levels.</li> <li>• Nuclear columns (cranial nuclei 3-12) and the location of their functional components (motor, sensory, somatic, visceral).</li> <li>• Their intracerebral course and site of emergence of the cranial nerves (review the intracranial and extracranial course, the branches, and structures supplied (motor and sensory) of cranial nerves 3-12).</li> </ul>	Lecture	2	Anatomy

role of the brainstem in cerebrospinal fluid circulation and neurovascular function.	<ul style="list-style-type: none"> <li>• The arrangement of sensory and motor tracts in the white matter.</li> <li>• Their continuity with the spinal cord and cerebrum.</li> <li>• The medial lemniscus, the fibres involved, and its significance.</li> <li>• Other collections of neurons - reticular formation, red nucleus, and their communications.</li> <li>• Cerebellar peduncles and the fibres contained in them (cerebellar connections).</li> <li>• Ventricular system - central canal, fourth ventricle, aqueduct, and its continuity with the third ventricle and cerebral hemispheres.</li> <li>• Fourth ventricle, its location, its closed part and open part, the boundaries, and structures in the floor of the ventricle.</li> <li>• Formation and circulation of cerebrospinal fluid in the brain.</li> <li>• Blood-brain barrier.</li> </ul>			
<p>11.21.Describe the anatomy of the cerebellum.</p> <p>11.22.Discuss the functions of the cerebellum, and its role in ipsilateral motor control.</p>	<p><b>Cerebellum</b></p> <ul style="list-style-type: none"> <li>• External features, the lobes and internal structure of cerebellum</li> <li>• Intracerebellar nuclei</li> <li>• Peduncles of cerebellum and fibres contained in them</li> <li>• Functions of the cerebellum and that they exert them</li> <li>• control on the same side (ipsilateral)</li> <li>• Types of neurons, and outline their distribution and the afferent and efferent pathways</li> </ul>	Lecture	2	Anatomy
<p>11.23.Explain the structure and function of the cerebellum and EPS.</p> <p>11.24.Explain the physiological basis of Signs and symptoms of Parkinson's disease and Huntington's chorea.</p>	<p><b>Cerebellum and Extra Pyramidal System</b></p> <ul style="list-style-type: none"> <li>• Functions of the extra pyramidal system.</li> <li>• Structure and function of basal ganglia.</li> <li>• Function of the cerebellum.</li> <li>• Describe the evolutionary significances of structure with function</li> </ul>	Lecture	2	Physiology

<p>11.25.Describe the development of the nervous system.</p> <p>11.26.Discuss the common congenital anomalies related to the nervous system.</p>	<p><b>Development of the Nervous System</b></p> <ul style="list-style-type: none"> <li>• Stages of neural tube development and its derivatives.</li> <li>• Formation and segmentation of the brain vesicles</li> <li>• Embryological basis of common congenital anomalies</li> <li>• Spina bifida, Anencephaly.</li> </ul>	Lecture	2	Anatomy
<p>11.27.Describe the organization and functional components of the autonomic nervous system.</p> <p>11.28.Explain the anatomical pathways and distribution of the sympathetic nervous system.</p> <p>11.29.Describe the structure and pathways of the parasympathetic nervous system</p>	<p><b>Autonomic Nervous System</b></p> <ul style="list-style-type: none"> <li>• Organization of autonomic nervous system</li> <li>• Basic plan of autonomic nervous system- preganglionic neuron and the postganglionic neuron and how it differs from the somatic nervous system</li> <li>• Two components sympathetic and parasympathetic</li> <li>• Basic differences in the location of the preganglionic neurons, postganglionic neurons and the neurotransmitters</li> <li>• Functions of the two systems</li> </ul> <p><b>Sympathetic nervous system</b></p> <ul style="list-style-type: none"> <li>• Centers in spinal cord</li> <li>• Arrangement of the sympathetic nerve trunk and the ganglia</li> <li>• Possible modes of distribution to the ganglia</li> <li>• Paravertebral ganglia and their connections.</li> <li>• Splanchnic nerves and the prevertebral (subsidiary) ganglia and plexuses</li> <li>• Distribution to the effector organs</li> <li>• The sympathetic trunk and ganglia in the neck and internal carotid plexus</li> <li>• Thorax - cardiac, pulmonary, oesophageal plexuses</li> <li>• Abdomen–celiac, aortic, superior mesenteric, hepatic, suprarenal</li> <li>• Pelvis – superior hypogastric and inferior hypogastric plexuses</li> </ul> <p><b>Parasympathetic nervous system</b></p> <ul style="list-style-type: none"> <li>• Anatomical components of the parasympathetic nervous system.</li> <li>• Centre (preganglionic neurons) in relation to nuclei of the 3rd, 7th, 9th, and 10th cranial nerves and the 2nd, 3rd, and 4th sacral spinal segments.</li> <li>• Parasympathetic ganglia in relation to branches of the above cranial nerves: <ul style="list-style-type: none"> <li>- Ciliary – 3rd nerve</li> <li>- Pterygopalatine – 7th nerve</li> <li>- Submandibular – 7th nerve</li> <li>- Otic – 9th nerve</li> <li>- Several ganglia in viscera – 10th nerve</li> </ul> </li> </ul>	Lecture	2	Anatomy

