



# Gastrointestinal, Hepatobiliary and Metabolism Module

MBBS Year-2 (Academic Year 2019-2020)

*KMU Central Curriculum Committee*

*Khyber Medical University, Phase V, Hayatabad | Peshawar*

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## Duration of Module: Nine Weeks

### Themes

1) Painful swallowing—-----1 week
2) Abdominal pain—-----2 weeks
3) Jaundice—-----1 week
4) Diarrhea and Constipation—1 week
5) Bleeding Per Rectum—-----1 week
6) Hyperglycemia-(Carbohydrate metabolism)- 1 week
7) Obesity (Lipid metabolism)- 4 days
8) Wasting (Protein metabolism)- 8 days

## **General learning outcomes**

At the end of this 6 weeks` module, the 2<sup>nd</sup> year students will be able to:

- 1) Describe the anatomy of oral cavity with respect to GI functions
- 2) Elaborate the structure and functions of salivary glands
- 3) Describe the structure and development of esophagus, stomach, small intestine and large intestine
- 4) Describe the anatomy of peritoneum and mesentery
- 5) Explain the movements, functions and regulations of gastrointestinal functions
- 6) Describe the structure, development and functions of hepatobiliary system and pancreas
- 7) Discuss the mechanisms of digestion and absorptions of carbohydrates, proteins, fats and other nutrients
- 8) Describe different physiological reflexes occurring upon stimulation of gastrointestinal organs
- 9) Discuss the chemistry and functions of gastrointestinal hormones
- 10) Describe common pathological conditions like peptic ulcers, viral hepatitis, obstructive jaundice, carcinoma of esophagus and colorectal cancers
- 11) Explain the metabolic processes related to carbohydrates, fats and protein metabolism
- 12) Describe the components of medical ethics
- 13) Explain research ethics, research misconduct and plagiarism
- 14) Explain the psychosocial aspects of common psychiatric and functional bowel disorders

## Theme 1: Painful swallowing

Subject	Topic	S. No	Learning objectives
<b>Gross anatomy</b>	Oral cavity	1	Describe the musculature of tongue Describe the nerve supply of tongue
	Salivary glands	2	Describe the gross anatomy of parotid, submandibular and sublingual salivary gland
	Esophagus	3	Describe the extent, course, relations and gross structure of esophagus.
<b>Embryology</b>	Development of tongue	4	Describe the developmental events of tongue Enlist various anomalies of tongue development
	Development of esophagus	5	Describe the development of Esophagus
	Development of salivary glands	6	Describe the development of salivary glands
<b>Histology</b>	Oral cavity	7	Describe the microscopic structure of lips
		8	Describe the histological features of tooth in longitudinal and transverse section
		9	Explain the histology of tongue.
		10	Differentiate between the microscopic picture of anterior 2/3rds and posterior 1/3rds of the tongue

	Esophagus	11	Identify the epithelium of esophagus and esophageal glands in mucosa
		12	Differentiate between musculature in different parts of the esophagus
<b>Physiology</b>	General principles of gastrointestinal motility	13	Describe electrical activity of gastrointestinal smooth muscle
		14	Describe the mechanism of excitation of smooth muscle of gastrointestinal
		15	Differentiate between slow wave and spike potential
	Neural control of GIT function (Enteric Nervous system)	16	Differentiate between mesenteric and submucosal plexus.
		17	Classify the following enteric nervous system neurotransmitters as excitatory or inhibitory: norepinephrine, acetylcholine, CCK, VIP, histamine, and somatostatin
		18	Describe the role of autonomic nervous system in regulation of GIT's function
		19	Differentiate between sympathetic and parasympathetic modulation of the enteric nervous system and the effector organs of the GI tract

