Describe/discuss/explain how a disease condition that thickens the tissue barrier between the alveolar space and pulmonary capillary blood might affect the mechanism(s) by which oxygen is transported in the blood between the pulmonary capillaries and the tissue capillaries. Work individually;

Among different factors, Fick’s law states that the diffusion of a gas or amount of gas transferred into the pulmonary artery is proportional to the surface area of the tissue but inversely proportional to the thickness of the tissue.

Vgas = A x D x (P1-P2)/ T

Vgas: diffusion of gas across a sheet of tissue, A: surface area of the tissue, D: diffusion constant of the specific gas, (P1-P2): partial pressure difference of the gas on each side of the tissue, T: tissue thickness. Therefore, when a disease conditions thickens the tissue barrier, the rate of oxygen diffusion from the alveolar space to the blood in the pulmonary capillaries goes down.

In normal circumstances, transfer of O2 into the pulmonary capillary is perfusion limited, meaning the amount of O2 taken up by the blood depends on the amount of blood flow and not on the diffusion properties of the blood-gas barrier. Under typical resting conditions, the capillary PaO2 reaches the alveolar PAO2 when the RBC is about 1/3 of its way along the capillary (the difference in PO2 between alveolar gas and end-capillary blood is immeasurably small), which means the blood cells have taken up all the O2 available through the alveolus when they reach the venous side of the capillary. When the tissue barrier between the alveolar space and pulmonary capillary thickens, it is less easy for O2 to diffuse through the barrier, the pressure equilibrium does not occur by the time the blood reaches the end of the capillary (see figure below from B&L[15] p.482). The transfer of O2 into the capillary is now partly diffusion limited (\*), the level of O2 drops on the artery side. An increase of Aa gradient attributable to incomplete diffusion could be observed (PAO2 up, PaO2 down) and diffusion limitation responds well to 100% O2.

\*: although according to B&L[15] p.477: “alveolar capillary block**,** or thickening of the air-blood barrier, is an uncommon cause of hypoxemia. Even when the alveolar wall is thickened, there is usually sufficient time for gas diffusion unless the red blood cell transit time is increased.”

