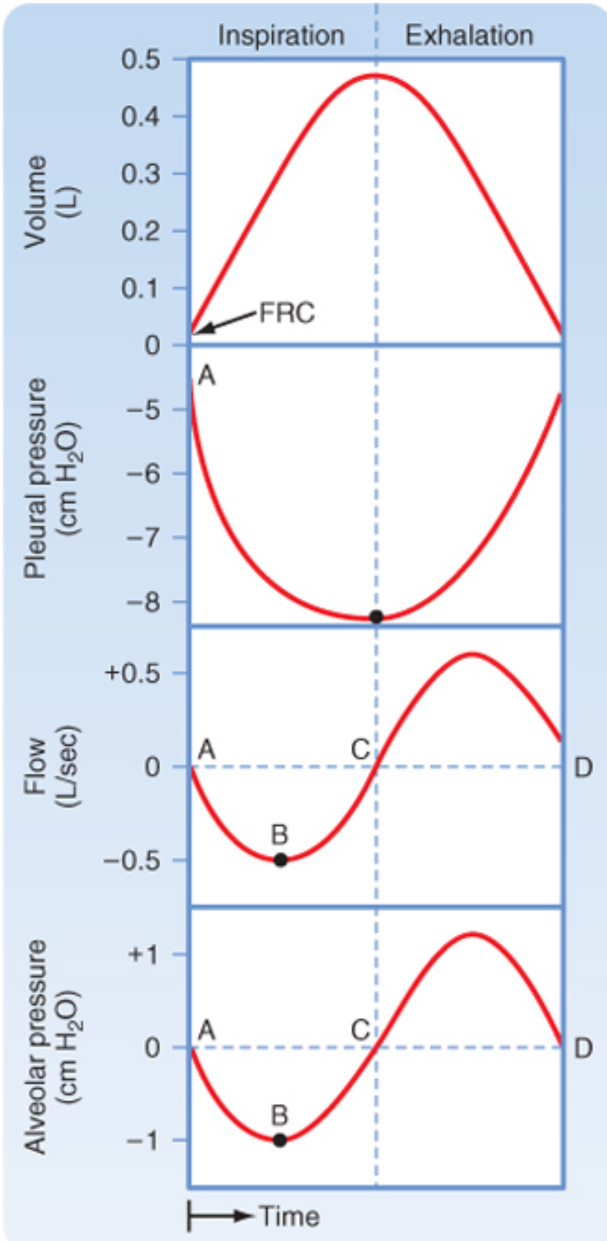
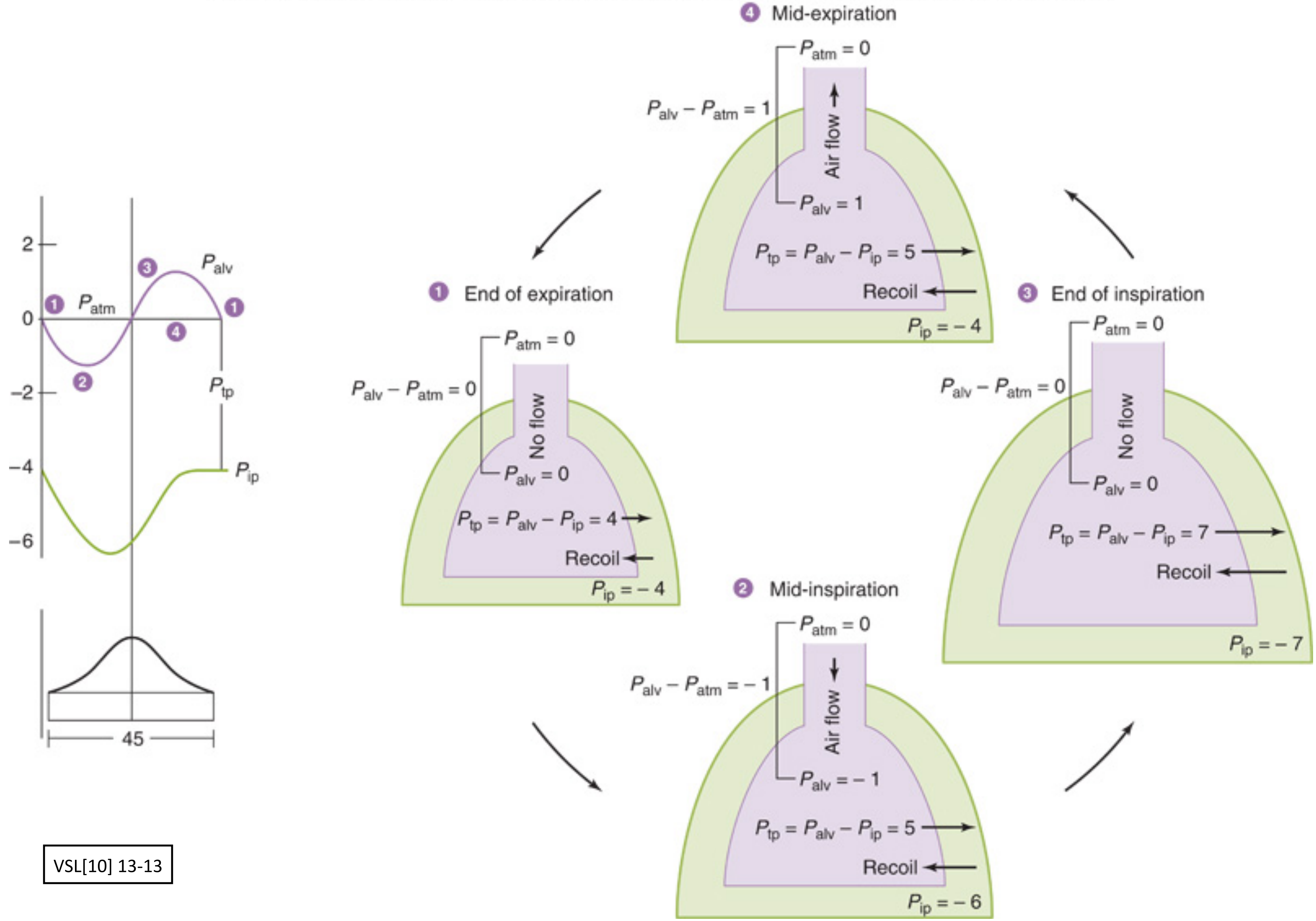