		20	Describe three types of gastrointestinal reflexes
	Hormonal control of Gastrointestinal motility	21	Describe gastrointestinal hormone actions, stimuli for secretion, and site of secretion
	Functional types of movements in the gastrointestinal tract	22	Describe the functional types of movements in the gastrointestinal tract
		23	Describe law of gut.
		24	Describe blood flow through the villus and its significance
	Gastrointestinal blood flow— Splanchnic circulation	25	Describe anatomy of the gastrointestinal blood supply
		26	Describe the effect of gut activity and metabolic factors on gastrointestinal blood flow
		27	Describe nervous control of gastrointestinal blood flow
	Ingestion of food	28	Describe the mechanics of ingestion of food
		29	Describe chewing and mastication



		30	Describe different stages of swallowing.
		31	Describe the effects of the pharyngeal stage of swallowing on respiration
	General principles of alimentary tract secretion	32	Describe basic mechanisms of stimulation of the alimentary tract glands
		33	Describe dual effect of sympathetic stimulation on alimentary tract glandular secretion
	Role of mucus and saliva	34	Describe the secretion of saliva and its nervous regulation
		35	Describe the plasma and saliva concentrations of Na <sup>+</sup> , Cl <sup>-</sup> , and HCO <sub>3</sub> <sup>-</sup> at low secretion rates and at high secretion rates and the principal cell types involved in each secretion rate.
		36	State the substrates and digestion products of salivary amylase (ptyalin).
		37	Identify the stimuli and cell types involved in GI secretion of mucous, and identify the function of salivary mucus.

		38	Describe three types of stimuli that increase salivary secretion.
		39	State the components of the saliva important in oral hygiene, and identify the role of salivary secretions in eliminating heavy metals
	Disorders of swallowing and esophagus	40	Describe the clinical abnormalities of swallowing mechanism
		41	Describe Achalasia and Megaesophagus
<b>Biochemistry</b>	Saliva	42	Describe the composition of salivary secretions
		43	Describe the formation and characteristics of salivary secretions
		44	Elaborate the functions of saliva
<b>Pathology</b>	Carcinoma of Esophagus	45	Describe the histological types and presentation of esophageal carcinoma
<b>ENT</b>	Oral ulceration	46	Enlist the causes of oral ulcerations
		47	Describe Aphthous ulcers and its treatment
		48	Describe the clinical features and drugs used to treat esophageal candidiasis

## Theme 2: Pain Epigastrium

<b>Gross Anatomy</b>	Anterior abdominal wall	49	Describe the origin, insertion, nerve supply and actions of anterolateral abdominal wall muscles
		50	Describe the formation of rectus sheath
		51	Describe the contents of rectus sheath
		52	Describe the surface anatomy of anterior abdominal wall Describe the structures related to transpyloric plane
		53	Enlist various types of abdominal hernias
	Inguinal canal	54	Describe the boundaries of inguinal canal
		55	Enlist the contents of inguinal canal in males and females
		56	Differentiate between direct and indirect inguinal hernia
	Peritoneum	57	Describe greater and lesser omentum
		58	Describe the nerve supply of peritoneum
		59	Describe the anatomy of lesser sac.
		60	Describe the boundaries of epiploic foramen
		61	Describe the various peritoneal pouches, recesses and ligaments

	Stomach	62	Describe the gross structure of stomach
		63	Describe the blood supply and lymphatic drainage of stomach
		64	Describe the anatomy of stomach bed
	Duodenum	65	Describe the gross structure and blood supply of duodenum
		66	Write the relations of various parts of duodenum
	Pancreas	67	Describe the gross structure of pancreas and its ductal system
<b>Histology</b>	Stomach	68	Enumerate the different layers of the stomach wall
		69	Write a note on gastric glands.
		70	Differentiate between fundic and pyloric mucosa
	Duodenum	71	Discuss histological features of duodenum and describe duodenal glands.
	Pancreas	72	Describe the histology of pancreas
		73	Differentiate histologically between exocrine and endocrine portions of pancreas
<b>Embryology</b>	Development of foregut	74	Describe the development of stomach
		75	Describe the development of duodenum

