

HUMAN ANATOMY & PHYSIOLOGY-II- BP201T

UNIT: 3 (URINARY SYSTEM)

CLASS: 7

TOPIC: URINE FORMATION

Urine formation is a blood cleansing function. Kidneys excrete the unwanted substances along with water from the blood as urine. When blood passes through glomerular capillaries, the plasma is filtered into the Bowman capsule. This process is called glomerular filtration. Filtrate from Bowman capsule passes through the tubular portion of the nephron. While passing through the tubule, the filtrate undergoes various changes both in quality and in quantity. Many wanted substances like glucose, amino acids, water and electrolytes are reabsorbed from the tubules. This process is called tubular reabsorption. And, some unwanted substances are secreted into the tubule from peritubular blood vessels. This process is called tubular secretion or excretion.

Urine formation includes three processes:

- A. Glomerular filtration
- B. Tubular reabsorption
- C. Tubular secretion.

GLOMERULAR FILTRATION

Glomerular filtration is the process by which the blood is filtered while passing through the glomerular capillaries by filtration membrane. It is the first process of urine formation. The structure of filtration membrane is well suited for filtration.

Filtration Membrane

Filtration membrane is formed by three layers: 1. Glomerular capillary membrane 2. Basement membrane 3. Visceral layer of Bowman capsule.

Glomerular capillary membrane is formed by single layer of endothelial cells, which are attached to the basement membrane. The capillary membrane has many pores called fenestrae or filtration pores with a diameter of 0.1 μ .

1. Basement membrane of glomerular capillaries and the basement membrane of visceral

layer of Bowman capsule fuse together. The fused basement membrane separates the endothelium of glomerular capillary and the epithelium of visceral layer of Bowman capsule.

Visceral layer of Bowman capsule: This layer is formed by a single layer of flattened epithelial cells resting on a basement membrane. Each cell is connected with the basement membrane by cytoplasmic extensions called pedicles or feet. Epithelial cells with pedicles are called podocytes. Pedicles interdigitate leaving small cleft like spaces in between. The cleft like space is called slit pore or filtration slit. Filtration takes place through these slit pores.

When blood passes through glomerular capillaries, the plasma is filtered into the Bowman capsule. All the substances of plasma are filtered except the plasma proteins. The filtered fluid is called glomerular filtrate. Glomerular filtration is called ultrafiltration because even the minute particles are filtered. But, the plasma proteins are not filtered due to their large molecular size. The protein molecules are larger than the slit pores present in the endothelium of capillaries. Thus, the glomerular filtrate contains all the substances present in plasma except the plasma proteins.

Glomerular filtration rate (GFR) is defined as the total quantity of filtrate formed in all the nephrons of both the kidneys in the given unit of time. Normal GFR is 125 mL/minute or about 180 L/day.

Filtration fraction is the fraction (portion) of the renal plasma, which becomes the filtrate. It is the ratio between renal plasma flow and glomerular filtration rate. It is expressed in percentage.

Filtration fraction = $(\text{GFR} / \text{Renal plasma flow}) \times 100$

Normal filtration fraction varies from 15% to 20%.

TUBULAR REABSORPTION

Tubular reabsorption is the process by which water and other substances are transported from renal tubules back to the blood. When the glomerular filtrate flows through the tubular portion of nephron, both quantitative and qualitative changes occur. Large quantity of water (more than 99%), electrolytes and other substances are reabsorbed by the tubular epithelial cells. The reabsorbed substances move into the interstitial fluid of renal medulla. And, from here, the substances move into the blood in peritubular capillaries. Since the substances are

taken back into the blood from the glomerular filtrate, the entire process is called tubular reabsorption.

Tubular reabsorption is known as selective reabsorption because the tubular cells reabsorb only the substances necessary for the body. Essential substances such as glucose, amino acids and vitamins are completely reabsorbed from renal tubule. Whereas the unwanted substances like metabolic waste products are not reabsorbed and excreted through urine.

Basic transport mechanisms involved in tubular reabsorption are of two types:

1. Active reabsorption

2. Passive reabsorption.

1. Active Reabsorption Active reabsorption is the movement of molecules against the electrochemical (uphill) gradient. It needs liberation of energy, which is derived from ATP. Substances reabsorbed actively from the renal tubule are sodium, calcium, potassium, phosphates, sulfates, bicarbonates, glucose, amino acids, ascorbic acid, uric acid and ketone bodies.

2. Passive Reabsorption Passive reabsorption is the movement of molecules along the electrochemical (downhill) gradient. This process does not need energy. Substances reabsorbed passively are chloride, urea and water.

TUBULAR SECRETION

Tubular secretion is the process by which the substances are transported from blood into renal tubules. It is also called tubular excretion. In addition to reabsorption from renal tubules, some substances are also secreted into the lumen from the peritubular capillaries through the tubular epithelial cells. Dye phenol red was the first substance found to be secreted in renal tubules in experimental conditions. Later many other substances were found to be secreted.

