Pulmonary Volumes & Capacities

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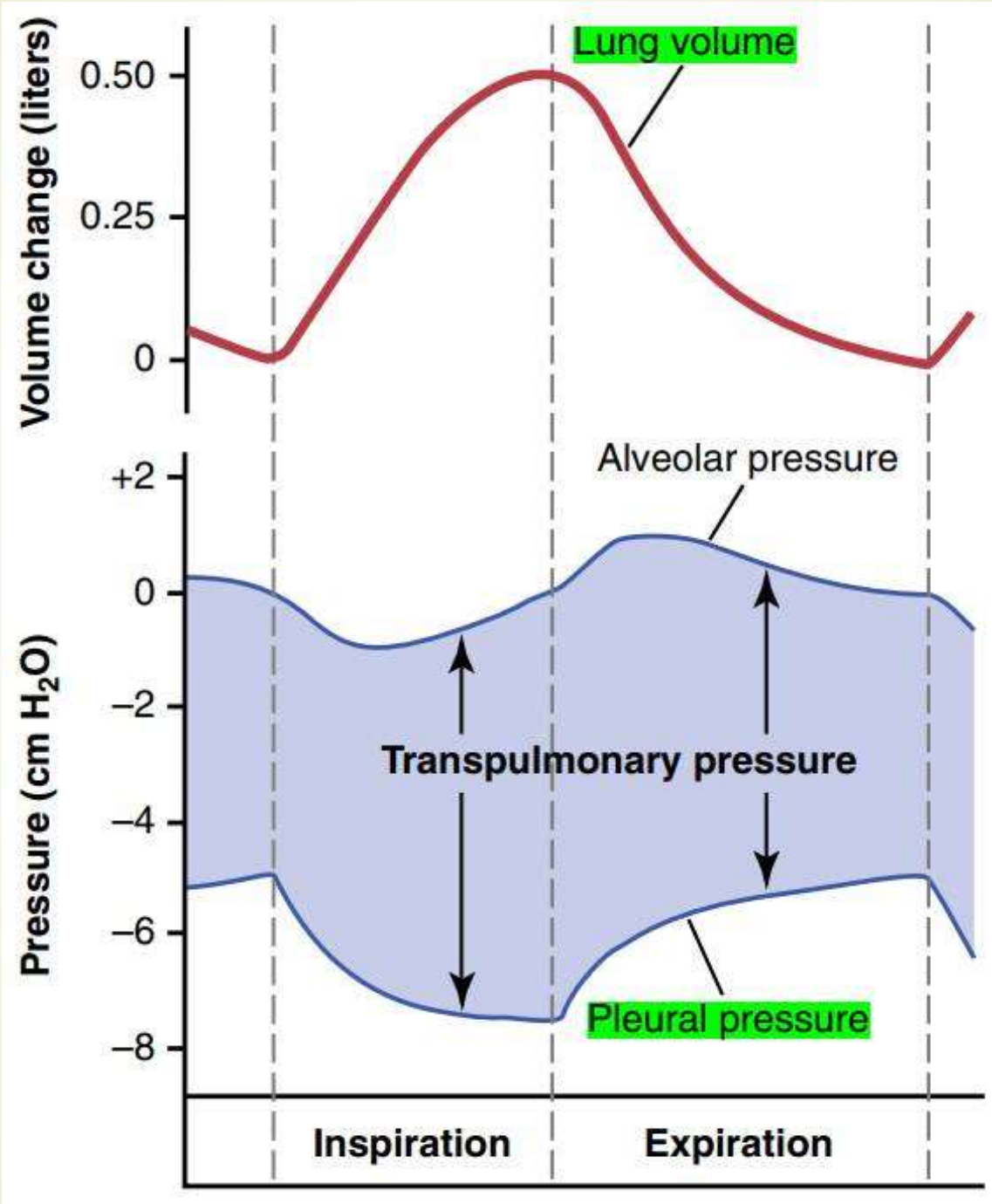
Relationship b/W Pleural, Alveolar, and Transpulmonary Pressure

- **Pleural Pressure**:
  pressure of the fluid in the thin space between the **lung pleura** and **chest wall pleura**.