	<ul style="list-style-type: none"> <li>Communications of the ganglia, their branches, and structures innervated.</li> </ul>			
11.30.Explain the blood supply to nervous system and the clinical implications.	<b>Blood Supply to Nervous System</b> <ul style="list-style-type: none"> <li>Arterial supply of the brain, including the circle of Willis and its variations.</li> <li>Venous drainage of the brain, including dural venous sinuses.</li> <li>Clinical implications of ischemia or hemorrhage in the brain</li> </ul>	Lecture	2	Anatomy
11.31.Explain the microscopic structure of the blood brain barrier	<b>Microscopic structure of the blood brain barrier</b>	Lecture	1	Anatomy
11.32.Explain the formation, circulation, absorption, and functions of cerebrospinal fluid (CSF), and describe its normal composition.  11.33.Discuss the normal intracranial pressure (ICP), the causes of increased ICP.  11.34.Structure and function of the blood-brain barrier (BBB).	<b>CSF and Blood Brain Barrier</b> <ul style="list-style-type: none"> <li>CSF formation circulation and absorption, normal composition and functions</li> <li>Use of CSF analysis as diagnostic tool</li> <li>Normal intra cranial pressure and causes of increased intracranial pressure.</li> <li>The nature of the Blood brain barrier (BBB), functions and compounds which cross the BBB.</li> </ul>	Lecture	2	Physiology
11.35.Describe the intracranial course of cranial nerves, as well as their extracranial course and structures they supply.	<b>Cranial Nerves</b> <ul style="list-style-type: none"> <li>Skull and foramina</li> <li>Development of brain stem and nuclear columns</li> <li>Functional components of cranial nerves 3-12</li> <li>Central nuclei and connections</li> <li>Intracerebral course and site of exit from brain and intracranial course</li> </ul>	Lecture	2	Anatomy

11.36.Demonstrate methods for testing cranial nerve function and how to assess motor, sensory, and parasympathetic nerve integrity.	<ul style="list-style-type: none"> <li>• Extra cranial course, branches and structures supplied</li> <li>• Describe distribution -motor, sensory, parasympathetic nerves</li> <li>• Describe how to test for cranial nerve function</li> </ul>			
11.37.Describe the functions of cranial nerves  11.38.Relate the knowledge of Cranial nerve functions to describe the dysfunctions.	<b>Cranial Nerves</b> <ul style="list-style-type: none"> <li>• Functions of the 3rd 4th and 6th nerves.</li> <li>• Function and nerve distribution of the 5th nerve.</li> <li>• Conditions which affect these nerves and clinical manifestation.</li> <li>• 7th nerve and 7th nerve palsy, (LMN &amp; UMN lesions of 7th nerve)</li> <li>• Lesions at different sites of 9th and 10th nerve.</li> <li>• 11th nerve, distribution &amp; functions and dysfunctions.</li> <li>• Anatomical pathway of 12th nerve distribution functions and dysfunction</li> <li>• Conditions which affect these nerves and clinical manifestation.</li> <li>• Demonstrate clinical evaluation of cranial nerves</li> </ul>	Lecture	2	Physiology
11.39.Describe the anatomy of the eyeball.  11.40.Explain the pathway of light through the eye.  11.41.Discuss the anatomical basis of common clinical problems related to the eye.	<b>Eye</b> <ul style="list-style-type: none"> <li>• Anatomy of the eyeball, including its layers and their functions.</li> <li>• Pathway of light through the eye, focusing on the cornea, lens, and retina, and their roles in vision.</li> <li>• Extraocular muscles, their nerve supply, and their role in eye movement.</li> <li>• Common anatomical features of the eye using imaging techniques.</li> <li>• Anatomical basis of common clinical problems related to the eye.</li> </ul>	Practical Lecture	2 2hrs	Physiology Anatomy
11.42.Describe visual pathway and the organizations of visual cortex, the anatomical basis for visual field changes.	<b>Vision</b> <ul style="list-style-type: none"> <li>• Describe the organization of the retina</li> <li>• Explain how light rays in the environment are brought to a focus on the retina and the role of accommodation in this process</li> <li>• Define hyperopia, myopia, astigmatism, presbyopia, and strabismus.</li> <li>• Describe the electrical responses produced by rods and cones, and explain how these responses are produced.</li> </ul>	Lecture	2hrs	Physiology

