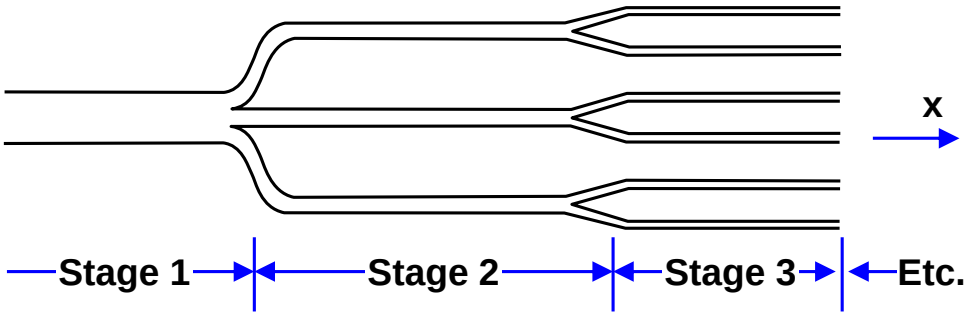
Problem 160D

Both the mammalian respiration system and the mammalian blood circulation system are networks of tubes in which the flow from one large tube (respectively the trachea and the aorta) branches into parallel flows in tubes of smaller size. This branching continues through a number of stages:



If, for each stage, the number of tubes is denoted by n and the cross-sectional area for each and every tube in that stage is denoted by A_n, find the relation between A_n and n such that the pressure gradient, dp/dx, is the same for each stage. How does the average velocity depend on n? Assume steady, fully-developed Poiseuille flow in all tubes even though this may not be the case in the actual systems.

If the diameter of the aorta is 3 cm and the diameter of the microcirculation (the smallest tubes) is 8×10^{-6} m, calculate the number of tubes at the microcirculation stage which would be present if the above property were to exist. The actual number is much smaller than this. Where, then, does most of the pressure drop occur in the blood circulation system?