- The normal pleural pressure at the beginning of inspiration is about **−5 centimeters** of **water** (cm H2O)

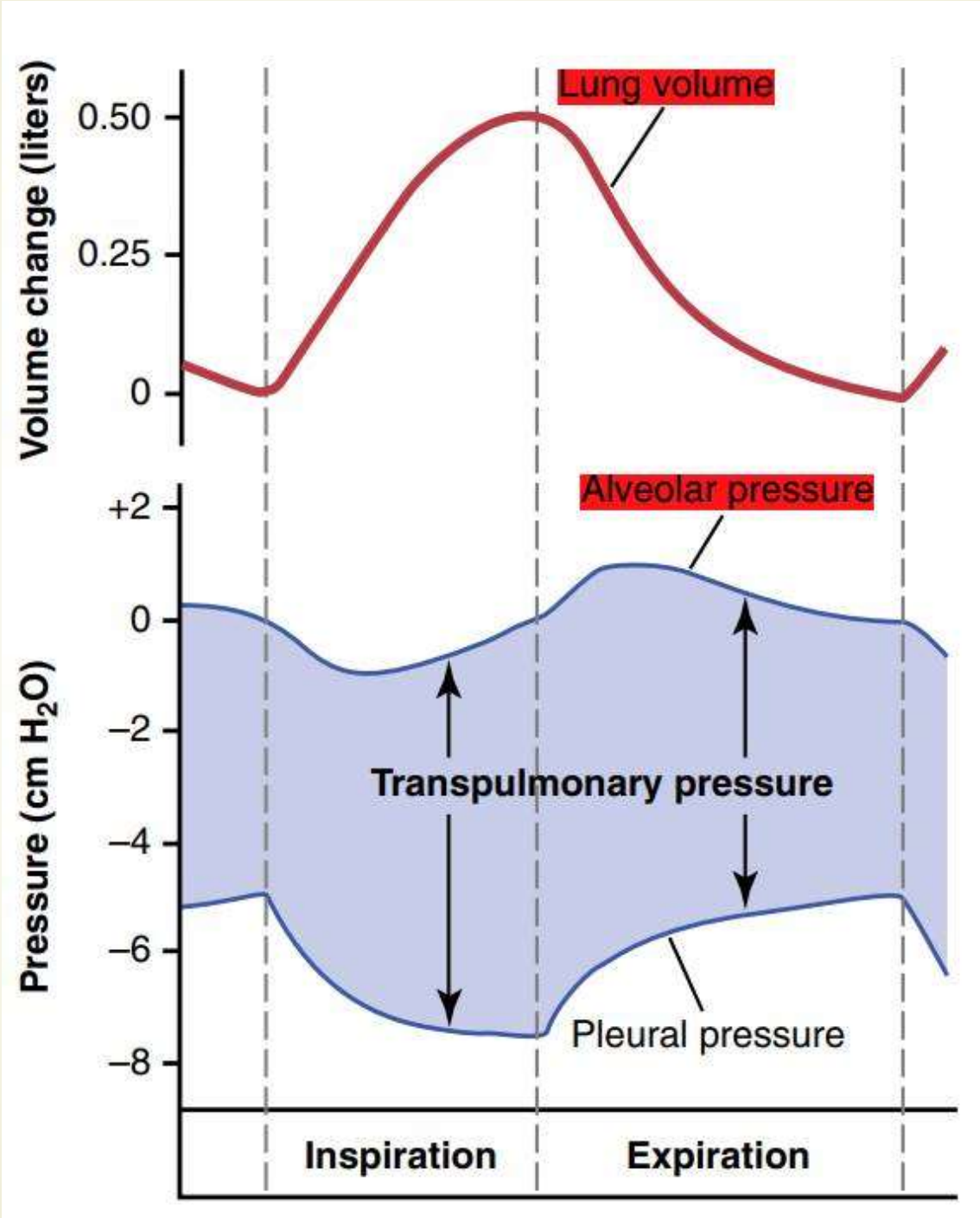
- During normal inspiration, **expansion of the chest cage** pulls **outward** on the lungs → creates more negative pressure of about **−7.5 cm H2O**.

