Biochemistry

Departmental Objective

At the end of the course in Biochemistry the students should be able to:

- acquire the basic & integrated knowledge on major biomolecules, enzymes, hormones and nutrients with fundamental chemical process within body system upon which life depends.
- demonstrate skills in performing and interpreting Biochemistry laboratory tests and procedures with emphasis on those used in Bangladesh.
- demonstrate skills in using the modern biochemical appliances.
- equip themselves with requisite knowledge for higher studies and research.
- develop sound attitude towards the need for continuing self-directed learning.

List of Competencies to acquire:

After completing the course of Biochemistry in MBBS course the students will-

1) apply the learned knowledge of biochemistry in medicine.
2) familiar with the biomolecules forming the structure of human body, their functions and role in health and diseases.
3) explain the role of enzymes in the diagnosis and treatment of diseases.
4) identify the source of energy in human body and the process by which this energy is derived from food.
5) explain metabolism of the body in fed and fasting state and consequences of prolonged starvation.
6) explain the role of liver in metabolism and derangement of metabolism in impaired liver function. Explain dyslipidemia and their clinical consequence
7) describe the water and electrolyte content of human body and their functions. Identify the types, causes and consequences of dehydration and over hydration. Explain the causes the consequences of electrolyte imbalance.
8) describe the sources of acids and bases in our body and the mechanism of their normal balance. Explain the causes and consequences of acidosis and alkalosis and the parameters to diagnose them.
9) demonestrate their basic conception about nutrients, balanced diet. Describe the common nutritional disorders of our country and their causes and consequences.
10) describe the components of balanced diet and explain the basic principles of making a diet chart. Attain the skill to assess nutritional disorders anthropometrically.
11) explain the basis of genetics and molecular biology and the common genetic disorders and explain the modern technology in molecular biology in the diagnosis and treatment of diseases.
12) diagnose diabetes mellitus, impairment of renal, liver and thyroid functions.

Attain the skill to perform and interpret the common biochemical tests in the diagnosis of diseases. Attain the skill to perform common bedside biochemical tests.

Distribution of teaching - learning hours

Lecture	Tutorial	Practical	Total teaching hours	Integrated teaching hour for Phase I	Formative Exam		Summative exam	
					Preparatory leave	Exam time	Preparatory leave	Exam time
117 hours	100 hours	100 hours	317 hrs	36 hrs	35 days	42 days	30 days	30 days
Time for integrated teaching, examination, preparatory leave of formative & summative assessment is common for all subjects of the phase								
Related behavioral, professional & ethical issues will be discussed in all teaching learning sessions								

Teaching - learning methods, teaching aids and evaluation

Teaching Methods			Teaching aids	In course evaluation
Large group	Small group	Self learning		
Lecture Integrated teaching	Tutorial Practical Demonstration Problem solving	Assignment, self assessment and self study.	OHP Video tapes, Audio player Slide Projector Charts, Flip charts, Models, Specimens White board and marker Chalk board and chalk Computer and multimedia Study guide and manuals	• Item Examination (oral or written) • Card final (only written) • Term Examination • Term final (written, oral+ practical [OSPE & traditional])

Related Equipments:

Glass wares, micropipette, distilled water plant, p^H meter.

Laboratory equipments:

Photoelectric colorimeter, Centrifuge machine, PCR mechine, Incubator, Water bath, Hot air oven, Height and weight measuring instrument.

1st Professional Examination:

Marks distribution of Assessment of Biochemistry:

Total marks – 400

- Written=200 (Formative- 20+MCQ (SBA+MTF) 40+(SAQ+SEQ)140)
- SOE=100
- Practical= 100 (OSPE-50+ Traditional-40 + Assignment-10)

Learning Objectives and Course Contents in Biochemistry
Biophysics & Biomolecules

