

Ventilation – movement of gas from the environment to gas exchange space, i.e. the lung

Movement of gas requires a DRIVING FORCE, pressure gradient

Goal of ventilation is to provide oxygen and remove carbon dioxide

Oxygen – source and sink?

Carbon dioxide – source and sink?

Ventilation is the product of the breathing frequency times the tidal volume

Law of Partial Pressures

total pressure of a gas is the sum of partial pressures of the gases present

$$P_{\text{tot}} = P_1 + P_2 + P_3 + \dots + P_n$$

Dalton's Law

The partial pressure of the gas can be found by knowing the total pressure and the fractional concentration of the individual gas species

$$P_X = P_{\text{tot}} * F_X$$

$$P_{\text{O}_2} = (760) * 0.209 = 159 \text{ mmHg}$$

Water Vapor Correction

Air also has much less H₂O vapor than lung gas which is completely saturated with water vapor. $P_{\text{H}_2\text{O}} = 47 \text{ mmHg}$ at 37° C.

This is corrected by:

$$P_X = (P_B - 47) * F_X$$

$$P_{\text{O}_2} = (760-47)*0.209=149 \text{ mmHg}$$

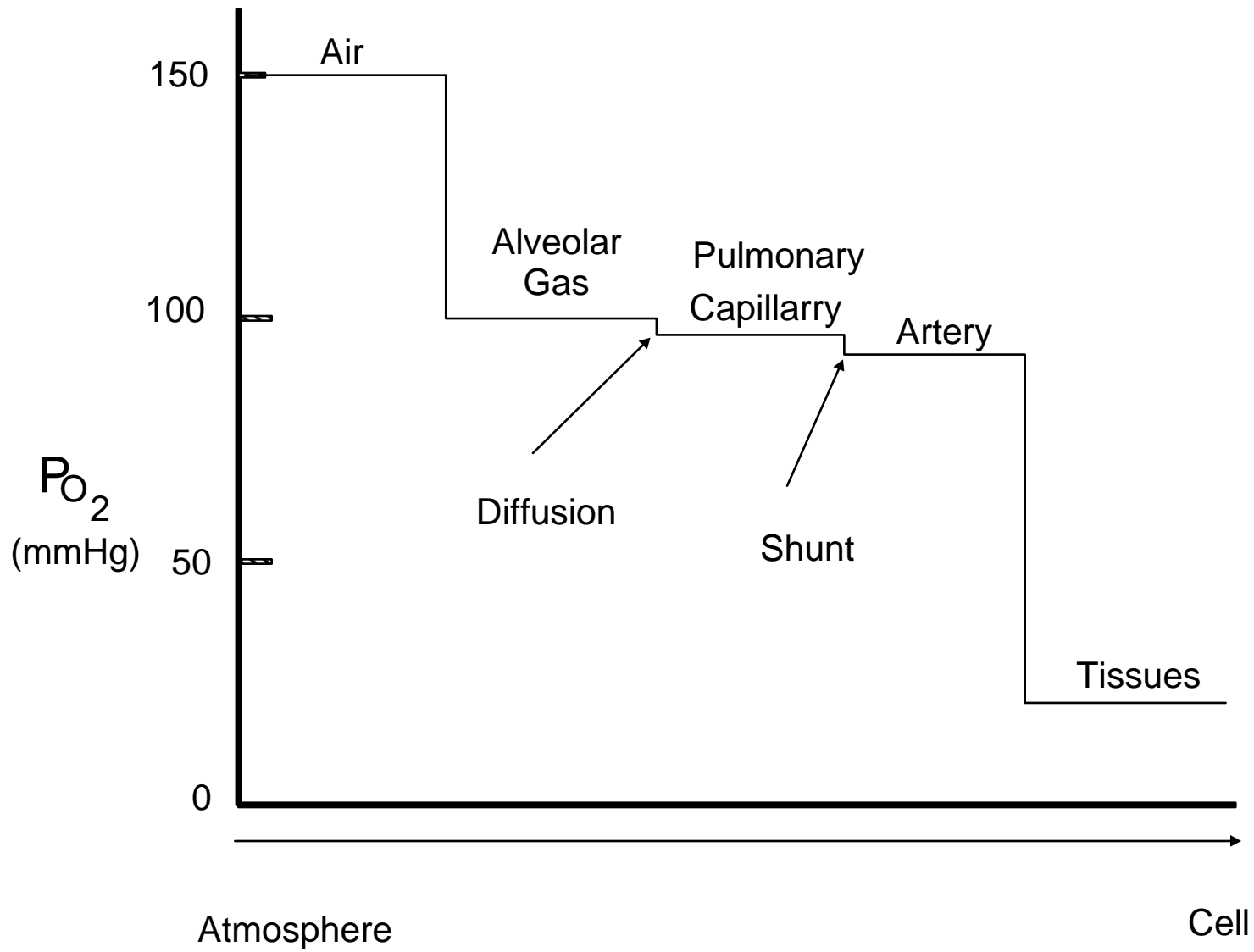
Henry's Law

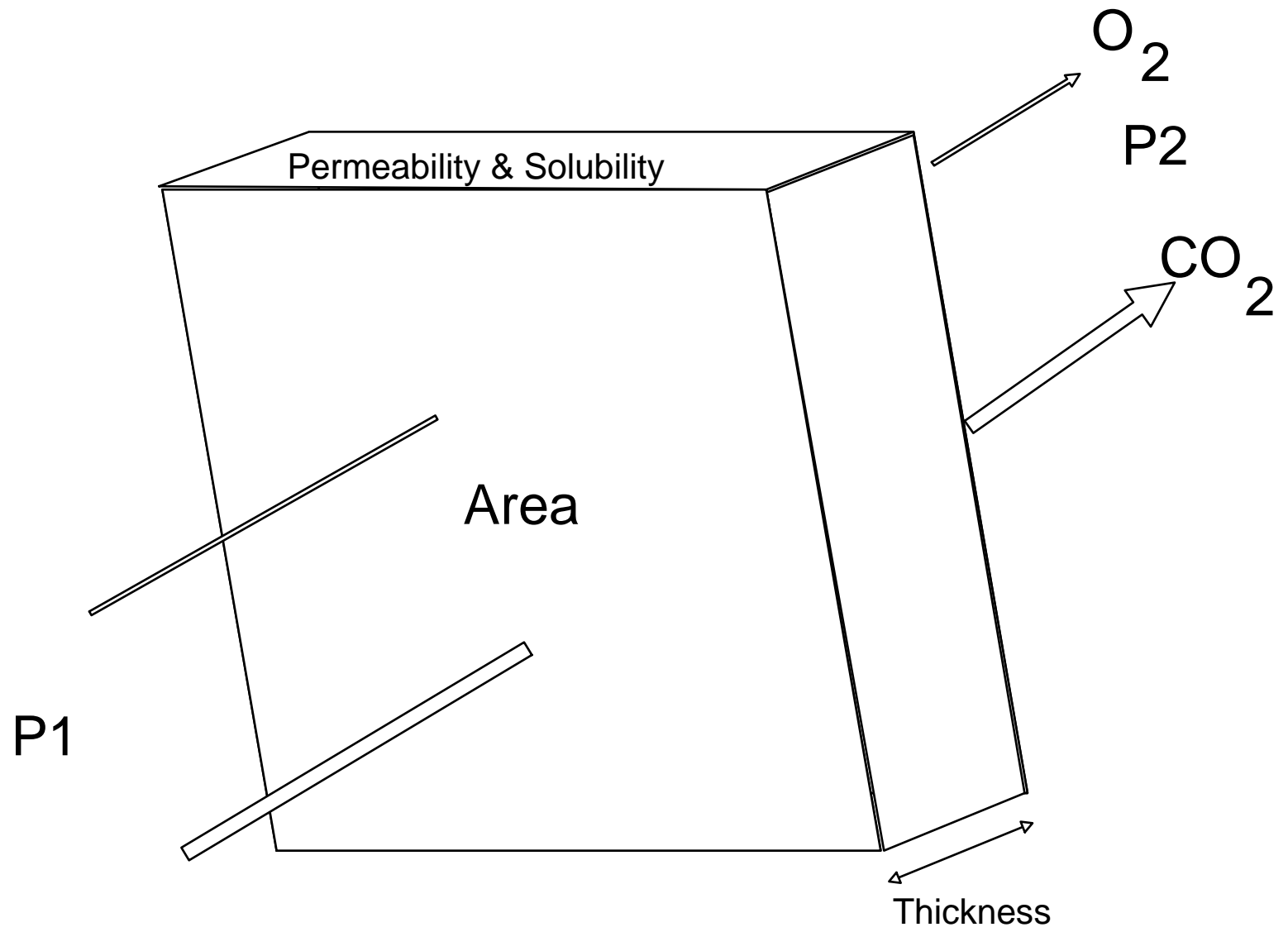
The volume of gas dissolved in liquid is proportional to the partial pressure

$$C_X = k * P_X$$

where k is a constant that is the solubility of the gas

$$C_{O_2} = 0.003 * 100 \text{ mmHg} = 0.3 \text{ ml O}_2 / 100 \text{ ml}$$





Fick's Law of Diffusion

The rate that molecules move through this membrane to reach equal concentrations, equilibrium, is given by:

$$J = D * A * \alpha * (C_1 - C_2) / X$$

α = Solubility, becomes an important factor in the lung

The Respiratory Pump

I. The chamber

A. The thorax

B. The muscles

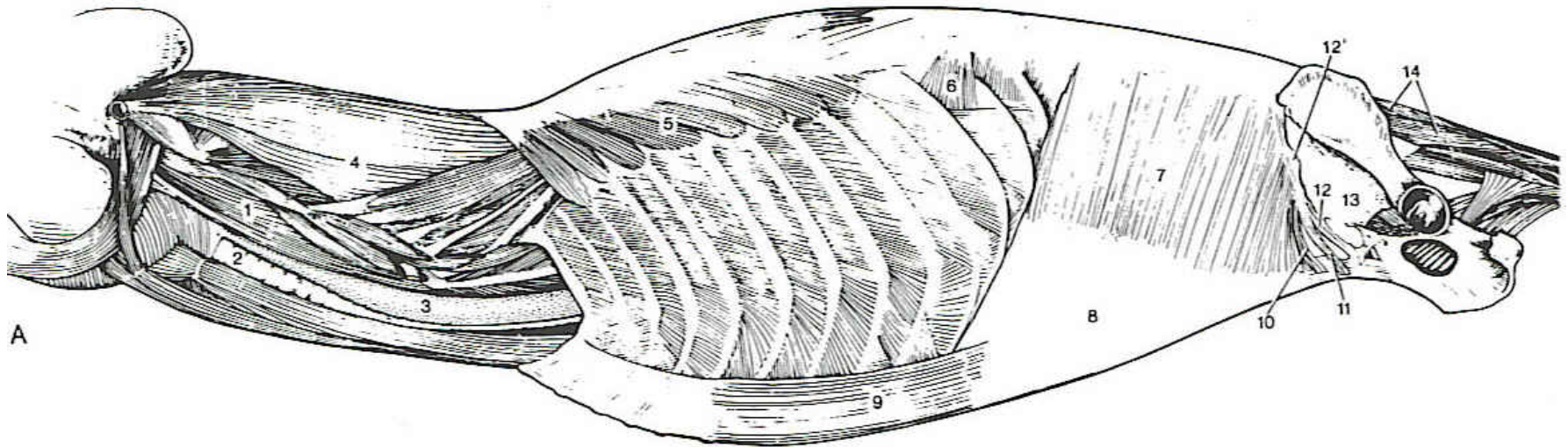
1. Diaphragm

2. Intercostal muscles

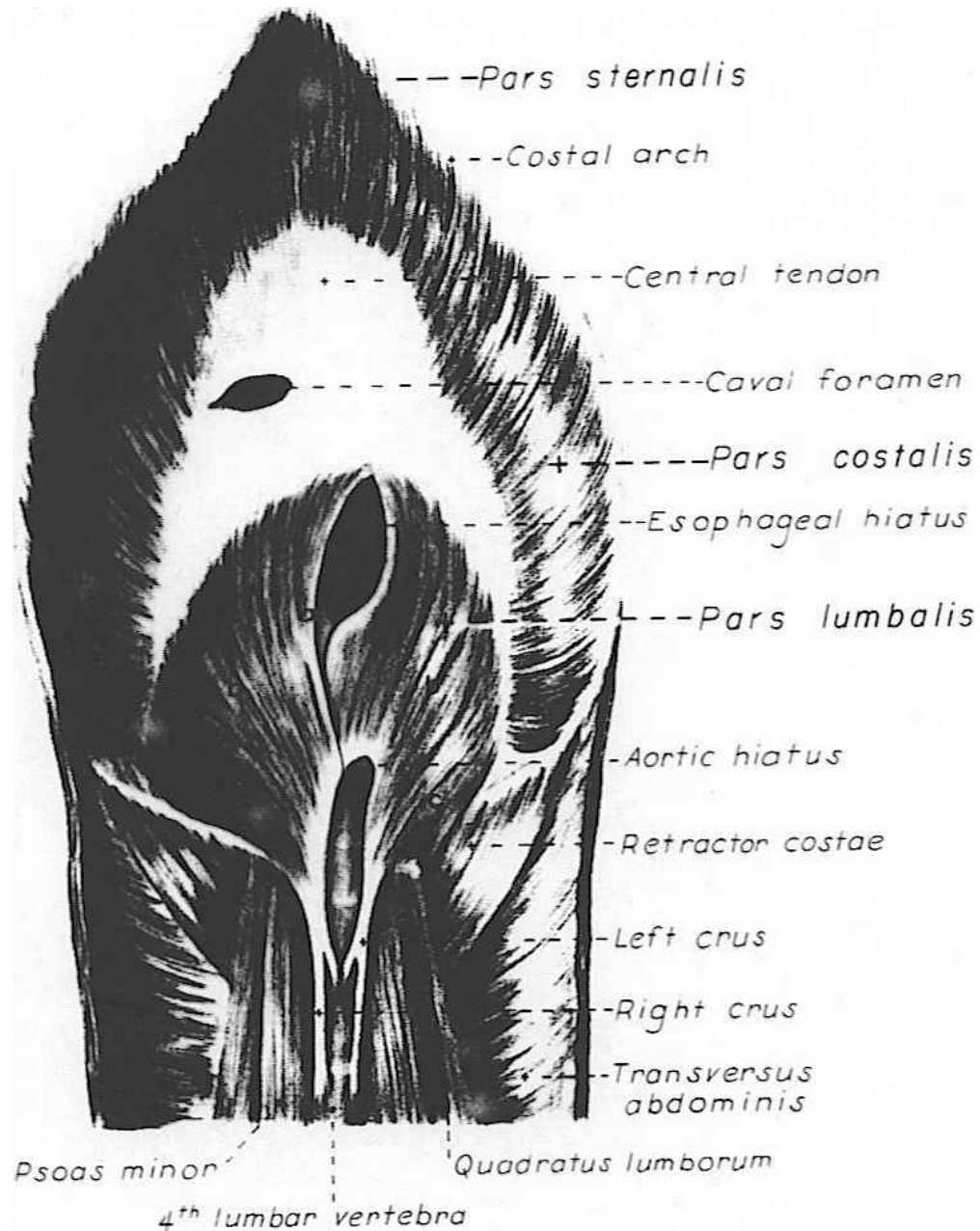
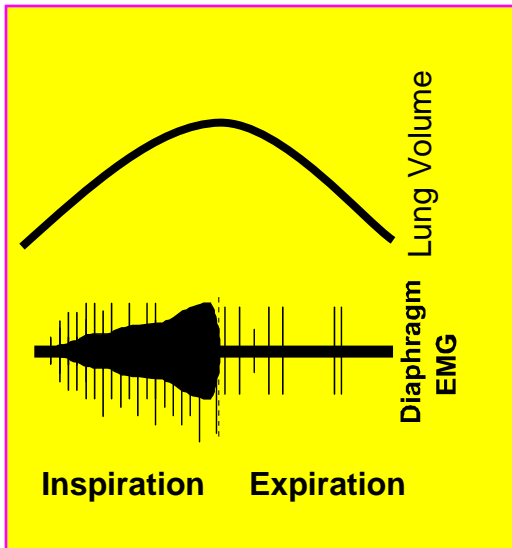
3. Abdominal muscles