- This increasingly negative pressure from -**5 to – 7.5** → an increases of 500 ml in lung volume (Tidal volume)
- During, expiration, this is essentially reversed


Volume change (liters)
0.50
0.25
0
Lung volume
Alveolar pressure
+2
0
−2
−4
−6
−8
Pressure (cm H_2O)
Transpulmonary pressure
Pleural pressure
Inspiration
Expiration

Alveolar Pressure—Air Pressure Inside the Lung Alveoli

- When there is **no air is flowing into or out of the lungs** → pressures in **all parts of the respiratory tree**, all the way to the **alveoli**, are equal **to atmospheric pressure**, which is considered to be **zero reference pressure** in the airways—that is, **0 cm H2O pressure**.
- To cause **inward flow of air into the alveoli during inspiration**, **alveolar pressure falls from 0 cm H20 to -1 cm H2O** → pulls 500ml of air into alveoli during inspiration.
- During expiration, **alveolar pressure rises to about +1cm H2O**, which forces the 0.5 liter of inspired air out of the lungs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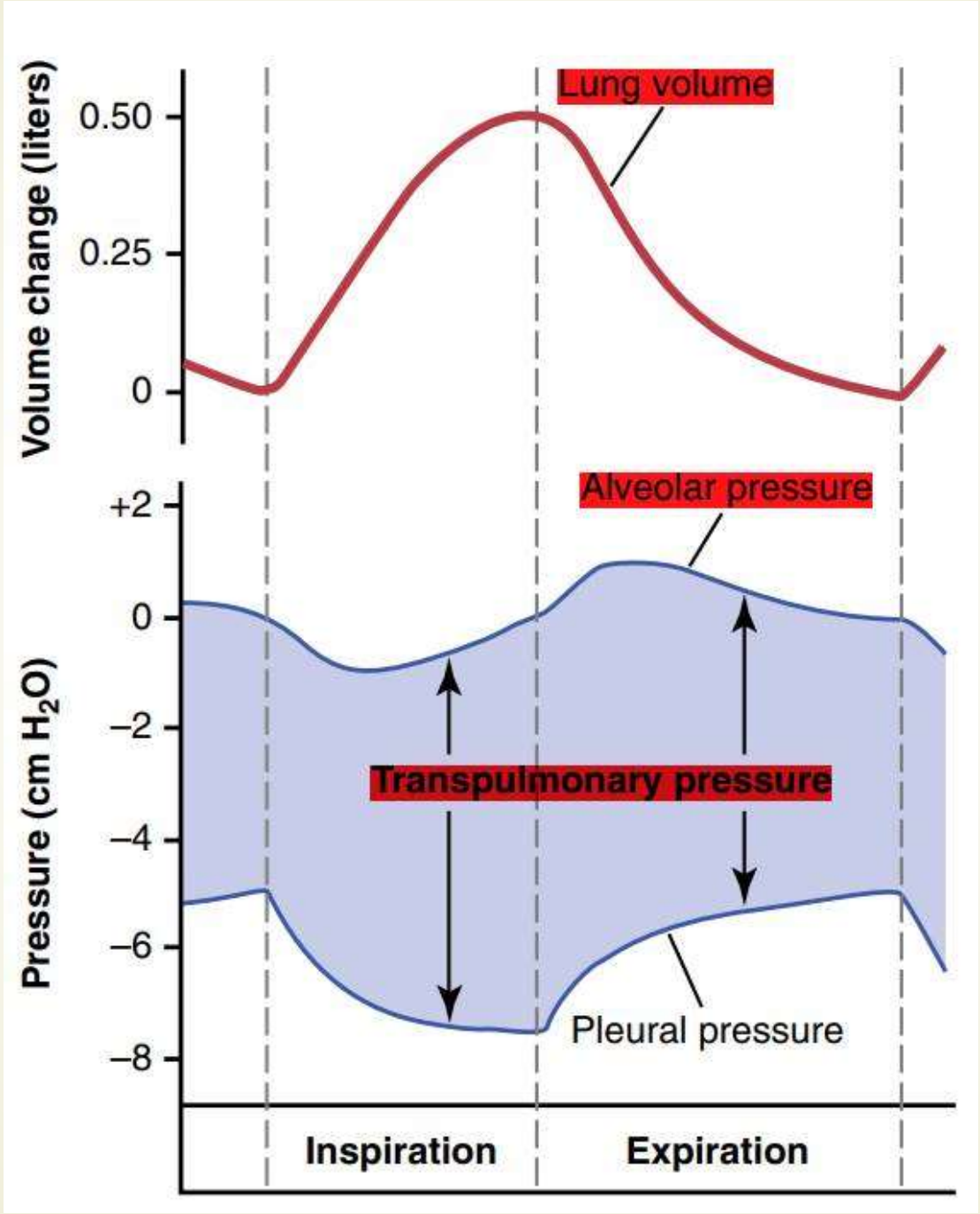
Transpulmonary Pressure—Difference between Alveolar and Pleural Pressures

