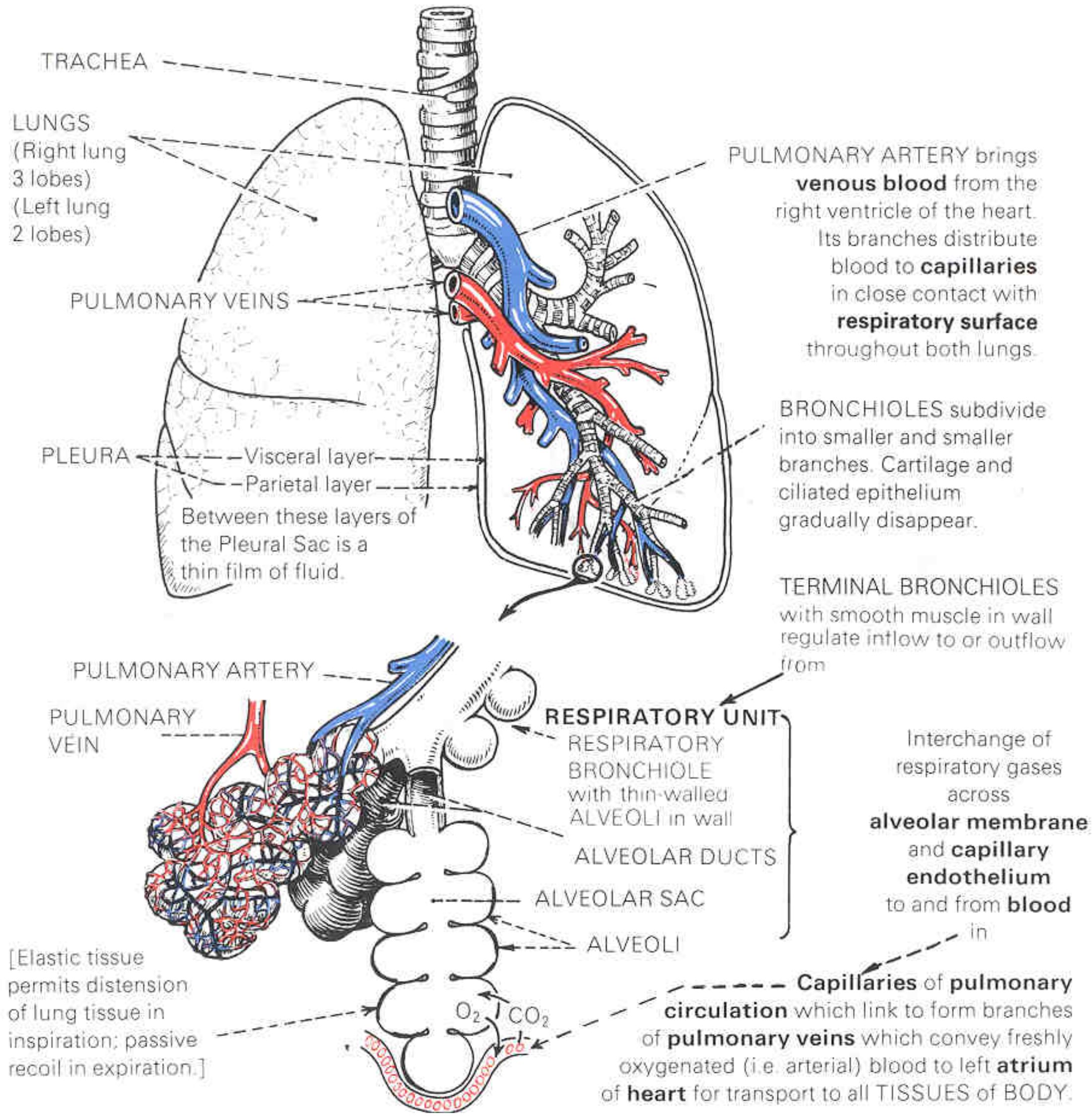
The trachea and the bronchial 'tree' conduct air down to the **respiratory surfaces**.