<p>11.43. Describe retina and explain how it's adapted to its function.</p> <p>11.44. Discuss night blindness &amp; vitamin A deficiency, color blindness and strabismus.</p> <p>11.45. Explain the principles of refraction, accommodation and convergence.</p> <p>11.46. Discuss hyperopia, myopia, astigmatism, presbyopia.</p> <p>11.47. Describe and perform common clinical tests used to assess visual acuity, color vision and visual field defects.</p>	<ul style="list-style-type: none"> <li>Describe the electrical responses and function of bipolar, horizontal, amacrine, and ganglion cells.</li> <li>Trace the neural pathways that transmit visual information from the rods and cones to the visual cortex</li> <li>Describe the responses of cells in the visual cortex and the functional organization of the dorsal and ventral pathways to the parietal cortex.</li> <li>Define and explain dark adaptation and visual acuity</li> <li>Describe the ventral pathways involved in colour vision</li> </ul> <ul style="list-style-type: none"> <li>Use of Snellen and J charts</li> <li>Procedure of testing visual acuity</li> <li>Use of the Ishihara chart</li> <li>Methods of testing visual field</li> </ul>	Practical	2	Physiology
<p>11.48. Describe the anatomy of the external, middle, and inner ear, in relation to their roles in hearing, sound transmission, and balance.</p> <p>11.49. Identify common procedures and imaging modalities related to the ear.</p> <p>11.50. Explain the anatomical basis of common ear-related clinical conditions</p>	<p><b>Ear</b></p> <ul style="list-style-type: none"> <li>Anatomy of the external, middle, and inner ear, including their components and functions in hearing and balance.</li> <li>Role of the ossicles, Eustachian tube, and cochlea in sound transmission and auditory perception.</li> <li>Structure and function of the vestibular system and its role in maintaining balance and equilibrium.</li> <li>Common procedures and imaging modalities related to the ear, and relate their relevance to anatomical structures.</li> <li>Anatomical basis of common clinical problems related to the ear.</li> </ul>	Lecture	2hrs	Anatomy



<p>11.51.Describe capture and transmission of sounds in the ear.</p> <p>11.52.Explain how sound waves are converted into generator potential.</p> <p>11.53.Describe the major structures of the vestibular and cochlea system and its physiological basis of hearing and equilibrium.</p>	<p><b>Auditory and vestibular apparatus</b></p> <ul style="list-style-type: none"> <li>• Components and functions of the external, middle, and inner ear.</li> <li>• Way that movements of molecules in the air are converted into impulses generated in hair cells in the cochlea.</li> <li>• Roles of the tympanic membrane, the auditory ossicles (malleus, incus and stapes) and scala vestibule in sound transmission.</li> <li>• Auditory impulses pathway from the cochlear hair cells to the auditory cortex.</li> <li>• Coding of loudness and timbre in the auditory pathways.</li> <li>• Forms of deafness and the tests used to distinguish between them.</li> <li>• Detection of rotational acceleration and detect linear acceleration</li> <li>• Sensory inputs that provide the information that is synthesized in the brain into the sense of position in space.</li> <li>• Evaluation of hearing disorders, basics of Rinne's &amp; Weber's tests and audiometry.</li> </ul>	<p>Lecture</p> <p>2hrs</p> <p>Physiology</p>		
<p>11.54.Describe the structural organization of the Central Nervous System.</p> <p>11.55.Explain the functional pathways and their clinical relevance</p>	<p><b>Central Nervous System</b></p> <p><b>Spinal Cord</b></p> <ul style="list-style-type: none"> <li>• Vertebral level that marks the lower limit of the spinal cord</li> <li>• The structures that lie in the canal below this level</li> <li>• Levels to which the dura mater, arachnoid mater and pia mater extend</li> <li>• Extent of the coverings and the spaces</li> <li>• Reasons for varying proportions of grey matter and white matter in the different regions</li> <li>• Types of neurons in the anterior horn and state where the axons of these neurons terminate</li> <li>• Arrangement of the nuclear columns and neurons in the posterior horn</li> <li>• Main ascending and descending and outline the fibres in them</li> <li>• Neurons in a sensory pathway and state their location <ul style="list-style-type: none"> <li>- 1<sup>st</sup> order neuron in the dorsal root ganglion</li> <li>- 2<sup>nd</sup> order neurons in the spinal cord</li> <li>- 3<sup>rd</sup> order neuron in the thalamus is in the thalamus</li> </ul> </li> <li>• Formation of a spinal nerve</li> <li>• The cauda equina and the contents of the lower lumbar and sacral vertebral canal</li> <li>• The boundaries of an intervertebral foramen</li> <li>• Results of prolapse of IV disc</li> </ul>	<p>Lecture</p> <p>2hrs</p> <p>Anatomy</p>		