- Pressure difference between that in the **alveoli** and that on the **outer surfaces of the lungs (pleural pressure);**
- It is a measure of the **elastic forces in the lungs** that **tend to collapse the lungs at each instant of respiration**, called the **recoil pressure**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Lung Compliance

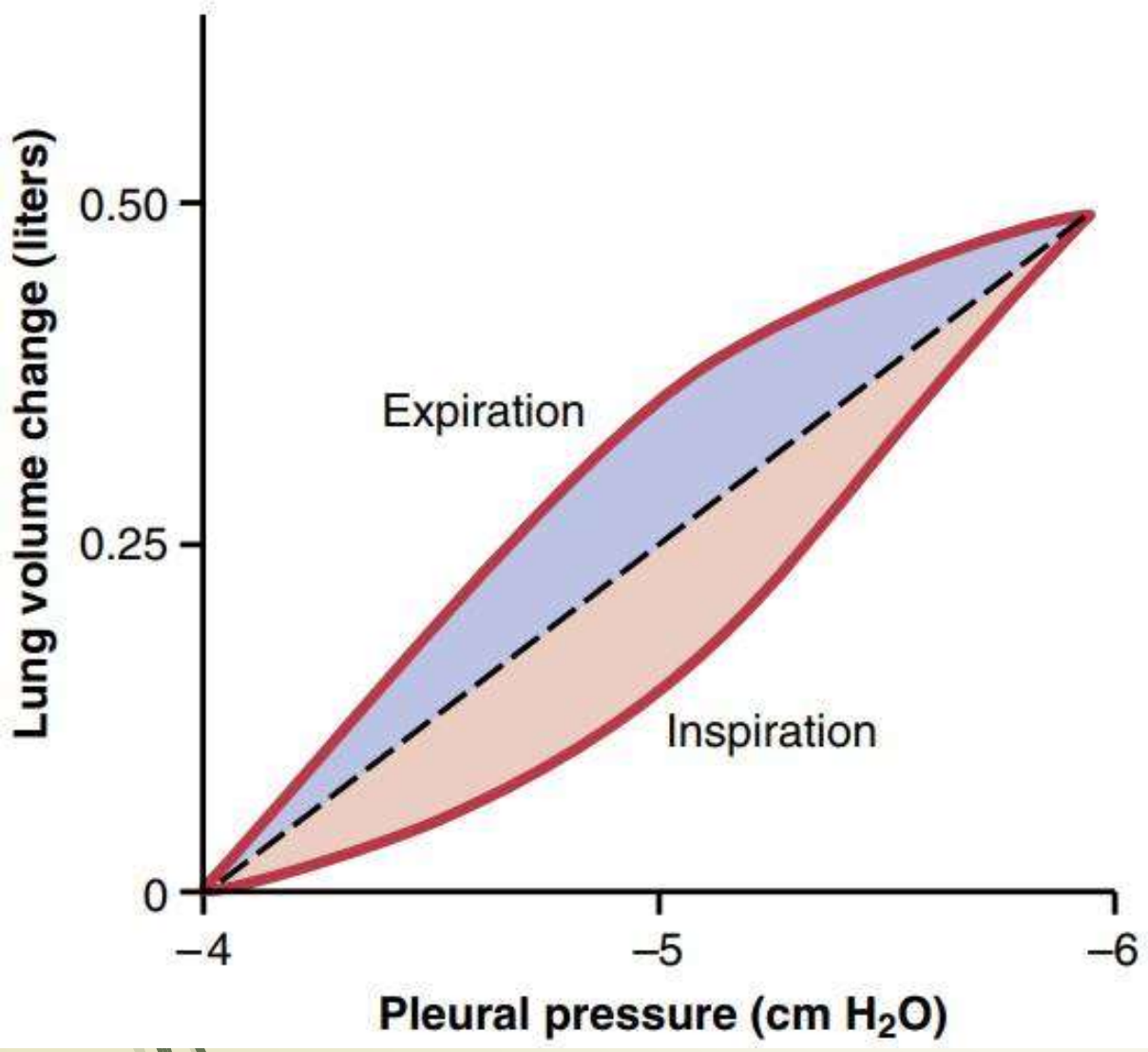
Change in lung volume for a **change in pressure** ($\Delta V/\Delta P$). i,.e. **Transpulmonary pressure**