Figure 21-9 Changes in alveolar and pleural pressure during a tidal volume breath. Inspiration is to the left of the vertical dotted line and exhalation is to the right. Positive (relative to atmosphere) pressures are above the horizontal dotted line and negative pressures are below. See text for details. At points of no airflow, alveolar pressure is zero.



4 Mid-expiration
$P_{atm} = 0$
$P_{alv} - P_{atm} = 1$
Air flow
$P_{alv} = 1$
$P_{tp} = P_{alv} - P_{ip} = 5$
Recoil
$P_{ip} = -4$
1 End of expiration
$P_{atm} = 0$
$P_{alv} - P_{atm} = 0$
No flow
$P_{alv} = 0$
$P_{tp} = P_{alv} - P_{ip} = 4$
Recoil
$P_{ip} = -4$
3 End of inspiration
$P_{atm} = 0$
$P_{alv} - P_{atm} = 0$
No flow
$P_{alv} = 0$
$P_{tp} = P_{alv} - P_{ip} = 7$
Recoil
$P_{ip} = -7$
2 Mid-inspiration
$P_{atm} = 0$
$P_{alv} - P_{atm} = -1$
Air flow
$P_{alv} = -1$
$P_{tp} = P_{alv} - P_{ip} = 5$
Recoil
$P_{ip} = -6$
2
0
−2
−4
−6
P_{atm}
P_{alv}
P_{tp}
P_{ip}
45

VSL[10] 13-13

Airflow in Airways

- Two main factors determine flow (if $\Delta P = K$)
  - Pattern of airflow
    - Laminar
      - Small airways
    - Turbulent
      - Nose, mouth, trachea, bronchi, branch points
  - Airway resistance
    - Primarily in large bronchi
    - Minor in small airways
    - Modulated by lung volume and neurohumoral agents

