Specialist Diploma in Sports & Exercise Sciences

SDSES02

SD-Sport and Exercise Physiology
Continual Assessment 1
METABOLIC REQUIREMENTS FOR DRAGON BOAT

INTRODUCTION

1. The metabolic requirements of a sport is dependent on the intensity and duration of the activity. Although all three energy systems are contributing to the total energy required by the body to perform the activity, however one or two of the energy systems will typically be predominant. This report will study into the three energy systems required in the sport of dragon boat, and suggest training strategies that will enhance the performance of the energy systems of the athlete.

2. In a typical dragon boat race, the distance is neither a sprint nor one of a marathon distance. A typical dragon boat race in Singapore is usually a 'middle distance' race, between 500m to 800m, which will usually last between 2 to 5 minutes. This is comparable to a 800m run or a 200m swim which in their respective sport, neither is considered to be a sprint or marathon event.

3. **Start and Finishing Phase.** Other than being a middle distance event, the 'starts' in a dragon boat race is usually a very intense burst of energy for typically 8-10 seconds to ensure that the bow of the boat is being lifted up and also to allow the boat to break its inertia and go into motion. Following the 'starts', there is usually about 30 seconds of fast and powerful drives to propel the boat to reach a certain velocity and glide. Similarly, the 'final charge' will take on the same intensity as the 'starts' but it usually last even longer in duration, usually between 30 to 45 seconds. During these phases, the rower will typically give 85%-95% of maximal effort, as if in a sprint event. As such, the predominant system at work during these phases will be the **anaerobic** system.

4. **Sustenance Phase.** Other than the above mentioned phases, there will be a period of sustenance to ensure that the boat does not lose its velocity and glide that was built in the earlier phases. This sustenance phase usually last for about 1 to 3 minutes...
(depending on length of race course). The stroke frequency can reach between 65-75 strokes per minute. As such, the rower will engage in a very high but steady-state *aerobic* activity.

**ENERGY SYSTEMS**

5. As mentioned earlier, all energy systems are at work as long as there is physical activity. The difference lies in which energy system contributes more to the production of the energy required. However, there is only one compound that the muscle is powered by, the *Adenosine Triphosphate* (ATP) molecule. ATP is stored in the body in small amounts and is easily expended through short bouts (up to about 5 seconds) of intense activity. Hence to enable the physical actions, ATP has to be resynthesised continuously.

6. ATP, when combined with water (hydrolysis), catalysed by ATPase, will split into Adenosine Diphosphate (ADP), Phosphate and Energy. However, this process is reversible, i.e. ATP is replenished through the combination of ADP with Phosphocreatine (PCr), catalysed by Creatine Kinase (Phosphorylation). (McArdle, Katch and Katch, 2000)

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ATP \leftrightarrow ADP + Pi + Energy
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PCr + ADP \leftrightarrow Cr + ATP
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7. PCr, like ATP, has small limited amounts stored in the body. When the well of PCr has expended and is unable to replenish in time to provide the energy required, performance will be reduced while other source of fuel are being exploited. Fats, Carbohydrates and Proteins (last resort) can also be broken down to produce ATP, although not as immediate.

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1 ATP consists of adenosine and three groups of inorganic phosphate.
8. **ATP-PCr System.** As the name suggests, ATP and PCr are the main elements of the ATP-PCr system. PCr will break down to release a phosphate and energy, which in turn is used to build back ATP. This system is known to be anaerobic due to the fact that it can be conducted in the absence of oxygen, i.e. it does not rely on oxygen for this reaction. Due to its very short chemical process duration, ATP-PCr usually provides the energy required up to the first 5 seconds of any physical activity. Due to the presence of PCr present in the body, ATP can continue to provide energy for up to an additional 8 seconds. PCr stores will require about 3 to 5 minutes to replenish, hence once after about 13 seconds, the ATP-PCr system will fail to provide energy effectively, hence the next dominant energy system will be the anaerobic system.

9. **Anaerobic System.** Glycogen will be broken down into glucose to provide energy for the athlete. Glucose is able to, through the process of oxidation, generate about 36 moles of ATP. The breakdown of glucose (glycolysis) is conducted in two stages (anaerobic and aerobic).