	<ul style="list-style-type: none"> <li>• Basis for the selection of the site for a lumbar puncture</li> <li>• Blood supply of the spinal cord and</li> <li>• Grooves and elevations that demarcate important areas</li> <li>• Arrangement of grey matter and the nuclear columns</li> <li>• Arrangement of white matter and list the major ascending and descending tracts</li> <li>• Cells of the dorsal root ganglia are the 1<sup>st</sup> order neurone in the sensory pathway</li> <li>• Cells of the posterior horn of the grey matter are the 2<sup>nd</sup> order neurons in the sensory pathway of normal sensation</li> <li>• Cauda equina and the contents of the lower lumbar and sacral vertebral canal</li> </ul>			
<p>11.56. Describe the organization of ascending spinal tracts.</p> <p>11.57. Explain the functional and clinical significance of ascending spinal tracts.</p>	<p><b>Ascending Spinal Tracts</b></p> <ul style="list-style-type: none"> <li>• Sensory receptors for the different sensory modalities and give their location</li> <li>• Peripheral afferent pathway for different sensory information</li> <li>• Discuss the significance of the epidural, subdural, and subarachnoid spaces in relation to clinical conditions touch</li> <li>• Pathways in CNS through spinal cord, brain stem, thalamus to primary sensory cortex in cerebrum for the above sensation. State the tracts involved</li> <li>• Locations of the neurons in these pathways</li> <li>• Sites of sensory decussation</li> <li>• Lemnisci and the fibres contained in them- medial, spinal and lateral Lemnisci</li> <li>• Segmental innervations of the skin</li> </ul>	Lecture	2hrs	Anatomy
<p>11.58. Describe the microscopic structure, layers, and specialized appendages of the skin and their functions.</p> <p>11.59. Interpret histopathological changes in common skin disorders, and techniques for studying skin scrapings.</p>	<p><b>Microscopic Structure of the Skin</b></p> <ul style="list-style-type: none"> <li>• Layers and cells of the skin</li> <li>• Specialized skin appendages: Hair follicles, sebaceous glands, sweat glands, and nails.</li> <li>• Role of skin in thermoregulation, sensation, and barrier function.</li> <li>• Histopathological changes in common skin disorders and wound healing.</li> <li>• Techniques for studying skin scrapings.</li> </ul>	Lecture	2	Anatomy

