Bio390 **PERIPHERAL CIRCULATION and RESISTANCE**

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1. In mammalian circulatory physiology, resistance to flow is measured in **peripheral resistance units**, PRU. What are the dimensions of PRU's if blood flow is measured in $\frac{ml}{\min}$ and pressures are measured in mm Hg?

R = ΔP / $\dot{Q}$ = mm Hg / ($\frac{ml}{\min}$) = mmHg * min * ml^{-1}

ANS: **(mmHg * min) / ml**

2. Estimate the total resistance (in PRU's) for the **systemic circulation** given the following information:

cardiac output: $\frac{5000\ \text{ml}}{\min}$
mean aortic pressure: 95 mm Hg
mean right atrial pressure: 4 mm Hg

ΔP for the systemic circulation = 95 - 4 = 91 mmHg

Thus, R = ΔP / $\dot{Q}$ = 91 mmHg / $\frac{5000\ \text{ml}}{\min}$ = 0.0182 PRU

ANS: **0.0182 PRU**

3. Assume that mean pressures in the left atrium and pulmonary arteries are 2 and 13 mm Hg, respectively. Which circuit, systemic or pulmonary, has the greater resistance to flow? How many times greater?

First, we need to find the total peripheral resistance of the pulmonary circulation. In this case ΔP = 13 - 2 = 11 mmHg. Recall that the left and right sides of the heart MUST on the average pump the same amount of blood. So, following the procedure as in #2:

R = ΔP / $\dot{Q}$ = 11 mmHg / $\frac{5000\ \text{ml}}{\text{min}}$ = 0.0022 PRU

The ratio of the resistance of the systemic to pulmonary circulations is therefore
0.0182 PRU / 0.0022 PRU = 8.27 X
ANS: **the resistance of the systemic circulation is about 8.3X greater under these conditions**

4. Consider a hypothetical circulatory system composed of 5 circuits arranged in parallel. Each component circuit has a resistance of 3 PRU's. The total pressure gradient in this system is 100 mm Hg.

a. Estimate the total resistance for this circulatory system.

This is just a problem of parallel resistances of equal values. Thus

1/Rtotal = 1/R1 + 1/R2 + 1/ R3 + 1/R4 + 1/ R5

now since R1 = R2 = ... = R5, then

1/ Rtotal = 5/ R1

or

Rtotal = R1 / 5

Since R1 = 3 PRUs

then Rtotal = 3 PRU / 5 = 0.6 PRUs

ANS: **0.6 PRUs**

b. Estimate flow rate (in $\frac{\text{ml}}{\text{min}}$) through one of the circuits.

$\dot{Q}$ = ΔP / R = 100 mmHg / 3 PRU = 33.3 ml/min

ANS: **33.3 ml/min**

Note that the total flow through this system would be 5 times this amount or 166.5 ml / min

c. Estimate total resistance in this circulatory system **IF** the five component circuits (each having an individual resistance as given above) were arranged "in series".

Series resistances add, therefore in this case Rtotal = 5*R1 = 5*3 PRU = 15 PRU which is 5X the resistance of parallel circuit

ANS: **15 PRU**

Notice that, hopefully to no one's surprise, if one were to calculate system flow in this case, it would be:

$\dot{Q} = \Delta P / R$ = 100 / 15 = 6.67 ml / min which is 5X less than if the circuit was set in parallel (see above).