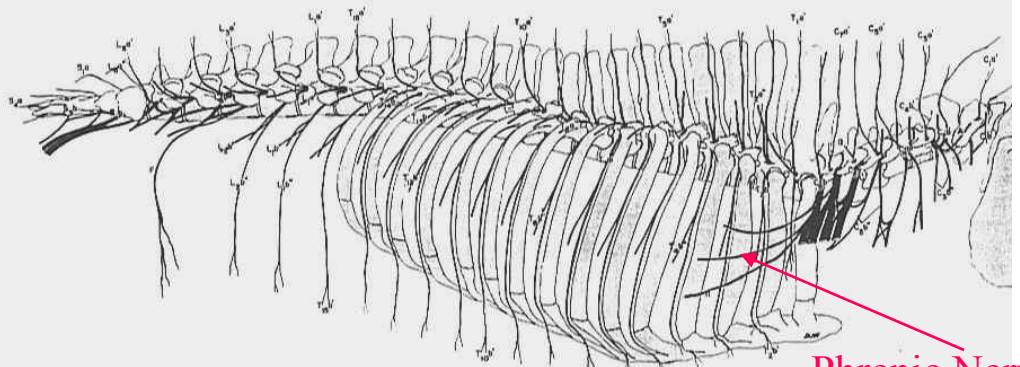
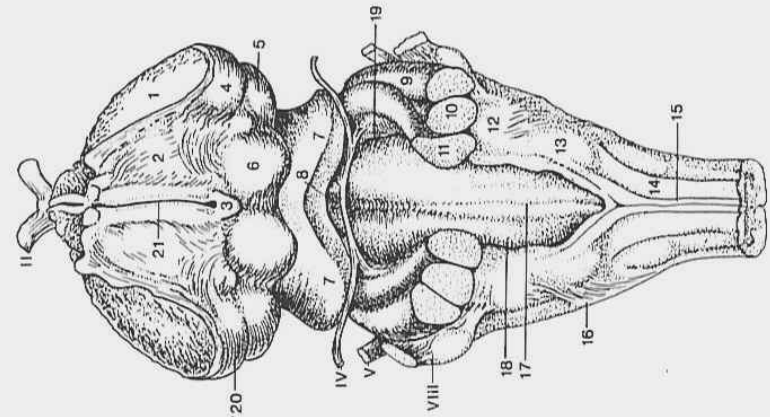
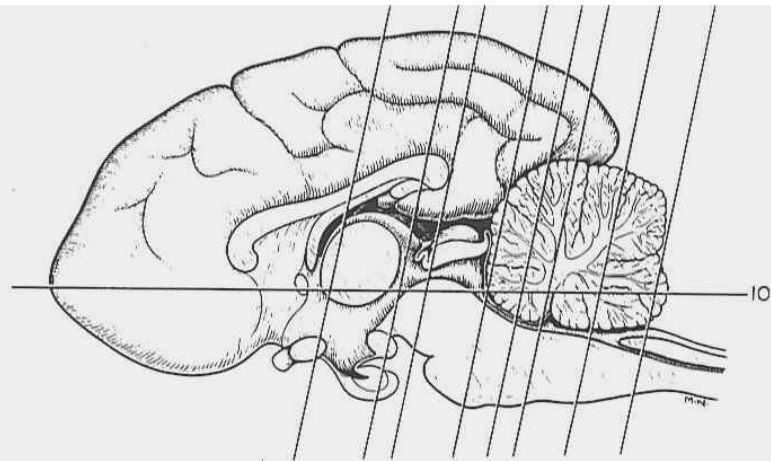
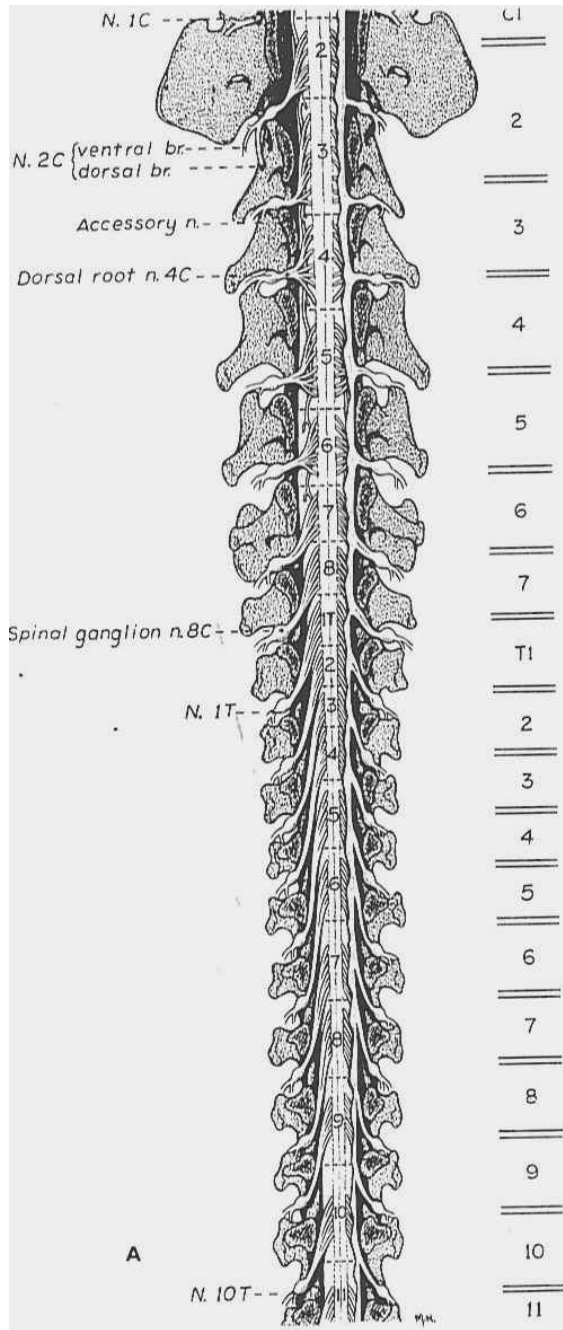
C. The pumping forces