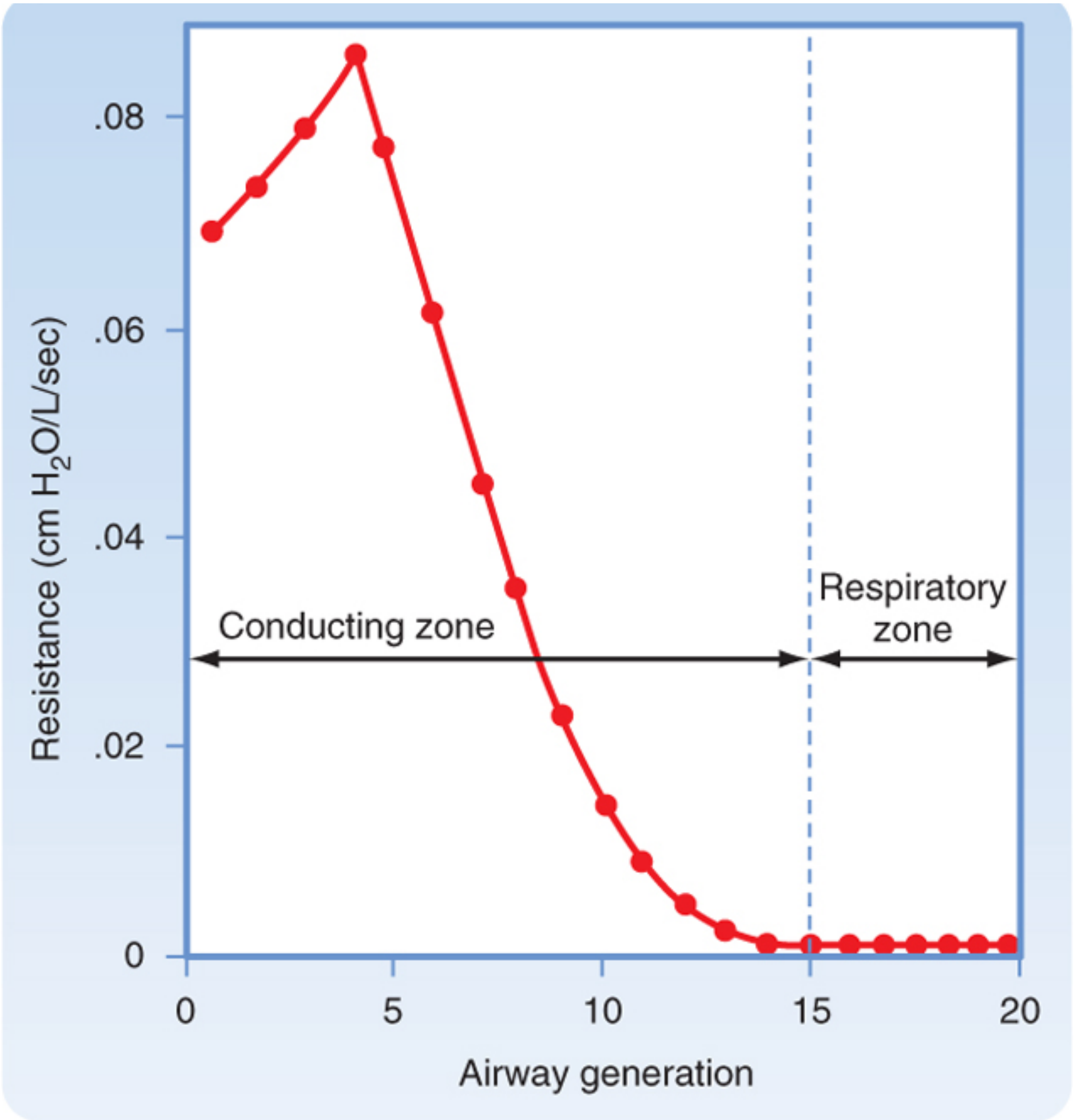


Figure 21-10 Airway resistance as a function of the airway generation. In a normal lung, most of the resistance to airflow occurs in the first eight airway generations.

