

**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB**  
**Syllabus of B. Sc. In Medical Lab Technology**  
**(Effective for 2020-2021 Admission Session)**  
**Choice Based Credit System**  
**140 Credit (3-Year UG) MAKAUT Framework**  
**w.e.f 2020-21**

**Curriculum Structure**

**CBCS – MAKAUT UG degree (Hons) 140 Credit FRAMEWORK (Revised)**

<b>Subject Type</b>	<b>Semester I</b>	<b>Semester II</b>	<b>Semester III</b>	<b>Semester IV</b>	<b>Semester V</b>	<b>Semester VI</b>
<b>CC</b>	C1, C2	C3, C4	C5,C6,C7	C8,C9,C10	C11,C12	C13,C14
<b>DSE</b>					DSE1, DSE2	DSE3, DSE4
<b>GE</b>	GE1	GE2	GE3	GE4		
<b>AECC</b>	AECC 1	AECC 2				
<b>SEC</b>			SEC 1	SEC 2		
	4 (20)	5 (20)	4 (26)	5(26)	4 (24)	4 (24)

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**1<sup>st</sup> Semester**

Subject Type	Course Name	Course Code	Credit Distribution			Credit Points	Mode of Delivery			Proposed Moocs
			Theory	Practical	Tutorial		Offline	Online	Blended	
CC 1	Human Anatomy I	BML(T) 101	4	0	0	6	✓			As per MAKAUT Notification
		BML 191	0	2	0					
CC 2	Human Physiology I	BML(T) 102	4	0	0	6	✓			
		BML 192	0	2	0					
GE 1	Students will have to select from the GE Basket					6			✓	
AECC 1	English Communications	BML 164	2	0	0	2	✓			
<b>Semester Credits</b>						<b>20</b>				

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**2<sup>nd</sup> Semester**

Subject Type	Course Name	Course Code	Credit Distribution			Credit Points	Mode of Delivery			Proposed Moocs
			Theory	Practical	Tutorial		Offline	Online	Blended	
CC 3	Human Anatomy II	BML(T) 201	4	0	0	6	✓			As per MAKAUT Notification
		BML 291	0	2	0					
CC 4	Human Physiology II	BML(T) 202	4	0	0	6	✓			
		BML 292	0	2	0					
GE 2	Students will have to select from the GE Basket					6			✓	
AECC 2	Environmental Science	BML 265	2	0	0	2	✓			
<b>Semester Credits</b>						<b>20</b>				

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**3<sup>rd</sup> Semester**

Subject Type	Course Name	Course Code	Credit Distribution			Credit Points	Mode of Delivery			Proposed Moocs
			Theory	Practical	Tutorial		Offline #	Online	Blended	
CC 5	Pathology	BML(T) 301	4	0	0	6	✓			As per MAKAUT Notification
		BML 391	0	2	0					
CC 6	Haematology-I	BML(T) 302	4	0	0	6	✓			
		BML 392	0	2	0					
CC 7	Biochemistry	BML(T) 303	4	0	0	6				
		BML 393	0	2	0					
GE 3	Students will have to select from the GE Basket					6			✓	
SEC 1	Lab Management and Medical Ethics	BML 354	1	0	1	2	✓			
<b>Semester Credits</b>						<b>26</b>				

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**4<sup>th</sup> Semester**

Subject Type	Course Name	Course Code	Credit Distribution			Credit Points	Mode of Delivery			Proposed Moocs
			Theory	Practical	Tutorial		Offline #	Online	Blended	
CC 8	Microbiology	BML(T) 401	4	0	0	6	✓			As per MAKAUT Notification
		BML 491	0	2	0					
CC 9	Haematology- II	BML(T) 402	4	0	0	6	✓			
		BML 492	0	2	0					
CC 10	Immunology	BML(T) 403	4	0	0	6				
		BML 493	0	2	0					
GE 4	Students will have to select from the GE Basket					6			✓	
SEC 2	Histotechnique	BML 455	1	0	1	2	✓			
<b>Semester Credits</b>						<b>26</b>				

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**5<sup>th</sup> Semester**

Subject Type	Course Name	Course Code	Credit Distribution			Credit Points	Mode of Delivery			Proposed Moocs
			Theory	Practical	Tutorial		Offline	Online	Blended	
CC 11	Immunohematology and blood banking	BML(T) 501	4	0	0	6	√			As per MAKUT Notification
		BML 591	0	2	0					
CC 12	Parasitology and virology	BML(T) 502	4	0	0	6	√			
		BML 592	0	2	0					
DSE 1 (Any one)	Diagonostic cytology	BML 503 (A)	4	0	0	6			√	
		BML 593 (A)	0	2	0					
	Diagnostic Histopathology	BML503 (B)	4	0	0					
		BML593 (B)	0	2	0					
DSE 2 (Any one)	Clinical Enzymology	BML 504 (A)	4	0	0	6			√	
		BML 594 (A)	0	2	0					
	Biochemistry & Nutrition	BML 504 (B)	4	0	0					
		BML 594 (B)	0	2	0					
<b>Semester Credits</b>						<b>24</b>				

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**6<sup>th</sup> Semester**

Subject Type	Course Name	Course Code	Credit Distribution			CreditPoints	Mode of Delivery			Proposed MOOCs
			Theory	Practical	Tutorial		Offline	Online	Blended	
CC 13	Clinical Endocrinology & Toxicology	BML(T)601	4	0	0	6				As per MAKAUT Notification
		BML691	0	2	0				√	
CC 14	Diagnostic Molecular Biology	BML(T) 602	4	0	0	6				
		BML692	0	2	0				√	
DSE 3(Any one)	Advanced Diagnostic Techniques	BML 603 (A)	4	0	0	6				
		BML 693 (A)	0	2	0				√	
	Basic Laboratory Management	BML 603 (B)	4	0	0					
		BML 693 (B)	0	2	0					
DSE 4 (Any One)	Major Project	BML 681(A)	1	5	0	6				
	Internship	BML 681(B)	1	5	0				√	
Semester Credits						24				

**Note:**

Major Project/Internship- (Students have to engage in a full length/capstone project with a pre-specified Internal Guide (faculty member) throughout the semester). Industry collaboration is highly encouraged in case of Internship. (At least two-three times progress needs to be checked and evaluation needs to be done through PCA.) It will be followed by a report submission and viva as part of University examination.

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**B.Sc in Medical Lab Technology**

Program Outcomes or Graduate Attributes of B.Sc Medical Lab Technology Program under MAKAUT:

*Graduates will be able to demonstrate the following program outcomes:*

**PO1- Medical Laboratory Knowledge:** Apply the knowledge of clinical haematology, pathology, histopathology, clinical biochemistry, clinical enzymology, clinical immunology, clinical microbiology, clinical endocrinology & toxicology, diagnostic molecular biology and other medical lab technology specialisations to the solution of complex disease diagnosis.

**PO2- Design/Development of Solutions:** Identify, formulate, review and research design solutions for complex medical diagnostic problems and design medical experimental components or processes to meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal and environmental considerations.

**PO3- Medical Laboratory Professional and Society:** Create, select and apply techniques, resources and modern medical laboratory tools and techniques to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional Medical Laboratory Technology practice.

**PO4- Individual and teamwork:** Apply ethical principles and commit to professional ethics, responsibilities, and norms of the medical laboratory technologist practice as an individual, and as a member or leader in diverse teams and in multidisciplinary settings.

**PO5- Communication:** Communicate effectively on complex medical laboratory technologist activities with the medical laboratory technologist community and with society, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

**PO6- Lifelong Learning:** Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broad context of technological change.



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**Program Outcomes (PO) Mapping**

<b>PO#</b>	<b>Program Outcome</b>	<b>Mapped courses</b>
1	Medical Laboratory Knowledge	BML 101, BML 102, BML 201, BML 202, BML 301, BML 302, BML 303, BML 354, BML 401, BML 402, BML 501, BML 502, BML 543, BML 601, BML 602
2	Design/Development of Solutions	BML 455, BML 543, BML 544, BML 643, BML 644
3	Medical Laboratory Professional and Society	BML 265, BML 403, BML 455
4	Individual and Team Work	BML 403, BML 455, BML 543, BML 544, BML 643, BML 644
5	Communication	BML 164, BML 403, BML 644
6	Life-Long Learning	BML 455, BML 643, BML 644

**\*GE Courses are not in the above mapped list. Based on the choice of the learner that would necessarily be part of PO6 and the relevant PO's**

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		BML 191	0	2	0					
CC 2	Human Physiology I	BML(T) 102	4	0	0	6	✓			
		BML 192	0	2	0					
GE 1	Students will have to select from the GE Basket					6			✓	
AECC 1	English Communications	BML 164	2	0	0	2	✓			
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**Semester 1**

**CC 1- Human Anatomy 1**

**Course Objective:** The course is designed to provide a working knowledge and skills on cells and tissues and to understand anatomy of human body. Students will be able to develop an understanding of the structure and function of organs and organ systems in normal human body.

Sl	Course Outcome
1	Able to apply the concepts and knowledge of the general terminology of the human anatomy
2	Understand the cell and tissue structure
3	Describe the structure of skeletal, muscular, respiratory system
4	Recognise the parts of digestive system
5	Illustrate the different parts of Human body
6	Explain interrelationships among molecular, cellular, tissue and different organs.

**THEORY- BML(T) 101**

CO	Blooms Level (if applicable)	Modules	%age of questions
CO1	1, 2	M1	15
CO2	1, 2	M2	15
CO3	1,2	M3	25
CO4	1,2	M4	25
CO5	2 3	M5	10
CO6	2, 3	M6	10
			<b>100</b>

**PRACTICAL- BML 191**

CO	Blooms Level (if applicable)	Modules	%age of questions
CO1			
CO2			
CO3			
CO4			
CO5	1,2	M5	50

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CO6	1, 2	M6	50
			<b>100</b>

**Credits- 4T +2P**

**Module 1-Body Plan: 8h**

Terminology and General Plan of the Body, Body Parts and Areas, Terms of Location and Position, Body Cavities and Their Membranes, Dorsal cavity, Ventral cavity, Planes and Sections.

**Module 2 -Cells and Tissue: 10h**

Cells: Structure, function and location, Prokaryotic and eukaryotic cells, Cell organelles, Cell Division

Tissue, Types, Structure, Location and Function of Epithelial Tissue, Connective Tissue, Muscle Tissue, Nerve Tissue, Membranes, Glandular tissue. The Integumentary System: structure and function of The Skin, Subcutaneous Tissue

**Module 3- Musculoskeletal and Respiratory System: 10h**

Musculoskeletal System: Basic anatomy of important muscles and bones

Respiratory system: Basic anatomy of nose, larynx, trachea, bronchi and lungs

**Module 4-Digestive System: 10h**

Basic anatomy of oesophagus, stomach, small intestine, large intestine, liver, gall bladder, pancreas

**Module 5-Practical 1 (15 h)**

Demonstration of Major organs through models and slides

- a. parts of circulatory systems
- b. parts of respiratory system
- c. digestive system
- d. excretory system

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e. nervous system

**Module 6- Practical (25 h)**

Demonstration of

- a) structure of eye and ear from model
- b) structural differences between skeletal, smooth and cardiac muscles.
- c) various bones and joints
- d) various parts of male & female reproductive system from models

**Text Books:**

1. Chaurasia B D, (2016), Human Anatomy, 7th edition, CBS publishers.
2. SamareshMitra, Anatomy, 7th edition, Academic Publishers.

**Reference Books:**

1. Ross & Wilson,(2014),Anatomy & Physiology in health & illness,11th edition, Elsevier Publications.
2. Gerard J. Tortora and Bryan H.Derrickson,(Principles of Anatomy and Physiology,14th edition,Wiley Publications.

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**CC 2- Human Physiology 1**

**Course Objective:** The course is designed to provide basic knowledge of cells, tissues, blood, physiological functions and diseases phenomenon. The students will be able to develop an understanding of the physiological concepts associated with Medical Lab Technology.

SI	Course Outcome
1	Understand the cell physiology and composition of body and body fluid.
2	Illustrate the knowledge and apply the concept and principles of blood and cardiovascular system.
3	Explain the physiological function of respiratory system.
4	Develop physiological knowledge of gastrointestinal system.
5	Apply the knowledge, concept of physiological techniques in medical laboratory technology.
6	Apply the skill in diagnostic laboratory by using the modern tools and techniques and correlate between interdisciplinary branches.

