Kermack-McKendrick model and its version with vaccination are presented. First, we introduce a model with vaccination and then a numerical study that includes comparison of di erent vaccination strategies and searching for optimal vaccination strategy is presented. We proceed to introduce a stochastic model with migration and consequently we suggest its generalization and prove the existence and uniqueness of a solution to the stochastic di erential equation (henceforth SDE) describing this model. Three stochastic versions of Kermack-McKendrick model with vaccination are suggested and compared. A procedure of nding the optimal vaccination strategy is presented. We also prove the theorem on the existence and uniqueness of a solution to the SDE that drives a model with multiple pathogens. Finally, the stochastic di erential equation describing the general model is presented. We study properties of a solution to this SDE and present sufficient conditions for the existence of a solution that is absorbed by the natural barrier of the model.