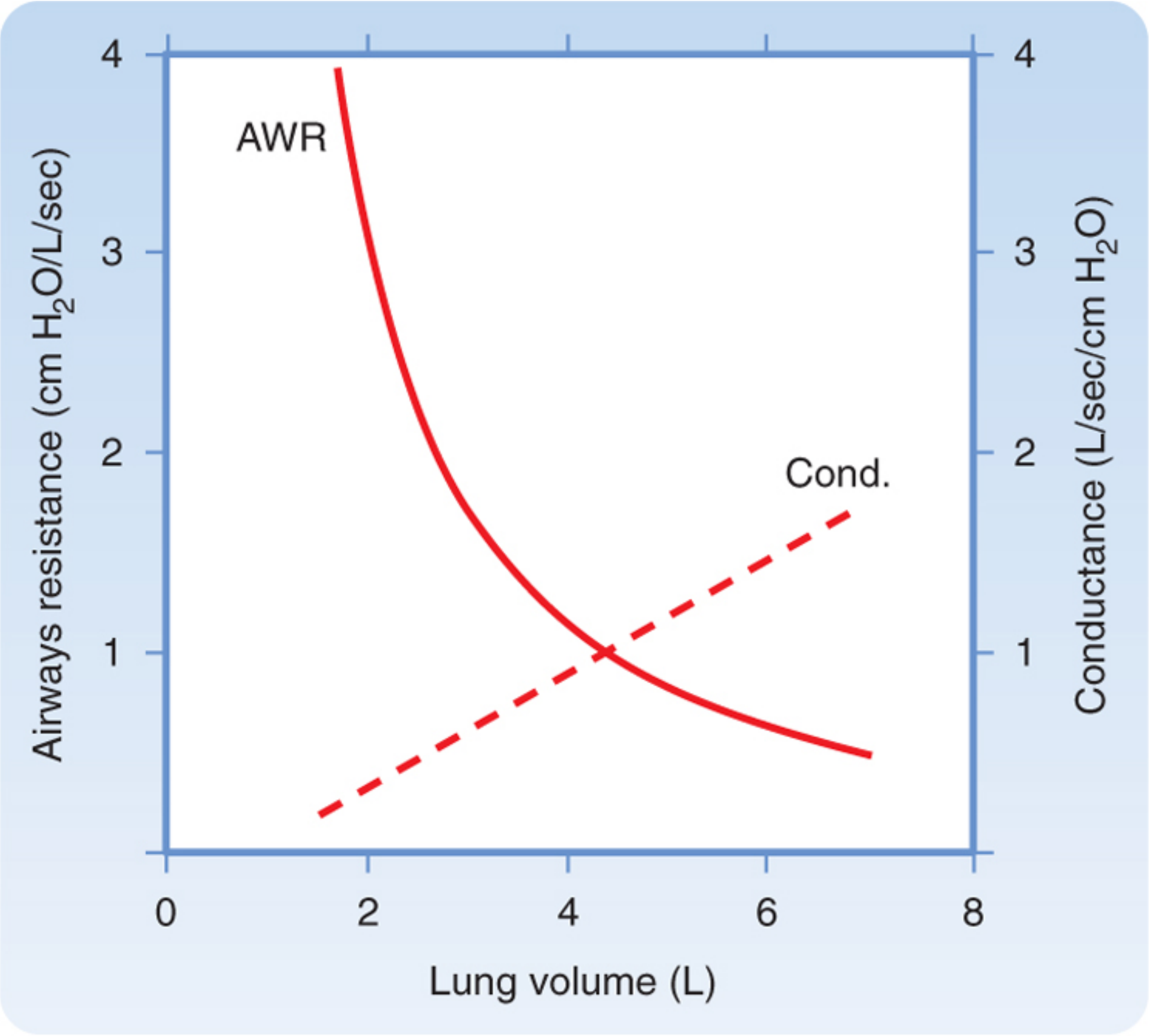


Figure 21-11 Airway resistance (AWR) and conductance (Cond.) as a function of lung volume.