<p>11.60. Describe a sensory receptor and its adaptation to function</p> <p>11.61. Describe the somato-sensory pathways, sensory modalities</p> <p>11.62. Discuss basic pathologies of the sensory pathways</p>	<p><b>Physiology of Sensory system</b></p> <ul style="list-style-type: none"> <li>• Basic physiological features of a sensory receptor.</li> <li>• Types of sensory receptors</li> <li>• Physiological basis of sensory transmission</li> <li>• Adaptation on sensory receptors.</li> <li>• Dorsal column pathways. Touch, position sense, vibration, proprioception, stereognosis, graphesthesia</li> <li>• Gustatory reception, identify the basic tastes.</li> <li>• Receptor and pathways of the olfactory system</li> <li>• Clinical amusement tests for sensory functions</li> </ul>	<p>Lecture</p>	<p>2</p>	<p>Physiology</p>
		<p>Practical</p>	<p>2</p>	<p>Physiology</p>
<p>11.63. Describe perception of different modalities of pain in the brain.</p> <p>11.64. Describe the physiology of pain and physiological and surgical methods of pain relief.</p>	<p><b>Pain</b></p> <ul style="list-style-type: none"> <li>• Pain perception Intensity location and quality of different sensation encoded in the brain.</li> <li>• Difference between Fast and slow pain Superficial, deep and visceral pain.</li> <li>• Referred pain and phantom limb</li> <li>• Hyperalgesia Endogenous analgesic system.</li> <li>• Pain relieving methods and their basis.</li> </ul>	<p>Lecture</p>	<p>2</p>	<p>Physiology</p>
<p>11.65. Describe the anatomy of the descending spinal tracts.</p> <p>11.66. Compare the characteristics of upper motor neuron (UMN) and lower motor neuron (LMN) lesions</p>	<p><b>Descending Spinal Tracts</b></p> <ul style="list-style-type: none"> <li>• Upper and lower motor neuron</li> <li>• Pathway from upper motor neuron in cerebral cortex to the lower motor neurons in brain stem and spinal cord, that control movements in different regions</li> <li>• Sites of decussation of these fibres and the outcome of the decussations</li> <li>• Location of the lower motor neurons and the types of lower motor neuron</li> <li>• Diagram to illustrate origin course and termination of the fibres of corticospinal/ pyramidal tracts</li> <li>• UMN lesion and LMN lesion</li> </ul>	<p>Lecture</p>	<p>2</p>	<p>Anatomy</p>
<p>11.67. Describe the anatomy of peripheral nerve pathways via cranial and spinal nerves.</p> <p>11.68. Explain the neural control of movement and the effects of lesions.</p>	<p><b>Peripheral pathway and nerve endings</b></p> <ul style="list-style-type: none"> <li>• Peripheral nerve pathway via cranial nerves and spinal nerves to relevant muscles/ groups of muscles</li> <li>• Structure of the nerve endings in striated muscle - motor end plate</li> <li>• Structure of sensory endings in muscle</li> <li>• Reflexes - reflex arc. stretch reflexes</li> <li>• Role of basal ganglia in muscle contraction</li> <li>• Role of cerebellum in modulation and coordination</li> </ul>	<p>Lecture</p>	<p>2</p>	<p>Anatomy</p>

	<ul style="list-style-type: none"> <li>- <i>Hemi section of spinal cord</i></li> <li>- <i>Lateral medullary syndrome</i></li> <li>- <i>Obstruction to anterior spinal artery</i></li> <li>- <i>Cerebral haemorrhage</i></li> </ul>			
<p>11.69.Physiological basis of motor system.</p> <p>11.70.Describe the descending motor pathway and function.</p> <p>11.71.Compare and contrast clinical features of UMN and LMN lesions.</p>	<p><b>Motor System</b></p> <ul style="list-style-type: none"> <li>• Function of the proprioceptive receptors in the skeletal muscle. Effect of gamma efferent discharge.</li> <li>• Function of a muscle spindle.</li> <li>• Function of the Golgi tendon organ as a regulator of muscle force. Stretch reflex.</li> <li>• Mono synaptic poly synaptic reflexes.</li> <li>• Examples of common stretch reflexes and their clinical significance.</li> <li>• Reciprocal innervation, inverse stretch reflex, clonus, and lengthening reaction</li> <li>• Withdrawal reflex and its clinical importance: - mass reflex, hypotonia and hypertonia.</li> <li>• Physiological basis of clinical features of LMN and UMN lesions.</li> </ul>	Lecture	2	Physiology
<p>11.72.Understand the Mechanism and Components of Reflex Arcs.</p> <p>11.73.Analyze Clinical Applications of Reflexes.</p> <p>Recognize Abnormal Reflexes and Their Clinical Significance</p>	<p><b>Physiology of Reflexes</b></p> <ul style="list-style-type: none"> <li>• Definition and components of a Reflex Arc</li> <li>• Types of Reflexes</li> <li>• Mechanism of Reflex Actions</li> <li>• Identify and interpret common reflexes (e.g., patellar, withdrawal, pupillary light reflex)</li> <li>• Modulation of Reflexes</li> <li>• Physiological and Clinical Implications of Reflexes</li> </ul>	Lecture	2	Physiology
<p>11.74.Explain the pathophysiology of lesions in the spinal cord and brainstem</p>	<p><b>Spinal cord and brain stem lesions</b></p> <ul style="list-style-type: none"> <li>• Multiple sclerosis.</li> <li>• Traumatic lesions of the spinal cord</li> <li>• Spinal Shock</li> <li>• Physiological basis of the tests used in confirming the brain stem death</li> <li>• Physiological basis of clinical features in CVA.</li> </ul>	Lecture	2hours	Physiology

