

4.5 Respiratory Control Models Models of respiratory control are abundant. 4.5.1 System Models There are several models that encompass the entire respiratory system, including the controlled system and respiratory controller. Contrarily, there is a large set of models that began with a ventilation requirement and concerned with the prediction of such variables as respiration rate, ratio of inhalation time to exhalation time, and breathing waveshape. For the most part, respiratory mechanical properties are included in a very rudimentary fashion, usually including constant resistances and compliances and one lung compartment. Grodins (1981) indicated that whereas some modern models satisfactorily reproduced respiration and gas inhalation at rest, no model had yet satisfactorily reproduced exercise effects. They might have involved removal of excess CO₂, return of blood acidity to normal levels, or resupply of hemoglobin oxygen saturation. These models sought to define respiratory control in terms of the maintenance of blood property homeostasis. In both control model types, there were strong appearances of elements of the respiratory mechanical models reviewed earlier (Section 4.4). Yet it is clear that many simplifications were included in the model, and correction of these is the aim of later work (e.g., Saunders et al., 1980). This was necessary because most model mathematics became extremely complicated once more realistic mechanical properties were included. This version was still subject to variation when it was published, and its authors left no doubt that there were still significant imperfections in the model. The model of Grodins et al. (1967) was split into two components: (1) a controlled system, called the plant or process, and (2) a controller. In general, the output of these models was respiratory ventilation. This class of models proceeded along the line of parameter optimization. Basis for other models Grodins Model: Of the models included in this book, the Grodins model (Grodins et al., 1967) is probably the most complex. Many models have been proposed that proceed from a premise of material balances. They proposed mechanisms by which experimental results were recreated. They were seldom concerned with respiratory details more minute than ventilation. The two major models presented here have been used as the basis for further model refinements. The version reviewed here was published in 1967 and has been the object of much subsequent work. In this section, several of the more important models are reviewed. Degrees of similarity appear, but differences have been the cause for discussion in the field. The model has existed in several forms, each a variant or improvement of the earlier ones. Of the two, the controlled system was far more fully described.