		76	Enlist various developmental anomalies of stomach
		77	Enlist various developmental anomalies of duodenum
	Pancreas	78	Describe the development of pancreas
		79	Enlist various anomalies of pancreas
<b>Physiology</b>	Motor function of Stomach	80	Describe the motor function of stomach.
		81	Describe basic electrical rhythm of the stomach wall
		82	Describe Pyloric pump
		83	Describe role of the pylorus in controlling stomach emptying
		84	Describe the regulation of gastric emptying
	Gastric secretion	85	Describe characteristics of the gastric secretions
		86	Describe the mechanism of secretion of different gastric glands
		87	Describe the phases and regulation of gastric secretion.
		88	Enlist the hormones that inhibit and increase gastric secretions.

		89	Enumerate the reflexes that inhibit and increase gastric secretions
<b>Biochemistry</b>	Gastric secretions	90	Describe the chemical composition of gastric secretions
		91	Describe the functions of HCl and other constituents of gastric secretions
		92	Discuss the mechanism of synthesis and secretion of HCl from gastric mucosa
		93	Discuss the mechanism of secretion and role of Intrinsic factor from gastric parietal cells
<b>Pathology</b>	Peptic ulcer disease	94	Describe the mechanism of formation of peptic ulcers, its stages and complications
		95	Describe the etiology, pathology and clinical presentation of gastric cancer
		96	Describe the mechanism of development, presentation and complications of acute pancreatitis
<b>Pharmacology</b>	Drugs used in Peptic ulcer	97	Classify the drugs used in Peptic ulcer disease
		98	Describe the mechanism of action of drugs used in Peptic ulcer

<b>Forensic Medicine</b>	Poisons identification through gastric lavage	99	Enlist indications and contraindications for gastric lavage Describe the sampling technique of gastric lavage fluid
<b>Medicine</b>	GERD and Peptic ulcer	100	Describe the etiology, clinical features, complications and drug treatment of GERD and peptic ulcer disease
<b>Surgery</b>	Peptic ulcer	101	Describe the complications of long- term peptic ulcer disease and its surgical management
	Lump in the abdomen	102	Describe common causes of lump in abdomen and enlist the common surgical procedures for treatment of hernia.
	Acute pancreatitis	103	Describe the etiology, clinical features, complications and management of acute pancreatitis

### Theme 3: Jaundice

<b>Gross Anatomy</b>	Liver	104	Describe the borders and surfaces of liver
		105	Describe the visceral surface of liver
		106	Describe the peritoneal reflections and associated ligaments of liver
		107	Describe the lobes and segments of liver
		108	Describe the blood supply of liver
		109	Describe the hepato renal pouch of morrison and its clinical significance
	Extra hepatic billiary apparatus	110	Describe the gross anatomy of gall bladder
		111	Describe calot's triangle
		112	Describe the gross anatomy of extra hepatic billiary tree
	Spleen	113	Describe the gross anatomy of spleen and blood supply of spleen
	Hepatic portal venous system	114	Describe the formation and tributaries / branches of hepatic portal venous system
		115	Explain the clinical significance of hepatic portal system
<b>Embryology</b>	Development of distal fore gut	116	Describe the development of liver
		117	Describe the development of gall bladder and billiary tree



		118	Describe the developmental anomalies of liver and biliary tree
<b>Histology</b>	Liver	119	Discuss the histological features of liver
		120	Describe liver parenchyma and general structural plan of the liver
		121	Describe the histological features of the structures present in the portal triad
	Spleen	122	Discuss the histological features of spleen
		123	Differentiate between red pulp and white pulp
<b>Physiology</b>	Pancreatic secretion	124	Describe the role of pancreatic secretions in digestion.
		125	Describe the phases and regulation of pancreatic secretion
	Physiology of liver	126	Describe Physiological Anatomy of the Liver
		127	Describe blood flow through the liver
		128	Describe metabolic functions of liver
		129	Describe Regulation of Liver Mass—Regeneration
		130	Describe Bilirubin formation and excretion

