Presented by Chris Hudd

**Study design dot point:**
- Chronic adaptations of the cardiovascular, respiratory and muscular systems to aerobic, anaerobic and resistance training.
Overview – The chronic adaptations

Theory summary
A long-term physiological change, in response to training loads, that allow the body to meet new demands.

Categorised as either:

- Aerobic adaptations
- Anaerobic adaptations

Occur at the following levels (locations) of the body:

- Respiratory level
- Cardiovascular level
- Muscular level
Types of training

Theory summary
The effects of training are specific to the type of training undertaken and to the body system in which the physiological change is occurring.

Overview:

Aerobic training methods
e.g. continuous, Fartlek, long interval

Anaerobic training methods
e.g. Plyometrics, resistance, short interval

Aerobic adaptations

Anaerobic adaptations

Image sources:
http://www.mildenhall.af.mil/News/Article-Display/Article/273033/the-male-runner-looking-for-a-new-personal-record/
http://www.dodlive.mil/2018/05/24/navy-seals-murph-challenge-has-become-big-memorial-day-deal/
Structural and functional change

Theory summary
Adaptations can either be structural (physical make-up) or functional (how it operates), and all lead to improved performance.

Below is a worked example of the effects of aerobic training on the heart.

<table>
<thead>
<tr>
<th>Structural change</th>
<th>Functional changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>• increase size of left ventricle chamber</td>
<td>• increase stroke volume</td>
</tr>
<tr>
<td></td>
<td>• decrease heart rate</td>
</tr>
</tbody>
</table>
Chronic adaptations

Theory summary
In this lesson we will focus on the following adaptations:

Overview:
Aerobic adaptations
Respiratory level
Cardiovascular level
Respiratory adaptations during aerobic training

**Theory summary**
When discussing changes at the respiratory level, we are talking about changes occurring in an athlete’s lungs.

Any changes at a respiratory level ultimately leads to an increase in the levels of oxygen that we are able to intake.
The respiratory changes that occur in the lungs

**Theory summary**
Below is a summary of the respiratory adaptations associated with aerobic training.

<table>
<thead>
<tr>
<th>Structural change</th>
<th>Functional changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Increased lung volume</td>
<td></td>
</tr>
<tr>
<td>• Greater alveolar-capillary surface area</td>
<td></td>
</tr>
<tr>
<td>• Increase sites for gas exchange</td>
<td>• Increased tidal volume (submax and max)</td>
</tr>
<tr>
<td></td>
<td>• Decreased respiratory rate (submax and max)</td>
</tr>
<tr>
<td></td>
<td>• Increased pulmonary diffusion</td>
</tr>
<tr>
<td></td>
<td>• Decreased ventilation (rest and submax)</td>
</tr>
<tr>
<td></td>
<td>• Increased ventilation (max)</td>
</tr>
<tr>
<td></td>
<td>• Increased ventilatory efficiency</td>
</tr>
</tbody>
</table>
### Increased lung volume

**Theory summary**
An increase in lung volume or capacity will increase the amount of air in the lungs at the end of a maximal inspiration. This ultimately means that an athlete is able to intake more air, and have greater volumes of oxygen available for delivery and consumption.

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<td></td>
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</table>
Increased alveolar-capillary surface area

**Theory summary**
An increase in the volume of the lungs leads to an increase in the available surface area of the alveolar-capillary interface.

An increase in the surface area between the alveoli air sacs and the blood vessels increases the number of sites available for pulmonary diffusion to occur.

<table>
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<th>Functional changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Increased alveolar-capillary surface area</td>
<td>• Increased pulmonary diffusion</td>
</tr>
</tbody>
</table>
Cardiovascular adaptations – Aerobic training

Theory summary
When discussing changes at the cardiovascular level, we are talking about changes occurring in an athlete’s heart, blood vessels, and blood.

Any changes at a cardiovascular level ultimately lead to an increase in the levels of oxygen we are able to transport.
The cardiovascular changes that occur in the lungs

**Theory summary**
Aerobic training leads to an increase in the size of the left ventricular cavity. An increase in the volume of this heart chamber has a number of beneficial functional changes for an aerobic athlete’s cardiovascular system.

