

Name: **Answers**

Cardiac Adaptations to Exercise

Overview

Over the course of a six month training program an endurance athlete had three cardiac measurements (heart rate, stroke volume and cardiac output) taken periodically to determine the effect training has on the heart. Complete the following activity to determine the effect training has on the heart and how maths is used by exercise physiologists to track the progress of an athlete.

Definitions

- Complete the following table to define the cardiac measurements that were taken during the training program (you may use the internet to help you).

| Cardiac value | Definition | Measurement unit |
|----------------|---|------------------|
| Heart rate | Amount of times the heart beats per minute | beats per minute |
| Stroke volume | Volume of blood that leave the left side of the heart per beat | ml per beat |
| Cardiac output | Volume of blood that leaves the left side of the heart per minute | L per minute |

Calculations

The following equation is used to calculate cardiac output:

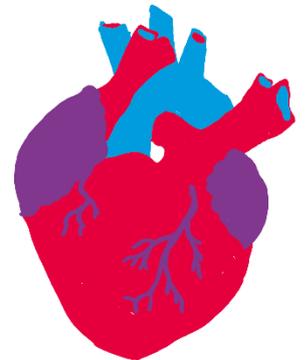
$$\text{Cardiac output} = \text{Heart rate} \times \text{stroke Volume}$$

- Rearrange the equation to make:
 - heart rate** the subject of the equation:

$$\text{Heart rate} = \text{cardiac output}/\text{stroke volume}$$

- stroke volume** the subject of the equation:

$$\text{Stroke volume} = \text{cardiac output}/\text{heart rate}$$



Resting values



The table below displays how training effects the cardiac values at rest.

3. Use the cardiac equations above to complete the values in the table below:

| Month of training | Heart rate | Stroke volume | Cardiac output | Cardiac output |
|-------------------|------------|---------------|----------------|----------------|
| 0 | 80 bpm | 60 ml | 4.800 ml/min | 4.800 L/min |
| 2 | 61 bpm | 85 ml | 5185 ml/min | 5.185 L/min |
| 4 | 55 bpm | 103 ml | 5665 ml/min | 5.665 L/min |
| 6 | 51 bpm | 110 ml | 5610 ml/min | 5.610 L/min |

4. Use excel to create 3 line graphs to display how training effects your heart function at rest.
- Graph One – Heart Rate (X axis – month of training, Y axis – heart rate)
 - Graph Two – Stroke Volume (X axis – month of training, Y axis – stroke volume)
 - Graph Three – Cardiac Output (X axis – month of training, Y axis – cardiac output)
5. Describe the trend of the graph for each of the cardiac values.

| Graph | Trend |
|----------------|---|
| Heart rate | Resting heart rate decreased over the training period |
| Stroke volume | Resting stroke volume increased over the training period |
| Cardiac output | Resting cardiac output increased over the training period |

6. Explain why you think training has this effect on an athlete's resting heart rate.

Training increased the stroke volume of the heart. As the stroke volume increases then the heart does not need to beat as often to maintain the same cardiac output. Therefore training will result in a decrease in the resting heart rate of an athlete.



Maximum effort values

The table below displays how training effects the cardiac values at maximum effort (exercising as hard as you can for 45 seconds).

7. Use the cardiac equations above to complete the values in the table below:

| Month | Heart rate | Stroke volume | Cardiac output | Cardiac output |
|-------|------------|---------------|----------------|----------------|
| 0 | 195 bpm | 120 ml | 23400 ml/min | 23.400 L/min |
| 2 | 196 bpm | 166 ml | 22736 ml/min | 22.736 L/min |
| 4 | 194 bpm | 203 ml | 39382 ml/min | 39.382 L/min |
| 6 | 195 bpm | 220 ml | 42900 ml/min | 42.900 L/min |

8. Use excel to create 3 line graphs to display how training effects your heart function at maximum effort.

- Graph One – Heart Rate (X axis – month of training, Y axis – heart rate)
- Graph Two – Stroke Volume (X axis – month of training, Y axis – stroke volume)
- Graph Three – Cardiac Output (X axis – month of training, Y axis – cardiac output)

9. Describe the trend of the graph for each of the cardiac values.

| Graph | Trend |
|----------------|--|
| Heart rate | Maximum heart rate stayed the same over the training program |
| Stroke volume | Maximum stroke volume increased over the training program |
| Cardiac output | Maximum cardiac output increased over the training program |

10. Explain why you think that training has this effect on an athlete's stroke volume.

As the heart is a muscle, when you complete training the left side adapts by getting bigger and stronger. The increase strength and size of the left ventricle allows it to move more blood each beat.

11. If we were to measure the athlete's oxygen consumption per minute at maximum effort would the value be greatest at zero or six months? Explain how you were able to come to this conclusion.

The oxygen consumption would be greatest after 6 months of training. I made this conclusion as the cardiac output increased, this means that more blood is flowing through the body. As

the blood carries oxygen, the increase in blood moving would mean more oxygen is being transported and used by the body.