The respiratory chamber

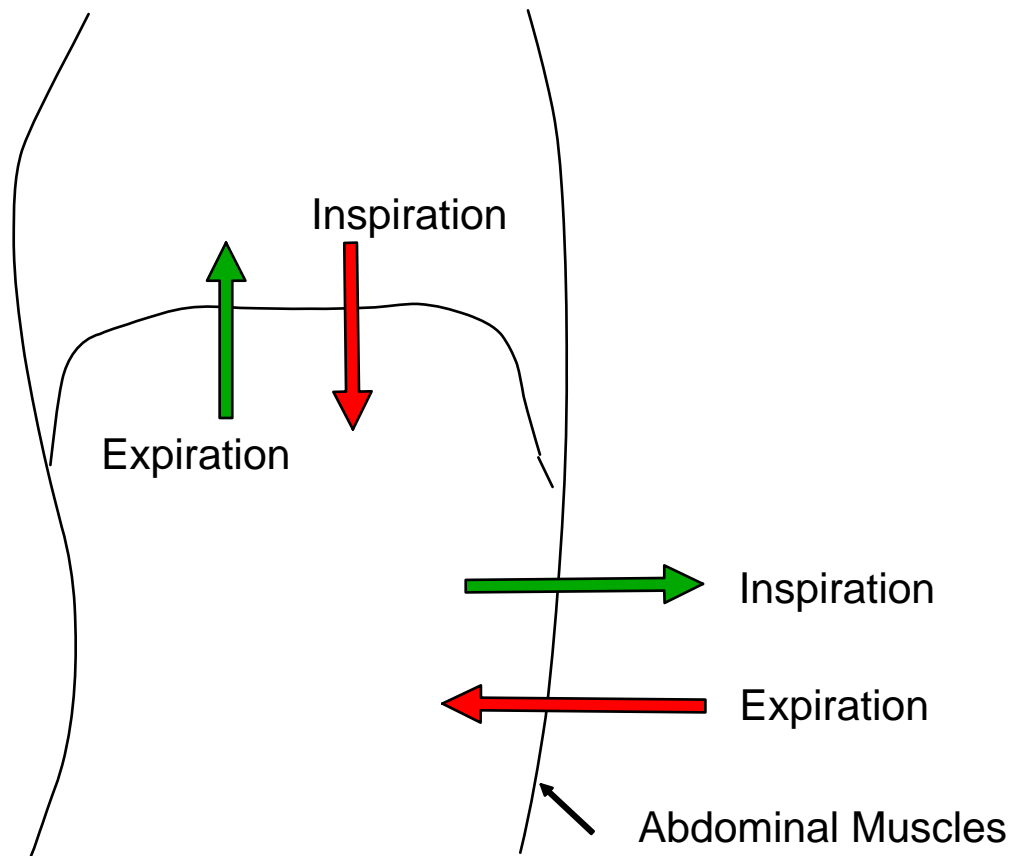


Diaphragm: the primary inspiratory muscle



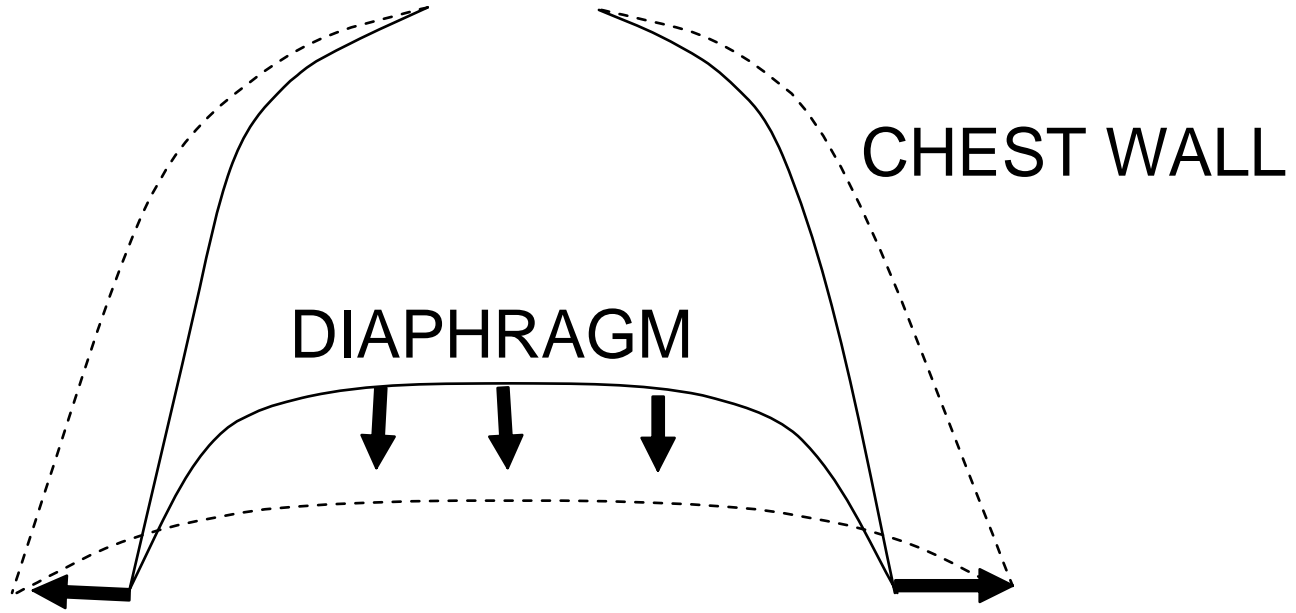


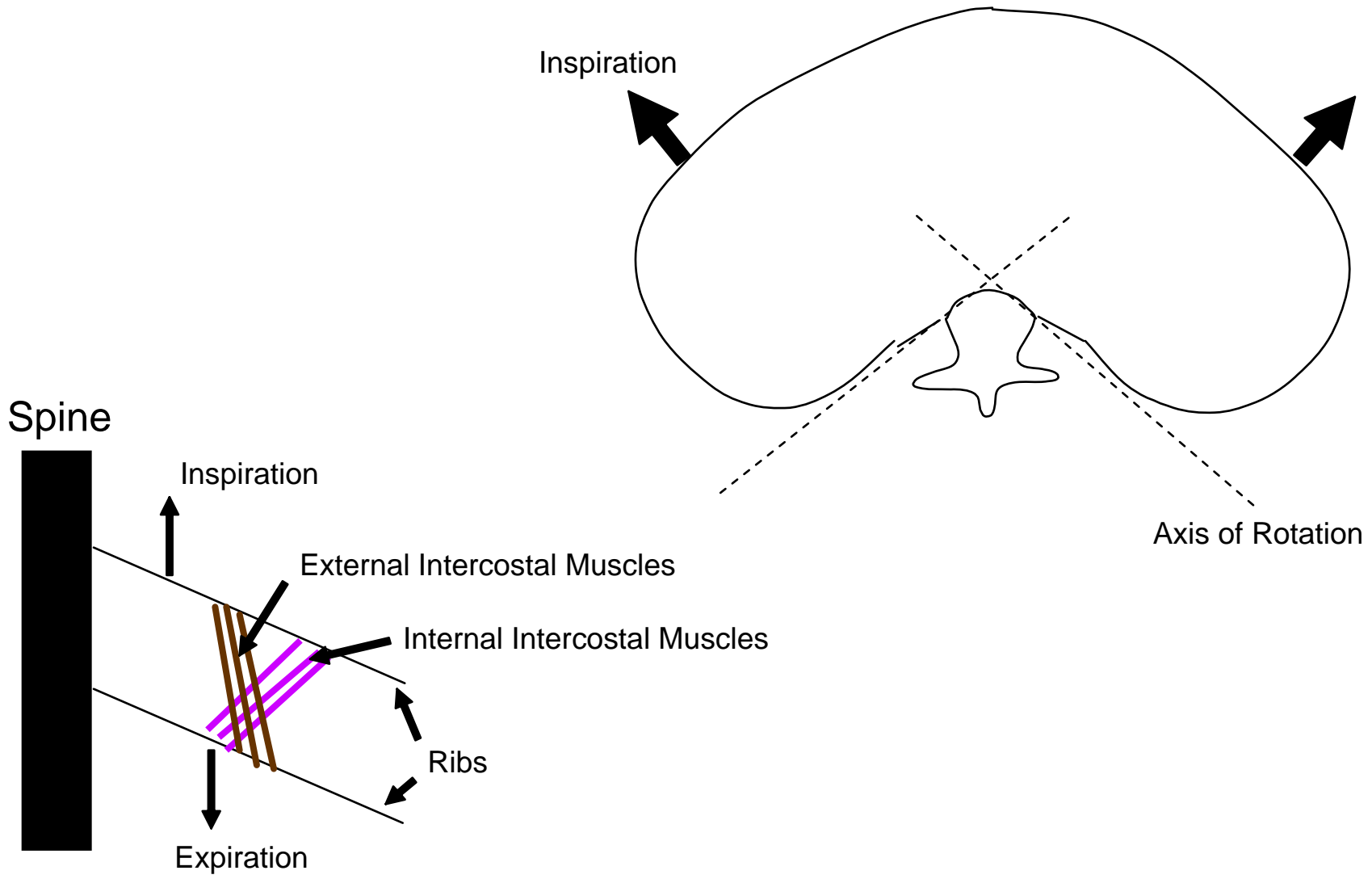