10. **Stage 1 of the process will see one molecule of glucose break down into two molecules of pyruvate (through a 10-steps process), with phosphofructokinase (PFK) as the rate limiting enzyme. When there is a need for energy quick, PFK will speed up the glycolysis process. This increase will not allow H⁺ to move into the Electron Transport Chain, thus it combines with Pyruvate to become lactic acid. And when this rate of lactic acid production exceeds the rate of removal of lactic acid, there will be an increase in H⁺, which can lead to earlier muscle fatigue, because lactic acid dissociates to become lactate and H⁺.

11. **This energy system supports the activities for up to about 45 seconds, thereafter, the aerobic energy system will be the predominant source for energy.**

12. **Aerobic System.** The aerobic system uses a series of processes to produce ATP.
for energy usage. In the process of breaking down glycogen, slow glycolysis occurs, after which, the product pyruvate converts into Acetyl Coenzyme A instead of lactic acid. (Wilmore & Costill, 2005) After which Acetyl CoA moves into the Krebs cycle.

13. During the Krebs cycle, Acetyl CoA is further broken down into CO2 and hydrogen, in order to produce another two ATPs. The hydrogen formed during this process and the earlier glycolysis can cause cells to be too acidic. Hence the hydrogen ions combine with NAD and FAD (enzymes) and are transported to the Electron Transport Chain. In ETC, hydrogen combines with oxygen to form water, which will prevent acidification. At the end of this process, a total of 34 ATPs are being formed.

14. Fat can be metabolised in the Krebs cycle and electron transport chain process, something which glycolysis cannot do. The process of breaking down of fats (triglycerides) into glycerol and free fatty acids (FFA) is called lipolysis. The FFA will undergo beta oxidation and reduced into Acetyl CoA before it can undergo the process of Krebs cycle. Due to the need for repeated process of beta oxidation, fats take a longer time to break down and hence is the source for fuel only in activities that last a long duration.

TRAINED STRATEGIES

15. Anaerobic Capacity. As dragon boat races usually involve equally high levels of anaerobic and aerobic energy systems, although the duration of the race may last longer than 2 minutes, the anaerobic system should not be neglected. One of the ways to improve the performance of the athlete is to ensure that muscle fatigue is overcome by coping with excess lactic acid. Adaptation training on the muscles, by introduction of high intensity workout, can be performed to ensure that the body can still function effectively even under high levels of lactic acid.
16. **Interval training of high intensity** (90% - 100% effort) but **short duration** of between 30 seconds to 2 minutes can be performed. The interval of rest (usually between 1:4 or 1:5) should be sufficient to ensure that ATP stores can be replenished fast enough to ensure that the next set is effectively executed.

17. **Aerobic.** Aerobic capacity is required to be able to train for aerobic power, which is an important component in middle distance races. One of the ways to assess the aerobic capacity is to increase the lactate threshold of the athlete. One of the ways to increase the LT of an athlete during training will be the introduction of interval training.

18. However, in contrast to anaerobic interval training, aerobic **interval training** will need the athlete to train at **low intensity** (70 – 85% of the athlete's maximum heart rate), but **longer duration**, e.g. between 5 to 10 minutes. The recovery should be on the ratio of 1:1.

19. Another method to train an athlete's aerobic capacity is to engage the athlete in **steady state rowing of longer duration** such as between 15 minutes to 1 hour. However the level of intensity for such a training should be at the **anaerobic threshold** of the athlete, so that the body will be trained to remove lactic acid from the blood and as a result increase the anaerobic threshold. With an increased anaerobic threshold, the athlete will be able to race harder and longer before feeling fatigue.

**CONCLUSION**

20. The predominance of the three energy systems in the production of energy for an athlete is dependent primarily on the intensity and duration of the activity. Thus, it is essential to understand the demands of the sport on the energy systems, so as to allow the appropriate training to be conducted to improve the efficiency of the relevant energy
system. The demands of the sport of dragon boat is relatively equal on the anaerobic and aerobic system, hence training for both systems is essential.

(1520 words)

References: