# *RENAL MODULE*

MBBS Year-2 (Academic Year 2019-2020)

*KMU Central Curriculum Committee*

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

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# List of Themes

| Theme No. | Theme Name | Duration |
|---|---|---|
| 1 | Flank Pain /Loin Pain | 1 week |
| 3 | Scanty Urine /Urinary retention and Edema | 1 week |
| 2 | Urinary Incontinence | 1 week |

# Theme-1 Loin pain/ Flank Pain

| Subject | Topic | Learning objectives |
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| **Gross anatomy** | 1.Overview of the urinary system | 1. List and describe the main components of the urinary system |
| | 2. Kidneys | 2. Discuss the location, anatomical structure, and relations of right and left kidneys to other abdominal organs<br>3. Discuss the gross morphological composition of kidneys<br>• Capsule<br>• Pericapsular adipose tissue<br>• Cortex<br>• Medulla<br>• Pelvis<br>• Hilum<br>• Vascular system within kidneys<br>• Arterial supply<br>• Venous drainage<br>• Lymphatic's<br>• Innervation<br>4. Enumerate the various coverings of the kidney<br>5. Explain the clinical significance of coverings of the kidneys<br>6. Describe the structures entering and leaving the hilum of kidney and their relations |
| | 3.Posterior abdominal wall | 7. Describe the general features of lumbar vertebrae |
| | | 8. Describe the special features of lumbar vertebrae |
| | | 9. Enlist the muscles of posterior abdominal wall. Describe their origin, insertion, nerve supply and actions |
| | | 10. Explain the course and relations of Abdominal Aorta |
| | | 11. Enumerate and elaborate the paired branches of abdominal aorta |
| | | 12. Discuss the formation of inferior vena cava |

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| **Embryology** | 4.Development of the urinary system | 13. Trace the embryological origins and development of the urinary system |
| | 5.Congenital anomalies of the urinary system | 14. List and describe the common congenital anomalies of kidney and ureter. |
| **Histology** | 6.Kidney | 15. Describe the parenchyma of kidney<br>16. Enlist different components of uriniferous tubules<br>17. Describe Histological features of the various components of Nephron<br>18. Describe the histological features of renal corpuscle<br>19. Describe filtration barrier<br>20. Describe the parts of collecting tubules<br>21. Describe the microscopic anatomy of collecting duct<br>22. Enlist the components of juxtaglomerular apparatus |
| **Physiology** | 7.Physiological Anatomy Of the kidneys and Overview of its Functions | 23. States major functions of the kidneys & brief physiological anatomy of kidney. |
| | | 24. Define the components of the nephron and their interrelationships: renal corpuscle, glomerulus, nephron, and collecting-duct system. |
| | | 25. Draw the relationship between glomerulus, Bowman's capsule, and the proximal tubule. |
| | | 26. Describe the 3 layers separating the lumen of the glomerular capillaries and Bowman's space; defines podocytes, foot processes, and slit diaphragms. |
| | | 27. Define glomerular mesangial cells and states their functions and |

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| | | location within the glomerulus. Detail of renal vessels & Pressure within them. Describe, in general terms, the differences among superficial cortical, midcortical, and juxtamedullary nephrons. |
| | | 28. List the individual tubular segments in order; states the segments that comprise the proximal tubule, Henle's loop, and the collecting-duct system; defines principal cells and intercalated cells. |
| | | 29. Define juxtaglomerular apparatus and describes its 3 cell types; states the function of the granular cells. |
| | | 30. Define the basic renal processes: glomerular filtration, tubular reabsorption, and tubular secretion |
| | 8.Glomerular Filtration:<br>Determinants and Equation | 31. Describe how molecular size and electrical charge determine filterability of plasma solutes; states how protein binding of a low-molecular-weight substance influences its filterability. |
| | | 32. State the formula for the determinants of glomerular filtration rate, and states, in qualitative terms why the net filtration pressure is positive. |
| | | 33. Define filtration coefficient and states how mesangial cells might alter the filtration coefficient; states the reason glomerular filtration rate is so large relative to filtration across other capillaries in the body. |
| | | 34. Describe how arterial pressure, afferent arteriolar resistance, and efferent arteriolar resistance influence glomerular capillary pressure. |
| | | 35. Describe how changes in renal plasma flow influence average glomerular capillary oncotic pressure. |

