To account for every alveoli in the lung, we must take note of the fact that the ventilation perfusion ratio (r) is NOT constant. To do this we number each alveoli using an index \( i = 1, 2, \ldots, 3 \times 10^8 \). We can then find the flux of gas through the \( i \)th alveolus with the following equation:

\[
f_i = Q_i r_i \sigma P_i - \frac{P_v}{r_i + \sigma kT} + \sigma kT \frac{V_A}{Q_i}.
\]

Summing together the \( 3 \times 10^8 \) equations will then give a new function of the total transport of gas in the lung.

Gas movement in the lungs

To simplify the modelling of gas transport in one alveolus we make the following assumptions:

1. Ideal Gas Law. The gas behaves as an ideal gas in the alveolar air: \( P_A = kT c_A \).
2. Simple Solution. The gas forms a simple solution in the blood. In particular, for the arterial blood: \( \sigma P_a = c_a \).
3. Equilibrium. As the blood passes through the alveolus, it achieves equilibrium with the alveolar air. Therefore the partial pressure of each gas in the blood leaving the alveolus is the same as in the alveolar air: \( P_a = P_A \).

The equations above can then be manipulated to yield:

\[
c_a = \sigma kT \frac{r c_1 + c_v r + \sigma kT}{Q_i}.
\]

We can then use this to solve for an equation describing the net transport of the gas of interest.

\[
f = Q(c_a - c_v) = Qr \sigma \frac{P_i - P_v}{r + \sigma kT}.
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