There is no exchange of gases in these tubes.

IP[5] p132



What is “Respiratory” Air?

See B&L[6+], pages 444-446

- Composition
  - ≈21% O_2
  - ≈79% N_2
  - trace amounts of other gases
- Partial pressure (of a gas in a mixture)
  - $P_X = \%X \times P_{baro}$
    - $P_{oxygen} = 0.21 \times 760$ mmHg = 160 mmHg
- Humidification
  - Inhaled air is humidified; saturated with water vapor
    - $P_{water\ vapor}$ = 47 mmHg (@ body temperature)
    - $P_{oxygen,\ saturated} = 0.21 \times (760 - 47)$ mmHg = 150 mmHg

What is Alveolar Gas?

- $P_{alv\ oxy} = P_{inhaled\ (wet)\ oxy} - (P_{alv\ CO2}/RQ)$
  - $RQ = CO_2$ excreted by lung/O_2 uptake in lung
  - $RQ = \dot{V}_{CO2}/\dot{V}_{O2}$
    - $0.7 \leq RQ \leq 1$
      - “normal” $RQ \approx 0.8$
- $P_{alv\ CO2} = \dot{V}_{CO2} \times ((P_{baro} - P_{water\ vapor})/\dot{V}_{alv})$
  - $\dot{V}_{alv}$ = alveolar ventilation
    - $= \dot{V}_{tidal} - \dot{V}_{dead\ space}$

See B&L[6+], pages 444-446

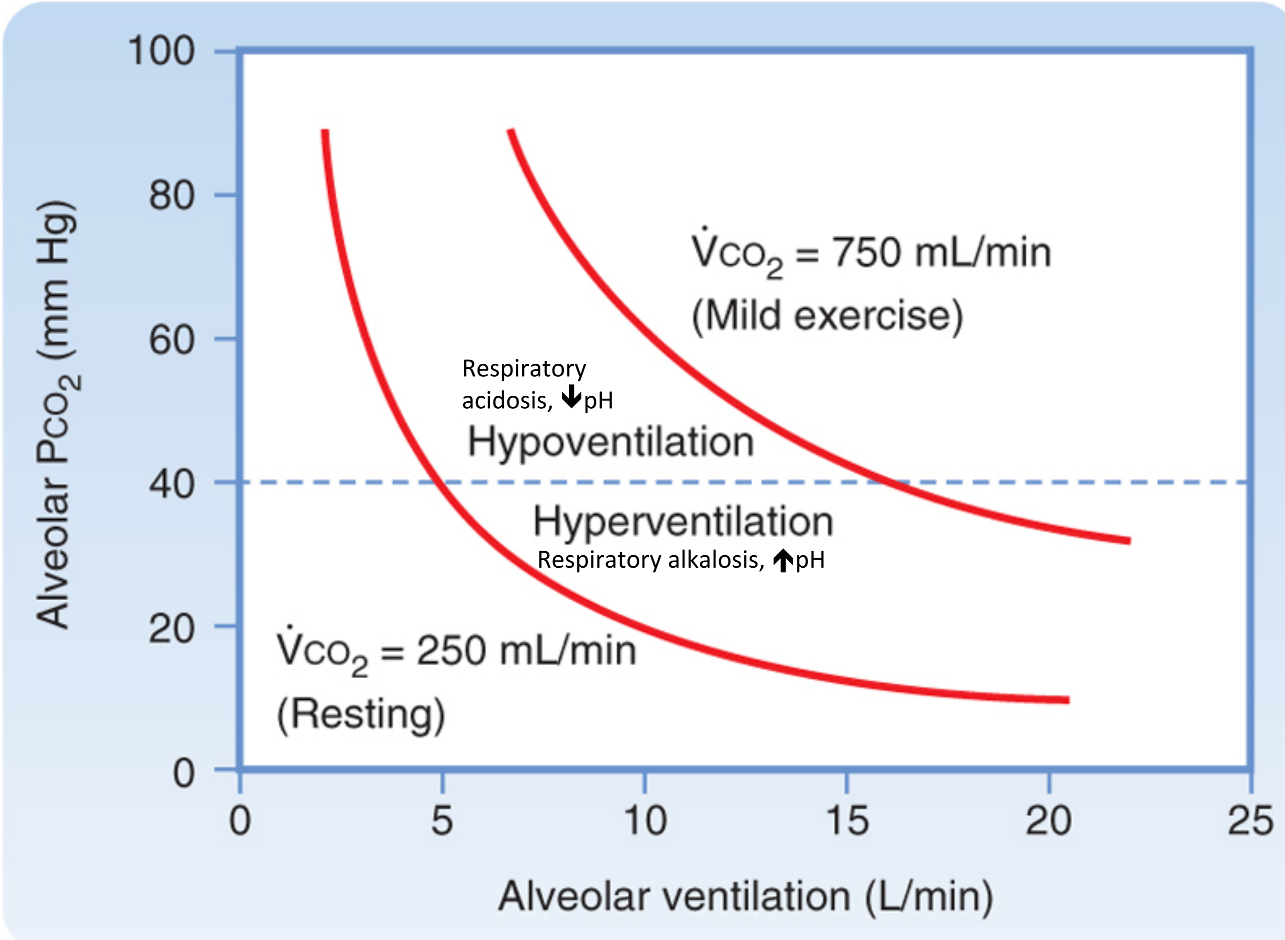


Figure 22-1 Alveolar PCO_2 as a function of alveolar ventilation in the lung. Each line corresponds to a given metabolic rate associated with a constant production of CO_2 (Vco_2 isometabolic line). Normally, alveolar ventilation is controlled to maintain an alveolar Pco_2 of about 40 torr. Thus, at rest, when Vco_2 is approximately 250 mL/min, alveolar ventilation of 5 L/min will result in an alveolar Pco_2 of 40 mm Hg. A 50% decrease in ventilation at rest (i.e., from 5 to 2.5 L/min) results in doubling of alveolar Pco_2. During exercise, CO_2 production is increased (Vco_2 = 750 mL/min), and to maintain a normal Pco_2, ventilation must increase (in this case to 15 L/min). Again, however, a 50% reduction in ventilation (15 to 7.5 L/min) will result in doubling of Pco_2.

Distribution of Ventilation

- When upright …
  - Not uniform throughout lung
    - More to base than to apex
      - Less evident at higher lung volumes
- At terminal respiratory units …
  - Local regulation
    - Airway resistance
    - Alveolar compliance
  - Affect fill/empty time
    - $\tau = RC$