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| | | 36. State the Starling forces involved in capillary filtration. |
| | | 37. State how changes in each Starling force affect glomerular filtration rate |
| | 9.Nervous & Hormonal Control of Renal Circulation | 38. Define renal blood flow, renal plasma flow, glomerular filtration rate, and filtration fraction, and gives normal values. |
| | | 39. State the formula relating flow, pressure, and resistance in an organ. |
| | | 40. Describe sympathetic nerve supply of renal vessels & hormones affecting renal vessels |
| | | 41. Describe the effects of changes in afferent and efferent arteriolar resistances on renal blood flow |
| | 10.Auto regulation of GFR and renal blood flow | 42. Define auto regulation of renal blood flow and glomerular filtration rate |
| | | 43. Describe the myogenic and tubuloglomerular feedback mechanisms of auto regulation. |
| | 11.Review of Transport Mechanisms across the Cell Membrane(Active and Passive transport) | 44. Define and state the major characteristics of diffusion, facilitated diffusion, primary active transport, secondary active transport (including symport and antiport) and endocytosis. |
| | | 45. Define osmolality and osmolarity, and states why osmolarity is commonly used to approximate osmolality. |
| | | 46. Describe what is meant by the expression "water follows the osmoles." |
| | | 47. Describe qualitatively the forces that determine movement of reabsorbed fluid from the interstitium into peritubular capillaries. |
| | | 48. Compare the Starling forces governing glomerular filtration with those governing peritubular capillary absorption. |

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| | | 49. Compare and contrasts the concepts of $T_m$ and gradient-limited transport. |
| | | 50. Describe 3 processes that can produce bidirectional transport of a substance in a single tubular segment; states the consequences of pump-leak systems. |
| | | 51. Contrast "tight" and "leaky" epithelia. |
| **Biochemistry** | 12.Acid-base balance & imbalance | 52. Study the sources of Hydrogen Ion, pH & Anion Gap |
| | | 53. Describe Buffer Systems operating in the Body<br>54. Carbonic acid,protein,and phosphate buffer<br>55. Transporting acid and mitigating pH changes |
| | | 56. Describe Respiratory Regulation of Acid Base Balance |
| | | 57. Describe Renal Regulation of Acid Base Balance |
| | | 58. Describe Disorders of Acid Base Balance: their causes, mechanisms and compensations of Respiratory Acidosis & Alkalosis and Metabolic Acidosis & Alkalosis |
| **Pathology** | 13.Smoky urine | 59. List the common kidney symptoms<br>60. Discuss the pathophysiology of renal infections<br>61. Describe Symptoms associated with renal pathology<br>62. Classify renal diseases<br>63. Explain Pathophysiology of renal infections<br>64. Describe Treatment of chronic pyelonephritis |
| | 14.Renal disorders | 65. Define the terms Nephrotic syndrome, nephritic syndrome, Azotemia.<br>66. Enlist the Causes types of renal stones. |

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| | | 67. Enlist the causes and describe the pathogenesis of urinary tract infection. |
| | 15.Systemic disease affecting kidneys | 68. Explain how systemic diseases can affect renal function<br>69. Systemic diseases affecting renal function<br>- Diabetes<br>-Cardiovascular disorders (hypertension, CHF)<br>-Immunological disorders (SLE, glomerulonephritis)<br>-Cancers (myeloma)<br>-Hematological disorders (sickle cell anemia, HUS) |

## Practical

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| **Anatomy** | 16.Surface anatomy of the urinary system and radiology | | 70. Identify the gross anatomic features the kidneys, renal pelvis, ureter, urinary bladder and urethra<br>71. locate renal angle<br>72. Perform renal punch and its clinical significance<br>73. Develop Understanding of KUB<br>74. Identify different parts of urinary system on IVU |
| **Biochemistry** | 17.Titrable acidity of urine | | 75. Find out PH of urine |

