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;

Diffusion though tissues is described by Fick’s law: the diffusion of a gas through a sheet of tissue is proportional to the tissue area, and the difference in gas partial pressure between the two sides, and inversely proportional to the tissue thickness:

Vgas = A x D x (P1-P2)/T

Vgas: diffusion of gas across the 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. 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 red blood cells are about 1/3 of their ways along the capillary (the difference in PO2 between alveolar gas and end-capillary blood is then immeasurably small), which means the blood cells have taken up all the O2 available through the alveoli when they reach the other side of the capillary. When the tissue barrier between the alveolar space and pulmonary capillaries thickens, it is less easy for O2 to diffuse through the barrier, the pressure equilibrium might not occur by the time the blood reaches the end of the capillaries (figure below from B&L[15] p.482 and the O2 abnormal curve). The transfer of O2 into the pulmonary capillary blood is now partly diffusion limited. Compared to normal circumstances, as the blood leaves the pulmonary capillaries, the level of oxygen has dropped, O2 saturation and concentration have decreased and less oxygen is now reaching the tissue capillaries. An increase of AaDO2 gradient attributable to incomplete diffusion could be observed (PAO2 same or up, PaO2 down and AaDO2 = PAO2 - PaO2).