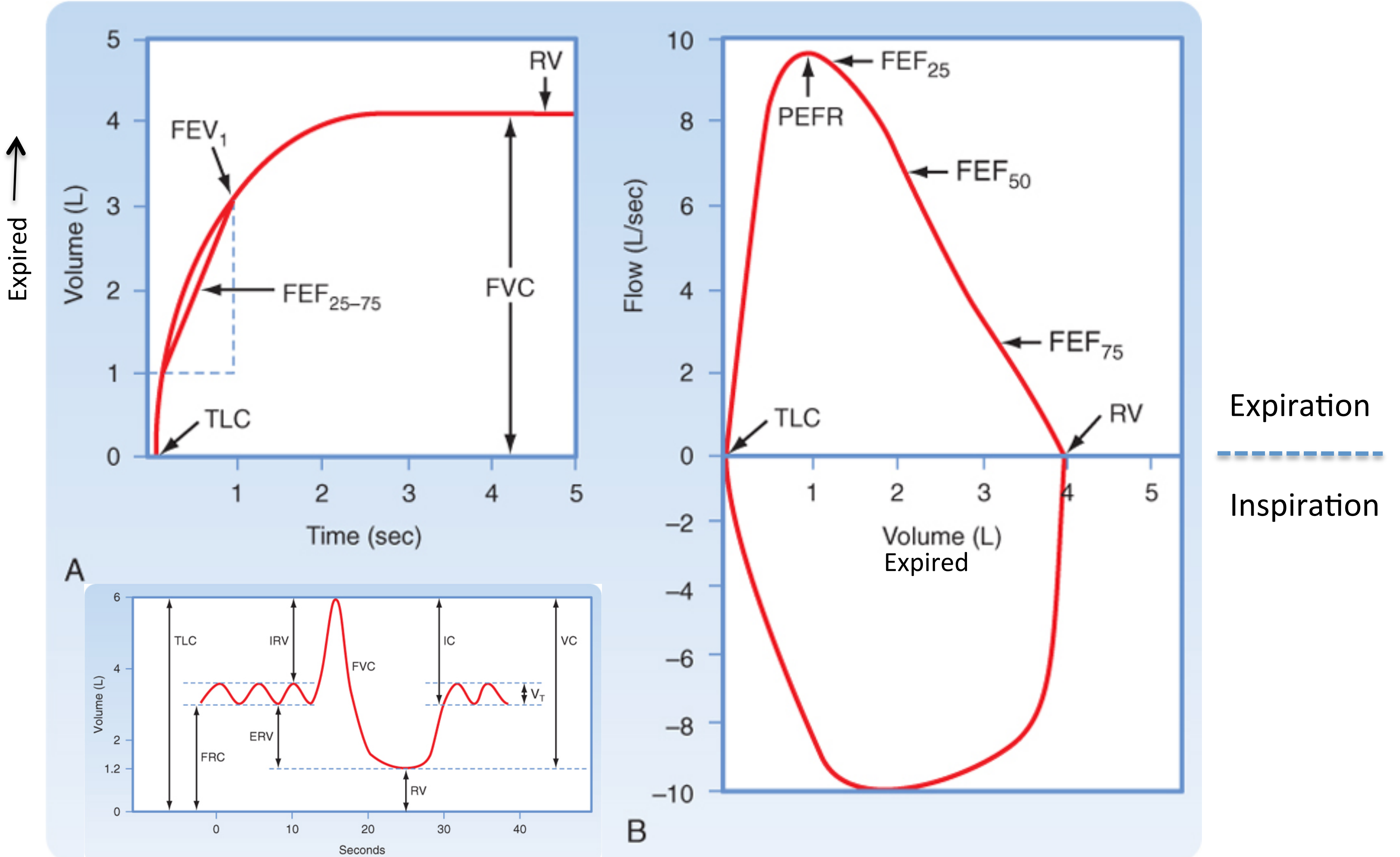


Figure 21-12 The clinical spirogram (A) and flow-volume loop (B). The subject takes a maximal inspiration and then exhales as rapidly, as forcibly, and as maximally as possible. The volume exhaled is plotted as a function of time. In the spirogram that is reported in clinical settings, exhaled volume increases from the bottom of the trace to the top (A). This is in contrast to the physiologist's view of the same maneuver (see Fig. 21-1), in which the exhaled volume increases from the top to the bottom of the trace. Note the locations of TLC and RV on both tracings.