**THEORY- BML(T) 102**

CO	Blooms Level (if applicable)	Modules	%age of questions
CO1	1, 2	M1	15
CO2	1, 2	M2	25
CO3	1, 2	M3	15
CO4	1, 2	M4	25
CO5	1, 2	M5	10
CO6	1, 2	M6	10
			<b>100</b>

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**PRACTICAL- BML 192**

CO	Blooms Level (if applicable)	Modules	%age of questions
CO1			
CO2			
CO3			
CO4			
CO5	1,2	M5	50
CO6	1, 2	M6	50
			<b>100</b>

**Credits- 4T+2P**

**Module I- Cellular Physiology and Lymphatic System: 8h**

Cell physiology: Structure, membrane, transport across cell membrane, Active, Passive, Diffusion, Osmosis, Tonicity, Homeostasis.

Organization of the Body, Body Composition, Body Fluid Volumes and its Measurement.

Lymphatic system-Composition & function of lymph, lymphatic tissue, Immunity with the role of thymus.

**Module 2-Blood and Cardiovascular System:12h**

Blood-composition, function, cellular component & their function, haemoglobin & anaemia, blood groups and coagulation.

General arrangement, heart, arteries, veins and capillaries, heart structure and function, cardiac cycle, heart sounds, heart rate, blood pressure, mechanism of circulation, definition of hypertension & shock.

**Module 3- Respiratory System: 10h**

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Parts of respiratory system, mechanism of respiration, pulmonary function, pulmonary circulation, lungs volume, Gas transport between lungs and tissues.

Definition of hypoxia, dyspnoea, cyanosis, asphyxia and obstructive airways diseases.

**Module 4- Gastrointestinal Physiology:10h**

Organs of GIT and their structure & function, secretion, digestion, absorption and assimilation, gastrointestinal hormones, physiology of digestion of carbohydrates, proteins & lipids, Structure & function of liver, spleen, gall bladder & pancreas, Jaundice, Cirrhosis & Pancreatitis.

**Module 5: Practical (16h)**

1. To measure pulse rate
2. To measure blood pressure
3. Demonstration of ECG

**Model 6: Practical (21 h)**

1. Collection of blood sample and separate serum and plasma.
2. To perform Hemoglobin by Sahli's Method
3. To perform Hemoglobin by CMG method.
4. To perform Total RBC count.
5. To perform total leucocyte count.
6. To perform differential leucocyte count.
7. To perform PCV

**Text Books:**

1. C.C. Chatterjee, Human Physiology (vol 1 &2) 12 Ed, , Medical Allied Agency
2. G.K. Pal, Comprehensive Textbook of Medical Physiology, Jaypee Brothers Medical Publishers
3. Sembulingam K, (2012), Essentials of Medical Physiology, 6th edition, Jaypee Publications



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**Reference Books:**

1. Guyton and Hall,(2011) Textbook of Medical Physiology,12<sup>th</sup> Edition,Saunders/Elsevier
2. Ross & Wilson,(2014),Anatomy & Physiology in health & illness,11th edition, Elsevier Publications
3. SujitChaudhury,(2011),Concise Medical Physiology,6th edition, NCBA
4. Gerard J. Tortora and Bryan H.Derrickson,(Principles of Anatomy and Physiology,14th edition,Wiley publications

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Course: English Communication

Code: BML 164

**Course Objective:**

The course is designed to develop the student's communicative competence in English by giving adequate exposure in the four communication skills - LSRW - listening, speaking, reading and writing and the related sub-skills, thereby, enabling the student to apply the acquired communicative proficiency in social and professional contexts.

**Course Outcome:**

Sl	Course Outcome	Mapped modules
1	Students will be able to Remember & Understand the basic concepts of the usage of English grammar & vocabulary in communication.	M1
2	Students will be able to Comprehend facts and ideas by organizing, comparing, translating, interpreting, giving descriptions, and stating the main ideas given in written texts.	M1,M2
3	Students will be able to Synthesise and Apply acquired linguistic knowledge in producing various types of written texts	M1, M3
4	Students will be able to Comprehend facts and ideas from aural inputs and Synthesise and Apply acquired linguistic knowledge in giving spoken response	M1, M4

**Syllabus:**

Module Number	Content	Total Hours	%age of questions	Blooms Level (if applicable)	Remarks (If any)
M 1	Functional grammar & Vocabulary	2	10	1,2	
M 2	Reading Skills	2	20	1,2	
M 3	Writing Skills	8	40	2,3,4,	
M 4	Listening & Speaking Skills	8	30	2,3,4	
		<b>20</b>	<b>100</b>		

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**Detailed Course Curriculum:**

**Paper: English Communication**

**Code:**

**Contact Hours / Week: 2L**

**Credits: 2**

**Module 1 : Functional Grammar & Vocabulary :** Tense: Formation and application; Affirmative / Negative / Interrogative formation; Modals and their usage; Conditional sentences; Direct and indirect speech; Active and passive voice; usage of common phrasal verbs, synonyms & antonyms.

1L + 1T

**Module 2 : Reading Skills:** Comprehension passages; reading and understanding articles from technical writing. Interpreting texts: analytic texts, descriptive texts, discursive texts; SQ3R reading strategy.

1L + 1T

**Module 3 : Writing Skills:** Writing business letters - enquiries, complaints, sales, adjustment, collection letters, replies to complaint & enquiry letters; Job applications, Résumé, Memo, Notice, Agenda, Reports – types & format, E-mail etiquette, advertisements

4L + 4T

**Module 4 : Listening & Speaking**

Listening: Listening process, Types of listening; Barriers in effective listening, strategies of effective listening

Speaking: Presentations, Extempore, Role-plays, GD, Interview

4L + 4T

**Suggested readings:**

1. Bhatnagar, M & Bhatnagar, N (2010) Communicative English for Engineers and Professionals. New Delhi: Pearson Education.
2. Raman, M & Sharma, S (2017) Technical Communication. New Delhi: OUP.
3. Kaul, Asha (2005) The Effective Presentation: Talk your way to success. New Delhi: SAGE Publication.
4. Sethi, J & Dhamija, P.V. (2001), A Course in Phonetics and Spoken English. New Delhi: PHI.
5. Murphy, Raymond (2015), English Grammar in Use. Cambridge: Cambridge University Press.

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**2<sup>nd</sup> Semester**

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			Theory	Practical	Tutorial		Offline	Online	Blended	
CC 3	Human Anatomy II	BML(T) 201	4	0	0	6	✓			As per MAKAUT Notification
		BML 291	0	2	0					
CC 4	Human Physiology II	BML(T) 202	4	0	0	6	✓			
		BML 292	0	2	0					
GE 2	Students will have to select from the GE Basket				6			✓		
AECC 2	Environmental Science	BML 265	2	0	0	2	✓			
<b>Semester Credits</b>						<b>20</b>				

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**CC3: Human Anatomy II**

**Credits- 4T+2P**

**Course Objective:** The course is designed to provide a working anatomical knowledge and skills on cardiovascular system, nervous system, special sense, genitourinary system.

Sl	Course Outcome
1	Able to apply the concepts and knowledge of anatomy of the cardiovascular and lymphatic system.
2	Understand the anatomical structure of brain, spinal cord, cranial nerves, spinal nerve.
3	Describe the position and structure of Pituitary, Thyroid, Parathyroid, Pancreas, Adrenal.
4	Able to demonstrate the anatomical structure of eye, ear and nose.
5	Describe the anatomical structure of male and female reproductive system.
6	Demonstrate the position and structure of cardiovascular system, nervous system, endocrine glands, ear, eye, nose, male and female reproductive organs.

**THEORY- BML(T) 201**

CO	Blooms Level (if applicable)	Module	%age of questions
CO1	1,2	M1	20
CO2	1,2	M2	24
CO3	1,2	M3	20
CO4	1,2	M4	16
CO5	1,2	M5	20
CO6			
			100

**PRACTICAL- BML 291**

CO	Blooms Level (if applicable)	Module	%age of questions
CO1			
CO2			
CO3			
CO4			
CO5			
CO6	2,3	M6	100

**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB**  
**Syllabus of B. Sc. In Medical Lab Technology**  
**(Effective for 2020-2021 Admission Session)**  
**Choice Based Credit System**  
**140 Credit (3-Year UG) MAKAUT Framework**  
**w.e.f 2020-21**

**Detailed Syllabus**

**Module 1-Cardiovascular system: 8h**

Basic anatomy of heart and important blood vessels Brief introduction about Lymphatic System.

**Module 2-The Nervous System: 10h**

Basic anatomy of brain and spinal cord, meninges and cerebrospinal fluid, Cranial Nerves.

**Module 3-Endocrine System: 8h**

Brief anatomy of Pituitary, Thyroid, Parathyroid, Pancreas, Adrenal.

**Module 4- Special Senses: 6h**

Basic anatomy of eye, ear and nose.

**Module 5-Genitourinary system: 8h**

Basic anatomy of kidney and associated organs, male reproductive organs, female reproductive organs.

**Module 6- Practical: 20h**

1. Cardiovascular system - Demonstration from model of heart, cardiovascular system, Lymphatic System.
2. Nervous System - Demonstration from model of brain and spinal cord.
3. Endocrine System - Demonstration of Pituitary, Thyroid, Parathyroid, Pancreas, Adrenal from chart.
4. Special Senses- Demonstration from model of eye, ear and nose.
5. Genitourinary system - Demonstration of male and female reproductive organs from model and chart.

**Text Books:**

1. Chaurasia B D, (2016), Human Anatomy, 7th edition, CBS publishers.
2. Samaresh Mitra, Anatomy, 7th edition, Academic Publishers.

**Reference Books:**

1. Ross & Wilson, (2014), Anatomy & Physiology in health & illness, 11th edition, Elsevier Publications.
2. Gerard J. Tortora and Bryan H. Derrickson, (Principles of Anatomy and Physiology, 14th edition, Wiley Publications.

**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB**  
**Syllabus of B. Sc. In Medical Lab Technology**  
**(Effective for 2020-2021 Admission Session)**  
**Choice Based Credit System**  
**140 Credit (3-Year UG) MAKAUT Framework**  
**w.e.f 2020-21**

**CC4: Human Physiology II**

**Credits- 4T+2P**

**Course Objective:** The course is designed to provide basic knowledge of renal, muscular, nervous, endocrine and reproductive system. The students will be able to develop an understanding of the physiological concepts associated with Medical Lab Technology.

Sl	Course Outcome
1	Understand the function of renal system.
2	Illustrate the concept of muscular system.
3	Explain the physiological function of nervous system.
4	Develop physiological knowledge of endocrine system.
5	Apply the knowledge, concept of reproductive physiology.
6	Apply the skill in diagnostic laboratory by using the modern tools and techniques and correlate between interdisciplinary branches.

**THEORY- BML(T) 202**

CO	Blooms Level (if applicable)	Module	%age of questions
CO1	1,2	M1	24
CO2	1,2	M2	16
CO3	1,2	M3	24
CO4	1,2	M4	16
CO5	1,2	M5	20
CO6			
			100

**PRACTICAL- BML 292**

CO	Blooms Level (if applicable)	Module	%age of questions
CO1			
CO2			
CO3			
CO4			
CO5			
CO6	2,3	M6	100

**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB**  
**Syllabus of B. Sc. In Medical Lab Technology**  
**(Effective for 2020-2021 Admission Session)**  
**Choice Based Credit System**  
**140 Credit (3-Year UG) MAKAUT Framework**  
**w.e.f 2020-21**

**Detailed Syllabus-**

**Module I- Organs of Excretory System: 10h**

Kidneys, Nephron, Mechanism of Excretion, Urine formation (Glomerular filtration and Tubular reabsorption), Electrolytes: their balances and imbalances Introduction of acidosis and alkalosis

**Module 2- Muscular System: 6h**

Muscle nerve physiology, types of muscles, their gross structural and functional difference with reference to properties.

**Module 3- Nervous system: 10 h**

General organization of CNS, function of important structure and spinal cord, neuron, nerve impulse, type of nerves according to function, autonomic nervous system- organization & function.

**Module 4- Endocrine System: 6h**

Brief introduction about endocrine glands and their secretion, common endocrinological disorder such as diabetes mellitus, hyper & hypothyroidism, dwarfism, gigantism, tetany.

**Module 5- Reproductive System: 8h**

Male & female reproductive organs, sex hormones, secondary sexual characteristics, puberty, spermatogenesis, oogenesis, menstrual cycle, pregnancy, menopause, contraceptive measures.

**Module 6: Practical** 20h

1. To perform total platelet count.
2. To perform bleeding time.
3. To perform clotting time.
4. To study about intrauterine contraceptive devices.
5. To demonstrate microscopic structure of bones with permanent slides.
6. To demonstrate microscopic structure of muscles with permanent slides.
7. To study about CSF examination.