Learning Objectives	Contents	Teaching Hours
At the end of the course, students will be able to: • define biochemistry and explain its importance in medicine. • define solution, standard solution and types of standard solution. • describe colloid and crystalloid with example, define dialysis and mention its biomedical importance. • define p^H, p^K and p^H scale and mention their importance. • define acid, base, strong acid and weak acid. • define buffer. State the body fluid buffers with their basic mechanism of action. • state Handerson Hasselbach equation and its importance. • define and classify isotope. State its biomedical importance. • define and classify carbohydrates. Mention the sources and importance of biologically important monosaccharides, disaccharides and polysaccharides. • describe the reducing property of carbohydrate. • define amino acid, peptide, polypeptide and protein. • state their sources and functions. • explain the structure of protein and denaturation of protein. • define and classify lipids, state their sources, functions and biomedical importance. • define and classify fatty acids, state their sources, function and biomedical importance, mention eicosanoids with their origin. • state the sources and importance of essential fatty acids: omega-3 fatty acid, omega-6 fatty acid and transfatty acid. • define steroids and sterols. • describe the sources, and biomedical importance of cholesterol. • define and classify enzymes, describe the factors affecting enzyme activity. • define isoenzyme with example and mention their clinical application. • state the biomedical importance of enzyme. • co-factors and mention their functions.	**<u>CORE:</u>** • Introduction to Biochemistry • Concept of solutions • Colloids and crystalloids. • Concept of pH and buffer. • Concept of isotope. • Concept of Biomolecules: Carbohydrates. • Amino acids and proteins. • Lipids and fatty acids. • Enzymes	Lecture: 18 hours Tutorial: 25 hours Practical: 20 hours Total teaching hours: 65 hours

Food, Nutrition, Vitamins and Minerals

Learning Objectives	Contents	Teaching Hours
At the end of the course, students will be able to: • define and explain nutrients, essential nutrients, macro and micronutrients, food, proximate principles of food, diet, balanced diet. • define and explain with full meaning of the abbreviations- BMR, BMI, SDA. • mention the basis of calculating the calorie requirement of a person. • describe the sources, requirement and function of carbohydrate as nutrient and describe the importance of fibers in diet. • state glycaemic index (GI) with its importance. • describe sources, requirement and function of protein as nutrients; mention the name and significance of essential amino acid; state the biological value of protein. • describe the sources, requirement and function of lipids as nutrients. • mention the sources and nutritional role of PUFA • define and classify vitamins. • describe the sources, function, RDA, deficiency disorders of water-soluble vitamins. • describe the sources, functions, RDA, deficiency disorders and toxicity of fat-soluble vitamins. • state the role of minerals as nutrients, define trace elements. • state the importance of minerals: sodium, potassium, calcium, iron, iodine, fluoride, selenium, manganese, copper, zinc etc. • describe iron metabolism. • describe the biochemical basis of the common nutritional disorders e.g. PEM, night blindness, goiter, obesity, nutritional anaemia.	**CORE:** • Basic concepts of food, nutrition and dietary principles. • Energy balance and calculation of energy equivalent of food. • Nutritional aspect of carbohydrates, fats and proteins, Fibers. • Vitamins and minerals. • Common Nutritional disorders.	Lecture: 18 hours Tutorial: 15 hours Practical: 10 hours Total teaching hours: 43 hours

Digestion, Absorption, Bioenergetics and Metabolism

Learning Objectives	Contents	Teaching Hours
At the end of the course, students will be able to: • define digestion, absorption, metabolism, anabolism, and catabolism. • describe the phases of metabolism • describe biological oxidation, respiratory chain and oxidative phosphorylation. • enumerate high and low energy compounds, describe ATP. **Carbohydrate Metabolism:** • describe digestion and absorption of carbohydrate with endproducts. • define glycolysis and describe the pathway, state the conversion of pyruvate to lactate, acetyl CoA and oxaloacetate. • calculate the amount of energy liberated in glycolysis and oxidative decarboxylation of pyruvate. • describe citric acid cycle and explain why it is called an amphibolic and final common metabolic pathway. • calculate the amount of energy liberated in TCA cycle and total energy liberated from complete oxidation of a mole of glucose in aerobic and in anaerobic conditions. • define glycogenesis and glycogenolysis and state their role in storage and supply of glucose to meet body's demand. • state the importance of HMP pathway. • define gluconeogenesis and describe its process and importance. • describe glucose homeostasis and mention its importance, • state the glucostatic functions of liver with other biochemical functions.	**CORE:** • Introduction to metabolism • Biological oxidation, respiratory chain and oxidative phosphorylation. • High and low energy compounds. ATP • Phases of metabolism (digestion, absorption and intermediary metabolism) • Glycolysis • Citric acid cycle • Glycogenesis and glycogenolysis • Hexose monophosphate shunt • Gluconeogenesis • Blood glucose homeostasis • Cori cycle	Lecture: 29 hours Tutorial: 18 hours Practical: 25 hours Total teaching hours: 73hours

