Initial Responses To Exercise

To explain initial responses to exercise, I am investigating a case study of a rower who is competing in a 2000m race. I am now going to interpret & describe how the rower's cardiac and respiratory system is functioning in th e initial stages of the event.

Time During Race	**Heart Rate** (Beats Per Minute)	**Respiratory Rate** (Breaths Per Minute)
Before	65bpm	12bpm
1 Minute Into The Race	201bpm	68bpm

The reason why his heart rate increases just before the race could be due to a n umber of reasons. One could be that he had a pre warm up session which requires the heart to pump blood faster throughout the body so he is prepared for the race. A second called be due to adrenaline which is a hormone that is secreted by the adrenal medul la in response to stress and increases heart rate, pulse rate, and blood pressure, and raises the blood levels of glucose and lipids. Another reason could be that he has taken a quick form of energy such as a lucozade tablet and the sugar is making his hea rt pump faster in preparation for an event.

Stroke Volume (SV): The volume of blood pumped out of the left ventricle of the heart per beat. It is the difference between the end diastolic volume and the end systolic volume. Typically, the stroke volume is 7 5 ml for an untrained man at rest, and 105 ml for a trained athlete at rest. The resting stroke volume varies according to whether the person is supine, sitting, or standing. Stroke volume increases as the intensity of exercise increases. It may reach 200 ml in highly trained endurance athletes during maximal exercise.

Cardiac Output (Q): The amount of blood per minute pumped out by each of the two ventricles of the heart. A typical value in an adult at rest is 5 litres per minute. The output of each ventricle is the product of the stroke volume (about 70 ml) and the heart rate (about 70 per minute). The output increases with muscular activity, in work or exercise perhaps to a maximum of 4-5 times the resting rate in an average healthy person, or up to 6 -7 times in athletes; heart rate increases by a greater factor than stroke volume.

Approximate Cardiac Outputs:

Before The Race:	
Approximate Cardiac Output	= 5 Litres
Cardiac Output (Q)	= 65 x Stroke Volume
	=5000ml/ 65 = 76.92ml
1 minute into the race:	
Approximate Cardiac Output	=30 Litres
Cardiac Output (Q)	=201 x Stroke Volume
	=3000/ 201 = 149.25ml

(P1)

Nervous System:

The human nervous system is the basis for the range and subtlety of all human movement. The nervous system, controlled by the brain, generates and sends every impulse that is directed into the musculoskeletal system for the stimulation of both muscular movement and reaction to a stimulus. The brain is the organ that operates the body; the human mind is the more of a complicated concept, connected to the physical organ and the nervous system, but extending into the aspects of intelligence, reasoning abilities, and human perception.

Physical abilities that are at the essence of athletic ability, including muscular control, han d-eye coordination, reaction time, and the utilization of the body's composition of fast -twitch versus slow-twitch fibres, are all determined by the brain.

The nervous system consists of highly sophisticated series of nerves and neurons that extend to every part of the body. CNS (Central Nervous System) itself is subdivided into two major operational systems: the somatic (or voluntary) nervous system and the autonomic nervous system. The somatic system directs movement and the control of the skeletal muscles. The nerves that extend into the muscles ultimately terminate in a motor neuron, the device that transmits the partic ular instruction to the muscle fibres. The speed with which the particular neuron is designed to direct its impulses into the muscle fibr e will dictate whether the fibre is a fast-twitch or slow-twitch fibre. The autonomic system is responsible for the regulation of a number of bodily functions that are either involuntary, or where the body generates an initial response that may be the subj ect of further voluntary action. This includes the management of the body's "fight or flight" response, triggered when the brain, after receiving stimulation of a threat or other challenge, focuses the production of adrenaline, the hormone that stimulates heart rate, respiratory function and the expansion of blood vessel capacity.

It is from this information why I believe the rower was able to perform as the race begins. The sound from the starting gun would have initiated the CNS to send information to bo th the Autonomic Nervous system and the Somatic Nervous System . The Autonomic Nervous system would have received information from the CNS telling it that the brain has received stimulation of a challenge and therefore has directed the production of adrenal ine which would have then been handed over to the Somatic Nervous system which would take on the adrenaline and transport it to the muscles via Motor Neurones. The motor neurones would then receive information from the CNS saying which muscles and which mu scle fibres are required for the rower to perform from start to finish.

(P2)

Energy System:

Energy is required for all kinds of bodily processes including growth and development, repair, the transport of various substances between cells and of course, muscle contraction. Skeletal muscle is powered by one and only one compound... adenosine triphosphate (ATP). However, the body stores only a small quantity of this 'energy currency' within the cells and it's enough to power just a few seconds of a ll-out exercise. So the body must replace or resynthesize ATP on an ongoing basis.