**Text Books:**

1. C.C. Chatterjee, Human Physiology (vol 1 &2) 12 Ed, , Medical Allied Agency
2. G.K. Pal, Comprehensive Textbook of Medical Physiology, Jaypee Brothers Medical Publishers
3. Sembulingam K, (2012), Essentials of Medical Physiology, 6th edition, Jaypee Publications

**Reference Books:**

1. Guyton and Hall,(2011) Textbook of Medical Physiology,12<sup>th</sup> Edition, Saunder/Elsevier
2. Ross & Wilson,(2014),Anatomy & Physiology in health & illness,11th edition, Elsevier Publications
3. Sujit Chaudhury,(2011),Concise Medical Physiology,6th edition, NCBA
4. Gerard J. Tortora and Bryan H.Derrickson,(Principles of Anatomy and Physiology,14th edition,Wiley publications



**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB**  
**Syllabus of B. Sc. In Medical Lab Technology**  
**(Effective for 2020-2021 Admission Session)**  
**Choice Based Credit System**  
**140 Credit (3-Year UG) MAKAUT Framework**  
**w.e.f 2020-21**

**AECC 2- Environmental Science**

**Semester Credits- 2T**

**Course Objective:** The course is designed to provide a working knowledge of environment, ecology and physical sciences for problem solving. The learner will be able to remember, understand and apply the taught concepts and methods involving social and environmental processes for betterment of environmental health and safety.

**COURSE OUTCOMES (CO):**

Sl	Course Outcome	Mapped modules
1	Be able to remember the basic concepts related to environment & ecology	M1,M2
2	Be able to remember & understand the scientific problem related to air, water, noise & land pollution	M1, M2
3	Be able to understand environmental laws , regulations , guidelines and n applying those for maintaining quality of environmental health and safety .	M1, M2,M3

Module Number	Content	Total Hours	%age of questions	Covered CO	Blooms Level
Module 1	Environmental Concepts	7	30%	1,2	L1
Module 2	Resources & Pollution	6	30%	2,3	L1, L2
Module 3	Environment Management	7	40%	1,2,3	L2,L3

**SYLLABUS**

Module 1: Environmental Concepts – Definition & basic concept of Environment & Ecology, man, society & environment, their interrelationship, Elements of ecology elements of ecology - species, population, community, definition of ecosystem- Structure & function of ecosystem (Bio geo chemical cycles, food chain, energy flow, ecological pyramid), Biodiversity & its threats and remedies. [7]

Module 2: Resources & Pollution – renewable & non-renewable resources, Bio-degradable and non-biodegradable pollutants, Sources & Effects of Pollution, Methods of Control (Air, Water. Land, & Noise)

Module 3: Environment Management - Concept & scope of environment Management, National environmental policy & Environmental Legislations in India, Environment Management System – ISO 14000, Environmental Audit, Eco mark, green Industry, Cases on Environment Impact Assessment.

**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB**  
**Syllabus of B. Sc. In Medical Lab Technology**  
**(Effective for 2020-2021 Admission Session)**  
**Choice Based Credit System**  
**140 Credit (3-Year UG) MAKAUT Framework**  
**w.e.f 2020-21**

**REFERENCES**

Suggested Readings

1. N.K. Oberoi: Environmental Management, Excel Books
2. G.N. Pandey: Environmental Management, Vikas
3. K.M. Agrawal & P.K. Sikdar: Text Book of Environment, MacMillan
4. L.W. Canter: Environmental Impact Assessment, McGraw Hill
5. M.P. Poonia & S.C. Sharma, Environmental Studies, Khanna Publishing House (AICTE Recommended Textbook – 2018)
6. Masters, G. M., "Introduction to Environmental Engineering and Science", Prentice-Hall of India Pvt. Ltd.,1991.
7. De, A. K., "Environmental Chemistry", New Age International
8. Fundamentals of Ecology -Odum, E.P.
9. Instant notes on Ecology -Mackenzie, A., Ball, A.S. and Virdee, S.R. (1999) Viva Books
10. G. Dasmahapatra – Basic Environmental Engineering & Elementary Biology, Vikas Publication
11. Environmental Science, Cunningham, TMH
12. Environmental Pollution Control Engineering, C.S.Rao, New Age International
13. Environmental Science, Wright & Nebel, PHI
14. Environmental Pollution Analysis, S.M.Khopkar, New Age International

**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB**  
**Syllabus of B. Sc. In Medical Lab Technology**  
**(Effective for 2020-2021 Admission Session)**  
**Choice Based Credit System**  
**140 Credit (3-Year UG) MAKAUT Framework**  
**w.e.f 2020-21**

**3<sup>rd</sup> Semester**

Subject Type	Course Name	Course Code	Credit Distribution			Credit Points	Mode of Delivery			Proposed Moocs
			Theory	Practical	Tutorial		Offline #	Online	Blended	
CC 5	Pathology	BML(T) 301	4	0	0	6	✓			As per MAKAUT Notification
		BML 391	0	2	0					
CC 6	Haematology-I	BML(T) 302	4	0	0	6	✓			
		BML 392	0	2	0					
CC 7	Biochemistry	BML(T) 303	4	0	0	6				
		BML 393	0	2	0					
GE 3	Students will have to select from the GE Basket					6			✓	
SEC 1	Lab Management and Medical Ethics	BML 354	1	0	1	2	✓			
<b>Semester Credits</b>						<b>26</b>				

**# Only in case offline classes are not possible due to reasons like COVID Pandemic the classes will be in synchronous online mode**

**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB**  
**Syllabus of B. Sc. In Medical Lab Technology**  
**(Effective for 2020-2021 Admission Session)**  
**Choice Based Credit System**  
**140 Credit (3-Year UG) MAKAUT Framework**  
**w.e.f 2020-21**

**BML 301: Pathology**

**Credits- 4L+2P**

**Course Objective:** This curriculum will provide an introductory nature and build the concepts of how human system work in altered and diseased stage under the influence of various internal and external stimuli.

Sl	Course Outcome
1	Tell the basic knowledge about the history and terminology of pathology.
2	Demonstrate the knowledge of inflammation, hypertension and other pathological condition.
3	Explain the different metabolic disorder like diabetes, protein energy malnutrition and others.
4	Infer the pathological condition of different infectious diseases.
5	Illustrate the knowledge about the cancer and related topics.
6	Apply the skill to draw the blood sample and able to perform few basic tests related to pathology.

**THEORY- BML(T) 301**

CO	Blooms Level	Module	%age of questions
CO1	1,2	M1	20
CO2	1,2	M2	24
CO3	1,2	M3	20
CO4	1,2	M4	18
CO5	1,2	M5	18
			100

**PRACTICAL- BML 391**

CO	Blooms Level	Module	%age of questions
CO6	2,3	M6	100

**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB**  
**Syllabus of B. Sc. In Medical Lab Technology**  
**(Effective for 2020-2021 Admission Session)**  
**Choice Based Credit System**  
**140 Credit (3-Year UG) MAKAUT Framework**  
**w.e.f 2020-21**

**Module 1- 10h**

Introduction & history of pathology, Basic definitions and familiarization with the common terms used in pathology, causes and mechanisms of cell injury, reversible and irreversible injury, Introduction of hyperplasia, hypoplasia, hypertrophy, atrophy, metaplasia, necrosis and apoptosis.

**Module 2- 10h**

General features of acute and chronic inflammation, Vascular changes, cellular events, Cells and mediators of inflammation, Phagocytosis and its mechanism. Tissue Renewal and Repair, healing and fibrosis, cirrhosis, introduction of oedema, hyperaemia, congestion, haemorrhage, haemostasis, thrombosis, embolism, infarction, shock and hypertension.

**Module 3- 10h**

Protein energy malnutrition, deficiency diseases of vitamins, Role and effect of metals (Sodium, potassium, zinc, iron and calcium) and their deficiency diseases, nutritional excess and imbalances. Aetiology and pathophysiology of diabetes, arteriosclerosis, myocardial infarction, respiratory diseases (COPD), Parkinson disease.

**Module 4- 10h**

Infectious Diseases: pathogenesis & overview of modes of infections, prevention and control with suitable examples like Dengue. Routine examination of CSF, semen, sputum and stool.

**Module 5- 10h**

Cancer: Definitions, nomenclature, characteristics of benign and malignant neoplasm, metastasis, Carcinogens and cancer, concept of oncogenes, tumour suppressor genes, DNA repair genes and cancers stem cells.

**Module 6- Practical: 26 h**

1. Blood collection procedure.
2. Determination of haemoglobin by various methods.
3. Blood smear preparation.
4. Leishman Staining.
5. Total count of WBC.
6. Differential count WBC.
7. Determination of Total RBC count.
8. Determination of platelet count.

**Suggested Readings**

Harshmohan (2017), Textbook of Pathology, 7th edition, Jaypee Publications  
Robbins, (2012), Text book of Pathology, 3rd edition, Elsevier Publications

**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB**  
**Syllabus of B. Sc. In Medical Lab Technology**  
**(Effective for 2020-2021 Admission Session)**  
**Choice Based Credit System**  
**140 Credit (3-Year UG) MAKAUT Framework**  
**w.e.f 2020-21**

**BML 302: Haematology –I**

**Credits- 4L+2P**

**Course Objective:** Students will learn the differential diagnosis and appropriate diagnostic evaluation of common hematologic abnormalities.

Sl	Course Outcome
1	Demonstrate knowledge about the structure of haemoglobin and other blood cells and functions.
2	Explain the morphology of RBC and their abnormalities.
3	Relate the knowledge about leucopoiesis and the ESR.
4	Explain the definition, types and lab investigations of anaemia.
5	Illustrate the knowledge about haemostatic mechanism and coagulation.
6	Make use of the skill to perform the test for different haematological investigations.

**THEORY- BML (T) 302**

CO	Blooms Level	Module	%age of questions
CO1	1,2	M1	26
CO2	1,2	M2	18
CO3	1,2	M3	15
CO4	1,2	M4	20
CO5	1,2	M5	21
			100

**PRACTICAL- BML 392**

CO	Blooms Level	Module	%age of questions
CO6	2,3	M6	100

**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB**  
**Syllabus of B. Sc. In Medical Lab Technology**  
**(Effective for 2020-2021 Admission Session)**  
**Choice Based Credit System**  
**140 Credit (3-Year UG) MAKAUT Framework**  
**w.e.f 2020-21**

**Module I- 10h**

Haemoglobin: Structure, function, types, normal and abnormal haemoglobins. Estimation of haemoglobin by various methods with advantages and disadvantages. Hemocytometry: visual and electronic method, Neubauer counting chamber, RBC count, WBC count, Platelets count, absolute eosinophil count. Principle, procedure, calculation, significance, precautions involved during counting. Absolute count of various WBCs. Estimation of  $G-6-PD$ .

**Module 2- 10h**

RBCs: formation, morphology, cytoskeleton, anisocytosis, poikilocytosis, metabolism, role of 2, 3- DPG and oxygen dissociation curve. Packed cell volume, red cell indices (MCV, MCH, MCHC), physiological and pathological variations in value, reticulocyte count.

**Module 3- 10h**

ESR: physiological and pathological changes in values Erythrocyte sedimentation rate, manual and automated method, factor-affecting ESR.

Extravascular and intravascular haemolysis.

Leukopoiesis: Stages of Leukocyte Maturation, Features of Cell Identification

**Module 4- 10h**

Anaemia and its classification: Morphological and etiological, pathogenesis, laboratory investigations. Iron deficiency anaemia: pathogenesis, laboratory investigations. Megaloblastic anaemia, pernicious anaemia and Haemolytic anaemia: pathogenesis, laboratory investigations.

**Module 5- 10h**

Overview of haemostasis and coagulation, Stages of platelets development, Primary and Secondary haemostasis, Role of platelets, coagulation inhibitory system, Fibrinolysis. Complete blood count, determination by automated method and significance of each parameter, Reticulocyte count Mechanism of coagulation, coagulation factors, Bleeding time, clotting time, platelet count, protamine sulphate test, clot retraction test.

