

	Spiral I
MODULE TITLE	Urinary system-1
INTRODUCTION	This module introduces the learners to the development, and the gross and microscopic structures of the urinary system. It is connected with and supports the Renal and excretory-2 module. Students learn how the urinary system functions, the processes and causes of its malfunction and some of the drugs which act on the kidneys. The students will gain an understanding of the electrolyte and acid-base disorders. This module also introduces the young learners to major clinical aspects of related diseases so that they can relate basic sciences to the applied / clinical aspects.
RATIONALE	Before students get exposed to complete clinical aspects of diseases related to the urinary system, it is imperative that they achieve thorough understanding of what the system is about, how it functions and how diseases may be caused.
TARGET STUDENTS	Second year MBBS, 2022
DURATION	4 weeks
MODULE OUTCOMES	By the end of the module, students will be able to relate the structure (gross, microscopic and biochemical) and the normal processes with the underlying disease processes and their clinical manifestations
DEPARTMENTS	<ol style="list-style-type: none"> 1. Anatomy 2. Biochemistry 3. Physiology
OBJECTIVES	OBJECTIVES By the end of the module, students should be able to:

LECTURES/ DEMONSTRATIONS

ANATOMY

1. Gross anatomy of kidneys

- Describe the gross structure of kidney, its location and shape
- Discuss the coverings, and cortex and medulla, relations and functions of kidneys
- Discuss the clinical conditions related to kidneys

2. Blood supply, nerve supply and lymphatic drainage of kidneys

- Describe in sequence the structures passing through the hilum of kidneys
- Discuss the blood supply of kidney in detail, with clinical segmentation of kidney according to its blood supply
- Discuss the nerve supply and lymphatic drainage of kidney
- Discuss the clinical conditions related to blood supply of kidney

3. Gross anatomical features of ureter and urinary bladder & urethra

- Enumerate the parts of urinary system (ureter, urinary bladder and urethra)
- Describe the structure, course, anatomical constrictions, and relations of ureter
- Explain the location, apex, base, surfaces and relations of urinary bladder
- Describe the trigone of the urinary bladder
- Explain the support to the urinary bladder
- Describe the blood supply, nerve supply and lymphatic drainage of ureter, urinary bladder and urethra

4. Surface anatomy of Urinary system

- Mark the following structures on the surface of a human body/ mannequin:
 - i. Kidney
 - ii. Ureter
 - iii. Urinary bladder

5. Histological features of kidney

- Describe the histological features of kidney (cortex & medulla)
- Discuss the histological features of a nephron and their types
- Describe the filtration barrier and its significance
- Explain the juxtaglomerular apparatus, its location and significance

6. Histological features of ureter, urinary bladder and urethra

- Discuss the lining epithelium of Ureter, Urinary Bladder & Urethra
- Describe the arrangement of layers in ureter, urinary bladder and urethra & their microscopic appearance

7. Development of kidney, ureter & urinary bladder

- Describe the role of intermediate mesoderm in the formation of kidney
- Describe the development and the fate of the three progenitors of urinary system: pronephros, mesonephros and metanephros
- Discuss the development of the following:
 - i. Nephron

- ii. Collecting system of kidney
- iii. Ureter
- iv. Urinary bladder

8. Anomalies of kidney, ureter & urinary bladder

- Describe the congenital anomalies of kidney (polycystic kidney, pelvic kidney, horseshoe kidney), ureter (Bifid ureter) and urinary bladder

BIOCHEMISTRY

TOPIC 1: WATER DISTRIBUTION, REGULATION & DISTURBANCES

1. Water distribution, regulation & disturbances

- Describe the distribution of water in the body
- Discuss the hormonal regulations of water homeostasis and their exchanges
- Explain the regulatory mechanism by which the water balance is maintained
- Discuss the biochemical consequences of dehydration and overhydration
- Discuss the clinical disorders associated with water balance abnormalities and their management

2. PH Disturbances

- Describe the maintenance of normal pH
- Discuss the renal mechanism of pH regulation
- Discuss the biochemical consequences of respiratory and metabolic acidosis and alkalosis
- Explain the compensatory mechanism in metabolic pH disturbances
- Discuss the Arterial blood gases (ABGs) in metabolic pH disturbances
- Discuss the ABGs in compensated metabolic pH disturbances

3. Sodium and chloride disturbances

- List the sources of dietary sodium and chloride
- Discuss the normal daily requirement of Sodium and chloride
- Explain the distribution of sodium in extracellular and intracellular compartments
- Describe the biochemical role and metabolism of Sodium and chloride
- Discuss the clinical disorders associated with sodium and chloride disturbances (e.g. Hypertension)
- Discuss the laboratory investigations related with the disturbances of these electrolytes (e.g. dehydration and over-hydration)

4. Potassium and phosphate disturbances

- List the sources of dietary potassium and phosphate
- Discuss the normal daily requirement of potassium and phosphate
- Explain the distribution of potassium and phosphate in extracellular and intracellular compartments
- Describe the biochemical role and the metabolism of potassium and phosphate
- Discuss the clinical disorders associated with potassium and phosphate disturbances (e.g. hypokalemia & hyperkalemia)
- Discuss the laboratory investigations related with the disturbances of these electrolytes

