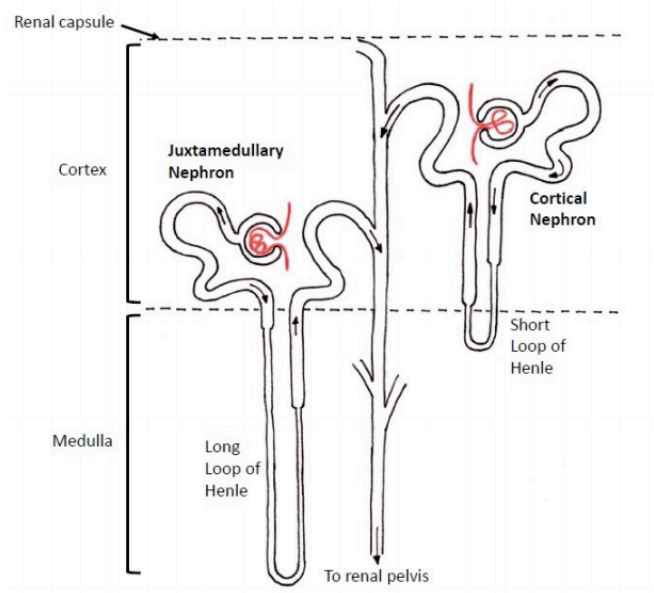
Physiol-11A11 Describe the functions of the loop of Henle, including the physiological mechanisms involved.

Background

Loop of Henle (LoH) is the portion of nephron between PCT and DCT
Comprised of thin descending limb, U-turn, thin + thick ascending limb

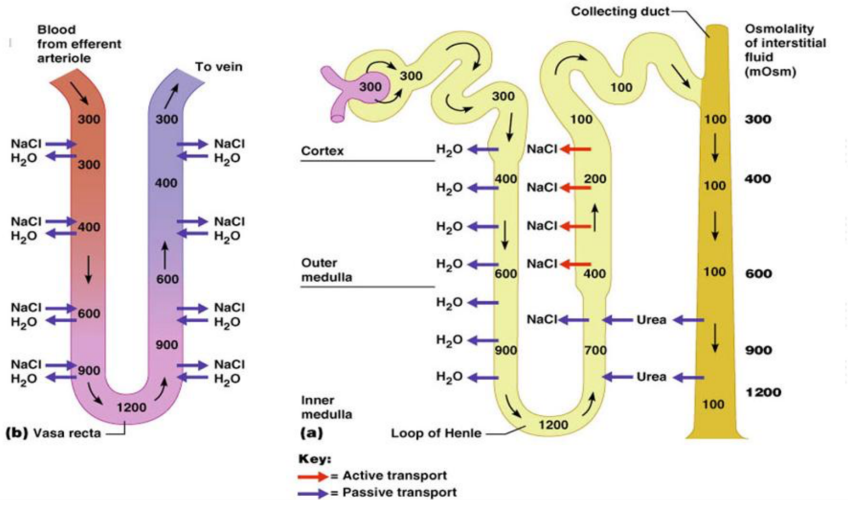


85% cortical nephrons – short LoH, thick ascending limb passive Na^+ reabsorption
15% juxtamedullary nephrons – long LoH, thick ascending limb active Na^+ reabsorption mainly via Na-K-2Cl co-transporter

Functions

1. generate high medullary osmotic gradient → used by medullary collecting duct to form concentrated urine
2. reabsorb water (~ 30% filtered in descending)
3. reabsorb electrolytes (Na^+, K^+, Cl^-, in ascending)
4. secrete urea (in thin ascending)

Mechanism



Counter current mechanism → creates concentrated medullary interstitium
Thin descending limb permeable to water, moderately permeable to solute
Thick ascending limb permeable to solute, impermeable to water

Thick ascending limb actively pumps NaCl into medullary interstitium → ↑ interstitial osmolality → water absorbed from descending limb → concentrates tubular fluid in descending limb → concentrated tubular fluid goes to ascending limb → repeat

This process progressively ***amplifies concentration gradient of medullary interstitium*** (300 → 1200 mOsm/kg), creating dilute tubular fluid exiting from thick ascending limb (100 mOsm/kg, as shown in above diagram)

Concentration of urine occurs in medullary collecting duct
In absence of ADH → MCD relatively impermeable to water → dilute urine formed
In presence of ADH → aquaporin insertion into luminal surface of MCD → water reabsorbed into medullary interstitium → concentrated urine

Vasa recta maintains hyperosmolar medullary interstitial
Vasa recta in close association with loop of Henle but direction of blood flow is **opposite** the direction of tubular flow

As vasa recta descends into medulla → water lost, solute gained
As vasa recta ascends from medulla → water gain, solute lost
Blood flow in vasa recta is very slow

Overall effect = solutes mostly kept within medullary interstitium; excess water is removed

Examiner's comments – This question was passed by 37% of candidates.

The question asked for both the **functions of the loop of Henle**, and **physiological mechanisms involved**. Both these points needed to be addressed to pass this question. Well structured answers included a brief relevant **anatomical description** of the loop of Henle, and a **description of the functions** which included the physiological mechanisms.

Very few candidates mentioned functions apart from the development of a concentration gradient, and many candidates were unable to describe the physiological process whereby that gradient is developed.

There was often confusion regarding the osmolality at various anatomical locations within the loop. Many candidates did not mention or were unable to explain the role of the vasa recta in the physiological mechanisms of concentration. Many answers were focussed on the collecting duct rather than on the loop of Henle, and several answers listed general functions of the kidney rather than those of the loop of Henle.

The examiner was aware of controversy relating to tubuloglomerular feedback in different textbooks, and marks were awarded accordingly. Many candidates obtained

near-maximal marks for an accurate and well-labelled diagram explaining the physiological mechanisms.