MITRON nexGEN® HIGH PERFORMANCE HOCKEY SYSTEM™

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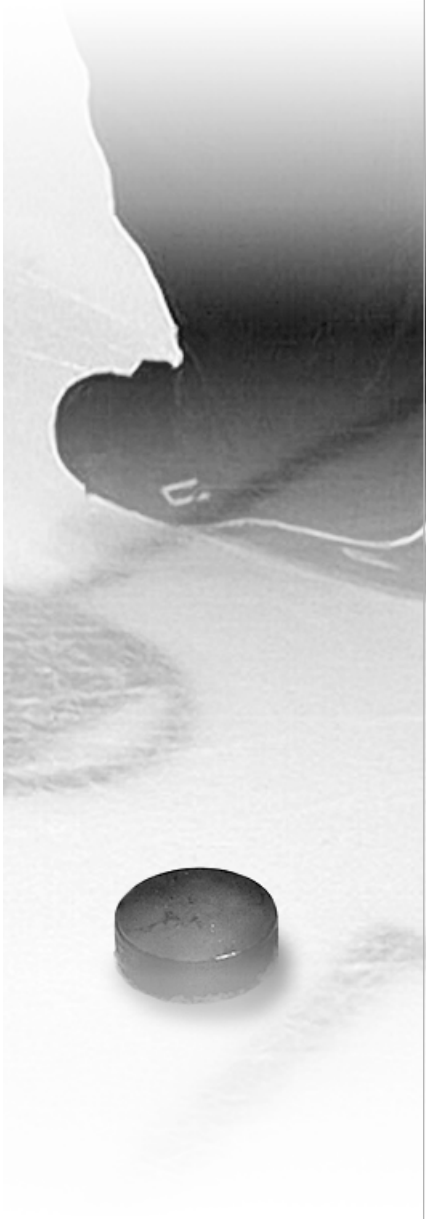
MITRON nexGen

SPECIALIZED COACHING CLINIC

MODULE 10

- PHYSICAL PREPARATION -

ENERGY SYSTEMS



TECHNICAL

TACTICAL

PHYSICAL

MENTAL

MITRON™ nexGEN®

Mitron High Performance - nexGen© Coach/Player Development System

COACH CLINIC MODULE 10
Physical Preparation - Energy Systems

First Edition

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TEMPLATE REVIEW	***PURPOSE OF THE MITRON PRACTICE TEMPLATE***
• Warm – up • ***Lapping*** • Individual Tactics • ***Lapping then return to drill*** • Group Tactical • ***Lapping then return to drill*** • Team Play • ***Lapping then return to drill*** • Skating and Corning • ***Lapping and cool down***	• ***CHAOS;*** • ***FATIGUE, and*** • ***UNPREDICTABILITY*** *- as well as -* • **APPLY FORECHECKING PRESSURE** • **STIMULATE PRIMARY TO SECONDARY FUNCTION REACTION**
• Executing hockey drills (whether they be hi-tempo/flow Mitron Drills or two dimensional standard drills) under conditions which occur frequently in game situations in order to procure the correct or appropriate response from the player.	
• The appropriate response is to have a player that is able to react to the unpredictable events occurring throughout the game in a manner that demonstrates the players full understanding of options to execute the correct tactic and thus having achieved effective ***DEVELOPMENT.***	
• Players simply move from a drill sequence to a lapping sequence every three or four minutes, within each practice component, as they progress through their practice.	
• High speed laps, as a form of high intensity exercise, functions as a stimulant causing an increase in the production of neurotransmitters, or chemicals, through a series of glands known as the limbic system, such as epinephrine, norepinephrine, serotonin, and various endorphins.	

COACHING PERFORMANCE STANDARDS	
KNOWLEDGE BASED	**SKILL BASED**
Coaching Development • Teaching/Coaching Skills • Practice Planning Skills • Problem Solving Skills	• Each coach should be able to, as realistically as possible, periodize the *technical, tactical, physical, and mental* skills required at each development level.
Team Development • Defensive Systems • Offensive Systems • Specialty Teams • Group Tactics	• Each coach should be well versed in the design and execution of high tempo flow practices.
Player Development • Skating • Puckhandling • Passing & Receiving • Checking • Shooting	• Each coach should be able to design and utilize drills that contain high flow with accurate game specificity.