# Theme-2 Edema and Urinary retention/ Scanty Urine

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| **Anatomy** | 18.Ureters | 76. Describe the gross anatomy of ureters |
| | | 77. Describe the relations of right ureter in males and females |
| | | 78. Describe the relations of left ureter in males and females |
| | | 79. Highlight the clinical significance of relations of right and left ureters in both sexes |
| | | 80. Discuss constrictions in ureter and their clinical relevance. |
| | 19.Urinary bladder | 81. Describe the gross structure of urinary bladder<br>82. Discuss the Ligaments/supports. |
| | | 83. Discuss the blood supply and nerve supply of urinary bladder |
| | | 84. Discuss the relations of urinary bladder in males |
| | | 85. Discuss the relations of urinary bladder in females |
| | 20.Prostate gland | 86. Describe the structure of prostate gland<br>87. Describe Lobes, capsule, relations and structures within prostate. |
| | | 88. Discuss the common problems resulting from abnormal growth of the prostate. Relate the symptoms to structures |
| | 21.Urethra | 89. Describe the gross anatomy of urethra |
| | | 90. Enlist the differences between male and female urethra |
| **Embryology** | 22.Development of the urinary system (Kidney and Ureter) | 91. Enlist the stages of development of kidneys |
| | | 92. Describe the formation of pronephric, mesonephric and metanephric kidneys |
| | | 93. Enumerate the derivatives of metanephricblastema and describe their development |
| | | 94. Enumerate the derivatives of metanephric diverticulum/ureteric bud |
| | | 95. Describe the changes in position and blood supply of kidneys during development |
| | | 96. Enlist the various types of developmental anomalies of kidneys along with their embryological causes |
| | | 97. Enlist the various types of developmental anomalies of ureters along with their embryological causes |

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| | 23.(Bladder and urethra) | 98. Describe the development of bladder<br>99. Discuss the developmental anomalies of bladder<br>100. Describe the development of male urethra<br>101. Describe the development of prostate and bulbourethral glands<br>102. Describe the development of female urethra<br>103. Discuss the developmental anomalies of male and female urethra |
| | 24. Prostate gland | 104. Describe Embryological development of prostate gland |
| | 25. Congenital anomalies of the urinary system | 105. List and describe the common congenital anomalies of of bladder and urethra. |
| **Histology** | 26. Ureter | 106. Describe the microscopic anatomy of ureter |
| | 27. Bladder | 107. Describe the histological features of urinary bladder |
| | 28. Prostate | 108. Describe the microscopic structure of prostate |
| | 29. Urethra | 109. Discuss the microscopic structure of male and female urethra |
| **Physiology** | 30. Body fluid compartments | 110. List the body fluid compartments<br>111. Recall the volumes of body fluid compartments<br>112. Discuss the interplay in fluid volumes between different fluid compartments<br>113. Describes principles of osmosis and osmotic pressure<br>114. Discuss the interplay between various pressures<br>115. Discuss principles of edema<br>• Intracellular fluid compartment<br>• Extracellular fluid compartment<br>• Intravascular fluids<br>• Blood<br>• Plasma<br>• Interstitial fluid<br>• Constituents of intra- and extracellular fluid compartments<br>• Calculating fluid volumes<br>• Osmosis and osmotic fluid regulation |

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| | 31. Reabsorption /Secretion along Different Parts of the Nephron | 116. List approximate percentages of sodium reabsorbed in major tubular segments.<br>117. List approximate percentages of water reabsorbed in major tubular segments.<br>118. Define the term *iso-osmotic volume* reabsorption.<br>119. Describe proximal tubule sodium reabsorption, including the functions of the apical membrane sodium entry mechanisms and the basolateral sodium-potassium-adenosine triphosphatase.<br>120. Explain why chloride reabsorption is coupled with sodium reabsorption, and lists the major pathways of proximal tubule chloride reabsorption.<br>121. State the maximum and minimum values of urine osmolality.<br>122. Define osmotic diuresis and water diuresis.<br>123. Explain why there is an obligatory water loss.<br>124. Describe the handling of sodium by the descending and ascending limbs, distal tubule, and collecting-duct system.<br>125. Describe the role of sodium-potassium-2 chloride symporters in the thick ascending limb.<br>126. Describe the handling of water by descending and ascending limbs, distal tubule, and collecting-duct system |
| | 32.mechanisms of regulation of tubular reabsorption | 127. Discuss the mechanisms of regulation of tubular reabsorption<br>•Reabsorption and secretion by the renal tubules<br>•Active and passive transport mechanisms<br>•Mechanism of reabsorption of specific substances (eg.<br>•Water, electrolytes)<br>•Reabsorption and secretion in different parts of the tubules<br>•Glomerular balance<br>•Peritubular and renal interstitial fluid physical forces<br>•Effect of arterial pressure on urine output<br>•Hormonal control of tubular reabsorption<br>•Aldosterone<br>•Angiotensin-II<br>•ADH<br>•Parathyroid hormone<br>•Nervous regulation of tubular reabsorption |