	Secretion of bile by liver	131	Describe the mechanism of secretion of bile by the liver
		132	Describe the function of bile salts in fat digestion and absorption
		133	Describe functions of the biliary tree in digestion
<b>Biochemistry</b>	Bile	134	Describe the constituents of bile
		135	Describe the functions of bile
		136	Describe the mechanism of gall stone formation
<b>Pathology</b>	Acute/ chronic viral hepatitis	137	Describe the different viruses causing acute and chronic hepatitis
		138	Describe the pathogenesis, stages and clinical presentation of liver cirrhosis
<b>Pharmacology</b>	First pass hepatic metabolism of drugs	139	Describe the mechanism of drugs detoxification and metabolism in the liver
	Hepatotoxic drugs	140	Enlist some of the commonly used hepatotoxic drugs and their toxicities

<b>Forensic Medicine</b>	Hepatotoxic poisons	141	Enlist the poisons which cause hepatotoxicity Diagnose poisoning through routine toxicological sampling
<b>Community Medicine</b>	Hepatitis B and C virus infection	142	Describe the epidemiology of hepatitis B and C virus infection and its control measures
		143	Describe water borne hepatitis (Hepatitis A and E) viruses and its control measures
<b>Medicine</b>	Liver cirrhosis	144	Describe the etiology, clinical features, complications and treatment options of liver cirrhosis
<b>Surgery</b>	Obstructive jaundice	145	Describe the etiology, clinical features, biochemical investigations and treatment options of obstructive jaundice

## Theme 4: Diarrhoea and Constipation

<b>Gross Anatomy</b>	Jejunum and ileum	146	Describe the gross features of jejunum and ileum
		147	Tabulate differences in gross features and blood supply of jejunum and ileum
	Mesenteries	148	Describe the mesentery of small intestine
	Appendix	149	Describe the gross features, blood supply and mesentery of appendix
		150	Describe the clinical correlates of appendix
	Abdominal aorta	151	Enumerate the branches of abdominal aorta.
		152	Describe the course and distribution of celiac trunk
		153	Describe the course and distribution of superior mesenteric artery
		154	Describe the course and distribution of inferior mesenteric artery
	Inferior vena cava	155	Describe the origin, course, tributaries and relations of inferior vena cava
	Lymphatic drainage	156	Describe the origin, course and relations of Cisterna chili
		157	Describe the lymphatic drainage of abdominal organs

<b>Embryology</b>	Development of midgut	158	Describe the formation and rotation of midgut loop
		159	Describe the physiological herniation of midgut loop
		160	Enlist the derivatives of mid gut loop
		161	Describe the development of mesenteries
		162	Describe the various anomalies of midgut development
<b>Histology</b>	Jejunum and ileum	163	Discuss histological features of jejunum and describe plica circulares.
		164	Discuss histological features of ileum and describe Payers patches.
		165	Discuss the various structural specializations meant for increasing the surface area of small intestine (plica circulares, crypts of Lieberkühn, villi and microvilli)
	Appendix	166	Discuss histological features of appendix.
<b>Physiology</b>	Movements of the small intestine	167	Describe different types of movements of small intestine.
		168	Describe the control of peristalsis by nervous and hormonal signals
	Secretion of small intestine	169	Describe secretion of mucus by Brunner's glands in the duodenum

	Pancreatic enzymes	170	Describe the chemistry, secretion, functions and regulation of pancreatic enzymes
	Intestinal digestive enzymes	171	Describe the chemistry, secretion, functions and regulation of small intestinal digestive enzymes
		172	Describe secretion of intestinal digestive juices by the crypts of Lieberkühn
	Gastrointestinal hormones	173	Describe the secretion, structure, functions and regulation of Gastrin, Secretin, Cholecystokinin and other GI hormones
	Disorders of small intestine	174	Describe abnormal digestion of food in the small intestine in pancreatic failure
		175	Describe malabsorption by the small intestinal mucosa in Sprue
<b>Biochemistry</b>	Pancreatic secretions	176	Describe the composition of pancreatic secretions
		177	Describe the mechanism of secretion and actions of pancreatic enzymes
		178	Describe the mechanism of synthesis of Bicarbonates
	Digestion and absorption	179	Describe the mechanism of digestion and absorption of fats in the intestines