MITRON DEVELOPMENT PREMISE

• The **PERFORMANCE** of an athlete in competition is directly proportional to the athlete's performance in practice!

• The **SUCCESS** of an athlete in competition is directly proportional to the actual specificity of the practice to the competition!

• The **OUTCOME** of specificity of training in practice is the ability to produce an **INTUITIVE HOCKEY VISION**!

INTUITIVE HOCKEY VISION

• The ability to read and understand the schematic flow of a hockey game.

• It's knowing:

√ ***where to be***
√ ***where to go***
√ ***when to get there, and***
√ ***what to do when you get there***!

Introduction

The human body is an amazing biological machine. The scope of this clinic is not to earn a masters degree in human biology, but to simply explain the basics of cell and exercise physiology relative to the sport of hockey. The topics covered should provide you with a sound understanding of what you need to know about training young players to function at peak performance specifically in hockey. This clinic will explore the reasons why some athletes and therefore teams seem to be able to perform better through a shift, a period and throughout a game. Consequently, this topic will focus on the **'energy systems'** while Module 11 will focus on the **'energy source'** or energy **"currency"**. Energy Systems cover organs of the body, while Energy Currency covers the links and reactions between the substances released or processed by the organs.

Why do you need to know this stuff

A greater majority of minor hockey and many professional coaches are quite ignorant to cell biology, while others have a reasonably good background. If you are one with a descent knowledge, please understand that many fellow coaches may not be well versed, and therefore as a member of the coaching discipline your feedback and assistance for those less astute is absolutely valuable. Professional coaches generally, have the luxury of professional exercise physiologists or trainers at their disposal, while minor hockey coaches generally have never had any formal athletic training or education in this field and have only played at a recreational level.This clinic is for both these coaches as well as a refresher for coaches with a more formal background or knowledge.

Abstract

Unless a person has some form surgically implanted device, the human body is made up of organic compounds bound by chemical substances. The natural body has no alloy, metal or plastic parts, or petroleum type additive lubricants, in fact think about it, there is not one single part that revolves like a wheel on a bearing.

Because of the constructive nature of the human body as well as chemical and electrical reactions that make the body move and the brain think, it is imperative to know why and how these happen and the effect of them happening. Only then will you as coach have the answer to why your team cannot skate, pass, handle the puck or physically last throughout an entire shift, period or game.

The most difficult occurance to watch in hockey is players being berated for poor effort, then to watch the coach in practice having no clue about how to properly train the players to improve their athletic performance. As a coach, the techniques you employ through a child's minor hockey experience sets out the formation of how their body adapts to athletic training. You have a duty to provide the players with proper training, since the mistakes made in the formative years may be adverse to a young player for life.

With a reasonable knowledge base you may not make high performance athletes out of all the players you come across but at the very least you will have given them the best experience you could have possibly left them with.

How does the sport of hockey affect the body

Factors affecting the Hockey Athlete

- Unique characteristic of the sport
  (speed, equipment, stick, puck, skates, frequency and duration of shifts, periods and games, ice surface, boards/confined area, body contact, etc.)
- Coaching competencies
  (understanding of athletisicm, technical and tactical ability and expertise, nutrition, diet, rest, physiology)
- Physiological demands on the athlete
  (game speed, work/rest ratio, impact, temperature, energy systems)
- Tactical demands
  (positional intellect, anticipation skills, patience)
- Seasonal calender
  (off-season, pre-season, in-season, playoffs, tournaments)

The foregoing topics explain the functions of various components the human body as they relate to the athletic competencies required in hockey.

Physical Preparation

The game of hockey has changed a great deal in the past two decades and one of the most significant changes has occurred in the area of fitness. It is now very important to develop as a "complete hockey player" who combines high levels of skill with fitness.

Hockey players benefit enormously from aerobic, strength, and power training. Development of strength and power relies heavily on a solid central and peripheral aerobic energy system, therefore, this aerobic system should be well trained and adapted to high work loads (sufficient training effect).

The Body's Response to Training

Muscles are used for each and every movement made, and as you might imagine different sports use different muscle groups to generate motion. In hockey, virtually every muscle and muscle group and all energy systems (which we cover later) in the body are utilized.