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| | 33.Concept Of Renal Clearance | 128. Define the terms clearance and metabolic clearance rate, and differentiates between general clearance and renal clearance.<br>129. List the information required for clearance calculation<br>130. State the criteria that must be met for a substance so that its clearance can be used as a measure of glomerular filtration rate; states which substances are used to measure glomerular filtration rate and effective renal plasma flow.<br>131. Predict whether a substance undergoes net reabsorption or net secretion by comparing its clearance with that of inulin or by comparing its rate of filtration with its rate of excretion.<br>132. Calculate net rate of reabsorption or secretion for any substance.<br>133. Calculate fractional excretion of any substance.<br>134. Describe how to estimate glomerular filtration rate from $C_{Cr}$ and describes the limitations.<br>135. Describe how to use plasma concentrations of urea and creatinine as indicators of changes in glomerular filtration rate. |
| | 34.Mechanism of diluted urine formation | 136. Describe the process of "separating salt from water" and how this permits excretion of either concentrated or dilute urine.<br>137. Describe how antidiuretic hormone affects water reabsorption.<br>138. Describe the characteristics of the medullary osmotic gradient.<br>139. Explain the role of the thick ascending limb, urea recycling, and medullary blood flow in generating the medullary osmotic gradient.<br>140. State why the medullary osmotic gradient is partially "washed out" during a water diuresis<br>141. Describe the origin of antidiuretic hormone and the 2 major reflex controls of its secretion; define diabetes insipidus; state the effect of antidiuretic hormone on arterioles.<br>142. Distinguish between the reflex changes that occur when an individual has suffered iso-osmotic fluid loss because of diarrhoea as opposed to a pure |

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| | | water loss (ie, solute-water loss as opposed to pure-water loss).<br>143. Describe the control of thirst.<br>144. Describe the pathways by which sodium and water excretion are altered in response to sweating, diarrhoea, haemorrhage, high-salt diet, and low-salt diet. |
| | 35.Mechanism of concentrated urine formation | 145. Discuss the mechanism of concentrated urine formation. |
| | 36. Renal regulation of Potassium | 146. State the normal balance and distribution of potassium within different body compartments, including cells and extracellular fluid.<br>147. Describe how potassium moves between cells and the extracellular fluid, and how, on a short-term basis, the movement protects the extracellular fluid from large changes in potassium concentration.<br>148. Describe how plasma levels of potassium do not always reflect the status of total-body potassium.<br>149. State generalizations about renal potassium handling for persons on high- or low-potassium diets.<br>150. State the relative amounts of potassium reabsorbed by the proximal tubule and thick ascending limb of Henle's loop regardless of the state of potassium intake.<br>151. Describe how the cortical collecting duct can manifest net secretion or reabsorption; describes the role of principal cells and intercalated cells in these processes.<br>152. List the 3 inputs that control the rate of potassium secretion by the cortical collecting duct.<br>153. Describe the mechanism by which changes in potassium balance influence aldosterone secretion.<br>154. State the effects of most diuretic drugs and osmotic diuretics on potassium excretion.<br>155. Describe the association between perturbations in acid-base status and the plasma potassium level |
| | 37.The prostate | 156. Discuss the physiological functions of the prostate |
| | 38.physiochemical aspects | 157. Discuss the physiochemical aspects (Diffusion, Adsorption, Viscosity, Colloid Osmotic pressure and role of Albumin in regulation of Osmotic pressure) |