Phrenic Nerve



 Passive Movement

 Active Contraction



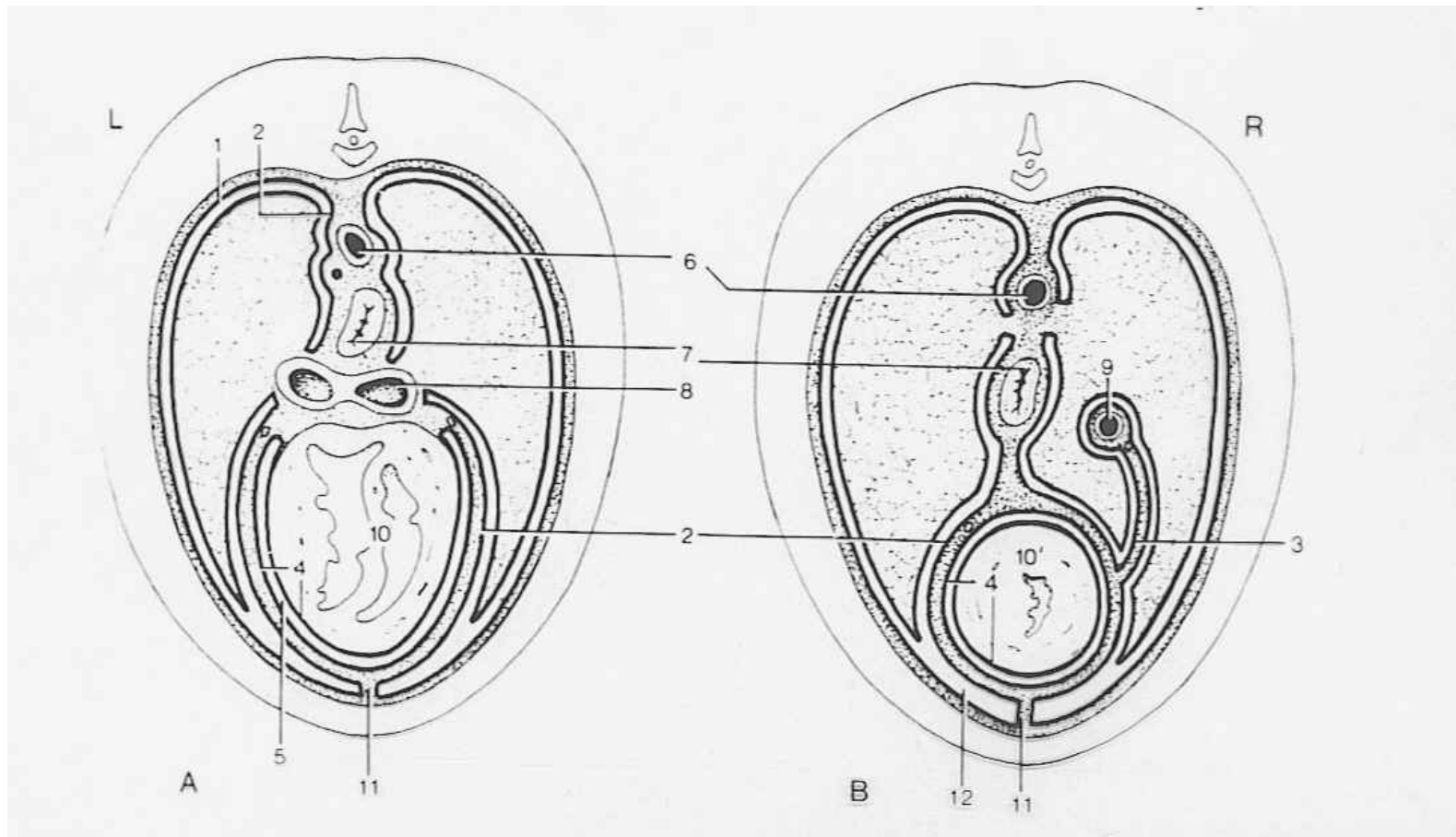


II. The Interaction of the Pump with the Lung

A. Pleura

B. The fluid filled pleural space