**Module 6: Practical 26h**

1. Determination of Total RBC count.
2. Determination of PCV

**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB**  
**Syllabus of B. Sc. In Medical Lab Technology**  
**(Effective for 2020-2021 Admission Session)**  
**Choice Based Credit System**  
**140 Credit (3-Year UG) MAKAUT Framework**  
**w.e.f 2020-21**

3. Determination of red cell indices
4. Demonstration of hypochromic microcytic slide.
5. Determination of bleeding time and clotting time.
6. General blood picture
7. Determination of G-6-PD
8. Differential Leucocyte Count.
9. Total leucocyte count
10. Demonstration of toxic granulation of neutrophil
11. Estimation of ESR.
12. To perform reticulocyte count

**Text Books:**

1. Sood Ramnik,(2015), Text book of Medical Laboratory Technology,2nd edition, Jaypee Publications.
2. Mukherjee K. L. (2017), Medical Laboratory Technology, Vol.1-3,3rd edition, Tata Mcgraw Hill

**Suggested Readings:**

1. Wintrobe's Clinical Haematology, (2014), 13th edition, Lippincott Williams & Wilkins
2. De Gruchy's Clinical Haematology in Medical Practice, (2012),Sixth edition, Wiley Publications
3. Dacie & Lewis Practical Haematology, (2011), 11th edition, Elsevier Publications



**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB**  
**Syllabus of B. Sc. In Medical Lab Technology**  
**(Effective for 2020-2021 Admission Session)**  
**Choice Based Credit System**  
**140 Credit (3-Year UG) MAKAUT Framework**  
**w.e.f 2020-21**

**BML 303: Biochemistry**

**Credits- 4L+2P**

**Course Objective:** The syllabus of biochemistry introduces the students about the basic knowledge and functions different biomolecules like carbohydrates, amino acids, proteins, enzymes, lipids, nucleic acids, vitamins and minerals. Students will know the basics of reagent preparation, instruments handling and can perform common analytical test.

Sl	Course Outcome
1	Demonstrate about different types carbohydrates, which we are taking as meal for generation of energy by metabolic pathways and understand the disease related to carbohydrates.
2	Illustrate the structure, properties and significance of amino acids and proteins, and the catalytic activity of enzymes.
3	Explain the lipid with its function and related disease.
4	Understand about the nucleic acids present in human body.
5	Demonstrate about functions of the vitamin, minerals and its deficiency disease.
6	Apply the knowledge and skill in diagnostic laboratory to perform biochemical test.

**THEORY- BML (T) 303**

CO	Blooms Level	Module	%age of questions
CO1	1,2	M1	20
CO2	1,2	M2	30
CO3	1,2	M3	15
CO4	1,2	M4	15
CO5	1,2	M5	20
			100

**PRACTICAL- BML 393**

CO	Blooms Level	Module	%age of questions
CO6	2,3	M6	100

**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB**  
**Syllabus of B. Sc. In Medical Lab Technology**  
**(Effective for 2020-2021 Admission Session)**  
**Choice Based Credit System**  
**140 Credit (3-Year UG) MAKAUT Framework**  
**w.e.f 2020-21**

**Module 1- Carbohydrates: 10h**

Classification, biomedical importance & properties.

Brief outline of metabolism: Glycogenesis, Glycogenolysis, Gluconeogenesis, Glycolysis, Citric acid cycle, HMP shunt, Regulation of blood glucose concentration, Diabetes Mellitus, Glycosuria, Glucose Tolerance Test.

**Module 2- Amino acids, Proteins and enzymes: 17h**

Amino acid: Amino acid-definition, classification, function, properties.

Protein and metabolic pathways: Protein-definition, classification and function. Primary, secondary, tertiary, quaternary structures of protein, Non-protein nitrogen, Nitrogen balance, Transamination and deamination, Uric acid formation, Urea cycle.

Enzymes: Definition, Cofactor & Coenzymes, Concept of active sites and general mode of action of enzymes, factor affecting enzyme activity, units of enzyme.

**Module 3- Lipids: 9h**

Classification of lipids, Biomedical importance, Classification of fatty acids, Essential fatty acids, Ketone body formation, Fatty liver, Ketosis, Cholesterol & its clinical significance, Lipoproteins in the blood composition & their functions in brief.

**Module 4-Nucleic acids: 6h**

Nitrogen bases, Nucleosides, Nucleotides, Structure, function and types of DNA and RNA, Role of Nucleic acid.

**Module 5- Vitamins and Minerals: 8h**

Vitamins: classification, function and disease associated with vitamins.

Minerals: Requirement, function and biological importance of Calcium, Iron, Iodine, Zinc, Phosphorus, Copper, Sodium and Potassium.

**Module 6- Practical: 26h**

1. Demonstration of glass and plastic apparatus and equipment (Colorimeter, spectrophotometer, Water distillation plant, pH meter) used in the Biochemistry Lab.
2. Handling and cleaning of the apparatus and equipment.
3. Preparation of different percentage, normal, molar solutions.
4. Preparation of solution by dilution.
5. Preparation of different buffers used in pathological laboratory and determine their PH.
6. Determination of glucose in a sample by both qualitatively (Benedict's method) and quantitatively.

**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB**  
**Syllabus of B. Sc. In Medical Lab Technology**  
**(Effective for 2020-2021 Admission Session)**  
**Choice Based Credit System**  
**140 Credit (3-Year UG) MAKAUT Framework**  
**w.e.f 2020-21**

7. Determine of total protein and albumin (quantitative estimation)
8. Determination of Ketone bodies, Bile salt, Bile pigments and urobilinogen in given sample.
9. Determination of cholesterol and triglyceride.
10. Determination of urea in blood.
11. Determination of creatinine in blood.
12. Determination of uric acid.

**Text Books:**

1. M Adhya & B Singha, (2018), Biochemistry (General and Ocular).
2. D M Vasudevan, (2011), Textbook of Medical Biochemistry, 6th edition Jaypee Publishers.
3. M N Chatterjea & Rana Shinde, (2012), Textbook of Medical Biochemistry, 8th edition, Jaypee Publishers.
4. D M Vasudevan & S K Das, Practical text Book of Biochemistry for medical Students, second edition, Jaypee Brothers Medical Publishers (P) Ltd
5. G Hegyi, J Kardos, M Kovács, A M Csizmadia, L Nyitray, G Pal, L Radnai, A Remenyi & I Venekei, (2013), National Development Agency.

**Suggested Readings:**

1. R K Murray, D K Granner, P A Mayes, V W Rodwell, 31<sup>st</sup> edition, Harper's Illustrated Biochemistry, MC Graw Hill Education (LANGE).
2. Nelson & Cox, 4th Edition, Lehninger principles of Biochemistry
3. J Berg J Tymoczko & L Stryer, 7<sup>th</sup> Edition, Biochemistry, W. H. Freeman and Company, New York
4. Voet & Voet, 4<sup>th</sup> edition, Biochemistry, John Wiley & Sons, Inc.

**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB**  
**Syllabus of B. Sc. In Medical Lab Technology**  
**(Effective for 2020-2021 Admission Session)**  
**Choice Based Credit System**  
**140 Credit (3-Year UG) MAKAUT Framework**  
**w.e.f 2020-21**

**BML 354: Lab management and Medical Ethics**

**Credits- 1L +1T**

**Course Objective:** Students would be competent enough to understand sample accountability, quality management system, biomedical waste management, calibration and validation of clinical laboratory instruments, Laboratory Information system (LIS), Hospital Information system (HIS) and financial management.

Sl	Course Outcome
1	Develop the knowledge about the basic laboratory ethics and laboratory accreditation procedure.
2	Apply the knowledge about the biomedical safety measure in laboratory practice.
3	Build the laboratory data collection and reporting system.
4	Utilize the quality control system in the diagnostic laboratory.
5	Develop the audit procedure related to laboratory accreditation and documentation.

CO	Blooms Level	Module	%age of questions
CO1	1,2,3	M1	25
CO2	1,2,3	M2	15
CO3	1,2,3	M3	20
CO4	1,2,3	M4	25
CO5	1,2,3	M5	15
			100

**Credits: 2**

**Module I: 5h**

Ethical Principles and standards for a clinical laboratory professional duty to the patient, duty to colleagues and other professionals, Good Laboratory Practice (GLP) Introduction to Basics of GLP and Accreditation, Aims of GLP and Accreditation, Advantages of Accreditation, Brief knowledge about National and International Agencies for clinical laboratory accreditation.

**Module 2: 5h**

Awareness/Safety in a clinical laboratory, General safety precautions. HIV: pre- and post-exposure guidelines, Hepatitis B & C: pre- and post-exposure guidelines.

**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB**  
**Syllabus of B. Sc. In Medical Lab Technology**  
**(Effective for 2020-2021 Admission Session)**  
**Choice Based Credit System**  
**140 Credit (3-Year UG) MAKAUT Framework**  
**w.e.f 2020-21**

**Module 3: 5h**

Sample analysis: Introduction, factors affecting sample analysis, reporting results, basic format of a test report, reported reference range, critical alerts, abnormal results, results from referral laboratories, release of examination results, alteration in reports.

**Module 4: 6h**

Quality Management system: Introduction, Quality assurance, Quality control system, Internal and External quality control, quality control chart, Biomedical Introduction and importance of calibration and Validation of Clinical Laboratory instrument. Examination procedures, reporting of results, preserving medical records Procurement of equipment and Inventory Control.

**Module 5: 5h**

Audit in a Medical Laboratory, Introduction and Importance, NABL & CAP, Responsibility, Planning, Horizontal, Vertical and Test audit, Frequency of audit, Documentation.

**Text Books:**

Henry's Clinical Diagnosis and Management by Laboratory Methods, (2011), 22<sup>nd</sup> edition, Elsevier

**Suggested Readings:**

1. Teitz, (2007), Fundamentals of Clinical Chemistry, 6th edition, Elsevier Publications
2. Bishop (2013), Clinical Chemistry, 7th edition, Wiley Publications

**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB**  
**Syllabus of B. Sc. In Medical Lab Technology**  
**(Effective for 2020-2021 Admission Session)**  
**Choice Based Credit System**  
**140 Credit (3-Year UG) MAKAUT Framework**  
**w.e.f 2020-21**

**4th Semester**

Subject Type	Course Name	Course Code	Credit Distribution			Credit Points	Mode of Delivery			Proposed Moocs
			Theory	Practical	Tutorial		Offline #	Online	Blended	
CC 8	Microbiology	BML(T) 401	4	0	0	6	✓			As per MAKAUT Notification
		BML 491	0	2	0					
CC 9	Haematology- II	BML(T) 402	4	0	0	6	✓			
		BML 492	0	2	0					
CC 10	Immunology	BML(T) 403	4	0	0	6				
		BML 493	0	2	0					
GE 4	Students will have to select from the GE Basket					6			✓	
SEC 2	Histotechnique	BML 455	1	0	1	2	✓			
<b>Semester Credits</b>						<b>26</b>				

**# Only in case offline classes are not possible due to reasons like COVID Pandemic the classes will be in synchronous online mode**

**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB**  
**Syllabus of B. Sc. In Medical Lab Technology**  
**(Effective for 2020-2021 Admission Session)**  
**Choice Based Credit System**  
**140 Credit (3-Year UG) MAKAUT Framework**  
**w.e.f 2020-21**

**CC8: Microbiology**

**Code- BML 401**

**Credits- 4L+2P**

**Course Objective:** This course prepares the students with handling of instruments and sterilization techniques. Students shall be able to identify and differentiate bacteria and fungus in biological samples

Sl	Course Outcome
1	Build the basic knowledge of microbiology.
2	Define the different equipment used in microbiology Lab.
3	Understand the mode of infection and safety measure taken in microbiology laboratory.
4	Explain the terminology used in host pathogen interaction.
5	Demonstrate the activities conducted in diagnostic microbiology.
6	Remember the character of different microorganism.
7	Utilize the knowledge and skill in diagnostic laboratory to perform different tests related to haematology.

**THEORY- BML (T) 401**

CO	Blooms Level	Module	%age of questions
CO1	1,2	M1	18
CO2	1,2	M2	15
CO3	1,2	M3	15
CO4	1,2	M4	12
CO5	1,2	M5	18
CO6	1,2	M6	22
			<b>100</b>

**PRACTICAL- BML 491**

CO	Blooms Level	Module	%age of questions
CO7	2,3	M7	100

**Module 1 9 h**

Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Edward Jenner. Introduction to bacterial taxonomy, Classification of Bacteria based on size, shape, arrangement, motility, flagella, spores, capsules, composition and detailed structure of Gram-positive and Gram-negative cell walls, plasma membrane, pili.

**Module 2 7h**

Basic knowledge of different types of microscope. Principle, working and use of Laminar air flow, biosafety cabinet, Centrifuge, Autoclave, hot air Oven, Incubator, Muffle Furnace, Mac-intos Field-jar etc.