ATP and creatine phosphate (also called phosphocreatine or PCr for short) make up the ATP-PCr system. PCr is broken down releasing a phosphate and energy, which is then use d to rebuild ATP. The enzyme that controls the breakdown of PCr is called creatine kinase. The ATP-PCr energy system can operate with or without oxygen but because it doesn't rely on the presence of oxygen it said to be anaerobic. During the first 5 second s of exercise regardless of intensity, the ATP-PCr is relied on almost exclusively. ATP concentrations last only a few seconds with PCr buffering the drop in ATP for another 5 -8 seconds or so. Combined, the ATP -PCr system can sustain all-out exercise for 3-15 seconds and it is during this time that the potential rate for power is at its greatest.

Glycolytic System is the breakdown of glucose and consists of a series of enzymatic reactions. Carbohydrates we eat supply the body with glucose, which can be stor ed as glycogen in the muscles or liver for later use.

'Competitional rowers display maximal oxidative and maximal anaerobic metabolic effort during racing. At competition level rowing a race of 2000m takes between 5.5 and 8.0 minutes requiring maintenance of high power for the duration. Aerobic energy is thought to account for 70-75% of the energy and anaerobic energy for the remaining 20 - 25%. Based from scientific evaluations of rowers performances; during a race situation, 67% of energy is derived from the aerobic system, 21% alactic anaerobic and 12% lactic anaerobic. ATP -PCr System covers the majority of the percentage of needed for rowers as they require Aerobic energy for around 70% - 75% percent of the race. This would have been used during and after the first minute of the race as the Creatine Phosphate from the carbohydrates is broken down via the help of Creatine Kinase and supplies the rebuilding of ATP during the race. This is then converted into energy which is transported to the muscles. Fat i s the secondary product that is then used in the same ATP -PCr process. Glycolytic processes also provide an important part of the energy supply with elevated lactate levels measured as high as 15 - 17mmol/l at the end of competition. ' (High Performance Rowing by John McArthur)s

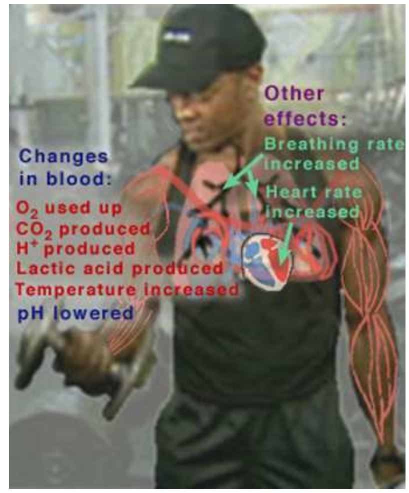
(P2)

Temperature:

You sweat more after you finish exercising than you do while you exercise. More than 70 percent of the energy that powers your muscles is lost as heat, causing your body temperature to rise during exercis e. To keep your body temperature from raising too high, your heart pumps the heat in your blood from your muscles to your skin, you sweat and it evaporates to cools your body. This is what occurs to the rower during the race.

Sweating is controlled by the temperature of the blood flowing to the part of the brain called the hypothalamus. When your temperature rises, you sweat more. During exercise, your heart beats very rapidly to pump blood to bring oxygen to your muscles and hot blood from the muscles to the skin where the heat can be dissipated. When you stop exercising, your heart immediately slows down, decreasing the amount of blood pumped to your skin, so your temperature rises higher and you sweat more. This is all due to Homeostasis. Homeostasis is the maintenance system of your body and providing normality to parts of the body like temperature and pH. Temperature regulation (as explained above) is an example of a homeostatic mechanism. The usual set point for the core temperature is 37 degrees Celsius (37°C): body temperatures above this norm result in sweating and an increase in blood flow to the skin to cool the body; low body temperatures result in an increase in basal metabolic rate (more fuel is burnt by the liver) and shivering to generate heat .

pH



During exercise, the muscles use up oxygen as they convert chemical energy in glucose into energy. This O_2 comes from haemoglobin in the blood. CO_2 and H^+ are produced during the breakdown of glucose, and are removed from the muscle via the blood. The production and removal of CO_2 and H^+, together with the use and transport of O_2, cause chemical changes in the blood. These chemical changes cause the pH of the blood to drop. If the pH of the body gets too low (below 7.4 which is Neutral); this is due to lactic acid altering the pH during exercise. Ideally, the pH of the blood should be maintained at 7.4. If the pH drops below 6.8 or rises above 7.8, death may occur. During the rowing race, the athlete's brain has received information from a stimulus (the race) which sends neurones to the adrenal glands that produces adrenaline which not only makes the heart pump more blood to the muscles, but increases respiration. Gaseous exchange occurs which helps the body receive more oxygen and deplete carbon dioxide out of the body. This not only helps slow the process of oxygen debt, but increases blood ventilation which is needed for an athlete during a race as is the process of eliminating lactic acid. We have 'buffers' in the blood to protect against large changes in pH. A 'buffer' solution is a solution consisting of a mixture of a weak acid that counteracts the increase or decrease of the ph during exercise. It has the property that the pH of the solution changes very little when a small amount of strong acid or alkali is added to it. Buffer solutions are used as a means of keeping pH at a nearly constant state in a wide variety of sports.