<p>11.75. Discuss physiological and anatomical basis of Speech.</p> <p>11.76. Relate the knowledge of speech in pathophysiology of speech disorders.</p>	<p><b>Speech</b></p> <ul style="list-style-type: none"> <li>Physiological and anatomical basis of Speech</li> <li>Neural control of speech</li> <li>Mechanism of speech production</li> </ul>	Lecture	2	Physiology
<p>11.77. Describe the physiological basis of sleep and consciousness.</p> <p>11.78. Explain the function of the reticular formation.</p> <p>11.79. Describe the pattern of normal sleep across the lifespan.</p> <p>11.80. Briefly outline common sleep disorders.</p> <p>Discuss the basics of EEG and the primary types of rhythms in the normal EEG</p>	<p><b>Sleep and EEG</b></p> <ul style="list-style-type: none"> <li>Physiological basis of Sleep &amp; consciousness.</li> <li>Function of the reticular formation.</li> <li>Pattern of normal night time sleep in adult age and the variation in the sleep pattern from birth to old age.</li> <li>Compare and contrast slow wave sleep and REM sleep.</li> <li>Sleep disorders.</li> <li>Primary types of rhythms that constitute the normal EEG and behavioral correlation of each of them.</li> <li>EEG and behavioral characteristic of slow wave sleep REM sleep.</li> </ul>	<p>Lecture</p> <p>Practical</p>	<p>2</p> <p>2</p>	<p>Physiology</p> <p>Physiology</p>
<p>11.81. Identify major anatomical structures of the brain and spinal cord using imaging modalities.</p> <p>11.82. Explain the role of CNS imaging in clinical diagnosis</p>	<p><b>Imaging Anatomy of the CNS</b></p> <ul style="list-style-type: none"> <li>Major anatomical structures of the brain and spinal cord on imaging.</li> <li>Basic imaging modalities of the CNS, including CT and MRI.</li> <li>Role of imaging in diagnosing common CNS pathologies (e.g., tumors, infarcts, and hemorrhages).</li> </ul>	Lecture	2	Anatomy



## 3.12 Molecular and Precision Medicine Module

Module code	Year	Semester	Credit
MEBS-2-1-4-2	02	01	02

### Introduction

The fields of molecular and precision medicine represent the forefront of medical science, revolutionizing how diseases are diagnosed, treated, and prevented. This course provides a basic but comprehensive exploration of the principles, techniques, and applications that underpin these transformative approaches, with a focus on leveraging molecular biology, genetic engineering, and personalized medicine for improved healthcare outcomes.

Molecular medicine is rooted in understanding the molecular mechanisms of diseases at the genetic, protein, and cellular levels. It emphasizes the use of advanced techniques like gene sequencing, biomarker identification, and molecular diagnostics to identify and target the underlying causes of diseases. Precision medicine takes this one step further by tailoring medical treatments to individual patients based on their genetic makeup, lifestyle, and environment, ensuring more effective and personalized care. Precision medicine is taking molecular information of an individual to tailor treatment and healthcare decisions. Precision Medicine is defined as an emerging approach for disease treatment and prevention that takes into account individual variability in genes, environment and lifestyle for each person” (National Institute of Health 2016, The Precision Medicine Initiative)

The rapid advancement of molecular biology and precision medicine is reshaping healthcare and creating new opportunities for clinicians, researchers, and healthcare professionals to deliver more effective and individualized care. By taking this course, you will:

- Gain expertise in state-of-the-art molecular techniques and diagnostic tools.
- Learn how to integrate precision medicine principles into clinical practices.
- Explore the cutting-edge advancements in cancer treatment and the challenges associated with their implementation.

Currently, a “one size fits all” concept without such precision information limits health outcomes. However, emerging and rapidly progressing technologies can now measure the molecular phenotypes of genes, chromatin, transcripts, proteins, metabolites and environmental exposures.