Learning Objectives	Contents	Teaching Hours
Lipid Metabolism • describe digestion and absorption of lipids (triacylglycerol, phospholipids, cholesterol esters) • enumerate the blood lipids with their sources and mention the anabolic and catabolic pathways of lipid metabolism. • describe the process of degradation of triacylglycerol. • state the processes of fatty acid oxidation and describe beta-oxidation of even and odd chain fatty acids. • state the sources and fate of acetyl-CoA. • name the ketone bodies. • describe ketogenesis and fate of ketone bodies, state the biomedical importance of ketone bodies. • define ketosis and mention the causes of ketosis and describe its pathogenesis. • enumerate the lipoproteins, state its general structure and functions, describe the metabolism of chylomicron, VLDL, LDL and HDL cholesterol, explain the clinical importance of LDL & HDL cholesterol. • state the role of HMG-CoA reductase in regulation of blood cholesterol level. • define eicosanoids, mention the basic steps of their synthesis.	**CORE:** • Digestion and absorption of lipid. • Blood lipids and pathways of lipid metabolism. • Triglyceride metabolism. • Beta-oxidation • Ketogenesis and ketosis. • Lipid transport and lipoprotein metabolism. • Ecosanoids.	

Learning Objectives	Contents	Teaching Hours
Protein Metabolism • describe digestion and absorption of protein. • state the concept of protein turnover, amino acid pool • define nitrogen balance, mention its types and state the routes of nitrogen loss. • state the pathways of amino acid catabolism. • define and describe transamination and deamination. • describe sources and way of disposal of ammonia, explain ammonia intoxication • describe the urea cycle including sites, reactions and importance of the cycle.	**CORE:** • Digestion and absorption of protein • Protein turnover, common amino acid pool, nitrogen balance • Pathways of protein metabolism • Deamination and transamination. • Fate of amino acid in the body • Source and disposal of ammonia **ADDITIONAL:** • Role of liver in over all metabolisms. • **Integrated metabolism** Metabolic adjustment of fed, fasting and starvation state.	

Renal biochemistry, body fluid, electrolytes and acid-base balance

Learning Objectives	Contents	Teaching Hours
At the end of the course, students will be able to: • define GFR, renal threshold, plasma clearance, osmolar clearance and free water clearance, describe mechanism of acidification of urine. • state the body fluid compartments and state the composition of ECF and ICF • state water turnover, water intake and output, describe volume homeostasis (water balance), enumerate volume disorders with example, define water intoxication. • explain the importance of major electrolytes (Na^+, K^+, Ca^{++}, Mg^{++} and PO_4^{--}) and mechanism of their homeostasis. • describe acid base homeostasis & state the simple acid base disorder with causes of acidosis and alkalosis and mechanism of their compensation and correction. • state acid base parameters, anion gap and base excess, • state the role of kidneys in water, electrolyte and acid-base balance. • state abnormal constituents in urine with normal urine volume and obligatory urine volume, explain limiting p^H of urine. • define and classify diuresis with example.	**CORE:** **Renal biochemistry in relation to water, electrolytes and acid base homeostasis** • Total body water and body fluid compartments. Composition of body fluids. • Regulation of normal water balance. • Major electrolytes and their homeostasis. • Volume disorders. • Acid base homeostasis & disorders.	Lecture: 20 hours Tutorial: 12 hours Practical: 20 hours Total teaching hours: 52 hours

Clinical Biochemistry and clinical endocrinology

Learning Objectives	Contents	Teaching Hours
At the end of the course, students will be able to: • state the basic concepts of clinical biochemistry eg quality control & quality assurance, specificity, sensitivity • mention measurements of unit eg SI unit • list the common anticoagulants used in laboratory • state the laboratory hazards with its types and specimen used in labooratory • state the normal level of serum bilirubin and mechanism of causation of jaundice. • describe the common liver function tests with interpretation. • explain the basis of application of clinical enzymology in disease. • state the lipid profiles of blood & their clinical importance. • state the causes and consequence of hyperglycaemia and hypoglycaemia. • state the laboratory diagnosis of diabetes mellitus, OGTT and its interpretation, define IFG, IGT and HBA_{1c}. • state renal function tests • define proteinuria and microalbuminuria, glycosuria. • state thyroid function tests with interpretation.	**CORE:** • Introduction to clinical biochemistry. • Normal biochemical values in conventional and Sl. Units. • Clinical enzymology related to liver and myocardial diseases. • Lipid profiles and dyslipoproteinemias. • Organ function tests (liver, kidney & thyroid) • Diagnosis of diabetes mellitus • Bilirubin metabolism and Jaundice. • Proteinuria and microalbuminuria	Lecture: 14 hours Tutorial: 15hours Practical: 20 hours Total teaching hours: 49 hours