5. Renal Function tests

- Discuss the clinical importance of renal disorders
- Discuss the importance of renal function tests for the diagnosis of renal disorders
- List the renal function tests
- Explain the renal function tests
- Interpret clinical conditions correlated with their laboratory investigations

TOPIC 2: NUCLEOTIDE METABOLISM

1. Purine Synthesis

- Discuss the structure and biochemical functions of nucleotides
- Name the different types of purines
- Describe the sources of carbon and nitrogen atoms in the purine ring
- Discuss the process of purine synthesis (Denovo and salvage pathways)
- Discuss the biochemical abnormalities related to purine synthesis (e.g. Lesch –Nyhan Syndrome & Von Gierke's Diseases)

2. Purine Degradation

- Describe the fate of dietary nucleoproteins
- Discuss the degradation of tissue purine nucleotides
- Explain the formation of uric acid
- Discuss the clinical significance of purine degradation abnormalities (e.g. Gout, Severe combined immunodeficiency diseases, purine nucleoside phosphorylase deficiency and hypouricemia)

3. Pyrimidine Metabolism

- Discuss the structure and biochemical functions of pyrimidine nucleotides
- Name the different types of pyrimidine
- Discuss the process of pyrimidine synthesis and degradation
- Discuss the biochemical abnormalities related to pyrimidine synthesis (e.g. Orotic aciduria)

PHYSIOLOGY

1. General functions of kidneys and excretory system

- List the general functions of kidneys
- Describe the structure, functions and types of typical nephron and its blood supply.

2. Glomerular filtration rate (GFR) and its regulating factors

- Define glomerular filtration rate
- Explain the composition of glomerular filtrate
- Discuss the major factors that regulate the GFR (Net filtration pressure, hydrostatic, and colloid osmotic pressures)

3. Auto-regulation of GFR and renal blood flow

- Define tubulo glomerular feedback
- Explain the functions of juxta glomerular apparatus and Macula densa
- Discuss myogenic auto-regulation

4. Tubular reabsorption and secretion

- Discuss the transport mechanisms among different segments of renal tubule

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- Explain the regulation of tubular reabsorption and secretion
- Discuss the hormonal control of tubular reabsorption secretion

5. Concentration and dilution of urine

- Explain counter current multiplier, and counter current exchange method
- Discuss the role of urea in urine formation
- Define obligatory urine volume

6. Acidification of urine

- Discuss different buffer systems in the body (bicarbonate, phosphate, ammonia)
- Explain the role of kidneys in acid base balance
- Discuss the changes in the level of urine PH (maximum/minimum level; 4.5-8)

7. Process of micturition and micturition reflex

- Explain physiology and innervation of bladder
- Explain micturition reflex

8. Plasma clearance and estimation of renal function

- Determine renal plasma flow, renal blood, GFR
- List the substances that are used to estimate renal function (PAH, inulin)
- Calculate clearance of PAH and inulin

9. Renal Hormones

- Explain the effects of different hormones on kidney function (erythropoietin, ADH, Angiotensin, aldosterone)

TUTORIALS

BIOCHEMISTRY

1. Water, electrolytes and pH disturbances

- Discuss the clinical importance of water, electrolytes and pH disturbances
- Correlate the interpretation of laboratory investigations with relevant clinical conditions

2. Nucleotide Metabolism

- Discuss the clinical importance of Nucleotide metabolism (e.g. Gout)
- Correlate the interpretation of laboratory investigations with relevant clinical conditions

PRACTICALS

HISTOLOGY

1. Histological features of kidneys

- Identify renal corpuscle
- Differentiate proximal and distal convoluted tubules
- Identify medullary rays, collecting tubules and collecting ducts
- Describe the histological features of kidneys

2. Histological features of Ureter & Urinary Bladder

- Identify the microscopic appearance and structure of the ureter & urinary bladder
- Discuss the microscopic features of ureter and urinary bladder

BIOCHEMISTRY

1. Detection of normal and abnormal urine constituents

- List the normal and abnormal urine constituents and its biochemical significance
- Outline the method for detection of normal and abnormal urine constituents by chemical tests and urine dipstick
- Detect the normal and abnormal constituents of urine by chemical tests and urine dipstick
- Correlate the interpretation of laboratory investigations with relevant clinical conditions

2. Urea & Creatinine estimation

- Explain the bio-techniques to estimate Urea and Creatinine in a sample
- Explain the principle of detection of Urea and Creatinine by spectrophotometry
- Estimate Urea and Creatinine levels by spectrophotometry
- Correlate the interpretation of laboratory investigations with relevant clinical conditions

3. Uric Acid estimation

- Explain the bio-techniques to estimate Uric acid in a sample
- Explain the principle of detection of Uric acid by spectrophotometry
- Estimate Uric acid level by spectrophotometry
- Correlate the interpretation of laboratory investigations with relevant clinical conditions

Internal Assessment	<ul style="list-style-type: none"> • It can be in the form of MCQs, OSPE, viva etc. • Internal evaluation carries 20% weight age in summative examination
Annual Examination	MCQs and OSPE (observed + un-observed)
Course Evaluation	Course evaluation will be obtained through a feedback form which will be posted on the JSMU website