The Use of Aerobic & Anaerobic Pathways in Dance

There are a number of aspects involved with physical fitness that are deemed as a necessity within the realm of contemporary dance. Physical fitness has been defined as "a set of attributes a person has in regards to a person's ability to perform physical activities that requires aerobic fitness, endurance, strength or flexibility and is determined by a combination of regular activity and genetically inherited ability" (www.cdc.gov). As dance has been classified as 'high-intensity intermittent exercise' (Wyon, 2005 Vol 9/No. 1), it is understood that all of these aspects should be trained and conditioned in order for the body to function correctly and to produce the much needed aesthetic demanded in dance. Good flexibility and range of motion in the joints and in the tissues could be thought of as important as the demands of the new and innovative choreography of today is searching for the most impressive and versatile body movements and positions. Excellent balance and control is required during *adagé* and neo-classical *pointé* work, as well as during partner work. Correct postural alignment and bone placement during performance not only gives a cleaner and more visually pleasing line through the body, but can also help with the avoidance of injury.

The efficient production of energy required for the body's movement and function will be the main focus in this work. The main energy producing pathways will be discussed in detail as well as the role of the ATP (adenosinetriphosphate) molecule within the working body. The three main energy pathways that will be examined are the two anaerobic systems and the aerobic system. The importance of improving and conditioning these pathways will also be discussed along with the present debate of 'aerobic vs anaerobic training' (www.optimum-physical-training.com). It will then be shown how the improvement of these energy systems may help to enhance the overall performance of a dancer with reference to quicker recovery time, injury prevention, improved muscle memory and overall aesthetics.

ATP is the body's main energy supplier. The molecule consists of one adenosine particle (consisting of adenine and ribose) with a string of three phosphate groups attached. When the bond between the second and third phosphate group breaks, a small amount of energy is released and absorbed by the surrounding cell. The ATP is then converted to ADP (adenosinediphosphate) with just the two remaining phosphates attached. This transference of energy happens throughout the body. It has been said that 'the role of ATP is so ubiquitous that it can be thought of as the "battery" that provides energy for everything that we do. Just as a battery can power either a flashlight or a radio, so can ATP be used to power any activity or physiological process. But ATP is not an ordinary battery-it is rechargeable' (www.biologymad.com). The ADP is 'recharged' within a cell organelle called mitochondria by adding another phosphate group to produce a new ATP molecule. This happens up to 'three times each minute' (Kornberg in www.trueorigin.org).

ATP can be produced in many ways. It is the end product of a process known as respiration where food and oxygen is processed into energy, lactic acid, water and carbon dioxide. This process can be broken down into three stages, glycolysis, link reaction and the Krebs cycle. The first stage is where a molecule of glycogen, called glucose, is broken down into pyruvate. If there is no oxygen present the pyruvate will then turn into lactate producing only two molecules of ATP, this is termed anaerobic respiration. If oxygen is present, it will react will the pyruvate and form acetyl CoA, this is termed the link reaction. The acetyl CoA is then transferred into the Krebs cycle where it becomes processed and broken down into carbon dioxide, water and thirty-six molecules of ATP. This process is known as aerobic respiration and is used to metabolise fats and proteins as well as glycogen. The third main way involves creatine phosphate instead of glucose and is broken down anaerobically. Creatine phosphate is stored in the muscles and can be converted very quickly into energy during a contraction (www.biologymad.com).

During dance classes and performances, both the aerobic and anaerobic systems will be working, but not necessarily at the same rate, 'at any one time all energy systems

are in use but the percentage use of each energy system is determined by the rate of demand for ATP by the muscle cell' (Wyon, 2005 Vol 7/No. 1). Strong, sharp, quick and controlled movements, using mainly localised muscle groups, rely heavily on the anaerobic system and usually last for only a few seconds. Sequences that involve travelling and continual movement over a longer, sustained period of time depend on the aerobic system. As mentioned previously, dance is intermittent and will demand, depending on the choreography, an ever changing combination of both.

As a dancer is rarely pushed to their maximum aerobic capacity during class, it can be sometimes assumed that more emphasis should be placed on the anaerobic system. However, more and more dancers are realising the importance of cardiovascular training, involving the heart and lungs, and will add extra workout sessions to their programs outside of the dance studio. Cardio-respiratory work such as running, swimming and cycling increases the stroke volume of blood and heart beats per minute allowing more oxygen to be pumped around the body and on to the muscle cells. This will also encourage more capillaries to open to accommodate the increased blood flow. This increased flow may also aid the removal of excess lactate in the muscles. This lactate, known as lactic acid, is used as an indicator of muscle fatigue and causes the burning sensation felt within the muscle towards the end of an exercise,

> *When either fitness levels are low or the intensity of dance is high, or both, lactic acid production is greater than its removal. The substance begins then to accumulate, causing muscle hyperacidity, and eventually brings physical effort to an end. Aspects related to cardiovascular proficiency- such as an increased number of muscle capillaries- may contribute to faster rates of lactic acid removal.*
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> (Koutedakis and Sharp 1999:17)

One of the most important characteristics of aerobic respiration is that this system is vital for the brain to function. The brain, amongst other important roles, is

responsible for concentration and mental awareness. This helps a dancer to remain focused, especially during long training sessions or performance rehearsals. If the dancers concentration levels start to decline there is a danger of either injuring themselves or the surrounding dancers. Being alert during a performance is important as a relatively small mistake could have huge consequences.