Pleura and Pleural Spaces



III. Pressures

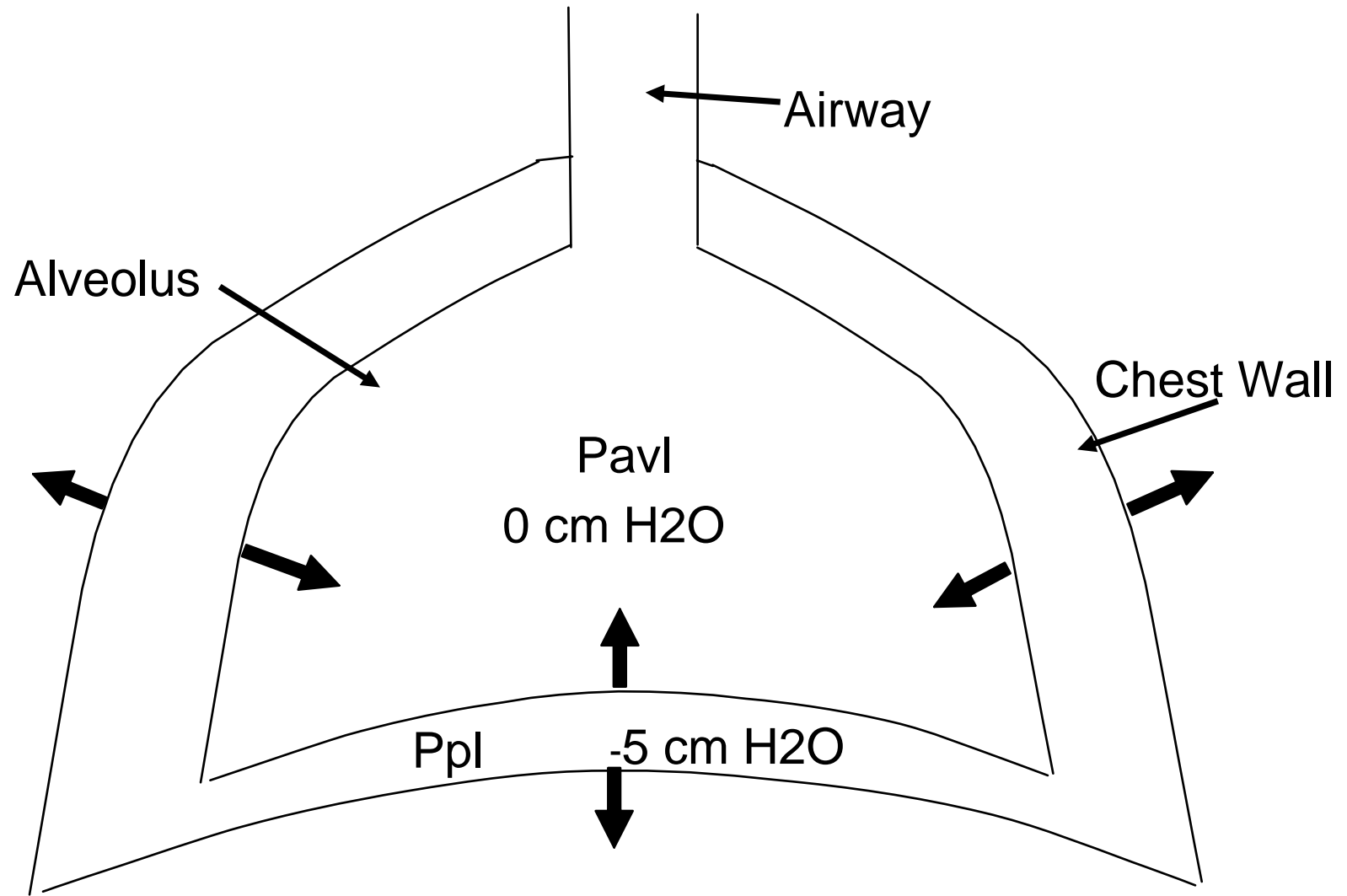
A. Pneumothorax

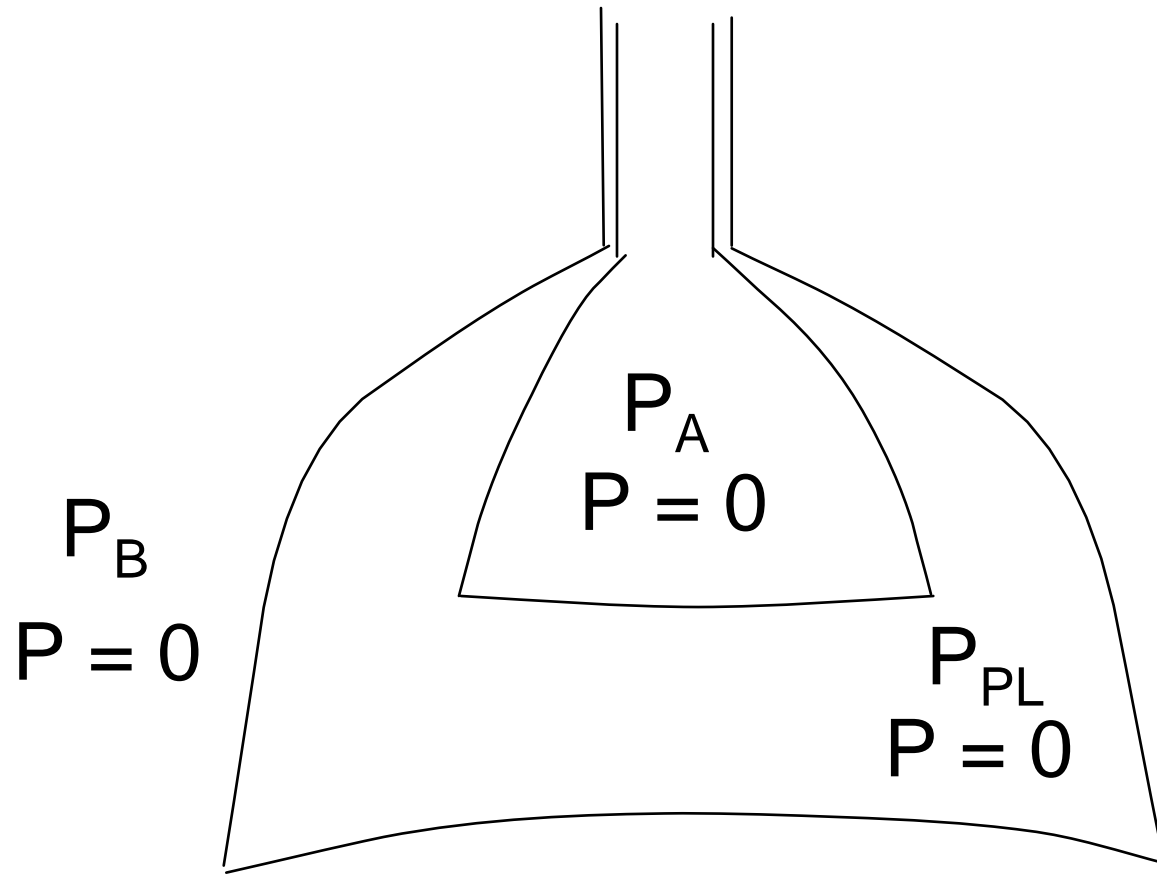
B. Balance between the lung and chest wall