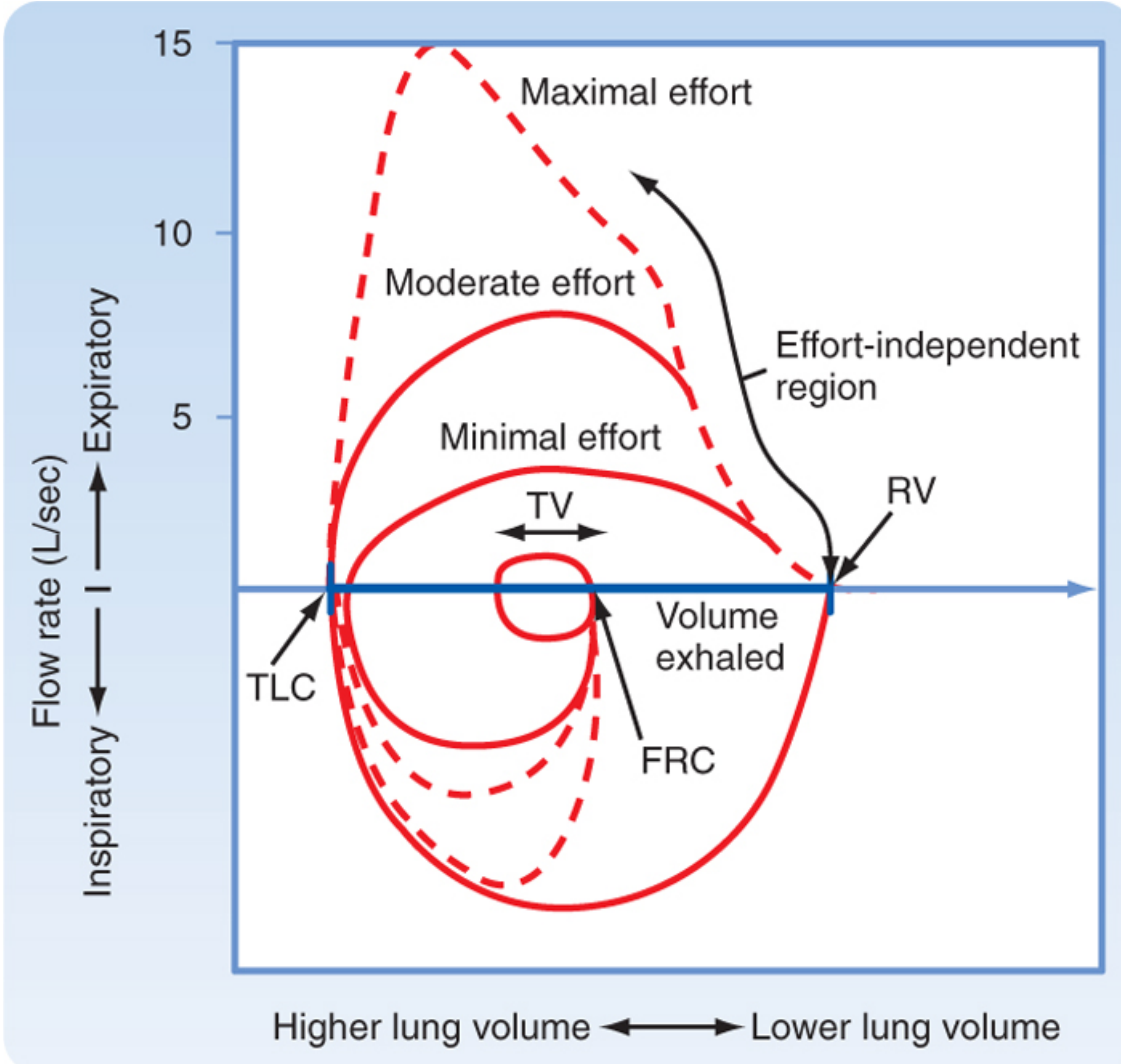


Figure 21-13 Isovolume curves. Three superimposed expiratory flow maneuvers are made with increasing effort. Note that peak inspiratory and expiratory flow rates are dependent on effort, whereas expiratory flow rates later in expiration are independent of effort.

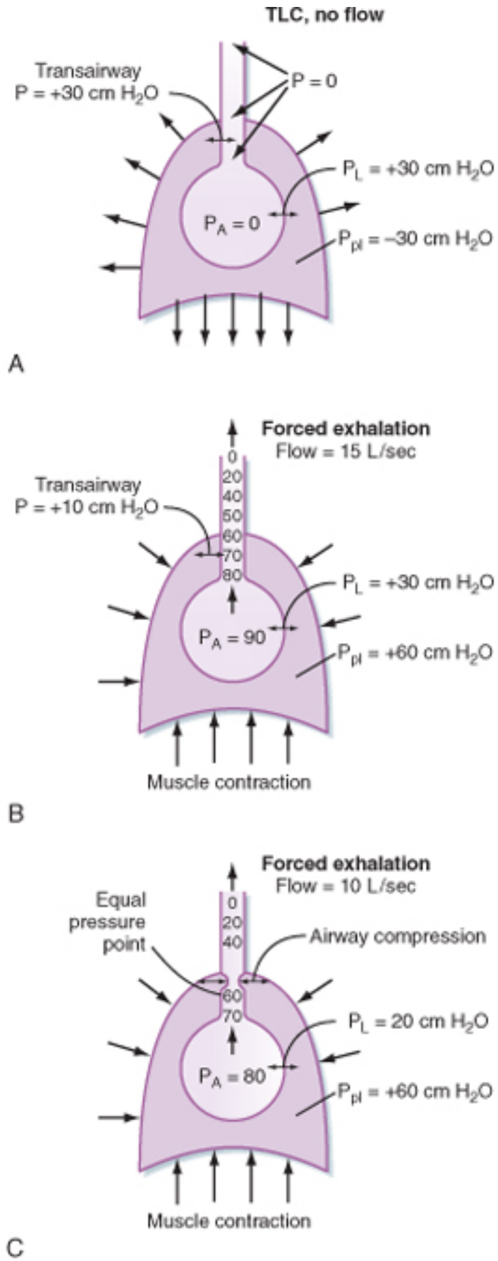


Figure 21-14 Flow limitation. A, End inspiration, before the start of exhalation. B, At the start of a forced exhalation. C, Expiratory flow limitation later in a forced exhalation. Expiratory flow limitation occurs at locations where airway diameter is narrowed as a result of negative transmural pressure. See text for further explanation.