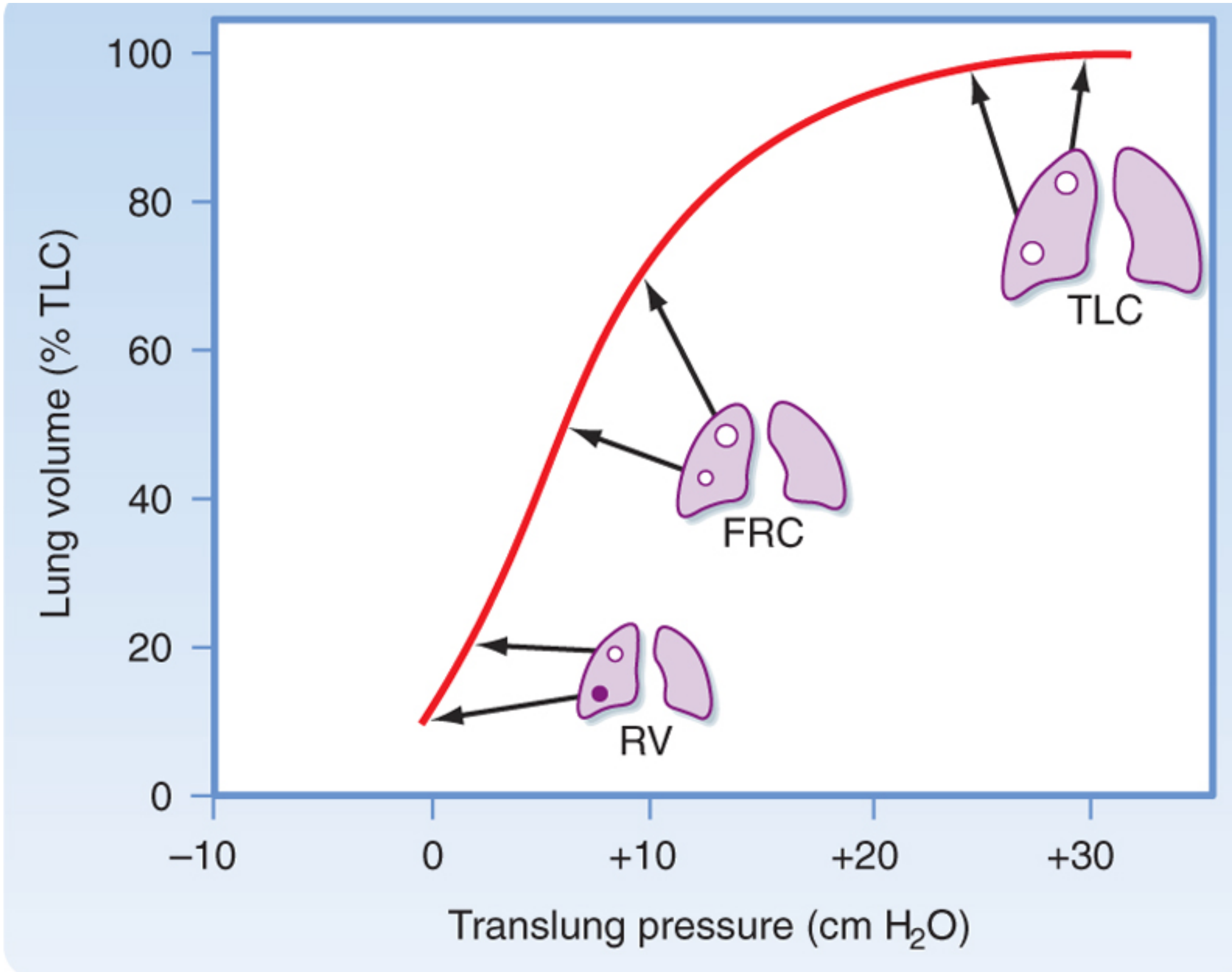


Figure 22-2 Regional distribution of lung volume, including alveolar size and location on the pressure-volume curve of the lung at different lung volumes. Because of suspension of the lung in the upright position, the pleural pressure (Ppl) and translung pressure (PL) of units at the apex will be greater than those at the base. These lung units will be larger at any lung volume than units at the base. The effect is greatest at residual volume (RV), is less at functional residual capacity (FRC), and disappears at total lung capacity (TLC). Note also that because of their location on the pressure-volume curve, inspired air will be differentially distributed to these lung units; the lung units at the apex are less compliant and will receive a smaller proportion of the inspired air than the lung units at the base, which are more compliant (i.e., reside at a steeper part of the pressure-volume curve).