When muscles move, they make demands on the rest of the body. During physical performance, just about every system in your body focuses its efforts on either contributing or shutting down to help the muscles do their work. As an example, your heart beats faster during strenuous exercise so that it can pump more blood to the muscles, while the stomach shuts down during strenuous exercise so that it does not waste energy that the muscles can use.

What Happens When You Compete

First compare opposite extremes, a long distance marathon runner versus a 100-meter sprinter.

- A marathon runner sets a pace well below maximum power output and sustains that pace for a long period of time. The runner is said to primarily use the **'aerobic energy'** or **'oxidative'** system which can theoretically last for hours.

- A 100 meter sprinter performs at all-out maximum power for the full duration of the event. This event starts from a stand still and may last only 8 - 15 seconds then its over. The 100 meter sprinter is said to use primarily the **'anaerobic altactic'** system, this system is also known by other names such as the **'ATP-CP'** or **'phosphagen'** system.

A hockey player is better compared to a 400 meter sprinter. These athletes are said to use both the aerobic system and the **'anaerobic lactic'** system otherwise known as **'glycogen-lactic'** which is the secondary system to the aforementioned anaerobic alactic system. Furthermore, although the output of the 400 meter sprinter is paced for a period then elevated to maximum at some point in the event, these cycles will generally only occur once per competition except in cases of elimination heats which are limited. In any event, the absolute maximum "all-out" performance the human body can deliver lasts between 45 - 120 secs. even for the most highly conditioned athlete.

The hockey player in contrast must repeat cycles of low-intensity and high-intensity performance several times on each shift, repeated several times per period with short periods of recovery between and for three periods or 60 minutes or more in case of overtime throughout the course of one event, which may be repeated more than once per day and or the following day with little opportunity for recovery.

The Three Energy Systems (ENERGY PATHWAYS)

There are three separate energy systems (pathways) that our bodies have to produce movement. A number of factors determine which of these energy systems is chosen, depending on the exercise intensity described above. To best explain this topic in the context of hockey development, we will relate the circumstances that occur a day in the life of a hockey shift. First we need to understand some physiology going on inside the body. We will look at the pathways by gaining a brief understanding of some current biological knowledge, then following the process from food intake to competition to waste removal.

Automobiles for example have a storage tank for fuel, they are not connected directly to the gas station at all times nor do they have an unlimited supply of fuel on board. The human body is no different, the body takes in fuel from food and water to cool, lubricate and cause reactions. The food is then broken down into different types of fuel and stored in tanks

- **liver** - as glycogen
- **fat cells** - as fat lipids
- **muscle cells** - as proteins

Organs Involved in Energy Systems

Since the primary factor that determines which energy system is called upon during athletic performance is the presence of oxygen (aerobic versus anaerobic), then it is important to understand the method the body undergoes to process oxygen. The sequence is as follows:

- oxygen is drawn from the environment
- released into the blood stream and pumped through the veins to the muscle cell
- penetrates the muscle cell and mixed with fuel
- waste material is collected
- carried back to the lungs or skin and excreted back into the environment

The secondary factor that determines which energy system is called upon during athletic performance is the type of fuel processed (glycogen, fat lipid, protein), then it is important to understand the method the body undergoes to draw and store the different fuels from our diet. The sequence is as follows:

- fuel is drawn and processed from the diet and stored in the proper tank
- released into the blood stream and pumped through the veins to the muscle cell
- penetrates the muscle cell and mixed with oxygen if present
- waste material is collected
- carried back to the lungs or skin and excreted back into the environment

By examining the above processes, we learn that the following organs and components have a role in processing oxygen and fuel in the athlete's energy systems:

- Lungs
- Heart
- Blood Vessels
- Liver
- Pancreas
- Fat Cells
- Muscle Cells and tissue
- Skin

By reexamining the above processes, we will also learn that the there are similarities between the two processes, but the key difference is that while oxygen supply is abundantly available and always present, fuel however, must be taken in, broken down into the specific type then stored. As a result, the storage tanks have a limited capacity of fuel. Diet and rest are key training components that will be covered in Clinic #12. Since we are concerned with Energy Systems in this Clinic we will focus on the organs and components and their role in athletic performance.