		180	Describe the mechanism of digestion and absorption of proteins in the intestines
		181	Describe the mechanism of digestion and absorption of carbohydrates in the intestines
		182	Describe the mechanism of absorption of Iron, Vitamin-B12 and Folate in the intestines
	Energy requirement of human body	183	Discuss the daily energy requirement of a human body in health and disease
		184	Define BMR
		185	Enlist the causes of high and low BMR
		186	Describe the daily requirements of common vitamins, Iron, Calcium, Iodine and other minerals
	Nutritional disorders	187	Define Protein energy malnutrition and its associated clinical conditions
	Adipose tissues	188	Discuss adipose tissue homeostasis
<b>Pharmacology</b>	Anti-diarrheal drugs	189	Classify anti-diarrheal drugs and their mechanism of action
	Drugs for constipation	190	Classify drugs used in constipation, and their mechanism of action

<b>Community Medicine</b>	Food borne infection	191	Describe the epidemiology of food borne infections and their control measures
<b>Paediatrics</b>	Acute gastroenteritis	192	Describe the aetiology, clinical features, complications and treatment of acute gastroenteritis



## Theme 5: Bleeding Per Rectum

<b>Gross Anatomy</b>	Large intestine	193	Describe the gross features of cecum, ascending, transverse and descending and sigmoid colon
		194	Describe the mesentery of large intestine
		195	Describe the gross anatomy of rectum
		196	Describe the gross anatomy of anal canal
		197	Describe the blood supply of anal canal and its clinical correlates.
		198	Describe the boundaries and contents of Ischiorectal (anal) fossa
<b>Embryology</b>	Development of hind gut	199	Describe the partitioning of cloaca
		200	Enlist the derivatives of hind gut
		201	Enlist the developmental anomalies of hindgut
<b>Histology</b>	Colon	202	Discuss the histological features of colon
		203	Describe the characteristic features of intestinal glands
	Rectum	204	Describe the histological features of Rectum
<b>Physiology</b>	Movements of the Colon	205	Describe different types of movements of colon
		206	Describe gastro-colic reflex and duodeno-colic reflexes

		207	Describe the mechanism of defecation reflex
	Secretion of Large Intestine	208	Describe secretion of mucus by the large intestine
	Disorders of Large intestine	209	Describe constipation, megacolon
		210	Explain mechanism of diarrhea and its causes.
		211	Explain paralysis of defecation in spinal cord injuries
	General Disorders of the gastrointestinal tract	212	Describe the mechanisms of Vomiting and Nausea
		213	Describe Vomiting Act
		214	Describe Gastrointestinal Obstruction
		215	Describe gases in the gastrointestinal tract (flatus)

<b>Biochemistry</b>	Intestinal juices	216	Describe the composition of intestinal juices
<b>Pathology</b>	Carcinoma of colon and Rectum	217	Describe the etiology, histological findings, clinical presentation and staging of carcinoma of colorectal carcinoma
<b>Surgery</b>	Colorectal malignancies	218	Describe the etiology, clinical features, investigations and management of colorectal cancers

