

Solutions to Homework Assignment – Module 12

1. [20 points] Discuss/explain what is meant by the term *ventilation/perfusion matching*. Describe/discuss/explain the local mechanism(s) that control ventilation/perfusion matching.

The term ***ventilation/perfusion matching*** refers to the (local) adjustments of blood flow and air flow to groups of alveoli so that the ratio of alveolar ventilation to perfusion is optimized (as much as possible) for the efficient exchange of gases (O_2 and CO_2) between alveolar air and pulmonary capillary blood. Put simply, it is the matching of alveolar ventilation and pulmonary capillary blood flow so that a respiratory unit has enough (not too much, not too little) air flow to allow for the proper addition of oxygen to, and the removal of carbon dioxide from, pulmonary capillary blood.

The local mechanisms are as follows:

Too much ventilation/insufficient blood flow

Local P_{CO_2} decreases (decreasing local $[H^+]$) and local P_{O_2} increases. These changes (1) increase the contraction of local airway smooth muscle, thereby increasing airway resistance, which reduces ventilation to better match the limited blood flow and (2) decrease the contraction of local blood vessel smooth muscle, thereby reducing local vascular resistance, which increases local blood flow to better match the existing excess air flow. Note that the changes to ventilation and to perfusion occur at the same time, so that ventilation and perfusion meet in the middle, so to speak.

Too much blood flow/insufficient air flow

Local P_{CO_2} increases (increasing local $[H^+]$) and local P_{O_2} decreases. These changes (1) decrease the contraction of local airway smooth muscle, thereby decreasing airway resistance, which increases local ventilation to better match the excess blood flow and (2) increase the contraction of local blood vessel smooth muscle, thereby increasing local vascular resistance, which decreases local blood flow to better match the existing limited air flow. Note that the changes to ventilation and to perfusion occur at the same time, so that ventilation and perfusion meet in the middle, so to speak.

See Video 3, Slides 8 and 9.

2. [20 points] Distinguish between the terms *anatomic dead space* and *physiologic dead space*.

Anatomic dead space is the volume of the conducting airways. ***Physiologic dead space*** is the anatomic dead space plus the volume of alveoli that are

ventilated but not perfused. See B&L[6+], pages 447 – 448; B&L[7], pages 466 - 467.

3. [20 points] Differentiate between the terms *pulmonary minute ventilation* and *alveolar minute ventilation*.

Pulmonary minute ventilation is the amount of air delivered to the lungs per minute; it is equal to the tidal volume (see B&L[6+], Figure 21-1; B&L[7], Figure 21.3) multiplied by the respiratory rate, in breaths per minute. ***Alveolar minute ventilation*** is the amount of air delivered to the alveoli per minute; it is equal to the (tidal volume - anatomic dead space volume) multiplied by the respiratory rate, in breaths per minute.