CHAPTER 12. STRUCTURE AND FUNCTIONS OF TRANSPORTERS-II

Active Transport Results in Solute Movement against a Concentration or Electrochemical Gradient

In primary active transport, solute accumulation is coupled directly to an exergonic chemical reaction, such as conversion of ATP to ADP+ Pi. Secondary active transport occurs when endergonic (uphill) transport of one solute is coupled to the exergonic (downhill) flow of a different solute that was originally pumped uphill by primary active transport.

Primary Active Transport

Na-K ATPase.

In animal cells, this active transport system is primarily responsible for setting and maintaining the intracellular concentrations of Na+ and K+ and for generating the transmembrane electrical potential. It does this by moving three Na+ out of the cell for every two K+ it moves in. The result is a transmembrane potential of 50 to 70 mV (inside negative relative to outside), which is characteristic of most animal cells and essential to the conduction of action potentials in neurons. The central role of the Na+K+ ATPase is reflected in the energy invested in this single reaction: about 25% of the total energy consumption of a human at rest!

Ion Gradients Provide the Energy for Secondary Active Transport

Na+-glucose symporters

In intestinal epithelial cells, glucose and certain amino acids are accumulated by symport with Na+, down the Na+ gradient established by the Na+ K+ ATPase of the plasma membrane. The apical surface of the intestinal epithelial cell is covered with microvilli, long thin projections of the plasma membrane that greatly increase the surface area exposed to the intestinal contents. Na+-glucose symporters in the apical plasma membrane take up glucose from the intestine in a process driven by the downhill flow of Na+:

$2Na^+_{out} + glucose_{out} \rightarrow 2Na^+_{in} + glucose_{in}$

The energy required for this process comes from two sources: the greater concentration of Na+ outside than inside (the chemical potential) and the transmembrane potential (the electrical potential), which is inside negative and therefore draws Na+ inward.