C. IntraPleural pressure, P_{pl}

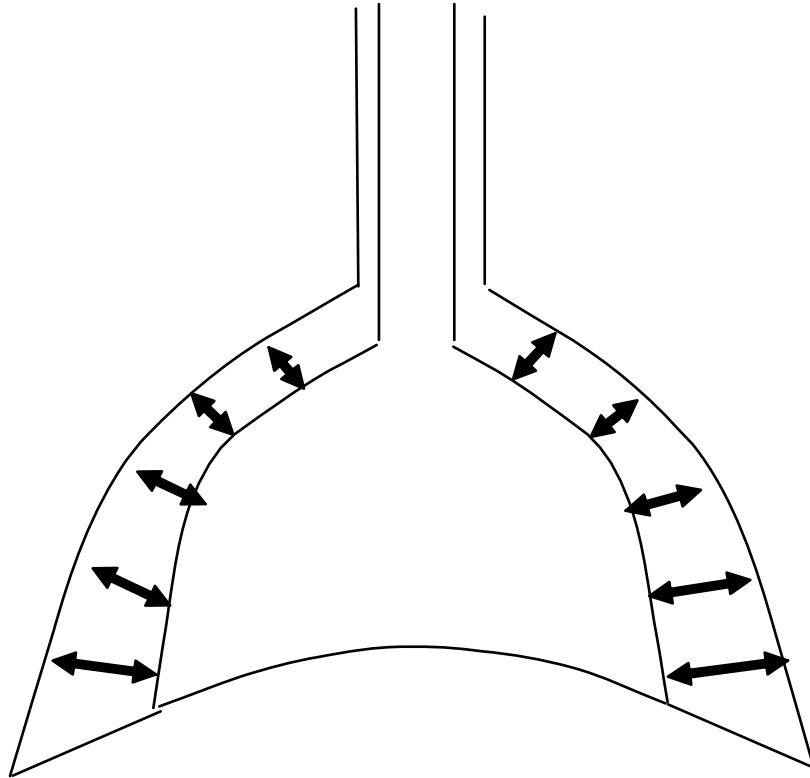
D. Alveolar pressure, P_A

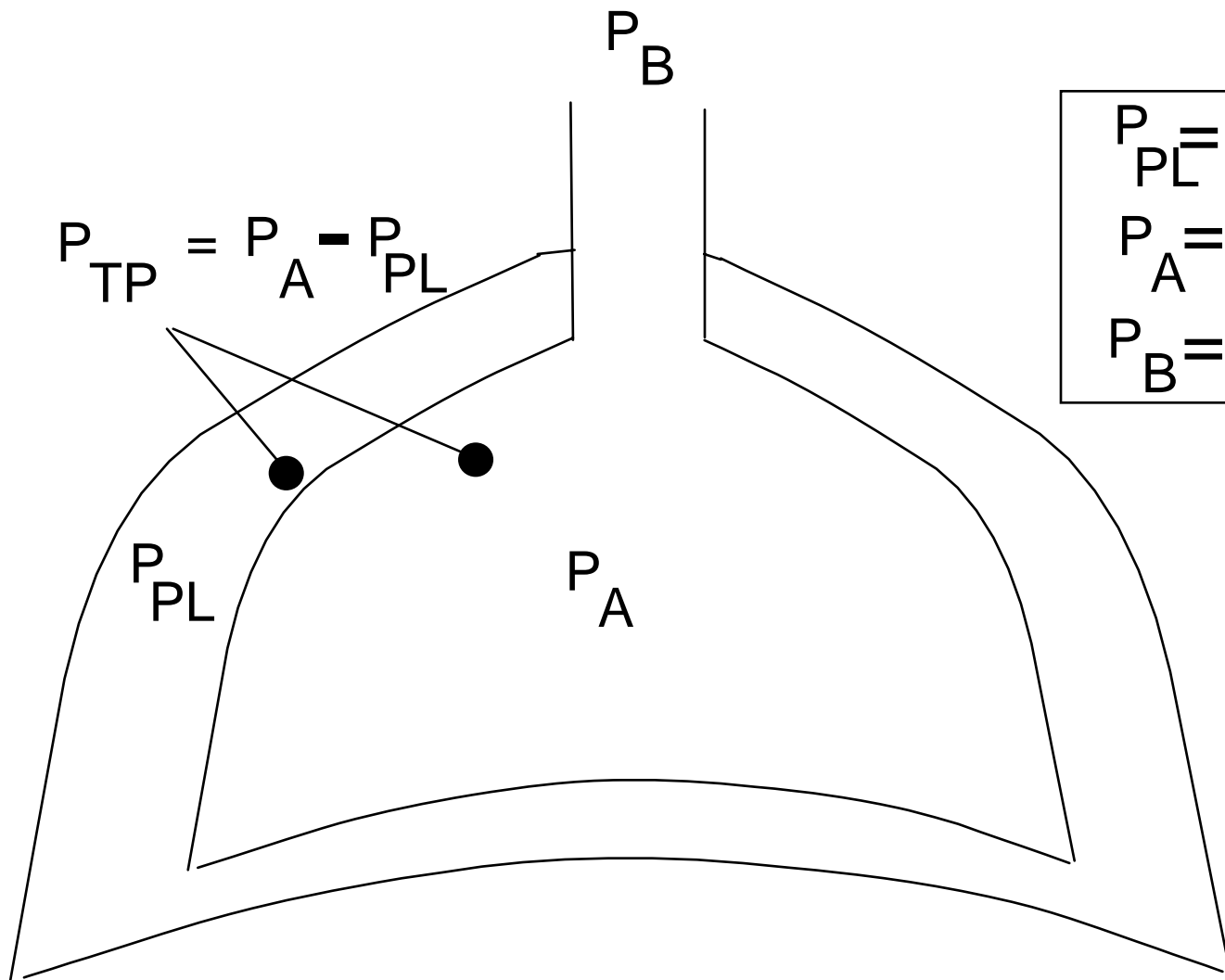
E. Related pressure: transpulmonary pressure, P_{TP}





Pneumothorax





P_{PL} = Pleural P
 P_A = Alveolar P
 P_B = Barometric P

P_{TP} = Transpulmonary P