By the end of this course, students will have a deep understanding of how molecular and precision approaches are driving innovation in medicine and will be prepared to apply these concepts in solving real-world medical challenges.

#### Overall Goal:

Students will develop an in-depth understanding of the principles, methodologies, and applications of molecular and precision medicine, enabling them to analyze and integrate cutting-edge techniques into clinical and research settings for improved patient care.

## Module Committee

<b>Module Coordinator</b>	Dr. Sumeth Perera - Senior Lecturer/Department of Biochemistry
<b>Committee members</b>	Dr. Joachim Perera – Consultant for Department of Anatomy Prof. M.N. Wickramaratne - Professor/Department of Biochemistry Dr. Irosha Nicholas -Basic Sciences Stream Coordinator, Head /Department of Biochemistry Dr. Kaushalya Kulathunga – Head/Department of Physiology Dr. Chamalika Weerakoon - Head/Department of Anatomy Dr. Amal Wageesha – Senior Lecturer/Department of Biochemistry Dr. Yasas Kolambage – Lecturer/Department of Anatomy Ms. Nadeesha Nilmini – Lecturer/Department of Biochemistry

## Module Learning Outcomes

At the end of the Molecular and Precision Approaches in Medicine module, the student should be able to:

1. Key Principles and Concepts
  - Define key terms and concepts in molecular and precision medicine, including molecular techniques, genetic variants, mutations, oncogenes, tumor suppressor genes, biomarkers, and precision therapy.
  - Explain the principles underlying molecular and precision medicine and their applications in healthcare.
2. Molecular Techniques in Medical Practice
  - Describe the principles and methodologies of commonly used molecular techniques (e.g., PCR, sequencing, CRISPR, and microarrays) in diagnosing and treating diseases.
  - Discuss the clinical applications of molecular techniques, highlighting their role in improving patient outcomes.
3. Genetic Variations and Implications
  - Describe genetic variants and mutations, their classifications, and their implications for health and disease.
  - Interpret molecular genetic tests and analyze their clinical relevance to diagnosis, treatment, and prognosis.
4. Genetic Engineering in Medical Practices
  - Explain the principles of genetic engineering techniques, such as recombinant DNA technology and gene editing tools (e.g., CRISPR-Cas9).
  - Assess the applications of genetic engineering in medical sciences, including gene therapy and vaccine development.
  - Evaluate the impact of genetic engineering on modern medicine and its ethical, legal, and social implications.
5. Molecular Biology of Cancer



- Explain the molecular basis of cancer, including the roles of oncogenes, tumor suppressor genes, and genetic mutations in tumor development.
  - Identify commonly used tumor markers for different types of cancers and assess their clinical significance in cancer diagnosis and prognosis.
  - Interpret laboratory reports for cancer diagnosis and explain their clinical implications.
6. Integrate Precision Medicine Approaches in Cancer Treatment
- Explain the role of OMICs-based biomarkers (e.g., genomics, transcriptomics, and proteomics) in cancer diagnosis and treatment.
  - Describe the principles and challenges of targeted cancer therapies, including their mechanisms and limitations.
  - Discuss immunotherapy approaches, their mechanisms, and the associated challenges in cancer treatment.
7. Reflect on the Importance of Molecular and Precision Medicine
- Justify the importance of molecular and precision approaches in improving the diagnosis, treatment, and prognosis of diseases.
  - Evaluate how advancements in molecular biology and precision medicine are shaping the future of healthcare.

## Course details with Intended Learning Outcome (ILOs)

Intended Learning Outcomes [ILOs]	Content Outline	T/L Activity	Duration (Hours)	Department
<p>12.1. Define key terms used in molecular and precision approaches in medicine).</p> <p>12.2. Explain the principles underlying molecular and precision medicine.</p> <p>12.3. Justify the importance of molecular and precision approaches in improving diagnosis, treatment, and prognosis.</p>	<p><b>Principles and Importance of Molecular and Precision Approaches in Medicine</b></p> <ul style="list-style-type: none"> <li>• Molecular medicine</li> <li>• Precision medicine</li> <li>• Biomarkers</li> <li>• Personalized therapy</li> </ul>	Lecture	2	Biochemistry