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**140 Credit (3-Year UG) MAKAUT Framework**  
**w.e.f 2020-21**

**Module 3    8 h** General safety measures used in Microbiology laboratory, Sterilization and disinfection: Various physical methods of sterilization – heat, UV radiation, ionizing radiation, filtration. Antiseptics & Disinfectants: Definition, types and properties, mode of action and use, Occurrence of lab infections, route of infections in laboratory.

**Module 4    5 h**

Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection.

**Module 5                    9h**

Specimen collection from patients, Culture medium used in microbiology, Preparation and standardization of inoculums, Antibiotic susceptibility testing in bacteriology, choice of antibiotics MIC and MBC: Concepts and methods for determination various methods of Antibiotic susceptibility testing with special reference to Stokes and Kirby-Bauer method.

**Module 6                    12 h**

Description, morphology, cultural characteristics, pathogenicity, clinical features and lab diagnosis of Staphylococcus, Streptococcus, Pneumococcus, Neisseria, Mycobacterium, Clostridia, Escherichia coli, Salmonella, Shigella, Proteus, Vibrio, Pseudomonas, Spirocheates, Yersenia.

Introduction of Mycology: Definition, general properties and classification Cutaneous mycoses, Systemic mycoses, Opportunistic mycoses. Culture and laboratory test for fungus.

**Module 7- Practical: 26 h**

1. Demonstration of Microscope and its parts.
2. Demonstration of glassware used in microbiology.
3. Demonstration of autoclave and sterilization of glass wares and of media
4. Demonstration of Hot air oven and sterilization of glass wares.
5. Demonstration of Laminar airflow, biosafety cabinet and media preparation
6. Demonstration of Centrifuge.
7. Demonstration of Incubator and preservation of cultures.
8. Preparation of media.
9. Preparation of culture plates
10. To perform Gram staining.
11. To perform Indian ink staining.
12. To perform Acid fast staining (Zeihl Neelsen staining).
13. To perform Hanging drop method
14. Antibiotic sensitivity test.
15. Examination of urine.
16. Examination of sputum



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**w.e.f 2020-21**

**Suggested Readings**

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology, 8th edition, University Press Publication.
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013).
3. Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
4. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier.
5. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education.

**CC 9: Haematology II**

**Code- BML 402**

**Credits- 4L+2P**

**Course Objective:** Students will be able to perform the differential diagnosis and appropriate diagnostic evaluation of common hematologic abnormalities.

<b>Sl</b>	<b>Course Outcome</b>
1	Understand the basic principle related to coagulation study and general blood picture.
2	Explain the pathogenesis, clinical features and lab investigations of aplastic and sideroblastic anaemia.
3	Demonstrate the pathogenesis, clinical features and lab investigations of sickle cell anaemia and thalassemia.
4	Built knowledge about the aetiology, classification, clinical features and laboratory investigations of Leukemia.
5	Able to illustrate the disorder related to blood coagulation, special attention to coagulation factor deficiency.
6	Apply the knowledge and skill in diagnostic laboratory to perform different tests related to haematology.

**THEORY- BML (T) 402**

<b>CO</b>	<b>Blooms Level</b>	<b>Module</b>	<b>%age of questions</b>
CO1	1,2	M1	20
CO2	1,2	M2	18
CO3	1,2	M3	20
CO4	1,2	M4	20
CO5	1,2	M5	22
			<b>100</b>

**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB**  
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**w.e.f 2020-21**

**PRACTICAL- BML 492**

CO	Blooms Level	Module	%age of questions
CO6	2,3	M6	100

**Module 1** 10 h

General blood picture estimation of iron, TIBC, Transferrin, Ferritin, Plasma haemoglobin, Vit.B12, Folic acid, Heinz bodies, Platelet count, Platelet aggregation test, PT, INR, APTT, Thrombin time. Role of coagulation factors.

**Module 2** 9 h

Aplastic anaemia, Anaemia of chronic disorders, Sideroblastic anaemia: aetiology, pathogenesis, clinical features, laboratory investigations. Bone marrow examination, composition & functions, aspiration techniques, processing and staining.

**Module 3** 10h

Sickle cell anaemia, sickle cell trait, aetiology, pathogenesis, clinical features, and laboratory investigations, Sickling test, Thalassaemia, classification, aetiology, pathogenesis, clinical features, laboratory Investigations.

**Module 4** 10 h

Leukemia and its classification, WHO and FAB classification, AML, ALL, CML, CLL, its aetiology, clinical features, laboratory investigations. Cytochemistry involved in diagnosis of various types of leukemia.

**Module 5** 11 h

Qualitative and quantitative disorders of platelets, disorders of secondary hemostasis, hemophilia and its lab diagnosis, Von- Willebrand disease, Disseminated intravascular coagulation, thrombosis, Disorder of fibrinogen, test for bleeding & coagulation disorders, correction studies for factor deficiency, quantitative factor assay, LE cells, its demonstration and significance.

**Module 6- Practical:** 26h

1. To perform sickling test.
2. To perform Heinz bodies.
3. To perform LAP scoring.
4. To determine total platelet count.
5. To perform PT.
6. To perform APTT.
7. To perform thrombin time.
8. To perform D-dimer test.
9. To determine fibrinogen conc.
10. Haemoglobin electrophoresis.

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**CC 10: Immunology**

**Code- BML 403**

**Credits- 4L+2P**

**Course Objective:** Prepare the students with the basic knowledge of immune system, its functions and its related disease. Students will able to carry out differential diagnosis of immune disease by the help of serological techniques.

Sl	Course Outcome
1	Illustrate the basic concept of immune cells, immune organs, antigens, haptens and immunogens.
2	Demonstrate different types of antibody and its structures and immune response.
3	Explain about the histocompatibility complex and its role in transplantation immunology.
4	Acquire knowledge on immunological disorder and its related diseases.
5	Understand about the immunization and its functions to protect from immune disease.
6	Apply the knowledge and skill in diagnostic laboratory to perform serological tests.

**THEORY- BML (T) 403**

CO	Blooms Level	Module	%age of questions
CO1	1,2	M1	17
CO2	1,2	M2	20
CO3	1,2	M3	21
CO4	1,2	M4	30
CO5	1,2	M5	12
			<b>100</b>

**PRACTICAL- BML 493**

CO	Blooms Level	Module	%age of questions
CO6	2,3	M6	100

**Module 1- 8h**

Historical background, general concepts of the immune system, innate and adaptive immunity, Cell and organs of immune system, Phagocytosis. Antigens, Immunogen, haptens: Properties, foreignness, molecular size, heterogeneity, B and T cell epitopes, T dependent and T independent antigens.

**Module 2- 11h**

Antibodies: Historical perspective of antibody structure; structure, function and properties of the antibodies; different classes, subclasses and biological activities of antibodies; isotype, allotype, monoclonal antibodies and polyclonal antibody, active and passive immunity; primary and secondary immune response.

Laboratory tests for demonstration of antigen – antibody reaction such as agglutination, precipitation.

**Module 3- 11 h**

**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB**  
**Syllabus of B. Sc. In Medical Lab Technology**  
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**w.e.f 2020-21**

Introduction of Major Histocompatibility Complex, organization of MHC and inheritance in humans; Antigen presenting cells, antigen processing and presentation. Mechanism of humoral and cell mediated immune response.

Introduction of transplant immunology, graft rejection, tissue typing for transplant, Laboratory test for transplant.

**Module 4- 14h**

Hypersensitivity and its types Introduction to Allergy and its laboratory test.

Autoimmune disorders, pathogenesis, organ specific and systemic autoimmune disorders and its markers such parietal cell antibody, anti sperm antibody, lupus anticoagulants, HLA-B27, anti CCP

Immunological disorders: primary and secondary immunodeficiency, SCID, AIDS, Tumour, types of tumours, Various Tumour Markers, their significance and method of estimation.

**Module 5- 6h**

Vaccines, classification and applications, Active and passive immunization, Immunoprophylaxis schedule in neonates, children and in pregnancy.

**Module 6- Practical: 26h**

1. To demonstrate agglutination reaction.
2. To perform RA test.
3. To perform WIDAL test.
4. To perform CRP test.
5. To perform HIV Tridot test.
6. To perform HBsAg rapid test.
7. To perform ASO test.
8. To perform TB IgG & IgM test.
9. To perform Dengue IgG & IgM test.
10. To perform RPR test.
11. Montoux test

**Suggesting Readings**

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley- Blackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6<sup>th</sup> edition W.H. Freeman and Company, New York.
4. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7<sup>th</sup> edition Garland Science Publishers, New York.
5. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
6. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB**  
**Syllabus of B. Sc. In Medical Lab Technology**  
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**140 Credit (3-Year UG) MAKAUT Framework**  
**w.e.f 2020-21**

**SEC 2: Histotechnique**

**Code- BML 455**

**Credits- 1L+1T**

**Course Objective:** Students would be able to carry out tissue processing and general staining.

Sl	Course Outcome
1	Understand the basic knowledge of histotechnique.
2	Demonstrate the tissue processing and microtome and its use
3	Able to explain the process of frozen tissue section in emergency and routine tissue staining.

CO	Blooms Level	Module	%age of questions
CO1	1,2	M1	24
CO2	1,2	M2	38
CO3	1,2	M3	38
			<b>100</b>

**Module 1: 8h**

Introduction of histopathology, cytology & histotechniques, care & maintenance of equipments used in histotechnology lab, safety measures in histotechnology lab. Recording, Labelling and transportation of tissue specimens, Basic concepts of fixation and various types of fixative used in histopathology and cytopathology.

**Module 2: 10 h**

Tissue and its types, Location and function, Grossing of tissues, sections, smears, tissue processing and its steps, manual and automated method. Decalcification, decalcification methods, types of decalcifying fluid, Processing of bones and teeth, Embedding media, its type and properties. Microtome, its type, Microtome knives, its type and knife sharpening, Section cutting, fault and remedies.

**Module 3: 10 h**

Cryostat, frozen sections of fresh, fixed and unfixed tissue, freeze drying, rapid frozen sections and staining for emergency diagnosis Dye chemistry, Stains and dyes, natural dye, acidic dye, basic dye, neutral dyes, fluorescence dye, mordant. Supravital staining, types of hematoxylin, Haematoxylin and eosin staining, counter staining, mounting and mounting media, advantages & disadvantages.

**Suggested Readings:**

1. Bancroft's Theory and Practice of Histological Techniques, 7th Edition, Elsevier Publications
2. Harshmohan (2017), Textbook of Pathology, 7th edition, Jaypee Publications
3. Godkar.B. Praful,(2016) Textbook of MLT, 3rd edition, Bhalani Publications
4. C F A Culling,(1974), Handbook of Histopathological and Histochemical Techniques: Including Museum Techniques, 3rd edition, Butterworths Publishers

**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB**  
**Syllabus of B. Sc. In Medical Lab Technology**  
**(Effective for 2020-2021 Admission Session)**  
**Choice Based Credit System**  
**140 Credit (3-Year UG) MAKAUT Framework**  
**w.e.f 2020-21**

**5th Semester**

Subject Type	Course Name	Course Code	Credit Distribution			Credit Points	Mode of Delivery			Proposed Moocs
			Theory	Practical	Tutorial		Offline	Online	Blended	
CC 11	Immunohematology and blood banking	BML(T) 501	4	0	0	6	✓			As per MAKUT Notification
		BML 591	0	2	0					
CC 12	Parasitology and virology	BML(T) 502	4	0	0	6	✓			
		BML 592	0	2	0					
DSE 1 (Any one)	Diagonostic cytology	BML 503 (A)	4	0	0	6			✓	
		BML 593 (A)	0	2	0					
	Diagnostic Histopathology	BML503 (B)	4	0	0					
		BML593 (B)	0	2	0					
DSE 2 (Any one)	Clinical Enzymology	BML 504 (A)	4	0	0	6			✓	
		BML 594 (A)	0	2	0					
	Biochemistry & Nutrition	BML 504 (B)	4	0	0					
		BML 594 (B)	0	2	0					
<b>Semester Credits</b>						<b>24</b>				

**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB**  
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**140 Credit (3-Year UG) MAKAUT Framework**  
**w.e.f 2020-21**

**Paper: Immunohematology & Blood Banking**

**Code: BML-501/591**

**Credits: 4L+2P.**

**Course objective**

Students would be able to make use of transfusion medicine, laboratory testing, quality control and apheresis techniques.

Sl	Course Outcome
1	Demonstrate the basic knowledge of Immunohematology and blood banking
2	Understand the different blood grouping system and donor selection criteria.
3	Explain the knowledge of transfusion transmissible disease and antigen antibody reaction.
4	Organise the knowledge and skill of preparation of blood components.
5	Outline the Apheresis procedure and role of different administrative bodies.
6	Examine and Evaluate to perform different activities related to transfusion medicines.

