Objectives
To describe the function of the nephron in detail.
To identify the steps of urine formation.
To examine the movements of substances per their respective locations in the nephron—focusing on the glomerulus.
To understand the forces responsible for the initial formation of filtrate.

Steps of Urine Formation
I. Glomerular filtration – Renal corpuscle (Glomerulus + Capsule)
II. Tubular reabsorption – PCT*
   *Functions in both reabsorption and secretion
III. Tubular secretion – DCT (mostly)

Step 1: Filtration
Glomerulus: Capillary network located within the Bowman’s Glomerular Capsule.
Role is filtration of blood producing: Filtrate = Blood minus cells and excluding large proteins. Similar to plasma.
Operates on hydrostatic pressure.

Nephron Capillary Beds
Step 1: Glomerulus
- Specialized for filtration: Via fenestrated glomerular endothelium (capillaries)
- Blood Flow
  - Afferent arteriole > glomerulus > efferent art.
  - Blood pressure is high because afferent art. are smaller in diameter than efferent art. (causes inc in B.P.)
  - Arterioles are high-resistance vessels.
Nephron Capillary Beds

2. Peritubular capillaries
   - Low-pressure, porous capillaries adapted for absorption
   - Arise from efferent arterioles
   - Cling to adjacent renal tubules in cortex
   - Empty into venules.

Nephron Capillary Beds

3. Vasa recta
   - Long vessels parallel to long loops of Henle
   - Arise from efferent arterioles of juxtamedullary nephrons
   - Function information of concentrated urine

Filtration Pressure

**Glomerular blood pressure** (HPg) – *main force*
   - Pushing water and solutes out of the blood.
   - (GBHP)

Opposing forces:
- **Capsular Hydrostatic Pressure** (CHP) – Pressure exerted by fluids in the glomerular/renal capsule.
- **Colloid Osmotic Pressure of Glomerular blood** (OPg) – Osmotic pressure in the fluid/blood of the glomerular capsule due to dissolved substances in blood. (BOP)

Net Filtration Pressure

The pressure responsible for filtrate formation

\[
NFP = GBHP - (CHP + BOP)
\]

NFP = 10 mm Hg

**Glomerular Filtration Rate** (GFR) – Volume of filtrate formed each minute by the combined activity of all 2 million glomeruli in the kidneys.

GFR = 125 ml/min

Filtrate

Contains:
- Water
- Urea
- Glucose
- Amino acids
- Ions:
  - Na+, K+, Mg++, Ca++, Cl-, SO4-, PO4-

Step 2: Tubular Reabsorption

Occurs throughout the nephron after the renal corpuscle, but most significant in the **Proximal Convoluted Tubule**.

Reclamation Process
Materials Reabsorbed

Include:

I. Ions:
- Calcium, Magnesium, Potassium, Chloride, Some Na+ (most abundant cation), & HCO3-

II. Large Molecules/Metabolites:
- Amino acids, Glucose, Urea

III. Water

Process of Reabsorption

Fluid is moved from the filtrate in the tubule to the peritubular capillaries.

Movement of materials is AGAINST their concentration gradient.

Reabsorption involves active transport – therefore ENERGY is required.

Reabsorption

Reabsorption of solutes back into the peritubular capillaries makes the blood hypertonic > attracts water via osmosis.

Tubular maximum – max amt of a substance that can be reabsorbed.

Step 3: Tubular Secretion

Reverse of reabsorption: selective addition to urine.

Movement of substances from blood directly into the filtrate via active transport.

Substances Secreted: Drugs, K+, H+, NH4+

Secretion very important in acid/base homeostasis.
Urine Composition

- <1% of total filtrate
- Mostly water
- Contains metabolic wastes and unneeded substances e.g. excess ions.
- Certain disease conditions may reveal solutes that should not be there e.g. proteins

Role of Kidney in Acid/Base Regulation

During Respiratory Acidosis (CO2 high)
Kidneys reabsorb bicarbonate and secrete H+ (and NH4+ ions).

During Respiratory Alkalosis (CO2 low)
Kidneys secrete bicarbonate and retain H+ and NH4+.