## Metabolism

<b>Theme-6: Glucose control (Carbohydrate metabolism)</b>			
<b>Biochemistr y</b>	Oxidative Phosphorylation	219	Describe the generation of proton gradient & the resultant motive force across the inner mitochondrial membrane by transport of electrons through ETC which in turn produces ATP by oxidative phosphorylation
		220	Describe the structure of ATP synthase enzyme(complex-V) & explain how it works as a rotary motor to synthesize ATP from ADP & Pi
	Respiratory Chain Inhibitors & Uncouples	221	Describe the control of the rate of respiration, oxidation of reducing equivalents via ETC & its tightly coupling with oxidative phosphorylation in mitochondria
		222	Discuss certain common poisons which block respiration or oxidative phosphorylation & identify their site of action
		223	Explain how uncouplers act as poisons by dissociating oxidation from oxidative phosphorylation via ETC but at the same time they may have a physiological role in generating body heat
	Glycolysis	224	Define Glycolysis
		225	Describe the entry of glucose into different kinds of cells through various GLUT transporters
		226	Describe the reactions of glycolysis

		227	Describe the transportation of NADH to Mitochondria via various Shuttles
		228	Describe the energetics of glycolysis
		229	Describe the fates of pyruvate
		230	Describe the types of glycolysis especially the anaerobic glycolysis
		231	Describe the key enzymes and regulation of glycolysis
		232	Discuss the glycolysis in RBC
		233	Describe the biomedical Significance and clinical disorders of glycolysis
		234	Discuss glycolysis in cancer cells
	Oxidation of Pyruvate	235	Describe the conversion of pyruvate into acetyl CoA
		236	Enumerate the enzymes & coenzymes of PDH complex
		237	Describe the sequence of reactions catalyzed by PDH complex.
		238	Describe the regulation of PDH complex
		239	Discuss the clinical aspects of PDH complex especially the congenital lactic acidosis
		240	
	Tricarboxylic Acid Cycle	241	Define citric acid cycle
		242	Describe the sources of acetyl CoA in mitochondria
		243	Describe the reactions of TCA
		244	Discuss the energetics of TCA

		245	Discuss the energy yield of one molecule of glucose when it is converted into carbon dioxide and water
		246	Name the vitamins that play key role in TCA
		247	Describe the amphibolic nature of TCA
		248	Discuss the regulation of TCA
		249	Enumerate the inhibitors of TCA and their sites of inhibition
	Gluconeogenesis	250	Define Gluconeogenesis
		251	Name the organs and sub cellular location where Gluconeogenesis occurs
		252	Describe the substrates or precursors of Gluconeogenesis
		253	Describe the three bypass reactions
		254	Describe the Gluconeogenesis from Fatty Acids
		255	Discuss the Cori's cycle
		256	Discuss the regulation of Gluconeogenesis
		257	Name the key enzymes of Gluconeogenesis
	Hexose Mono Phosphate shunt	258	Discuss the Role of Pentose Phosphate Pathway
		259	Name the tissues where Hexose Mono Phosphate shunt occurs
		260	Describe the reactions of the two parts of Hexose Mono Phosphate shunt
		261	Describe the Role of thiamine in Hexose Mono Phosphate shunt
		262	Enumerate the Similarities & differences b/w glycolysis and HMP shunt pathway

		263	Discuss the functions of NADPH (produced in Hexose Mono Phosphate shunt) in various tissues and cells
		264	Discuss G6PD deficiency and its effects in various tissues and cells
		265	Describe the regulation of HMP shunt pathway
	Uronic Acid Pathway	266	Enumerate the products of Uronic acid pathway and their importance
		267	Discuss why ascorbic acid is vitamin for humans
	Galactose Metabolism	268	Describe the uses & requirements of galactose in the body
		269	Discuss the various reactions with enzymes involved
		270	Describe the Genetic Deficiencies of Enzymes in Galactose Metabolism and their effects
	Fructose Metabolism	271	Describe the Main source of Fructose
		272	Discuss the various reactions with enzymes involved
		273	Discuss the Fructose formation in Seminal fluid
		274	Describe the mechanism of formation of diabetic cataract
		275	Discuss the Defects in Fructose Metabolism and their effects