**THEORY- BML (T) 501**

CO	Blooms Level	Module	%age of questions
CO1	1,2,3	M1	25
CO2	1,2,3	M1,M2	20
CO3	1,2,3	M2,M3	20
CO4	1,2,3,4	M3,M4	20
CO5	1,2,3,4	M4,M5	15
			<b>100</b>

**PRACTICAL- BML 591**

CO	Blooms Level	Module	%age of questions
CO6	3,4,5	M6	100

**Module-I (10 Hrs)**

Basic Principles of Blood Banking; Antigen, Antibody, naturally occurring antibody, Complement, ABO & Rh blood group system, Methods of blood group determination, Forward and Reverse grouping, Slide & Tube method, Gel method.

**Module-II (10 Hrs)**

Other blood group system such as Lewis, MNS, Kell Duffy etc. Anticoagulants and preservative used in blood bank, Donor selection criteria, Blood collection and processing

**Module-III (10 Hrs)**

Transfusion transmissible infectious disease screen, Coomb's test, Cross matching, Compatibility testing, Antibody Screening & Identification, Grading of Reaction/Agglutination

**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB**  
**Syllabus of B. Sc. In Medical Lab Technology**  
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**140 Credit (3-Year UG) MAKAUT Framework**  
**w.e.f 2020-21**

**Module-IV (10 Hrs)**

Blood components and its preparation, preservation, storage and transportation  
 Indications for different blood component transfusion, Blood transfusion reaction and its type, HDN Introduction of stem cell banking and bone marrow transplantation.

**Module-V (10 Hrs)**

Apheresis, indications of hemapheresis, plasmapheresis, plateletspheresis, plasmapheresis  
 Quality control of reagents, equipments, blood components used in transfusion medicine.  
 Role of NACO, Indian Red Cross Society and DGHS.

**MODULE—VI (PRACTICAL) (BML591) (26 Hrs)**

- 1-Forward blood grouping (Tube and slide method)
- 2- Reverse blood grouping.
- 3- Rh typing.
- 4- Rh negative or D<sup>u</sup> conformation.
- 5- Direct and indirect Coomb's test.
- 6- Major Cross matching.
- 7- Minor cross matching.
- 8- Blood donor selection.
- 9- Demonstration of blood collection procedure.
- 10- Blood group screening by finger pricking.
- 11- Demonstration of blood component separation.
- 12- Demonstration of storage of blood component.

***Suggested Readings:***

1. Godkar.B. Praful,(2016) Textbook of MLT,3<sup>rd</sup> edition,Bhalani Publications
2. Ochei J & Kolhatkar A(2000),Medical Laboratory Science: Theory & Practice, 3<sup>rd</sup> edition,Mcgraw Hill Education
3. Mukherjee .L.K(2017), Medical Laboratory Technology,Vol.1-3,3<sup>rd</sup> edition, Tata Mcgraw Hill
4. Sood Ramnik,(2015), Text book of Medical Laboratory Technology,2<sup>nd</sup> edition, Jaypee Publications
5. Wintrobe's Clinical Hematology,(2014),13<sup>th</sup> edition, Lippincott Williams & Wilkins
6. Principle & practice of Transfusion Medicine. Dr. R.N Makroo. Kongposh Publications.

**Paper: Parasitology & Virology**

**Code: BML-502/592**

**Credits : 4L+2P.**

**Course objective**

Students would be able to identify and infer different parasites and viruses with latest biomedical techniques.

Sl	Course Outcome
1	Acquire the knowledge of parasitology
2	Able to explain the diagnostics method in parasitology
3	Explain the nature and properties of viruses.
4	Apply the knowledge of different viral diseases.



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**140 Credit (3-Year UG) MAKAUT Framework**  
**w.e.f 2020-21**

5	Illustrate the knowledge about oncogenic viruses .
6	Experiment with different activities related to Parasitology & Virology.

**THEORY- BML (T) 502**

CO	Blooms Level	Module	%age of questions
CO1	1,2	M1	25
CO2	1,2,3	M1,M2	20
CO3	1,2,3	M2,M3	23
CO4	1,2,3	M3,M4	22
CO5	2,3,4	M4,M5	10
			<b>100</b>

**PRACTICAL- BML 592**

CO	Blooms Level	Module	%age of questions
CO6	2,3,4,5	M6	100

**Module-I (10 hours)**

Introduction of parasites, host, zoonosis, host parasites relationship, sources of infection, mode of infection, pathogenesis, lab diagnosis.

Protozoology: Entamoeba histolytica, Malarial Parasites, Leishmania, Trypanosomes, their morphology, life cycle, pathogenesis, clinical features and lab diagnosis.

Helminthology: Morphology, life cycle, pathogenesis, clinical features and lab diagnosis

Of Taenia solium, Taenia Saginata, Ascaris, Wuchereria bancrofti, Hookworm, Trichuris Dracunculus.

**Module-II (10 hours)**

Diagnostic methods in Parasitology: Introduction, Examination of stool, urine, Immunological diagnosis and serology

**Module- III (10 hours)**

Introduction: Discovery, nature, property and definition of viruses, concept of viroids, virusoids, satellite viruses and Prions. Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses.

Viral taxonomy: Classification of different groups of viruses,

Modes of viral transmission: Persistent, non-persistent, vertical and horizontal

Viral multiplication and replication strategies: Interaction of viruses with cellular receptors and entry of viruses. Assembly, maturation and release of virions

**Module IV (10 hours)**

Brief description of Poxviruses, Herpesviruses, Hepatitis viruses, retroviruses-HIV, TORCH profile. Symptoms, mode of transmission, prophylaxis and control of Polio, Rabies, Dengue, HIV, Influenza, swine flu, Ebola, Chikungunya, Japanese Encephalitis.

**Module V (10 hours)**

Introduction to oncogenic viruses, DNA and RNA viruses, concepts of oncogenes and proto-oncogenes, prevention & control of viral diseases, antiviral compounds and their mode of action, interferon and their mode of action, General principles of viral vaccination.

**Module VI-Parasitology & Virology**

**Code: BML- 592**

**Credits : 2(26 Hrs)**

1. Leishman staining for malarial parasites
2. Saline wet mount for observing ova and eggs of parasites.
3. Iodine wet mount for observing ova and eggs of parasites.

**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB**  
**Syllabus of B. Sc. In Medical Lab Technology**  
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**140 Credit (3-Year UG) MAKAUT Framework**  
**w.e.f 2020-21**

4. Concentration of stool samples by floatation method
5. Zinc sulphate conc. Method for stool sample
6. Demonstration of Trichuris, Ascaris and Hookworm
7. by permanent slides.
8. Aldehyde Chopra test for Kala Azar
9. To perform HBsAg/ Australia Ag by rapid method
10. To perform HBsAg by ELISA
11. To perform HIV Tridot method.
12. To perform HIV by ELISA
13. To perform Dengue IgG/IgM.

***Suggested Readings:***

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013)
3. Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
4. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4<sup>th</sup> edition. Elsevier
5. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education
6. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication
7. Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication

**DSE 1-Diagnostic Cytology**

**Credits: 4L+2P.**

**Course objective**

Students would be able to take part in collection, processing, staining and quality control in cytological diagnosis.

Sl	Course Outcome
1	Build knowledge about the basic structure of cells.
2	Apply the knowledge of the cell fixation, blocking and staining.
3	Demonstrate the FNAC and staining procedure.
4	Explain the process of different cytological fluid sample.
5	Illustrate the knowledge of modern cytological technique.
6	Able to experiment with different activities of diagnostic cytology.

**THEORY- BML 503 (A)**

CO	Blooms Level	Module	%age of questions
CO1	1,2	M1	18
CO2	1,2,3	M2	20
CO3	2,3	M3	20
CO4	2,3,4	M4	20
CO5	2,3,4	M5	22
			<b>100</b>

**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB**  
**Syllabus of B. Sc. In Medical Lab Technology**  
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**140 Credit (3-Year UG) MAKAUT Framework**  
**w.e.f 2020-21**

**PRACTICAL- BML 593 (A)**

CO	Blooms Level	Module	%age of questions
CO6	2,3,4,5	M6	100

**Module I (10 hours)**

Cell: basic structure and function, cell organelles, cell cycle, Benign and Malignant tumors, Instruments used in cytology, preparation of buffers, stains.

**Module II (10 hours)**

Instruments and equipments used in cytology Fixation and Fixatives used in cytology, Adhesive and mounting media, Cell block and cytospin technique, Staining such as PAP, H&E, significance of PAP-HPV, Destaining and restaining of slides, Cover slipping

**Module III (10 hours)**

Aspiration and exfoliative cytology, Patient preparation, Sample collection, Fixation, Processing and Staining. FNAC, collection, processing of sample and staining, on site quick staining procedure.

**Module IV (10 hours)**

Hormonal cytology in different age groups, Collection and processing of sputum, BAL, CSF, Pleural, peritoneal and pericardial fluid, Gynaecologic sample

**Module V (10 hours)**

Sex chromatin demonstration, Introduction of Immunocytochemistry, different markers and its applications, Automation in cytology, Liquid based preparation & automated screening device.

**Module VI -Practical Diagnostic Cytology (26 hrs)**

Credits : 2

1. Preparation of various cytological fixatives
2. Preparation of various stains used in cytology
3. Preparation of smear
4. To perform PAP staining
5. To perform Giemsa staining on fluid sample
6. To prepare cell suspension
7. Processing of various fluid samples

***Suggested Readings:***

Bibbo, (1997), Comprehensive Cytopathology, 2<sup>nd</sup> edition, Saunders Publishers  
 Koss's Diagnostic Cytology, Vol.1 & 2, (2006), 5<sup>th</sup> edition, Lippincott Godkar. B. Praful, (2016) Textbook of MLT, 3<sup>rd</sup> edition, Bhalani Publications  
 Ochei J & Kolhatkar A (2000), Medical Laboratory Science: Theory & Practice, 3<sup>rd</sup> edition, Mcgraw Hill Education  
 Mukherjee .L.K (2017), Medical Laboratory Technology, Vol.1-3, 3<sup>rd</sup> edition, Tata Mcgraw Hill  
 Sood Ramnik, (2015), Text book of Medical Laboratory Technology, 2<sup>nd</sup> edition, Jaypee Publications.

**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB**  
**Syllabus of B. Sc. In Medical Lab Technology**  
**(Effective for 2020-2021 Admission Session)**  
**Choice Based Credit System**  
**140 Credit (3-Year UG) MAKAUT Framework**  
**w.e.f 2020-21**

**DSE 1: Diagnostic Histopathology**

**Credits : 4L+2P.**

Course objective

Students would able to make use of tissue processing and general staining.

Sl	Course Outcome
1	Build the basic knowledge of microtome and tissue section cutting.
2	Able to perform the different types of tissue staining.
3	Acquire the knowledge of carbohydrate and connective tissue staining.
4	Utilize the knowledge and skill of processing of bones and nerve tissue.
5	Explain the Museum techniques and working principle of different types of microscope.
6	Able to compare different activities related to diagnostic histopathology.

**THEORY- BML 503 (B)**

CO	Blooms Level	Module	%age of questions
CO1	1,2,3	M1	20
CO2	1,2,3	M2	20
CO3	2,3,4	M3	20
CO4	2,3,4	M4	20
CO5	2,3,4	M5	20
			100

**PRACTICAL- BML 593 (B)**

CO	Blooms Level	Module	%age of questions
CO6	3,4,5,6	M6	100

Module-I(10 Hrs) Microtome, its type and working, various type of microtome, Microtome knives, its type and knife sharpening, Section cutting, fault and remedies, Section adhesive.
Module-II(10 Hrs) Progressive, regressive, vital, supravital staining, types of hematoxylin, Haematoxylin and eosin staining, use of control sections in tissue staining, mounting and mounting media, advantages & disadvantages.
Module-III( 10 Hrs) Staining of carbohydrates: preparation of Schiff reagent, PAS staining, Alcianblue, staining of glycogen. Connective tissue & its staining: Trichrome staining, verhoeff stain, Gomori's method, von Geison stain, PTAH stain.