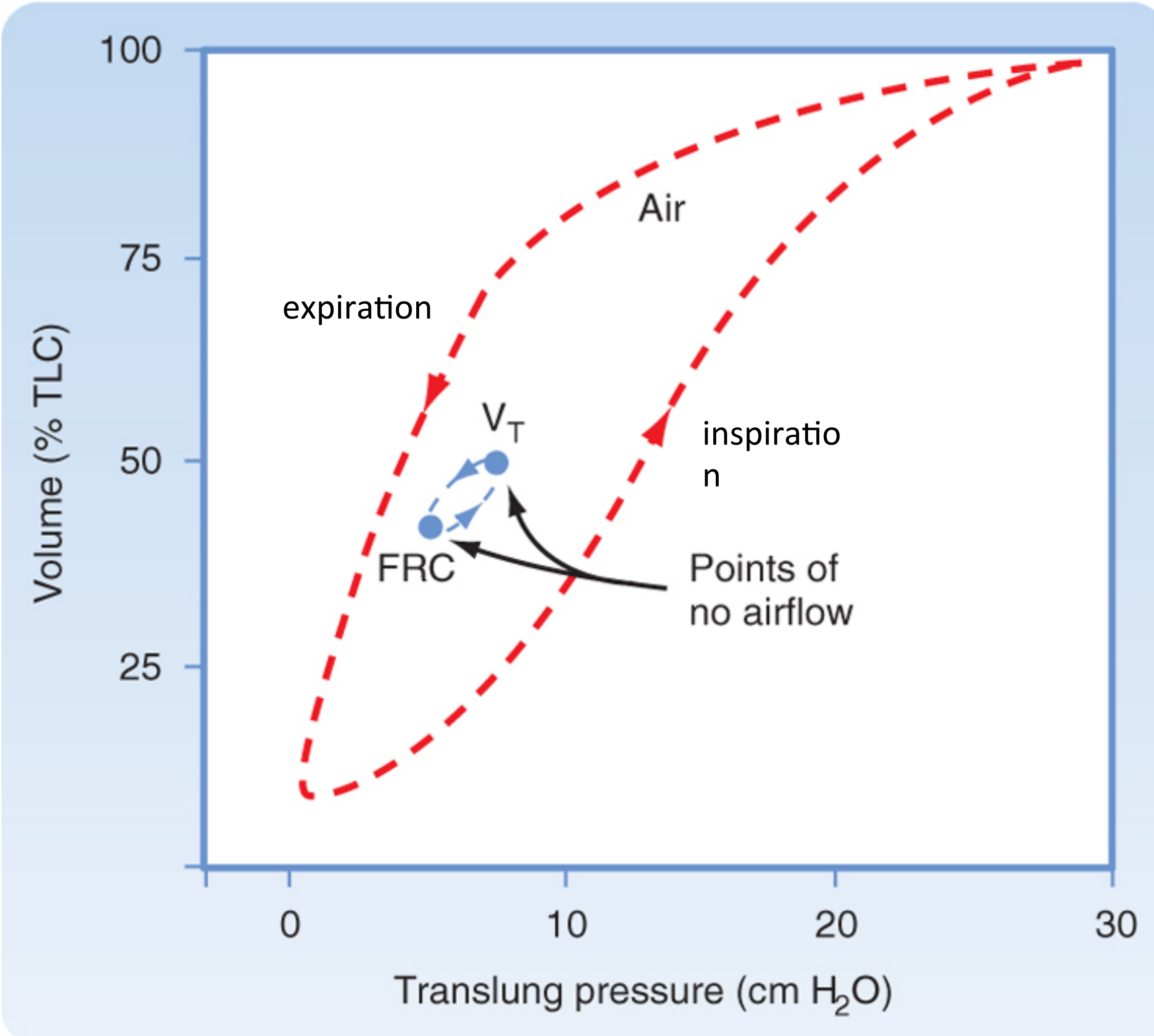
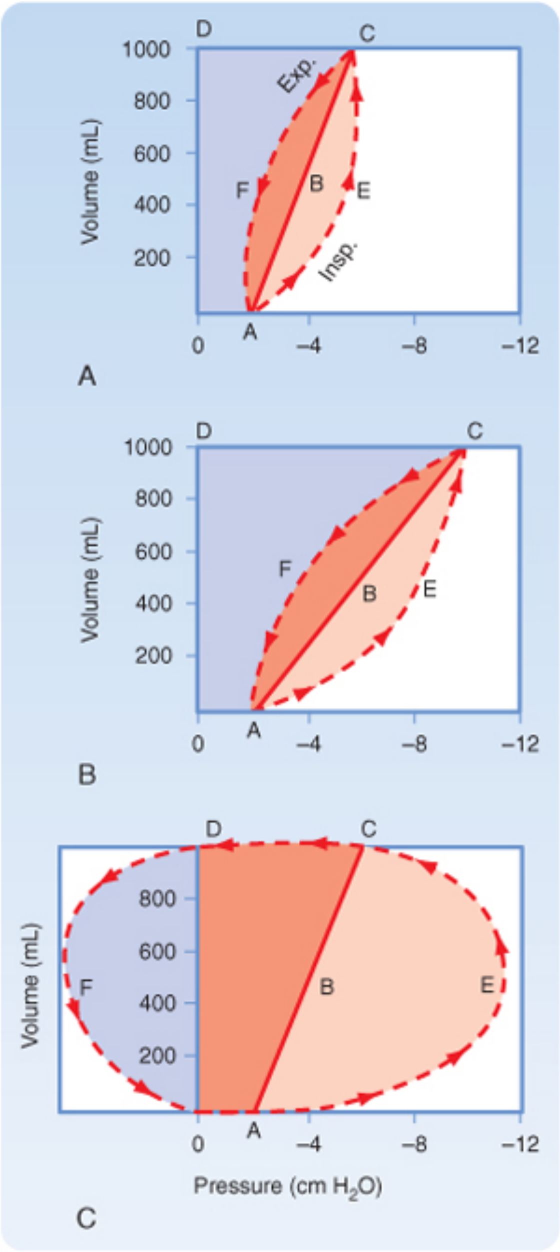


Figure 21-15 Inflation-deflation pressure-volume curve. The direction of inspiration and exhalation is shown by the arrows. The difference between the inflation and deflation pressure-volume curves is due to the variation in surface tension with changes in lung volume. Note the slope of the line joining points of no airflow. This slope is less steep than the slope from the deflation pressure-volume curve at the same lung volume.