<table>
<thead>
<tr>
<th>Structural change</th>
<th>Functional changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Increased left ventricle size</td>
<td>• Increased stroke volume</td>
</tr>
<tr>
<td></td>
<td>• Decreased heart rate (rest and submax)</td>
</tr>
<tr>
<td></td>
<td>• Decreased steady state heart rate</td>
</tr>
<tr>
<td></td>
<td>• Decreased recovery heart rates</td>
</tr>
<tr>
<td></td>
<td>• Increased cardiac output (maximal)</td>
</tr>
</tbody>
</table>
Blood vessels

Theory summary
Aerobic training leads to an increase in the density of capillaries that surround the working muscles. This will ultimately lead to an increase in the supply of oxygen and other nutrients.

<table>
<thead>
<tr>
<th>Structural change</th>
<th>Functional changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Increased capillarisation of skeletal muscles</td>
<td>• Increased blood flow to skeletal muscles</td>
</tr>
</tbody>
</table>
# Blood

**Theory summary**
Aerobic training leads to a number of changes related to the composition of an athlete’s blood.

<table>
<thead>
<tr>
<th>Structural change</th>
<th>Functional changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Increased blood plasma</td>
<td>• Increased blood volume</td>
</tr>
<tr>
<td>• Increased red blood cell count</td>
<td>• Decreased low-density lipoproteins (bad fats)</td>
</tr>
<tr>
<td>• Increased haemoglobin</td>
<td>• Decreased blood pressure</td>
</tr>
<tr>
<td>• Increased high-density lipoproteins</td>
<td></td>
</tr>
<tr>
<td>• increase HDL (good fats)</td>
<td></td>
</tr>
</tbody>
</table>
Multiple choice activity

A 38-year-old mother of two has decided to undertake an endurance running program to participate in the Melbourne Marathon in October.

Chronic respiratory adaptations, as a result of her participating in an 8 week training program to improve aerobic capacity, would include:

A. decreased resting heart rate, increased pulmonary diffusion, improved efficiency of the respiratory muscles.
B. increased myoglobin, increased cardiac output at maximal levels, improved pulmonary diffusion.
C. increased mitochondria, improved efficiency of the respiratory muscles, increased cardiac output.
D. improved efficiency of the respiratory muscles, improved pulmonary diffusion, increased total lung volume.
E. I don’t know.
Multiple choice – Response

A 38-year-old mother of two has decided to undertake an endurance running program to participate in the Melbourne Marathon in October.

Chronic respiratory adaptations, as a result of her participating in an 8 week training program to improve aerobic capacity, would include:

A. decreased resting heart rate, increased pulmonary diffusion, improved efficiency of the respiratory muscles.
B. increased myoglobin, increased cardiac output at maximal levels, improved pulmonary diffusion.
C. increased mitochondria, improved efficiency of the respiratory muscles, increased cardiac output.

D. **improved efficiency of the respiratory muscles, improved pulmonary diffusion, increased total lung volume.**

E. I don’t know.
What chronic adaptation is shown in the graph below?

A. Increased stroke volume
B. Decreased stroke volume
C. Decreased resting heart rate
D. Increased resting heart rate
E. I don’t know.
What chronic adaptation is shown in the graph below?

A. Increased stroke volume
B. Decreased stroke volume

C. Decreased resting heart rate *(41% correct)*

D. Increased resting heart rate

E. I don’t know.
The adaptation shown in the graph is possible because:

A. Stroke volume increases so the heart does not need to beat as often.
B. Oxygen consumption increases so the heart does not need to beat as often
C. Resting heart rate increases to increase the amount of oxygen delivered to the working muscles
D. Stroke volume and heart rate decrease due to an increase in the efficiency of the cardiovascular system.
E. I don’t know.
The adaptation shown in the graph is possible because:

A. Stroke volume increases so the heart does not need to beat as often. (59% correct)

B. Oxygen consumption increases so the heart does not need to beat as often

C. Resting heart rate increases to increase the amount of oxygen delivered to the working muscles

D. Stroke volume and heart rate decrease due to an increase in the efficiency of the cardiovascular system.

E. I don’t know.