- **Increased compliance = lung easier to fill** (eg, emphysema, aging)
- **Decreased compliance = lung harder to fill** (eg, pulmonary fibrosis, pneumonia, ARDS, pulmonary edema)

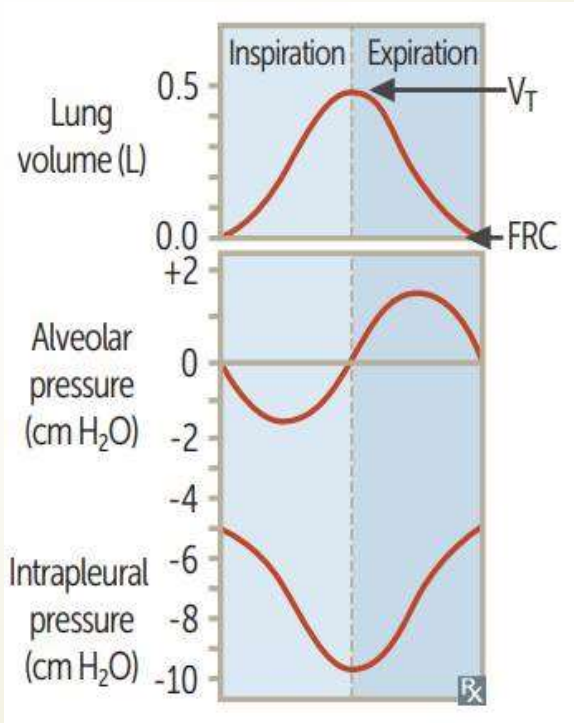
- The total compliance of both lungs together in the normal adult averages about 200 ml of air/cm H2O transpulmonary pressure.

- That is, every time the **transpulmonary pressure increases by 1 cm H2O, the lung volume will expand 200 ml.**