Koeppen & Stanton: Berne and Levy Physiology, 6th Edition.

Figure 21-16 Mechanical work done during a respiratory cycle in a normal lung (A), a lung with reduced compliance (B), and a lung with increased airway resistance (C).

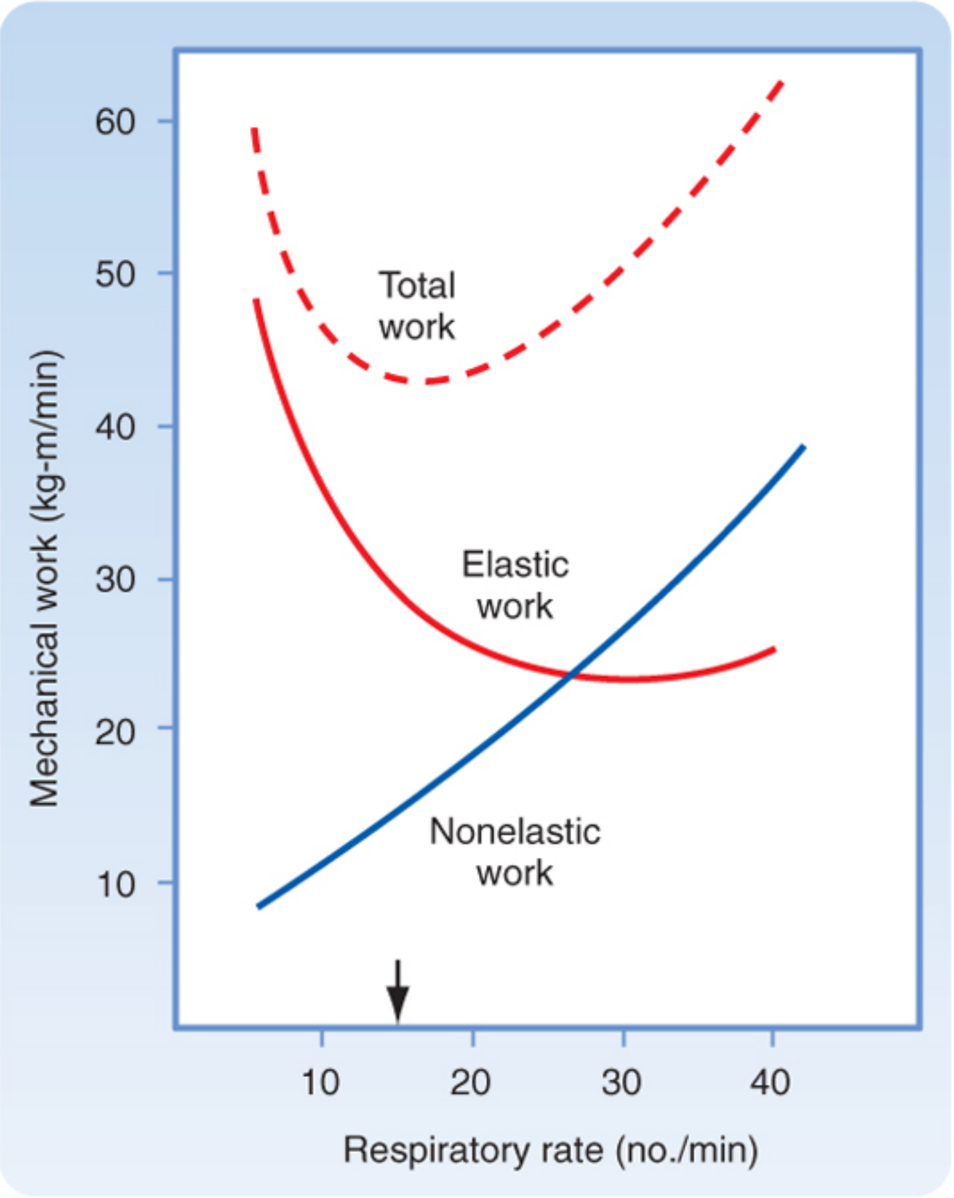


Figure 21-17 Effect of the respiratory rate on the elastic, nonelastic, and total mechanical work of breathing at a given level of alveolar ventilation. Subjects tend to adopt the respiratory rate at which the total work of breathing is minimal (arrow).

END

Video 5, Module 11