

BAE 103
Energy in Biological Systems

Problem Set No. 9

Concepts: Reynold's Number, Average Velocity and Pressure Loss

Due Date: Monday, March 12

- 9.1 The average human heart has a stroke volume of approximately 70 ml. Assuming the heart beats at a rate of 70 beats per minute (adult at rest), what is the volumetric output of the heart in liters per minute?
- 9.2 It is estimated that the human body contains 5.0 L of blood. If this is the case, how often is the blood recirculated (s) in the body of athlete with a heart rate of 180 beats per minute?
- 9.3 The aorta is approximately 25 mm in diameter and has a wall thickness of 2 mm (inside diameter of 21 mm). Blood is estimated to be four times as viscous as water. Using these values and the "at rest" output of the heart, is blood flow in the aorta laminar or turbulent? Support your answer by calculating the Reynold's number. The absolute viscosity of water at 37°C is 0.00072 N·s/m².
- 9.4 Estimate the pressure loss (Pa) in the aorta of an athlete during exercise. Assume the aorta is 125 mm long. The heart rate is 180 beat/min and the stroke volume is 200 ml.
- 9.5 Capillaries (the smallest blood vessels) are approximately 8.0 x 10⁻⁶ m in diameter. The total cross-sectional area of all capillaries in the human body is approximately 2000 times that of the aorta. Is blood flow through the capillaries turbulent or laminar? Support your answer by calculating Reynold's number for the capillaries non-athlete at rest.