Fundamentals of Molecular Biology and genetics

Learning Objectives	Contents	Teaching Hours
At the end of the course, students will be able to: • explain chemistry, & functions of nucleic acid, nucleosides, and nucleotides. • describe the structure and functions of DNA. • describe the structure, types and functions of RNA. • describe DNA organization, cell cycle and genetic code. • describe the the central dogma & processes of replication of DNA, • define gene, allele, genome, genotype, phenotype, trait, and codon. • describe transcription and post transcriptional modification. • describe translation and post translational modification. • explain the concepts & application of medical Biotechnology • explain the concepts & application of recombinant DNA technology. • explain the concept of DNA cloning, PCR, DNA fingerprinting • define and classify mutations, mutagens.	**CORE:** • Basic concepts of molecular biology. • Nnucleic acid, nucleosides, and nucleotides. • Replication, transcription and translation. • Gene, genome, allele, trait, genetic code, mutation, mutagens. • PCR, DNA cloning, recombinant DNA technology • Biomedical aspects of medical biotechnology: understanding & application.	Lecture: 18 hours Tutorial: 15 hours Practical: 05 hours Total teaching hours: 38 hours

Biochemistry practical

Learning Objectives	Contents	Teaching Aids	Teaching Hours
Students will be able to: • list the laboratory hazards and the precautions to prevent them. • identify the different laboratory glass wares and equipments. Mention their uses. • prepare different type of standard solution from supplied solute, solvent and standard solution. • identify different parts of photoelectric colorimeter. Demonstrate its technique and the basic principle of calculation. • perform different biochemical tests according to given method and manual. • know the clinical indication of performing biochemical tests. • interpret biochemical values to apply in clinical situations.	**CORE** • Identification of laboratory glass wares and equipment. • Preparation of solutions. • Sample collection & processing • Photometry. • Estimation, demonstration of technique, calculation and interpretation of result: • Blood glucose estimation. • Serum cholesterol estimation. • Serum urea • Serum creatinine • Serum total protein • Serum bilirubin • Abnormal constituents of urine and their clinical significance.	• OHP • Video tapes, Audio player. • Charts, Flip charts, Models, Specimens • White board and marker • Chalk board and chalks • Computer and multimedia • Study guide and manuals • Glass ware, micropipette • Distil water plant • pH meter • Laboratory equipments: • photoelectric colorimeter • Centrifuge machine • PCR mechine • Incubator • Water bath • Hot air woven • Height and weight measuring instrument	**100 hours**

Evaluation of Biochemistry
Summative Assessment (1st Professional Examination)

Components	Marks	Total Marks
Formative assessment	10+10	20
WRITTEN EXAMINATION Paper – I- MCQ (SBA+MTF) (SAQ+SEQ) Paper - II- MCQ (SBA+MTF) (SAQ+SEQ)	 20 70 20 70	180
PRACTICAL EXAMINATION OSPE Traditional methods Assignment on specific practical procedure	 50 40 10	100
ORAL EXAMINATION (**Structured**)		100
Grand Total		**400**

- OMR sheet will be provided for MCQ.
- Pass marks 60 % in each of theoretical, oral and practical.

Continuous Assessment Card

Card No- 1. Biophysics and Biomolecules

No.	Items	Marks(10 in each item)	Initials and date
1.	Introduction of biochemistry, acid, base, p^H, p^K, buffer, Henderson-Hasselbalch equation.		
2.	Solutions, crystalloid, colloid, dialysis and isotopes.		
4.	Carbohydrates.		
5.	Lipids		
6.	Amino Acids and Protein.		
7.	Enzymes, coenzymes, cofactors, isoenzsymes		

Card No- 2. Food, nutrition and vitamins

No	Items	Marks(10 in each item)	Initial and date
1.	Basic concepts of Nutrient, food, diet, balanced diet, essential dietary components, , total calorie calculation,DRI, RDA, MR, BMR, BMI, SDA.		
2.	Dietary fibers, nutritional importance of carbohydrate, lipid & protein, glycaemic index (GI) of food.		
3.	Minerals- (macro & micro), trace elements, common nutritional disorders, PEM, BMI. obesity, iron metabolism and its deficiency, iodine deficiency		
4.	Water soluble vitamins		
5.	Fat soluble vitamins		