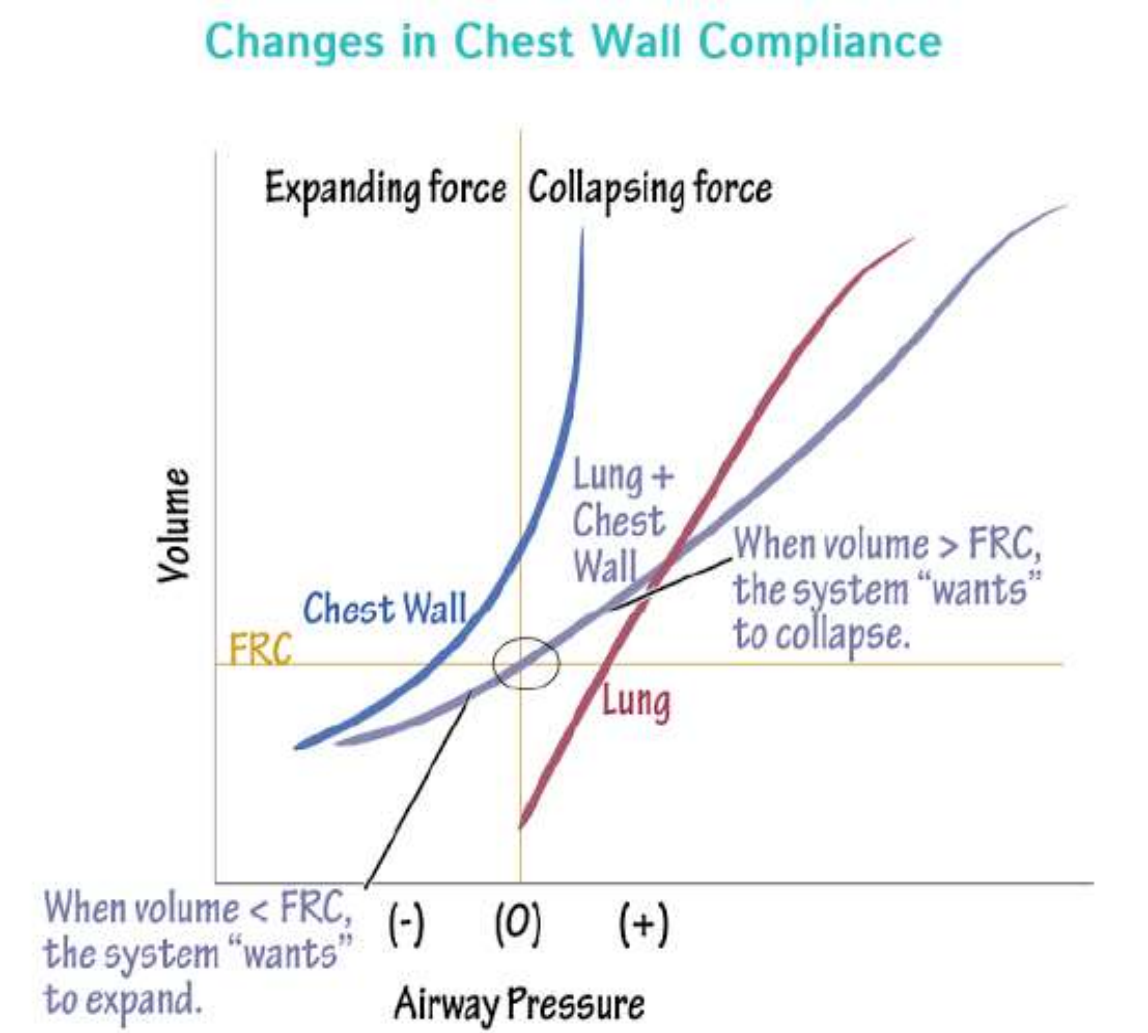
Lung compliance diagram



- Fig. showing relating **lung volume changes** to **changes in pleural pressure**, which, in turn, **alters transpulmonary pressure.**
- Note that the relationship is **different for inspiration and expiration.**
- **Lung inflation** follows a **different pressure-volume curve** than **lung deflation** due to need to **overcome surface tension forces** in **inflation**. This phenomenon is called **hysteresis**.



Combined lung and chest wall compliance



- Physiologically, there is a Tendency for **lungs to collapse inward** and **chest wall** to **spring outward (expand outward).**
- **At FRC**, **airway and alveolar pressures** equal **atmospheric pressure (called zero)**, and **intrapleural pressure (pleural pressure)** is **negative**.
- The **inward pull of the lung** is **balanced** by the **outward pull of the chest wall**

Spirometry

- Method of assessing lung function by measuring the **volume of air** that can be **expelled** from the lungs **after a maximal inspiration**
- **4 volumes and 4 capacities**
- **A capacity is a sum of two or more volumes**

