Module #1 Explanation

After the groups have shared the results of their experiments, have them enter their data in a spreadsheet application for graphing and analysis. Ideally, there should be multiple trials of each experiment. Time should be entered as the independent variable and blood pressure and pulse rate will both be dependent variables. Engage the students in a discussion of the implications of their findings.

Introduce the formulas discussed below. Engage the students in a discussion of the impact of the physical activities on the variables in the formulas.

TEACHER NOTES

Blood pressure is affected by cardiac output, peripheral resistance and blood volume. Mathematically, there is a direct relationship between blood pressure (BP), cardiac output (CO) and peripheral resistance (PR). This relationship can be expressed as:

BP = CO x PR (where CO = SV x HR and SV = EDV - ESV)

Cardiac output (CO) is the volume of blood pumped out by each ventricle in one minute. It can be represented as the product of heart rate (HR) and stroke volume (SV). **Heart rate** is the number of times the heart beats each minute. It can be determined by taking one's pulse.

Stroke volume is defined as the volume of blood pumped out by a ventricle with each heartbeat. It can be expressed as the difference between the **end diastolic volume** (EDV) and **end systolic volume** (ESV). **End diastolic volume** is the volume of blood found in the ventricle at the end of diastole. This is the greatest amount of blood found in the ventricle during the cardiac cycle. **End systolic volume** is the amount of blood left in the ventricle at the end of systole. This is the smallest volume of blood in the ventricle during the cardiac cycle.

The difference between the systolic and diastolic pressure is **pulse pressure**. It is often felt as a throbbing pulsation in an artery during systole. Because of the fluctuations in aortic pressure, mean atrial pressure (**MAP**) becomes significant. It is the pressure that propels the blood to the tissues through the cardiac cycle. Because of the longer lasting sequence of diastole, **MAP** is often represented as the diastolic pressure plus one-third the pulse pressure.

MAP = Diastolic Pressure + 1/3 Pulse Pressure

Peripheral resistance is the opposition to blood flow and is a measure of the amount of friction blood encounters as it passes through the blood vessels. Peripheral resistance is affected by (a) blood viscosity, (b) total blood vessel length and (c) blood vessel diameter.

Blood viscosity is the internal resistance to blood flow and is related to the thickness of a fluid. All liquids and gases exhibit this characteristic. Blood viscosity is fairly constant but an excessive number of red blood cells can increase blood viscosity, which ultimately increases blood pressure. Also, when the red blood cell number is low, blood can become less viscous which results in a decrease in peripheral resistance. **Blood vessel length** has a direct relationship with peripheral resistance. The longer the total vessel length, the greater the resistance.

Blood vessel diameter significantly affects peripheral resistance. The smaller the blood vessel diameter, the greater the resistance. Resistance varies inversely with the fourth power of the vessel radius (radius is half the diameter). Consequently, if the radius of a blood vessel is doubled, the resistance is one – sixteenth as much. Thus, the large arteries close to the heart contribute little to peripheral resistance whereas the smaller ones, which enlarge or constrict in response to neural and chemical controls, are major factors. Saturated or unsaturated fat within the blood vessel can substantially increase peripheral resistance.

Normal Blood Pressure for an Adult = 120 mm Hg/80 mm Hg
Normal Average Cardiac Output = 5250 ml/min
Normal Heart Rate = 75 beats/min
Normal Stroke Volume = 70 ml/beat
Normal End Diastolic Volume = 120 ml/beat (For an Adult)
Normal End Systolic Volume = 50 ml/beat (For an Adult)