<p>12.4. Describe the principles of commonly used molecular techniques in medicine</p> <p>12.5. Discuss the clinical applications of these the molecular techniques</p>	<p><b>Molecular Techniques in Medical Practices</b></p> <ul style="list-style-type: none"> <li>• PCR, DNA sequencing, RFLP, hybridization techniques: ELISA, Immunofluorescence /Immunohistochemistry</li> <li>• Molecular techniques in disease diagnosis, treatment monitoring, and research.</li> </ul>	Lecture Practical SGD	4	Biochemistry
<p>12.6. Describe genetic variants and mutations</p> <p>12.7. Interpret the molecular genetic tests and clinical implications</p>	<p><b>Genetic Variations &amp; Molecular Genetic Testing</b></p> <ul style="list-style-type: none"> <li>• Types of Genetic Variations (Polymorphisms, Mutations)</li> <li>• Mechanisms and effects of genetic variations (Point, Frameshift, Silence, Missense, Nonsense)</li> <li>• Pathogenicity of genetic variants and disease-causing variants</li> <li>• Molecular genetic testing to identify genetic variations</li> <li>• Online tools and databases for variant interpretation</li> </ul>	Lecture	2	Anatomy
<p>12.8. Discuss ethical, legal, and cultural considerations in genetic testing, genomic research, and clinical genetic services</p>	<p><b>Human Genetics Ethics &amp; Genetic Counselling</b></p> <ul style="list-style-type: none"> <li>• Principles of genetic counselling</li> <li>• Terms related to genetic testing: premarital, preconception, antenatal, newborn, pre-symptomatic/predictive, diagnostic</li> <li>• Ethical, legal and cultural issues in genetic and genomic services and research.</li> <li>• Phenotypic prevention and genotypic prevention</li> <li>• Pre-test and post-test counseling in genetic testing</li> </ul>	Lecture	1	Anatomy

<p>12.9. Describe the principles of genetic engineering techniques</p> <p>12.10. Explain the applications of genetic engineering in medical sciences</p> <p>12.11. Evaluate the impact of genetic engineering on modern medicine</p>	<p><b>Genetic Engineering in Medical Practices</b></p> <ul style="list-style-type: none"> <li>• Recombinant DNA technology</li> <li>• Vaccine production, gene therapy, and CRISPR/Cas9 gene editing.</li> <li>• Its role in developing personalized treatments</li> </ul>	Lecture SGD	6	Biochemistry
<p>12.12. Explain the molecular basis of cancer</p> <p>12.13. Describe the role of oncogenes and tumor suppressor genes in the development of cancer.</p> <p>12.14. List commonly used tumor markers for different cancers</p> <p>12.15. Discuss the clinical significance of tumor markers in cancer diagnosis and prognosis.</p> <p>12.16. Interpret laboratory reports relevant to cancer diagnosis and explain their clinical implications.</p>	<p><b>Molecular Biology of Cancer</b></p> <ul style="list-style-type: none"> <li>• Hallmarks of cancer</li> <li>• Action of oncogenes and tumor suppressor genes</li> <li>• Highlighting details on ovary, breast, prostate, colon, liver, and bone</li> <li>• Tumor markers in cancer diagnosis</li> <li>• Cancer clinical scenarios</li> </ul>	Lecture SGD	4 2	Biochemistry

<p>12.17.Explain the role of OMICs-based biomarkers in cancer diagnosis and treatment.</p> <p>12.18.Describe the principles and challenges of targeted cancer therapy.</p> <p>12.19.Discuss immunotherapy approaches along with their associated challenges.</p> <p>12.20.Explain the role of genetic variations in drug response and their implications for personalized medicine.</p>	<p><b>Introduction to Precision Approaches in Cancer &amp; Other Disorders</b></p> <ul style="list-style-type: none"> <li>• Genomics, transcriptomics, epigenomics, proteomics, metabolomics, pharmacogenomics</li> <li>• Targeted therapies for selected cancer types</li> <li>• T-cell transfer therapies and CAR-T cell therapy</li> </ul> <p><b>Pharmacogenomics</b></p> <ul style="list-style-type: none"> <li>• Genetic basis of drug metabolism</li> <li>• Genetic influences on drug response</li> <li>• Pharmacogenomic testing and clinical applications</li> </ul>	<p>Lecture SGD</p> <p>Flipped-Class</p>	<p>4</p> <p>1</p>	<p>Biochemistry</p> <p>Anatomy</p>
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