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| | 39.Regulation of extracellular fluid osmolality and sodium concentration | 158. Discuss the homeostatic function of the kidneys<br>159. Explain the mechanism by which kidneys are able to form diluted or concentrated urine<br>160. Describe Mechanism of formation of dilute urine<br>161. Describe Mechanism of formation of concentrated urine<br>162. Describe requirements for excreting a concentrated urine<br>163. Describe the counter-current mechanism<br>164. Describe Role of distal tubules and collecting ducts<br>165. Describe Quantifying urine concentration and dilution<br>166. Describe Disorders of urine concentration ability |
| | 40.Regulation of extracellular fluid osmolarity and sodium concentration-2 | 167. Discuss the homeostatic function of the kidneys<br>168. Discuss the principles of osmoregulation by the kidneys<br>169. Explain how the body regulated the osmolarity of fluid comparts<br>170. Describe Control of extracellular fluid osmolarity and sodium concentration<br>171. Describe Osmoreceptor-ADH feedback system<br>172. Describe Role of thirst in controlling extracellular fluid osmolarity and concentration<br>173. Describe Salt-appetite mechanism and Integrated response to sodium intake |
| | 41.Regulation of concentration of potassium, calcium, phosphate and magnesium | 174. Discuss the mechanisms of regulation of concentrations of various ions in the body<br>175. Describe the processes occurring at cellular level to maintain/excrete various ions in the kidneys<br>-Regulation of potassium<br>--Regulation of calcium<br>-Regulation of phosphate<br>-Regulation of magnesium |

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| | 42.Short and Long term control of Blood pressure by Kidneys | 176. Describe the 3 temporal domains of blood pressure control and the major mechanisms associated with them.<br>177. Describe the relationship between renin and angiotensin II.<br>178. Describe the 3 detectors that can alter renin secretion.<br>179. Define pressure natriuresis and diuresis.<br>180. Define tubuloglomerular feedback and describe the mechanism for tubuloglomerular feedback and auto regulation of glomerular filtration rate |
| **Biochemistry** | 43.Renal control of Calcium & Phosphorus | 181. State the normal total plasma calcium concentration and the fraction that is free. |
| | | 182. Describe the distribution of calcium between bone and extracellular fluid and the role of bone in regulating extracellular calcium. |
| | | 183. Describe and compare osteocytes osteolysis and bone remodelling. |
| | | 184. Describe renal handling of phosphate. |
| | | 185. Describe how parathyroid hormone changes renal phosphate excretion. |
| | 44.constituents of urine | 186. Describe the normal and abnormal constituents of urine |
| **General Surgery/urology** | 45.Urinary retention | 187. Describe the etiology, and management of urinary retention |
| | | 188. Describe the etiology, clinical features and treatment of Benign prostatic hyperplasia |
| **Pathology** | 46.Renal failure | 189. Enlist the causes of Renal failure/ uraemia and abnormalities related to micturition including incontinence<br>190. Discuss the causes and pathophysiology of Chronic Renal failure |
| | 47.Urinary stones | 191. Describe the pathophysiology of Urinary stones |
| | 48.Glomerular diseases | 192. Describe the etiology and pathogenesis of glomerulonephritis |
| | 49.Classification of kidney disorders | 193. Classify kidney disorders according to etiology, site of dysfunction and type of dysfunction<br>- Acute/ chronic |

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| | | -Infectious<br>-Immunological<br>-Neoplastic<br>-Vascular/interstitial /parenchymal<br>- Primary/systemic |
| | 50.Nephrotic syndrome | 194. Describe Nephrotic syndrome and its etiology |
| **Pharmacology** | 51.Nephrotoxic drugs | 195. Describe the mechanism of drug excretion |
| | | 196. Enlist nephrotoxic drugs |
| | | 197. Describe the mechanism of action of diuretic drugs |
| | 52.Drugs acting on the renal system (in NW module it's in theme of Scanty Urine) | 198. Classify diuretics |
| **Community Medicine/Public Health** | 53.Quality of life in problems of prostate | 199. Discuss quality of life issues in patients with prostate problems<br><br>200. Overview of the concept of quality of life (QoL)<br><br>201. Discuss the significance of quality of life in disease and treatment settings<br><br>202. Discuss quality of life issues in geriatric population |
| | | **Practical** |
| **Physiology** | 54.Intake output chart maintenance in bed ridden patients | 203. Maintain Intake output chart maintenance in bed ridden patients |
| | 55.Catheter insertion | 204. Preform insertion of catheter on dummy |