Cardiovascular training can also be used to burn off any excess calories, which will turn into fat, the body's fuel storage. However, by over working the aerobic system other systems could become neglected and could deteriorate, ' most people in favour of aerobics in the Aerobic vs Anaerobic Controversy rely heavily on the ability of the aerobic activity to reduce body fat… but fail to mention that you are also losing muscle, strength, power, speed and anaerobic capacity along with fat reduction' (www.optimun-physical-training.com). Current scientific research into the effects of cardio-respiratory training in dance performance seems to support this idea. In an article released by the International Association of Dance Medicine and Science (IADMS), it explains how overworking the aerobic pathway can have a 'negative effect' on anaerobic ATP production as specific enzymes needed to achieve the chemical reaction will have been 'suppressed' (Wyon, 2005 Vol 7/No.1). In another IADMS report they state at the end,

> *A note of caution must be made here, until research has indicated the extent that improved aerobic power can actually enhance dance performance, there is a need to make sure that dancer's do not over develop their aerobic systems to the detriment of the other energy providing systems. The development of aerobic capacity must be part of a comprehensive supplemental training program that addresses all aspects of dance performance demands, such as strength, power and agility.*
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> (Redding and Wyon, 2003 Vol 7: No.1)

With a fully efficient energy system supplying the right amounts of energy at the right moment, all the other aspects that are linked to physical fitness can be worked on. When a dancer is physically tired, the quality of movement and timing starts to deteriorate. The limbs start to tire, the posture may fall out of alignment and the correct execution of the technique is disregarded as the dancer struggles to finish the sequence. By improving the energy producing systems the dancer may be able to dance for longer during performance or in class, as they will be able to recover much quicker after each sequence,

> *The limitation of each system is the speed at which it can reach homeostasis after being depleted…a high aerobic capacity is beneficial to a performer in an anaerobic event as it will aid a faster recovery between bouts of high-intensity exercise and provide a greater amount of ATP via aerobic glycolysis.*
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> (Wyon, 2005 Vol 7/ No.1).

Another advantage of having a conditioned energy system is that the dancer may be less likely to suffer from injury. Most injuries occur when a dancer becomes fatigued both physically and mentally. Insufficient support during a landing from a jump, or lack of control during a leg kick could lead to torn ligaments, sprains as well as dislocations. Strength training, engaging the anaerobic system, could help to lower the chance of injury, 'improvements in muscles' ability to generate force seem to be a way for dancers to enhance their performance and reduce career hazards' (Koutedakis, Stravropoulos-Kalinoglou and Metsios, 2005 Vol 9: No.1). The prospect of sustaining an injury may be terrifying to some dancers, as it will mean time away from dancing. This may lead to loss of role to understudies within a company environment, weight gain, decrease in fitness levels, disassociation with peers as well as other psychological aspects involved with suffering an injury.

More energy means there may be an increase in the number of repetitions performed by the dancer. Repeating a new movement correctly over and over again creates what is called 'muscle memory'. This is where movements and aspects of dance

become ‘second nature’ such as pointing the toes, proper placement of the arms and head and engaging the core stabilising muscles. When learning new choreography, repetitions of movement motifs and connecting sequences will also add to the dancer’s muscle memory, allowing them to remember the dances during the next rehearsal.

Being able to maintain a good posture, good technique, good demonstration of controlled flexibility coupled with good musicality and bodily expression is what makes dancing an art and not a sport, ‘dance is a skill-based art-form. However, unless the ‘physiological dancer’ is honed to the same extent as the ‘artistic dancer’, the limiting factor within their performance capabilities will potentially be their physical conditioning’ (Wyon, 2005 Vol 7/ No.1). Having a well conditioned, efficient energy system will aid in the training and improvement of all the other aspects of physical fitness. High, controlled leg extensions can look exciting. Huge, powerful leaps can look electrifying. It is good aerobic and anaerobic fitness that allows a dancer to train efficiently and safely during technique classes, and to understand the economy of movement through repetition.

Although a dancer may be considered better than others due to a higher degree of flexibility, control, stamina, balance and jumps, it is probably due to being aerobically and anaerobically fit enough to endure the physical and mental challenges of intense, professional training. Improving these energy pathways will not automatically ensure a better a dancer, but will give them a decent base from which to start and develop their overall dance performance.