	Glycogen Metabolism	276	Describe the structure and functions of the glycogen especially the significance of its polymer nature
		277	Describe the Difference between Liver & muscle glycogen
		278	Describe the synthesis of glycogen by two mechanisms with its enzymes
		279	Discuss the breakdown of glycogen with its enzymes
		280	Describe the Regulation of Glycogen metabolisms
		281	Discuss the glycogen storage diseases with deficient enzymes and cardinal clinical features
<b>Theme 7: Obesity (Fat metabolism)</b>			
<b>Biochemistry</b>	Fatty acid (FA) synthesis ( <i>De Novo</i> )	282	Enumerate the organs where fatty acid synthesis occurs with sub cellular sites
		283	Discuss the source of Acetyl CoA that will be used for FA synthesis with reason
		284	Discuss how acetyl CoA comes out of mitochondria for the synthesis of FA
		285	Describe the steps of FA synthesis with enzymes
		286	Describe the FA synthase enzyme with its structure and components
		287	Describe the product of FA synthase and the subsequent fate of this product



		288	Discuss the regulation of FA synthesis
		289	Discuss why animals cannot convert fatty acids into glucose
		290	Describe the further elongation and desaturation of FA and its regulation
	Mobilization of stored fats (oxidation of FA)	291	Describe how fats are mobilized from adipose tissues to the organs where they will be used for oxidation
		292	Enumerate the various methods of oxidation of FA
		293	Discuss the stages of beta oxidation with its reactions
		294	Calculate the no. of ATP obtained when one molecule of palmitic acid is oxidized completely
		295	Describe the genetic deficiencies of FA oxidation i.e. MCAD & CAT deficiencies with their hallmarks
		296	Discuss the oxidation of odd-chain FA
		297	Compare the processes of FA synthesis with FA oxidation
	Metabolism of Ketone bodies	298	Enumerate the ketone bodies
		299	Define ketogenesis
		300	Describe the steps of ketogenesis
		301	Discuss the energy yield during ketogenesis in liver
		302	Enumerate the conditions in which there is increased ketogenesis

		303	Discuss utilization of ketone bodies
		304	Discuss the energy yield in ketone bodies utilization in extra hepatic tissues
		305	Describe the regulation of ketogenesis in well-fed healthy conditions, during early stages of starvation & in prolonged starvation
		306	Discuss the ketoacidosis in diabetes
	Complex Lipid metabolism	307	Describe the synthesis of triacylglycerol by two mechanisms
		308	Describe the synthesis of phosphatidic acid
		309	Enumerate the substances formed from phosphatidic acid
		310	Describe the synthesis of glycerophospholipids
		311	Discuss the degradation of glycerophospholipids
		312	Describe the synthesis of ceramide and sphingophospholipids (shingomyelin)
		313	Discuss the degradation of shingomyelin
		314	Discuss Niemann-Pick disease with its cardinal clinical features
		315	Discuss Farber disease with its cardinal clinical features
		316	Describe the synthesis of glycosphingolipids
		317	Describe the degradation of glycosphingolipids
		318	Describe the abnormalities of phospholipid metabolism i.e. true demyelinating diseases and sphingolipidosis

	Eicosanoid metabolism	319	Define eicosanoids and describe their two classes
		320	Describe the synthesis of prostanoids by cyclo-oxygenase pathway
		321	Enumerate the two isomers of cyclo-oxygenase with their inhibition
		322	Discuss why low dose aspirin therapy is used in strokes and heart attacks
		323	Describe biochemical reason for the adverse effects of NSAIDs & steroids
		324	Describe the catabolism of the prostanoids
		325	Describe the lipoxygenase pathway for synthesis of Leukotrienes and lipoxins
		326	Describe the synthesis of leuktriene biosynthesis inhibition
		327	Enumerate the leukotriene receptor antagonists
	Metabolism of cholesterol	328	Describe the major sites of cholesterol synthesis as well as sub cellular sites
		329	Describe the source of cholesterol synthesis
		330	Describe the various steps of cholesterol synthesis
		331	Discuss the regulation of cholesterol synthesis
		332	Enumerate the inhibitors of HMG CoA reductase inhibitors
		333	Describes the degradation and excretion of cholesterol with synthesis of bile acids, their conjugation, bile salt formation and micelle formation in lumen of the intestine

