# (Lecture 1) Renal Disease 1

## Overview

- Kidney anatomy and physiology
    - Functions of the kidney
    - Renal anatomy
    - Renal physiology
- Assessment of kidney function
    - Assessment of renal function
    - Endogenous markers
    - Case examples
    - How to assess renal function
    - Stages of CKD
    - Alternative assessment of renal function

## Learning Objectives

*Learning Objectives Renal Disease 1*

- List the main functions of the kidney
- Describe and interpret the tests used to investigate renal function
- Calculate creatinine clearance CrCL) using the Cockcroft-Gault equation

## Urinary System

- People usually have 2 kidneys
    - Okay to have one kidney as long as it is functioning properly
- Kidney's form urine
- Ureter connected kidney and urinary bladder
- Urinary bladder stores urine
- Urethra excretes urine

## Kidney Anatomy and Physiology

### Functions of the Kidney

- Excretory
    - Metabolic wastes e.g. urea, creatinine
    - Toxins
- Endocrine
    - Erythropoietin production
    - Renin (responsible for BP)
    - Prostaglandins
- Regulatory
    - Water balance
    - Electrolyte balance and acid-base balance
        - Sodium
        - Potassium
        - Chloride
        - Bicarbonate
        - Calcium
        - Magnesium

- Metabolic
    - Vitamin D
        - Produced in skin which is inactive, but the kidney activates it for it to be used

## Renal Anatomy //

Kidney has two sections

- Outer cortex
- Inner medulla

## Nephron //

- All functions in the kidney are performed by the Nephron which has two major components
    - Glomerulus
    - Tubular System
        - Proximal tubule
        - Diluting segment
        - Distal tubule
        - Collecting duct
- Approximately one million in each kidney capable of forming urine

## Renal blood supply

- Receives 20% of cardiac output -
    - 20% of the blood from the heart comes to the kidney
- Blood flow to the medullary region is poor at the best of time, risk of hypoxia is significant
- Blood at the glomerulus
    - Afferent arterioles - glomerular capillaries - efferent arterioles - peritubular capillaries
        - Most medications can cause kidney toxicity through affecting these arterioles

## Renal Physiology

## Steps in urine formation

- Filtration
    - Occurs at the glomerulus
    - All substances freely filtered
    - 180 litres of fluid is filtered by the nephrons in one day
        - 1% goes out as urine
        - The rest is reabsorbed
- Reabsorption
    - Occurs at tubules
    - Occurs when filtered material is moved back into the blood
- Secretion
    - Occurs at tubules
    - Removes selected material from the blood and places it in the filtrate

## Filtration (glomerular function)

- Glomerulus is a high pressure filtration system composed of a specialised capillary network
    - Blood is supplied to the glomerulus through the Afferent Arterioles (AA) and removed by the Efferent Arterioles (EA)
    - Large molecules generally unable to pass through glomerular membranes
    - Generates ultrafiltrate which

        - Contains water, glucose, sodium chloride and urea
        - Is free of blood, proteins and other large molecules
    - Reabsorption and secretion transform it into urine
- Glomerular filtration rate (GFR) helps determine how much damage has been done to kidneys and determine stage of kidney disease

## Physiology of the renal blood flow //

- Arteriole on both side of the glomerulus
- GFR is usually maintained by factors such as cardiac output, SNS tone, blood pressure, vascular volume
    - Reduction of any of these drivers will lead to reduced GFR and hence reduced urine production
    - Lower the GFR, the more damaged the kidney is
- Kidneys have inbuilt physiological defense measures to counteract reduced inflow using Prostaglandins and Angiotensin II
    - See autoregulation of GFR
    - Triple Whammy (tute)
        - ACE-Is and ARBs are first line therapy for hypertension because they are excellent in reducing proteinuria as well as high BP

## Tubular Function //

- Proximal tubule (PCT)
    - 70% of NA is reabsorbed in the PCT
- Loop of Henle (LOH)
    - 20% f NA, Cl and K is reabsorbed here
    - Urine concentration and dilution occurs in the LOF through an osmotic gradient provided by the countercurrent mechanism
    - Urine flow rate is regulated by NaCl, prostaglandins, adenosine and urine volume presented to the macula densa
- Distal tubule
    - Distal segment secrete k and bicarbonate
    - Proximal segment is impermeable to water
- Collecting Duct
    - Regulated urine concentration
    - Aldosterone receptors regulate NA uptake and K excretion
    - ADH increases water reabsorption
        - Absent of ADH causes collecting duct to be impermeable to water