CHAPTER 3
Renal Energy Metabolism

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A. Introduction
The kidney uses 20% of whole body oxygen, which is comparable to the figure for the heart muscle (Cohen and Barac-Nieto 1973), indicating that this organ has a high rate of oxidative metabolism. Since the early discovery that oxygen uptake paralleled glomerular filtration (Kramer and Deetjen 1960) and sodium reabsorption (Kiih et al. 1961) under experimental conditions, renal oxygen uptake has been seen as a measure of renal energy turnover. Only 20% of renal oxygen uptake has been calculated to be used for the basal requirements of the kidney. These calculations were based on the assumption that sodium reabsorption was the main energy-requiring function of the kidney and that oxygen was used exclusively for mitochondrial oxidative phosphorylation to provide ATP for transport ATPases. A quantity of 28–30 mol sodium was calculated to be transported per mol O\(_2\) consumed (Deetjen and Kramer 1961). Since then this basic relationship has been confirmed in studies with isolated perfused kidney (Silva et al. 1980), tubule suspensions (Gstraunthaler et al. 1985; Balaban et al. 1980) and microdissected tubule segments (Jung and Endou 1991). On the other hand, many more energy-consuming transport ATPases and metabolic functions have been attributed to defined segments of the nephron. Therefore any calculation on energy metabolism may be performed at the defined nephron level. This also holds for the sites of renal substrate turnover, which were originally thought to serve exclusively to cover renal energy demands (Pitts 1976; Cohen 1986). In the present review we seek to provide some basic information about the mechanisms of renal energy metabolism and summarize recent literature on segment-specific metabolic pathways in relation to transport function. Possible interference with the action of diuretics will also be considered.

B. Mechanisms of Renal ATP Formation
The \(\gamma\)-phosphate bond of adenosine triphosphate (ATP) is the main source of chemical energy used for renal transport processes. Active transport systems using this kind of energy are called ATPases. Under standard conditions the cleavage of this bond is equivalent to 7.3 kcal (30.6 kJ)/mol
Fig. 1. Pathway of ATP and GTP synthesis from their precursors with respect to the consumption of energy-rich P-bonds and their corresponding nucleotides. Numbers in parentheses are the required ATP and energy-rich phosphate bonds, respectively, assuming oxidation of NADH during xanthosine-5'-monophosphate synthesis.