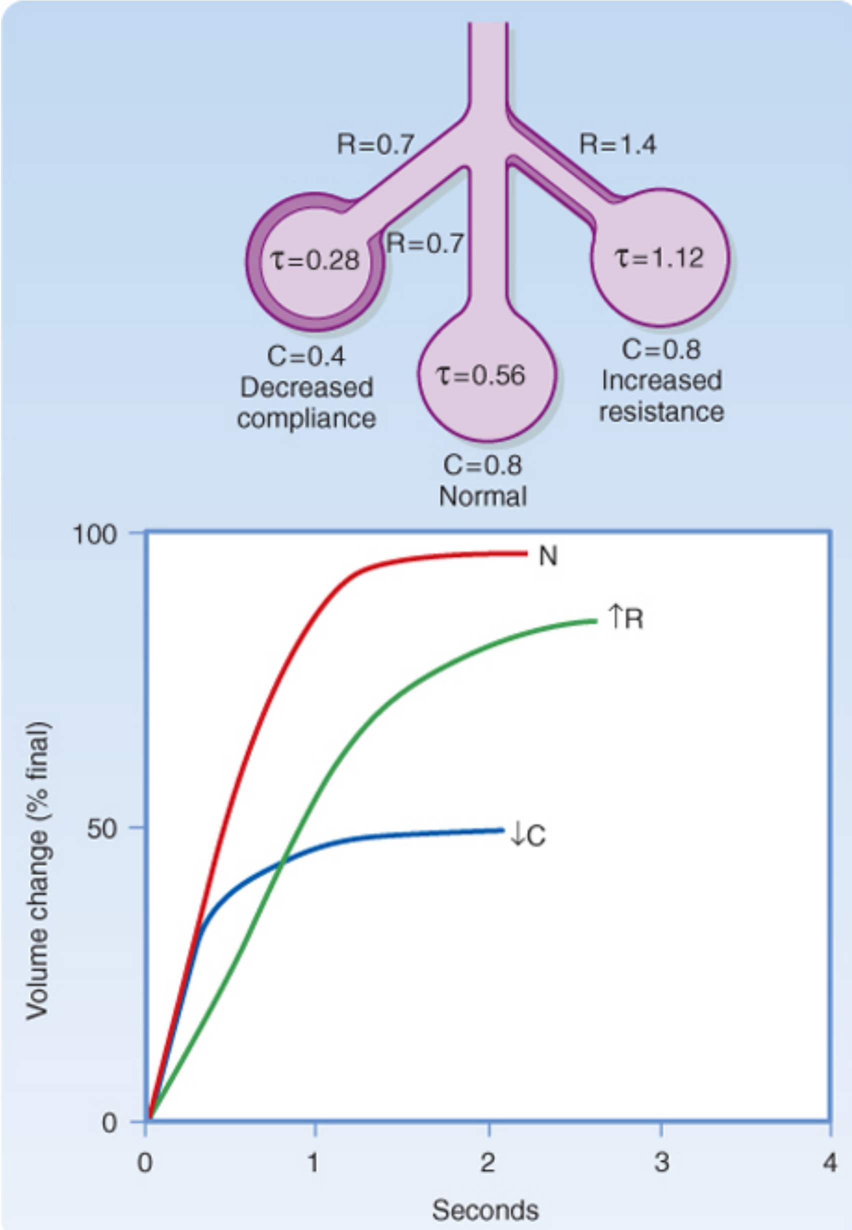


Figure 22-3 Examples of local regulation of ventilation as a result of variation in the resistance (R) or compliance (C) of individual lung units. In the upper schema are shown the individual resistance and compliance of three different lung units. In the lower graph are shown the volume of these three lung units as a function of time. In the upper schema, the normal lung has a time constant (τ) of 0.56 second. This unit reaches 97% of final equilibrium in 2 seconds, the normal inspiratory time, as shown in the lower graph. The unit at the right has a twofold increase in resistance; hence its time constant is doubled. That unit fills more slowly and reaches only 80% equilibrium during a normal breath (graph). The unit is underventilated. The unit on the left has reduced compliance (stiff), which acts to reduce its time constant. This unit fills faster than the normal unit but receives only half the ventilation of a normal unit.

Dead Space Ventilation

- Ventilation to airways without gas exchange
- Two kinds of dead space
  - Anatomic
    - Conducting airways
      - See Module 11, Video 2, Slide 4
  - Physiological
    - TOTAL volume of gas per breath with no gas exchange
      - Some alveoli are are ventilated but not perfused
    - Physiological = anatomic + “bad” alveoli

END

Video 1, Module 12