Blood Pressure:

Whether you're concentrating on exercising or your heart rate becomes elevated during sport, baroreceptors will detect your blood pressure is elevating slightly and they will dilate the tissue and vessels so there is less pressure for the blood to travel to . This is just a natural part of an elevated heart rate. Rowing consists more of a Dynamic movement that involves using the largest muscles of the body to create momentum. These are typically considered cardiovascular exercises. Performing these exercises increases the heart rate and demands large amounts of oxygen and energy, the blood pressure increases during the race as your pulse rate increase in speed.

(M1)

Activity of CV, Respiratory, Energy & Nervous Systems:

The Cardiovascular system serves five important functions during exercise:

1) Delivers oxygen to working muscles
2) Oxygenates blood by returning it to the lungs

3) Transports heat (a by-product of activity) from the core to the skin
4) Delivers nutrients and fuel to active tissues
5) Transports hormones

Exercise places an increased demand on the cardiovascular system. Oxygen demand by the muscles increases sharply. Metabolic processes speed up and more waste is created. More nutrients are used and body temperature rises. To perform as efficiently as possible the cardiovascular system must regulate these changes and meet the body's increasing demands. Before the race, the rower has a heart rate of 65 beats per minute after a warm up. Just before the race, his heart rate increases to 85 beats per minute. This is due to Anticipatory rise. Anticipatory rise is an increase in heart rate that typically occurs just before an activity is to be undertaken. It results from an increase in activity of the sympathetic nervous system causing the adrenal glands to release adrenaline and noradrenalin into the blood stream which also links to why the nervous system plays a huge part in an athlete. By the end of the first minute, the rower's heart rate has dramatically increased to 201 beats per minute. This is because the body is requiring more blood to be transported to the muscles hence why the heart is beating faster.

At rest, the rower's breaths per minute were at a low rate of 12bpm. Just before the race as they were lining up to start, his breath rate increases to 18bpm. After the first minute, the report says that the athlete was taking two breathes per stroke. They had average stroke rate of 34 in the first minute so therefore his breath rate was a total of 68 breaths in the first minute of the race. In terms of Respiration, the brain determines that you are going to do some kind of exercise via a stimulus and sends out nerve or electrical impulses to the muscles via a network of nerves and synapses. The intensity of the activity will be determined by the brain as the 'master regulator' and will make adjustments to all of the systems. So to run faster the brain sends out impulses to increase the speed and strength of each contraction via the nerves. This activity of movement triggers the medulla oblongata that more oxygen is needed. The respiratory system starts to scoop in more air and passes this into the lungs where it is broken down into oxygen which then is passed into the circulatory system. The oxygen is used in the combustion at the muscular level. As the demand for more air is needed the blood pressure goes up to drive the blood through the system and it will stay up to rate of the heart.

After the first minute of the race, the athlete quoted that his muscles were starting to ache. This is due to his ATP-PCr system decreasing in performance as there are no carbohydrates left for the ATP-PCr system to resynthersize. Rowers display maximal oxidative and maximal anaerobic metabolic effort during racing. At competition level rowing a race of 2000m takes between 5.5 and 8.0 minutes requiring maintenance of high power for the duration. Aerobic energy is thought to account for 70-75% of the energy and anaerobic energy for the remaining 20 - 25%. Based from scientific evaluations of rowers performances; during a race situation, 67% of energy is derived from the aerobic system, 21% alactic anaerobic and 12% lactic anaerobic. ATP-PCr System covers the majority of the percentage of needed for rowers as they require Aerobic energy for around 70% - 75% percent of the race. This would have been used during and after the first minute of the race as the Creatine Phosphate from the carbohydrates is broken down via the help of Creatine Kinase and supplies the rebuilding of ATP during the race. This is then converted into energy which is transported to the muscles. Fat is the secondary product that is then used in the same ATP-PCr process.

During the first minute of the race, the nervous system plays a huge part for the athlete, as it not only prepares the athlete for a competitive race (fight or flight theory), but it tunes his fibres within his muscles to be more respondent than usual and therefore stay in time with the Cox who is shouting the commands to make the rower's row. Physical abilities that are at the essence of athletic ability, including muscular control, hand-eye coordination, reaction time, and the utilization of the body's composition of fast -twitch versus slow-twitch fibres, are all determined by the brain.

(D1)