		334	Discuss the enterohepatic circulation of bile salts
		335	Discuss the role of bile acid sequestrants i.e. cholestyramine and dietary fibre
		336	Discuss the regulation of bile acid synthesis
	Metabolism of lipoproteins	337	Describe the structure of a typical lipoprotein particle
		338	Enumerate the various classes of LP
		339	Enumerate the functions of apolipoproteins
		340	Describe the steps of chylomicrons' metabolism
		341	Describe the metabolism of VLDL
		342	Describe the metabolism of LDL
		343	Describe the metabolism of HDL
	Disturbances of Lipid metabolism	344	Differentiate between hyperlipidemias and dyslipidaemia
		345	Describe the Classification of hyperlipidemias with enzyme deficiency

<b>Medicine</b>	hyperlipidemias	346	Describe the epidemiology, preventive strategies and diseases associated with hyperlipidemias
<b>Theme 8: Wasting (Protein metabolism)</b>			
<b>Biochemistry</b>	Amino acid pool & chemical processes for dissimilation of proteins	347	Discuss how amino acid pool is formed
		348	Discuss the chemical processes responsible for dissimilation of proteins: transamination, deamination and transdeamination
		349	Discuss the clinical importance of transaminases
	Ammonia transport and effects of ammonia toxicity on brain	350	Discuss how ammonia is formed in various tissues and transported to liver Discuss the effects of ammonia toxicity in brain
	Urea cycle & its associated inherited disorders	351	Describe the Krebs-Henselet Cycle of Urea Formation in Liver
		352	Describe the clinical significance of various enzymes involved in urea formation
	Metabolism of aromatic amino acids	353	Discuss biosynthesis, fate, metabolic functions and related inherited disorders of aromatic amino acids

	Metabolism of sulphur containing amino acids	354	Discuss biosynthesis, fate, metabolic functions and related inherited disorders of sulphur containing amino acids
	Metabolism of individual amino acids	355	Discuss biosynthesis, fate, metabolic functions and related inherited disorders of Glycine, serine, and alanine
		356	Discuss biosynthesis, fate, metabolic functions and related inherited disorders of acidic amino acids
		357	Discuss biosynthesis, fate, metabolic functions and related inherited disorders of branched chain amino acids

### List of practical works

Subject	Topic	S. No	Learning objectives
<b>Histology</b>	Lips and tongue	358	Identify the histological features of lips and tongue under the microscope
	Esophagus	359	Identify the histological features of Esophagus under the microscope
	Stomach	360	Identify the histological features of stomach under the microscope
	Duodenum	361	Identify the histological features of duodenum under the microscope
	Liver	362	Identify the histological features of liver under the microscope
	Gall bladder	363	Identify the histological features of gall bladder under the microscope
	Jejunum and Ilium	364	Identify the histological features of Jejunum and Ilium under the microscope

	Appendix	365	Identify the histological features of Appendix under the microscope
	Colon and Rectum	366	Identify the histological features of Colon and Rectum under the microscope
<b>Physiology</b>	Examination of abdomen	367	Examine a standardized patient's abdomen
<b>Biochemistry</b>	Determination of plasma proteins	368	Estimate the plasma proteins in a given blood sample
	Determination of free, total and combined acidity of the Gastric juice	369	Estimate free, total and combined acidity of gastric juice
	Determination of serum Bilirubin	370	Estimate serum Bilirubin in a given blood sample
	Determination of Titrable acidity of urine	371	Estimate the Titrable acidity of urine
	Determination of serum cholesterol	372	Estimate serum Cholesterol in a given blood sample