**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB**  
**Syllabus of B. Sc. In Medical Lab Technology**  
**(Effective for 2020-2021 Admission Session)**  
**Choice Based Credit System**  
**140 Credit (3-Year UG) MAKAUT Framework**  
**w.e.f 2020-21**

<p>Module-IV( 10 Hrs)</p> <p>Demonstration of minerals and pigments in tissue sample, Demonstration and identification of lipids, Demonstration of enzymes, diagnostic application and Demonstration of microorganism on tissue specimens.</p> <p>Processing and staining of bone marrow sample. Fixation, Processing and section cutting of bones, Techniques in neuropathology: Neurons staining, Myelin, Neuropathology lab specimen Handling.</p>
<p>Module-V(10 Hrs)</p> <p>Museum techniques</p> <p>Electron microscopy: Principle and working, of tissue. Fluorescence Microscope: Principle and working.</p> <p>Immunohistochemistry: principle, types, applications.</p>

**Module VI- Histopathology**

Credits :2 ( 26 hrs.)

1. Demonstration of glass wares and equipment used in histopathology lab.
2. To prepare alcohol of different concentration.
3. To prepare formalin from stock solution.
4. To sharp knife by honing and stropping.
5. Grossing of tissue
6. To perform tissue processing by manual method.
7. To perform section cutting of paraffin embedded tissue.
8. To fix the smear on glass slide.
9. To perform hematoxylin and eosin staining.

*Suggested Readings:*

1. Bancroft's Theory and Practice of Histological Techniques, 7th Edition, Elsevier Publications
2. Harshmohan (2017), Textbook of Pathology, 7<sup>th</sup> edition, Jaypee Publications
3. Godkar.B. Praful,(2016) Textbook of MLT, 3<sup>rd</sup> edition, Bhalani Publications
4. C F A Culling,(1974), Handbook of Histopathological and Histochemical Techniques: Including Museum Techniques, 3<sup>rd</sup> edition, Butterworths Publishers

**DSE 2-Clinical Enzymology & Automation**

**Code: BML-504 (A)/594A**

**Credits: 4L+2P.**

**Course objective**

Students would be able to compare contemporary methods and practical approaches that are used in the clinical laboratories for the investigation of the diseased state as well as outline the application of automation in laboratory.

Sl	Course Outcome
1	Develop idea about the enzyme and isoenzyme.
2	Make use of knowledge about co-enzymes.
3	Demonstrate about the Michaelis-Menten equation and its physiological significances.

**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB**  
**Syllabus of B. Sc. In Medical Lab Technology**  
**(Effective for 2020-2021 Admission Session)**  
**Choice Based Credit System**  
**140 Credit (3-Year UG) MAKAUT Framework**  
**w.e.f 2020-21**

4	Explain about the clinical significance of cardiac, Liver, and pancreatic enzymes in diagnosis.
5	Apply knowledge about automation in clinical laboratory and maintenance of equipments.
6	Able to assess different activities of diagnostic laboratories.

**THEORY- BML 504(A)**

CO	Blooms Level	Module	%age of questions
CO1	1,2,3	M1	22
CO2	1,2,3	M1,M2	20
CO3	2,3,4	M2,M3	20
CO4	2,3,4	M3,M4	20
CO5	2,3,4	M4,M5	18
			<b>100</b>

**PRACTICAL- BML 594(A)**

CO	Blooms Level	Module	%age of questions
CO6	3,4,5	M5,M6	100

**Module I (10 Hours)**

Introduction to enzymes, Classification of Enzymes, Isoenzymes, Concept of lock and key and induced fit theory, concept of activation energy and binding energy. Factors affecting enzyme activity

**Module II (10 Hours)**

Coenzyme: Classification, various types and function, structure of NAD<sup>+</sup>, NADP<sup>+</sup>, FAD and FMN, PPP. Units for measuring enzyme activity, factors affecting enzyme level in serum/ plasma. Clinical assay & its type, kinetic assay and end point assay for the enzymes

**Module III (10 Hours)**

Enzyme kinetics, the Michaelis-Menten equation and its physiological significances, Enzyme Inhibition, types of inhibitors of enzyme

**Module IV (10 Hours)**

Isoenzymes, their tissue distribution and clinical significance: ALT, AST, ALP, GGT, CPK, CK-MB, LDH, Troponin, Myoglobin, Amylase, Lipase, ACP

**Module –V (10 Hours)**

Basic Concepts of Automation, principle, working and maintenance of various clinical chemistry analyzers, point of care testing, Hospital Laboratory Management

**Module VI-Practical Clinical Enzymology (26 hours)**

**Credits : 2**

**1.To perform enzyme estimation of LFT**

1. To perform enzyme estimation of Cardiac profile
2. Determination of Troponin I
3. To perform enzyme estimation of Pancreatic disorder
4. To perform estimation of ACP.
5. Antenatal profile
6. Estimation of bicarbonate
7. Arterial blood gas analysis
8. Determination of Calcium

**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB**  
**Syllabus of B. Sc. In Medical Lab Technology**  
**(Effective for 2020-2021 Admission Session)**  
**Choice Based Credit System**  
**140 Credit (3-Year UG) MAKAUT Framework**  
**w.e.f 2020-21**

9. Creatinine and urea clearance test

***Suggested Readings:***

2. D M Vasudevan, (2011), Text book of Medical Biochemistry, 6<sup>th</sup> edition Jaypee Publishers
3. M N Chatterjea & Rana Shinde, (2012), Text book of Medical Biochemistry, 8<sup>th</sup> edition, Jaypee Publications
4. Singh & Sahni, (2008), Introductory Practical Biochemistry, 2<sup>nd</sup> edition, Alpha science
5. Lehninger, (2013), Principles of Biochemistry, 6<sup>th</sup> edition, W H Freeman
6. U Satyanarayan, (2008), Essentials of Biochemistry, 2<sup>nd</sup> edition, Standard Publishers
7. Teitz, (2007), Fundamentals of Clinical Chemistry, 6<sup>th</sup> edition, Elsevier Publications
8. Bishop (2013), Clinical Chemistry, 7<sup>th</sup> edition, Wiley Publications.

**DSE 2-BIOCHEMISTRY & NUTRITION**

**Credits- 4L+2P**

**Course Objective:** This course prepares the students with handling of instruments and sterilization techniques. Students shall be able to identify and differentiate bacteria and fungus in biological samples.

Sl	Course Outcome
1	Ability to understand the concept of solutions, PH and cell structure.
2	Able to understand the Metabolism of Carbohydrate and related disorder.
3	Explain the properties of protein and vitamins.
4	Demonstrate the different metabolic activities .
5	Illustrate the different hormonal activities.
6	Apply the knowledge to perform test of different biochemical components.

**THEORY- BML 504 (B)**

CO	Blooms Level	Module	%age of questions
CO1	1,2,3	M1	20
CO2	1,2,3	M1,M2	20
CO3	1,2,3	M2,M3	20
CO4	2,3,4	M3,M4	20
CO5	2,3,4	M4,M5	20
			<b>100</b>

**PRACTICAL- BML 594 (B)**

CO	Blooms Level	Module	%age of questions
CO6	3,4,5	M6	100

**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB**  
**Syllabus of B. Sc. In Medical Lab Technology**  
**(Effective for 2020-2021 Admission Session)**  
**Choice Based Credit System**  
**140 Credit (3-Year UG) MAKAUT Framework**  
**w.e.f 2020-21**

**Module 1            10 h**

Concepts of PH and buffers, Acid-base equilibrium, osmotic pressure and its physiological applications.

Morphology, Structure and functions of cell, cell membrane, Nucleus, Chromatin, mitochondria,

**Module 2            10h**

Metabolism of Carbohydrate, Lipid, Protein, Mineral: Glycolysis, TCA Cycle, Glycogenesis, Glycogenolysis, Gluconeogenesis, maintenance of Blood glucose, Inter conversion of different sugars. Metabolism of cholesterol, Ketone bodies, Athero- sclerosis and obesity

**Module 3            10 h**

proteins properties and reactions of proteins. Classification, Fat-soluble vitamins A, D, E, K Water soluble vitamins-B Complex and Vitamin C. Daily requirement physiological functions and disease of vitamin deficiency.

**Module 4 ( 10 h)**

Transmethylation, Deamination, Fate of Ammonia Urea synthesis and synthesis of creatinine, inborn errors of metabolisms. Iron, Calcium, Phosphorous, Trace elements.

**Module 5(10h)**

General characteristics and Mechanism of Hormone actions, Insulin, Glucose, Thyroid and Para-Thyroid hormones. Cortical sex hormones. Stokes and Kirby-Bauer method.

**Module 6            26 h**

1. Identification of carbohydrates (Qualitative Tests)
2. Identification of proteins (Qualitative Tests)
3. Estimation of serum lipase
4. Estimation of serum amylase.
5. Creatinine clearance test.
6. Estimation of total protein in urine.
7. Estimation of glucose in urine by Benedict's methods
8. Urine analysis – normal & abnormal constituents of urine.
9. Blood glucose estimation.



**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB**  
**Syllabus of B. Sc. In Medical Lab Technology**  
**(Effective for 2020-2021 Admission Session)**  
**Choice Based Credit System**  
**140 Credit (3-Year UG) MAKAUT Framework**  
**w.e.f 2020-21**

**6th Semester**

Subject Type	Course Name	Course Code	Credit Distribution			Credit Points	Mode of Delivery			Proposed MOOCs
			Theory	Practical	Tutorial		Offline	Online	Blended	
CC 13	Clinical Endocrinology & Toxicology	BML(T) 601	4	0	0	6				As per MAKAUT Notification
		BML691	0	2	0				✓	
CC 14	Diagnostic MolecularBiology	BML(T) 602	4	0	0	6				
		BML692	0	2	0				✓	
DSE 3(Any one)	Advanced Diagnostic Techniques	BML 603 (A)	4	0	0	6				
		BML 693 (A)	0	2	0				✓	
	Basic Laboratory Management	BML 603 (B)	4	0	0					
		BML 693 (B)	0	2	0					
DSE 4 (Any One)	Major Project	BML 681(B)	1	5	0	6				
	Internship	BML 681(B)	1	5	0				✓	
Semester Credits						24				

**Note:**

Major Project/Internship- (Students have to engage in a full length/capstone project with a pre-specified Internal Guide (faculty member) throughout the semester). Industry collaboration is highly encouraged in case of Internship.

(At least two-three times progress needs to be checked and evaluation needs to be done through PCA.) It will be followed by a report submission and viva as part of University examination.

**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB**  
**Syllabus of B. Sc. In Medical Lab Technology**  
**(Effective for 2020-2021 Admission Session)**  
**Choice Based Credit System**  
**140 Credit (3-Year UG) MAKAUT Framework**  
**w.e.f 2020-21**

**Paper: Clinical Endocrinology & Toxicology**

**Code: BML-601/691**

**Credits : 4L+2P.**

Course objective- After the exposure of the current paper students would be able to detect hormones and toxic substances in blood samples and also will be able to outline the basis of endocrine disorders.

Sl	Course Outcome
1	Build the basic knowledge of endocrine system.
2	Distinguish the different types of thyroid hormones and their measurement.
3	Interpret the knowledge of infertility profile.
4	Make use the knowledge of growth hormones and its abnormality.
5	Explain the drug abuse and their measurement.
6	Able to plan and perform the measurement of different hormones.