- **Tidal volume**: that volume of air moved into or out of the lungs during quiet breathing
- **Inspiratory reserve volume**: the maximal volume that can be inhaled after normal inspiration
- **Inspiratory capacity**: the sum of IRV and TV
- **Expiratory reserve volume**: the maximal volume of air that can be exhaled after normal exhalation
- **Vital capacity**: the volume of air breathed out after the deepest inhalation.
- **Total lung capacity**: the volume in the lungs at maximal inflation, the sum of VC and RV.
- **Residual volume**: the volume of air remaining in the lungs after a maximal exhalation

Lung volumes	Note: a **capacity** is a sum of ≥ 2 physiologic **volumes.**
Inspiratory reserve volume	Air that can still be breathed in after normal inspiration
Tidal volume	Air that moves into lung with each quiet inspiration, typically 500 mL
Expiratory reserve volume	Air that can still be breathed out after normal expiration
Residual volume	Air in lung after maximal expiration; RV and any lung capacity that includes RV cannot be measured by spirometry
Inspiratory capacity	IRV + TV Air that can be breathed in after normal exhalation
Functional residual capacity	RV + ERV Volume of gas in lungs after normal expiration
Vital capacity	TV + IRV + ERV Maximum volume of gas that can be expired after a maximal inspiration
Total lung capacity	IRV + TV + ERV + RV Volume of gas present in lungs after a maximal inspiration

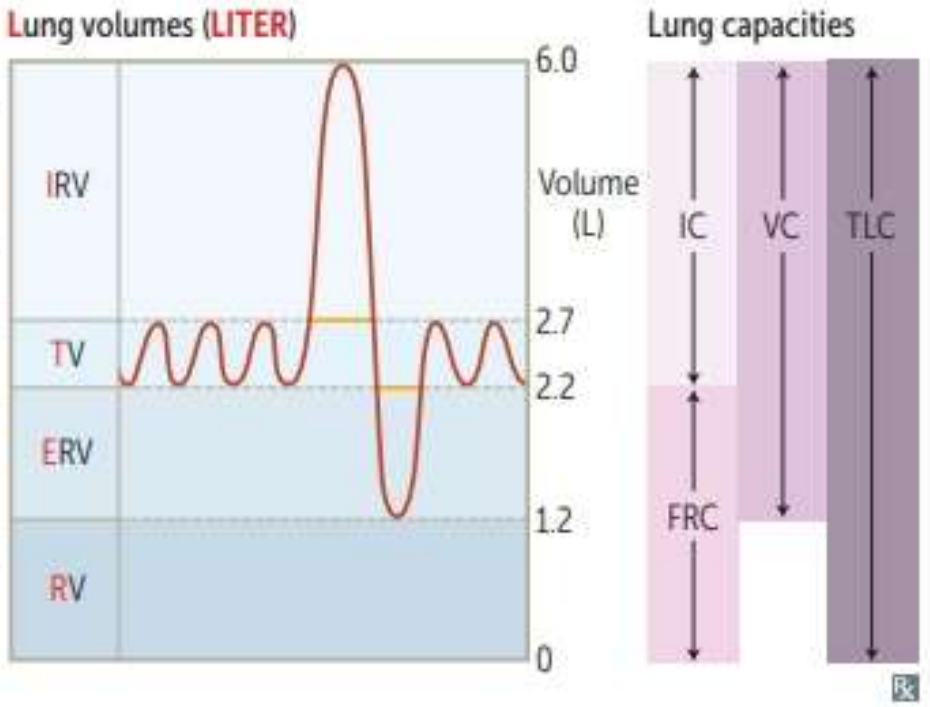


Table 38-1 Average Pulmonary Volumes and Capacities for Healthy, Young Adult Men and Women

Pulmonary Volumes and Capacities	Men	Women
Volume (ml)		
Tidal volume	500	400
Inspiratory reserve volume	3000	1900
Expiratory volume	1100	700
Residual volume	1200	1100
Capacities (ml)		
Inspiratory capacity	3500	2400
Functional residual capacity	2300	1800
Vital capacity	4600	3100
Total lung capacity	5800	4200

Thank You