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| **Biochemistry** | 56.Urine analysis | 205. Determine the normal/abnormal constituents in the urine<br><br>-Urine sugar<br>-Amino acids<br>-Proteins<br>-Hemoglobin<br>-Uric acid<br>-Urea<br>-Creatinine and chloride<br>-Calcium and phosphate<br>-Ammonia<br>-Ketone bodies<br>-Benzidine test for blood in urine |
| **Theme-3 Urinary incontinence** | | |
| **Anatomy** | 57.The Perineum | 206. Define the pelvis and the perineum<br>Discuss the openings in the pelvis and what passes<br>through them<br>207. List and describe the contents of the urogenital triangle<br>-Contents of the male urogenital triangle<br>-Urethral injuries<br>208. Injury to the perineum in childhood |
| **Physiology** | 58.Urinary bladder and micturition | 209. Describe the functional anatomy of urinary bladder<br>210. Explain the mechanism of micturition<br>211. Explain the micturition reflex and relate structures of the bladder with function<br>212. Explain basal cystometrogram<br>213. Describe the nervous control of bladder functions |
| | 59.Urinary incontinence | 214. Discuss the causes, symptoms and management of patients with urinary incontinence, urgency, frequency, burning micturition etc<br>215. Causes of urinary incontinence, urgency, frequency,<br>burning micturition |

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| | | 216. Terms related to urinary obstruction and incontinence<br><br>217. Describe Clinical presentation of continence disorders<br>218. Explain General management of incontinence |
| **Biochemistry** | 60.Water balance/metabolism | 219. Mechanism & regulation of Water balance<br>220. Disorders of water balance, such as dehydration & over hydration<br>221. Electrolytes (intracellular & extracellular cations) & its metabolism<br>222. Disorders of electrolyte metabolism |
| **Radiology** | 61.Radiological diagnosis of urinary pathologies | 223. Identify and describe the various anatomic landmarks of the renal system on radiographs<br>224. Discuss special radiological tests to determine renal function and pathologies<br>225. Describe normal radiographs of abdomen and pelvis<br>226. Describe special radiological tests to show renal pathology and function<br>227. Abdominal ultrasound |
| **Clinical (Nephrology/ Medicine)** | 62.Dialysis | 228. Describe the types, indications and the process of dialysis for kidney disease<br>229. Describe Types of dialysis<br>-Peritoneal dialysis<br>-Hemodialysis<br>-Hemofiltration<br>-Haemodiafiltration<br>-Intestinal dialysis<br>-indications for dialysis<br>230. Discuss disorders of acid-base balance, electrolyte abnormalities uremia or fluid overload resulting from acute and chronic renal failure, and intoxication<br>231. Describe The process of hemodialysis and peritoneal dialysis<br>232. Describe Dialyzable substances |
| Clinical (Nephrology/ Medicine) | 63.Patient with excessive urination | 233. Discuss the disorders associated with urine concentrating ability<br>234. Plan a line of investigation and management in renal disorders |

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| | | 235. Disorders of renal concentration ability<br>236. Comparison of excessive urine volume with increased frequency of micturition<br>237. Describe the mechanism of secretion and action of ADH<br>238. Describe Urine concentrating ability of the various parts of the nephron<br>Proximal convoluted tubule<br>Descending limb of loop of Henle<br>Ascending limb of loop of Henle<br>Collecting system |
| Clinical (Nephrology/ Medicine) | 64.Patient with continuous dribbling of urine | 239. Discuss the causes of urinary incontinence<br>240. Discuss the significance of radiological investigations in cases of urinary incontinence in children<br>241. Define and describe Enuresis, its causes and treatment<br>242. Describe Causes of urinary incontinence<br>243. Describe the micturition reflex<br>244. Discuss Tests for investigating urinary incontinence |
| **Pathology** | 65. common pathologies of perineal region | 245. List and define the common pathologies of the perineal region<br>246. Describe Urethral infection |
| **Practical** | | |
| **Anatomy** | 66.surface anatomy of the perineum and radiology | 247. Identification of the various structures forming the perineum on models<br>248. Identify the radiographic landmarks of the perineum |
| | 67.Histologic examination urinary system | 249. Identify the characteristic microscopic features of the urinary system<br>-Kidney<br>-Ureter<br>-Urinary bladder<br>-Urethra |

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| **Biochemistry** | 68.Creatinine in urine | 250. Estimation of creatinine in 24 hour urine sample |
| **Physiology** | 69.Arterial blood-gas analysis | 251. Arterial blood sampling<br>252. Analysis and interpretation of arterial blood gases |