Card No- 3. Digestion, absorption, bioenergetics and metabolism

No	Items	Marks(10 in each item)	Initial and date
1.	**Digestive juices**, local hormone of GIT, digestion & absorption of carbohydrate, lipid, protein.		
2.	**Bioenergetics-** biological oxidation, high energy phosphates, oxidative phosphorylation, respiratory chain. metabolism-definition, phases; anabolism, catabolism		
3.	**Carbohydrate metabolism**- glycolysis, fate of pyruvate, TCA cycle, HMP pathway, gluconeogenesis, glycogenesis, glycogenolysis, blood glucose regulation.		
4.	**Lipid metabolism:** lipolysis, Beta-oxidation of fatty acid, fate of Actyl-CoA, ketone bodies, ketosis & its pathoghenesis. Lipoproteins & their metabolism, Cholesterol metabolism.		
5.	**Protein metabolism:** Amino acid pool, Transamination, Deamination. Source & fate of ammonia, ammonia intoxication, Urea cycle.		

Card No- 4. Renal biochemistry, body fluid, electrolytes and acid base balance

No	Items	Marks(10 in each item)	Initial and date
1.	**Renal biochemistry-** GFR, tubular load, TM, renal threshold, plasma clearance, osmolar clearance, free water clearance, acidification of urine.		
2.	**Body fluid-** Body fluid compartments, daily water intake & output, water turnover, body fluid volume regulation, volume disorders and diuresis.		
3.	**Acid-Base Balance-** origin of acids & bases, maintenance of static blood p^H. Acid base disorders, their compensation & coprrection, anion gap and base excess.		
4.	**Serum Electrolytes-** Serum electrolytes & their reference ranges. Functions, regulations, hypo & hyper states **o**f serum $[Na^+]$, $[K^+]$ $[Ca^{++}]$ & $[PO_4^{--}]$		

Card No- 5. Clinical biochemistry and clinical endocrinology

No	Items	Marks(10 in each item)	Initial and date
1.	Clinical biochemistry- S I unit, Laboratory hazards, Sample collection, Photometry. Clinical enzymology, lipid profiles of blood.		
2.	Clinical enzymology and lipid profiles of blood.		
3.	Diagnosis of diabetes mellitus. OGTT, IGT, IFG and $HbA_{1C.}$		
4.	Thyroid function tests and interpretation.		
5.	Commonly done LFT. Jaundice.		
6.	Renal function tests and interpretation.		

Card No- 6. Fundamental of molecular biology and genetics

No	Items	Marks(10 in each item)	Initial and date
1.	Nucleic acids, nucleotides, DNA, RNA, DNA organization, Cell cycle.		
2.	The central dogma, Genome, Gene, Genetic code, Codon, Mutation, mutagens, Genotype, Phenotype, trait, allele.		
3.	Replication, Transcription and post transcriptional modification,		
4.	Translation and post translational modification.		
5.	Recombinent DNA technology, PCR, Cloning.		

Total Teaching Hours for Biochemistry

System	Lecture	Tutorial	Practical	Integrated teaching
1. Biophysics and biomolecules'	18	25	20	Common hour of Phase I
2. Food, nutrition, vitamins and minerals	18	15	10	
3. Digestion, absorption, bionergetics and metabolism	29	18	25	
4. Body fluids, electrolytes and acid base balance	20	12	20	
5. Clinical biochemistry and clinical endocrinology	14	15	20	
6. Molecular Biology and genetics (Fundamentals)	18	15	05	
Total Teaching Hours: (317)	**117**	**100**	**100**	**36**

Academic Calendar for Biochemistry

First Term				
System(Two)	**Lectures**	**Tutorials**	**Practical**	**Seminar**
Card-1.Biophysics and biomolecules and	18 hrs.	25 hrs.	20 hrs.	2 hrs.
Card-2. Food and Nutrition	18 hrs.	15 hrs.	10 hrs.	1 hrs.
	36 hrs.	40 hrs.	30 hrs.	3 hrs.

Second Term				
System(Two)	**Lectures**	**Tutorials**	**Practical**	**Seminar**
Card-3.Digestion,absorption, bioenergetics and metabolism	29 hrs.	18 hrs.	25 hrs.	2 hrs.
Card-4.Bodyfluids, electrolytes,renal	20 hrs.	12 hrs.	20 hrs.	1 hrs.
chemistry and acid base balance	49 hrs.	30 hrs.	45 hrs.	3 hrs.

Third Term				
System (Three)	**Lectures**	**Tutorials**	**Practical**	**Seminar**
Card-5.Clinical biochemistry and clinical Endocrinology	14 hrs.	15 hrs.	20 hrs.	02 hrs.
	18 hrs.			
Card-6.Molecular Biology	32 hrs.	15 hrs.	05 hrs.	02 hrs.
		30 hrs.	25 hrs.	04 hrs.