

Renal Physiology

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Since the kidney consists of numerous structural units named nephrons, renal physiology can be summarized like individual nephron (internephron) heterogeneity, axial (intranephron) heterogeneity of a single nephron, cellular (segmental) heterogeneity within each segment, and intracellular heterogeneity.

Recent identification of human genome makes it possible to understand classical renal physiology at molecular levels. Thus, in this lecture, molecular mechanisms regulating solutes handling within the kidney will be presented.

Renal NaCl reabsorption: Over 99% of filtered NaCl is reabsorbed within the nephron, in which 60% is from the proximal tubule (PT) through SGLTs, NPT2 and NHE3 in the apical membrane (AP), and NBC1 in the basolateral membrane (BL). Thirty % is absorbed in the thick ascending limb (TAL) through NKCC2 and NHE3 in AP. Seven % is absorbed in the distal tubule (DT) through NCC in AP. Two to 3% is taken up through ENaC in AP of the collecting duct (CD). On the other hand, Cl ions are absorbed mainly paralleled with Na ions except CFEX in AP and AE1 in BL of PT. In TAL, Cl ions are absorbed through NKCC2 in AP and ClC-Kb/barttin in BL whereas in DT, NCC in AP and ClC-Kb/barthrin in BL.

Renal potassium transport: Potassium is absorbed through Kir7.1 in AP of PT. In TAL exist NKCC2 and Kir1.1 at AP and Kir7.1 in BL. In the intercalated cell of CD (CCD), H-K ATPase and Kir1.1 absorbs and secretes K ions, respectively.

Renal acid-base handling: The following transporters participate proton and bicarbonate handling: H-ATPase, NHE3 and CFEX in AP, and NBC1 and AE1 in BL of PT; NHE3 in AP of TAL; H-K-ATPase and H-ATPase in AP, and AE1 in BL of type A intercalated cell of CCD; AE4 in AP, and H-K-ATPase and H-ATPase in BL of type B intercalated cell of CCD.

Renal handling of organic solutes: Glucose is absorbed in a low affinity fashion through SGLT2 in AP, and GLUT2 in BL of early PT (PCT). In late PT (PST), SGLT1 in AP and GLUT1 in BL absorb glucose in a high affinity fashion. Amino acids (AA) are absorbed only in PT.

Neutral AA through B0AT1 in AP, and LAT2/4F2hc and TAT1 in BL. Basic AA are through BAT1/rBAT in AP, and y+LAT1/4F2hc in BT. Acidic AA are through EAAC1 in PT and AGT1 in BL. Albumin is endocytosed in PT through megalin-cubilin complex.