**THEORY- BML (T) 601**

CO	Blooms Level	Module	%age of questions
CO1	1,2,3	M1	20
CO2	1,2,3	M2	20
CO3	1,2,3	M3	20
CO4	2,3,4	M4	20
CO5	2,3,4	M5	20
			<b>100</b>

**PRACTICAL- BML 691**

CO	Blooms Level	Module	%age of questions
CO6	2,3,4,5	M6	100

<p><b>Module –I (10 hours)</b>  Hormones, Classification of hormones, organs of endocrine system their secretion and function, regulation of hormone secretion.</p>
<p><b>Module –II (10 hours)</b>  Thyroid function test: Thyroid hormones, biological function, hypothyroidism, hyperthyroidism, Determination of T<sub>3</sub>, T<sub>4</sub>, TSH, FT<sub>3</sub>, FT<sub>4</sub>, TBG, Disorder associated with thyroid dysfunction.</p>
<p><b>Module-III (10 hours)</b>  Infertility profile: LH, FSH, TSH, Estrogen, Progesterone, Total Testosterone, Free testosterone, DHEA-S, 17- Ketosteroids, Prolactin, their estimation and clinical significance, reference range, hypo and hyper secretion, Triple Test</p>
<p><b>Module –IV (10 hours)</b>  Growth hormone, ACTH, Aldosterone, Cortisol clinical significance, reference range, hypo and hyper secretion</p>
<p><b>Module –V (10 hours)</b>  Introduction of Toxicology, Alcohol poisoning, Lead poisoning, Zinc poisoning, Mercury poisoning drugs abuse, screening procedure for drug screening, Immunoassay for drugs.</p>

**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB**  
**Syllabus of B. Sc. In Medical Lab Technology**  
**(Effective for 2020-2021 Admission Session)**  
**Choice Based Credit System**  
**140 Credit (3-Year UG) MAKAUT Framework**  
**w.e.f 2020-21**

**Module VI- Practical Clinical Endocrinology & Toxicology (26 hours)**

**Code: BML-691**

**Credits : 2**

1. To determine T<sub>3</sub> conc. in serum sample.
2. To determine T<sub>4</sub> conc. in serum sample.
3. To determine TSH conc. in serum sample.
4. To determine LH conc. in serum sample.
5. To determine FSH conc. in serum sample.
6. To determine Prolactin conc. in serum sample.
7. To determine TSH conc. in serum sample.
8. To perform TRIPLE test.
9. Demonstration of male and female infertility test.
10. Beta HCG

**Suggested readings:**

1. Teitz,(2007),Fundamentals of Clinical Chemistry,6<sup>th</sup> edition,Elsevier Publications
2. Bishop(2013),Clinical Chemistry,7<sup>th</sup> edition, WileyPublications
3. Henry's Clinical Diagnosis and Management by Laboratory Methods,(2011),22<sup>nd</sup> edition,Elsevier
4. D M Vasudevan, (2011),Text book of Medical Biochemistry,6<sup>th</sup> edition JaypeePublishers
5. M N Chatterjea & Rana Shinde,(2012),Text book of MedicalBiochemistry,8<sup>th</sup> edition,Jaypee Publications
6. Singh & Sahni,(2008),Introductory Practical Biochemistry,2<sup>nd</sup> edition, Alpha science
7. Lehninger,(2013),Principles of Biochemistry,6<sup>th</sup> edition, W H Freeman

**Paper: Diagnostic Molecular Biology**

**Code: BML-602/692**

**Credits: 4L+2P.**

Course objective: Students will be able to adapt to rendered to take up future molecular biology challenges and efficiently work in diagnostic molecular setup.

Sl	Course Outcome
1	Explain the knowledge of chromosome.
2	Able to examine the transcription apparatus.
3	Organise the Nucleic acid amplification testing .
4	Apply the knowledge of blotting technique.
5	Illustrate the knowledge about Radioisotopes and its application.
6	Able to conduct different test related to PCR.

**THEORY- BML (T) 602**

CO	Blooms Level	Module	%age of questions
CO1	1,2,3	M1	20
CO2	1,2,3	M2	20
CO3	1,2,3	M3	15
CO4	1,2,3	M4	20
CO5	1,2,3	M5	25
			<b>100</b>

**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB**  
**Syllabus of B. Sc. In Medical Lab Technology**  
**(Effective for 2020-2021 Admission Session)**  
**Choice Based Credit System**  
**140 Credit (3-Year UG) MAKAUT Framework**  
**w.e.f 2020-21**

**PRACTICAL- BML 692**

CO	Blooms Level	Module	%age of questions
CO6	2,3,4	M6	100

**Module-I (10 hours)**

Nucleic Acids, DNA, RNA, composition, structure, types, denaturation and renaturation of DNA, chemistry of DNA synthesis, general principles of replication, enzyme involved in DNA replication

– DNA polymerases, DNA ligase, primase, telomerase and other accessory proteins.

**Module- II (10 hours)**

Basic transcription apparatus, Initiation, elongation and termination of transcription, Eukaryotic Transcription of mRNA, tRNA and rRNA, types of RNA polymerases.

**Module –III (10 hours)**

Nucleic acid amplification testing, PCR, Principle, Types, applications, Thermal cyclers, RT PCR, reverse transcriptase PCR, Nested PCR

**Module –IV (10 hours)**

Blotting techniques, southern blotting and Western blotting

Introduction to chromosomes, its structure and disorder, Karyotyping, Chromosomal studies in hematological disorders (PBL and Bone marrow), FISH

**Module –V (10 hours)**

Radioisotopes and its application in measurement of blood volume, determination of red cell volume and plasma volume, red cell life span, platelet life span, radiation hazards and its prevention disposal of radioactive material

Introduction and applications of Flow cytometry, Stem cell banking, Prenatal Diagnosis.

**Module VI-Practical Diagnostic Molecular Biology- 26 hours**

**Code: BML-692**

**Contacts Hours / Week: 2PCredits : 2**

1. Isolation of DNA
2. Separation of DNA by Agarose gel electrophoresis
3. Demonstration of thermal cyclers and PCR.
4. Demonstration of PCR HLA B-27
5. Demonstration of PCR HIV
6. Demonstration of PCR MTB
7. Demonstration of triple test.

**Suggested Readings:**

1. Teitz,(2007),Fundamentals of Clinical Chemistry,6<sup>th</sup> edition,Elsevier Publications
2. Henry's Clinical Diagnosis and Management by Laboratory Methods (2011),22<sup>nd</sup> edition,Elsevier
3. Singh & Sahni (2008),Introductory Practical Biochemistry,2<sup>nd</sup> edition, Alpha science
4. Lehninger, (2013),Principles of Biochemistry,6<sup>th</sup> edition, W H Freeman.

**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB**  
**Syllabus of B. Sc. In Medical Lab Technology**  
**(Effective for 2020-2021 Admission Session)**  
**Choice Based Credit System**  
**140 Credit (3-Year UG) MAKAUT Framework**  
**w.e.f 2020-21**

**DSE 3: Advanced Diagnostic Techniques**

**Code- BML 603(A)/693(A)**

**Credits : 4L+2P**

**COURSE OBJECTIVE.**

- To understand the basic concepts of Chromatography
- To demonstrate Planning and Objectives of electrophoresis in clinical diagnosis.
- To explain Immunoassay particularly ELISA, RIA, FIA, FACS and their applications in clinical diagnosis.
- To examine the Radioisotopes, Radioactivity, instruments for radioactivity measurement.
- To make use of Centrifugation.

Course Outcomes (CO):

Sl. No.	Course Outcome
1.	Ability to examine and apply the concepts and knowledge of the Chromatography.
2.	Ability to evaluate and apply the Planning and Objectives of electrophoresis in clinical diagnosis.
3.	Make use of Centrifugation, fixed angle and swinging bucket rotors, RCF and sedimentation coefficient.
4.	Experiment with the Radioisotopes, Radioactivity, instruments for radioactivity measurement.
5.	Discuss Immunoassay particularly ELISA, RIA, FIA, FACS and their applications in clinical diagnosis.

THEORY- BML 603 (A)

CO	Blooms Level	Module	%age of questions
CO1	1,2,3	M1	20
CO2	1,2,3	M2	20
CO3	1,2,3	M3	15
CO4	2,3,4	M4	20
CO5	2,3,4	M5	25
			100

PRACTICAL- BML 693 (A)

CO	Blooms Level	Module	%age of questions
CO6	2,3,4,5	M6	100

**Detailed Syllabus:**

MODULE-I: (10 hrs) Chromatography, its principle, types and applications. Paper Chromatography, Thin layer chromatography, HPLC, Gas liquid chromatography, Ion exchange chromatography and their application in diagnosis.

MODULE-II(10 hrs): Basic Principle of electrophoresis, Paper electrophoresis, Gel electrophoresis, PAGE, SDS-PAGE, Agarose gel electrophoresis, buffer systems in electrophoresis. Electrophoresis of proteins and nucleic acids,

**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB**  
**Syllabus of B. Sc. In Medical Lab Technology**  
**(Effective for 2020-2021 Admission Session)**  
**Choice Based Credit System**  
**140 Credit (3-Year UG) MAKAUT Framework**  
**w.e.f 2020-21**

haemoglobin, immunoglobulin's, isoenzymes Applications of electrophoresis in clinical diagnosis.

MODULE-III(10 hrs): Centrifugation, fixed angle and swinging bucket rotors , RCF and sedimentation coefficient, differential centrifugation, density gradient centrifugation and Ultracentrifugation

MODULE-IV(10 hrs): Radioisotopes, Radioactivity, instruments for radioactivity measurement, applications of radioisotopes in clinical biochemistry

MODULE V(10 hrs): Immunoassay: ELISA, RIA, FIA, FACS and their applications in clinical diagnosis.

Module VI-Practical Advanced Diagnostic Technique

Credits : 2(26 hrs)

1. To perform separation of amino acids by paper chromatography
2. To perform separation of amino acids by thin layer chromatography
3. To perform separation of DNA by Agarose gel electrophoresis.
4. Separation of protein by PAGE
5. Separation of protein by paper electrophoresis
6. Separation of haemoglobin

**Suggested Readings:**

1. Teitz,(2007),Fundamentals of Clinical Chemistry,6th edition, Elsevier Publications
2. Henry's Clinical Diagnosis and Management by Laboratory Methods,(2011),22nd edition, Elsevier
3. Singh & Sahni,(2008),Introductory Practical Biochemistry,2nd edition, Alpha science
4. Lehninger,(2013),Principles of Biochemistry,6th edition, W H Freeman
5. Wilson & Walker, Practical Biochemistry,2nd edition

**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB**  
**Syllabus of B. Sc. In Medical Lab Technology**  
**(Effective for 2020-2021 Admission Session)**  
**Choice Based Credit System**  
**140 Credit (3-Year UG) MAKAUT Framework**  
**w.e.f 2020-21**

**DSE 3-Principles of Laboratory Management & Medical Ethics**  
**BML-603(B)/ 693(B)**  
**Credits : 4L+2P.**

**Objective:**

To demonstrate the patient management system by good laboratory practice, quality control and accreditation

Course Outcomes (CO):

Sl. No.	Course Outcome
1.	Apply the concepts and knowledge of the Good Laboratory Practice
2.	Able to manage the patient's clinical samples collection.
3.	Ability to evaluate the Sample analysis.
4.	Explain the overview of Quality Management system.
5.	Organise Audit in a Medical Laboratory, Outline the Importance, Assess the NABL & CAP, Responsibilities.
6.	Make use of the knowledge about the laboratory work flow .

THEORY- BML 604(B)

CO	Blooms Level	Module	%age of questions
CO1	1,2,3	M1	25
CO2	1,2,3	M2	20
CO3	1,2,3	M3	20
CO4	2,3,4	M4	20
CO5	2,3,4	M5	15
			100

PRACTICAL- BML 694(B)

CO	Blooms Level	Module	%age of questions
CO6	2,3,4,5	M6	100

**Detailed Syllabus:**

MODULE I (10 hrs)- Principles and standards for a clinical laboratory professional and their role to the patient, colleagues and other professionals. Introduction to Basics of GLP and Accreditation. Advantages of Accreditation, Brief knowledge about National and International Agencies for clinical laboratory accreditation

MODULE-II (10 hrs): General safety rule in laboratory. Pre- and post-exposure guidelines for HIV, Hepatitis B & C:. Patient management for clinical samples collection, transportation and preservation, Sample accountability, Purpose of accountability.

MODULE-III (10 hrs): Sample analysis: Introduction, factors affecting sample analysis, reporting results, basic format of a test report, reported reference range, clinical alerts, abnormal results, results from referral laboratories, release of

**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB**  
**Syllabus of B. Sc. In Medical Lab Technology**  
**(Effective for 2020-2021 Admission Session)**  
**Choice Based Credit System**  
**140 Credit (3-Year UG) MAKAUT Framework**  
**w.e.f 2020-21**

examination results, alteration in reports

MODULE-IV (10 hrs): Introduction to Quality assurance, Quality control system, Internal and External quality control and quality control chart. Importance of calibration and Validation of Clinical Laboratory instrument, Ethics in Medical laboratory Practice, reporting of results, preserving medical records Procurement of equipment and reagents.

MODULE V (10 hrs): Audit in a Medical Laboratory, Introduction and Importance, NABL & CAP, Responsibility, Planning, Horizontal, Vertical and Test audit, Frequency of audit, Documentation

Module VI-BML 693 (B) (26 hrs)

- 1- Estimation of blood glucose level and compare with QC sample.
- 2- Comparison of value of the unknown sample with QC data.
- 3- Preparation of LJ chart.
- 4- Preparation of work flow of a large category of laboratory from sample collection to report delivery.

**Suggested Readings:**

1. Teitz,(2007),Fundamentals of Clinical Chemistry,6th edition, Elsevier Publications
2. Bishop (2013), Clinical Chemistry,7th edition, Wiley Publications
3. Henry's Clinical Diagnosis and Management by Laboratory Methods, (2011),22nd edition, Elsevier