Heart and Lungs

Although each of the organs listed above (as well as others) play important roles, the two key component organs are the Heart and Lungs. This is because no matter how well an athlete has eaten and processed fuel for storage, no matter how well the athlete has trained to build strong powerful muscles or how genetically perfect they may be from an athletic structure point of view, if the heart and lungs are not highly efficient, the body cannot process the oxygen in the air and fuel stored in the body and pump these elements to the muscle cell where it's needed and evacuate waste materials that lead to fatigue.

The efficiency of the lungs is measured by the volume of oxygen known as the VO_2max or the "tidal volume". The athlete's lungs need to be able to expand over and above those of a normal person and be able to secrete oxygen into the blood through efficient aveoli. Training must increase the size of the lungs, the rate of compression and the transfer rate.

The efficiency of the heart is measured by its volume capacity as well as its stroke rate, combined these factors increase the cardiac flow rate or "stroke volume". Training must strengthen the heart muscle, and increase the heart volume and rate.

Liver

The Liver is the storage tank for the "high octane" fuel stored as glycogen. Glycogen comes from processing glucose in high carbohydrate foods. Athletes and coaches need to gain a solid understanding of high glycemic index foods that are quickly and easily absorbed by the liver. Insofar as training can improve the athlete, the liver can only be so large and thus absorb a limited amount of fuel, therefore, excessively incorrect diets may lead to obesity through high fat storage. However, high performance athletes commonly take in 10 - 12,000 calories per day of high glycemic, low fat foods. The purpose is to store the majority of the food as glycogen fuel. What can be improved upon is the body's adaptation to releasing the glycogen as needed for competition or the liver efficiency. It is important to understand that the glycogen molecule is a large molecule that is broken down several times for the production of power. In particular, when it reaches the muscle cell the glycogen molecule is split in half into two pyruvate molecules. But the muscle only has so many holes that the pyruvate can fit through, therefore, when the athlete needs more fuel quickly the muscle cell needs to open up, therefore the body calls on another organ to send a substance to do this.

Pancreas

When glycogen reaches the cell and is split into pyruvate, if the athlete pushes harder in competition, therefore needing more fuel in the cell, the body calls on the the pancreas to release Insulin. Insulin released from the pancreas enters the blood stream and arrives at the muscle cell thereby opening new passageways permitting more glycogen to penetrate the muscle cell.

This is the point that determines how efficient the heart and lungs are in processing this excess glycogen, and therefore, determines which energy system is predominantly in effect.

(**Diabetes** is a disease which affects the processing of insulin. In general:
Type 1 - Pancreas doesn't release insulin;
Type 2 - Muscle cell does react (open with) to insulin.

What Goes on Inside the Muscle

Muscles and more microscopically the muscle cells operate similarly to an internal combustion automobile engine.

• The automobile engine requires a fuel to be injected and mixed with air. This fuel/air mixture is then compressed and ignited to generate force to spin the engine to move the vehicle, after which the residue produces an exhaust of toxic gases.

• Muscles cells are biomechanical engines, take in a source of energy and they use it to generate force to contract the muscle to move the body part, after which a toxic gas is exhausted. The fuel used by a muscle is a chemical called adenosine triphosphate (ATP) for their energy source. During the process of "burning" ATP, your muscles need three things:

- Oxygen, chemical reactions require ATP and oxygen is consumed to produce ATP.
- Metabolic waste elimination (carbon dioxide, lactic acid) from the chemical reactions.
- Heat dissipation, like an internal combustion engine, working muscles generate excessive heat.

In order to continue moving, your muscles must continuously make ATP. For this to occur, your body must supply oxygen to the muscles and eliminate the waste products and heat. The more strenuous the activity, the greater the demands on the working muscle. If these demands are not met, then muscle movement will cease - that is, you become exhausted and you won't be able to keep going.

This is what may be happening inside those players that are being berated for poor effort.

When performing in sports, several things happen in the body, breathing gets heavier and faster, heart rate increases, muscles hurt and you perspire. These responses to competition or exercise are all normal whether you are a well trained athlete, workout regularly, once in a while or rarely. To meet the demand of performance, the body employs an orchestrated sequence of responses within all its internal systems and organs including the heart, blood vessels, nervous system, lungs, liver, pancreas and skin.

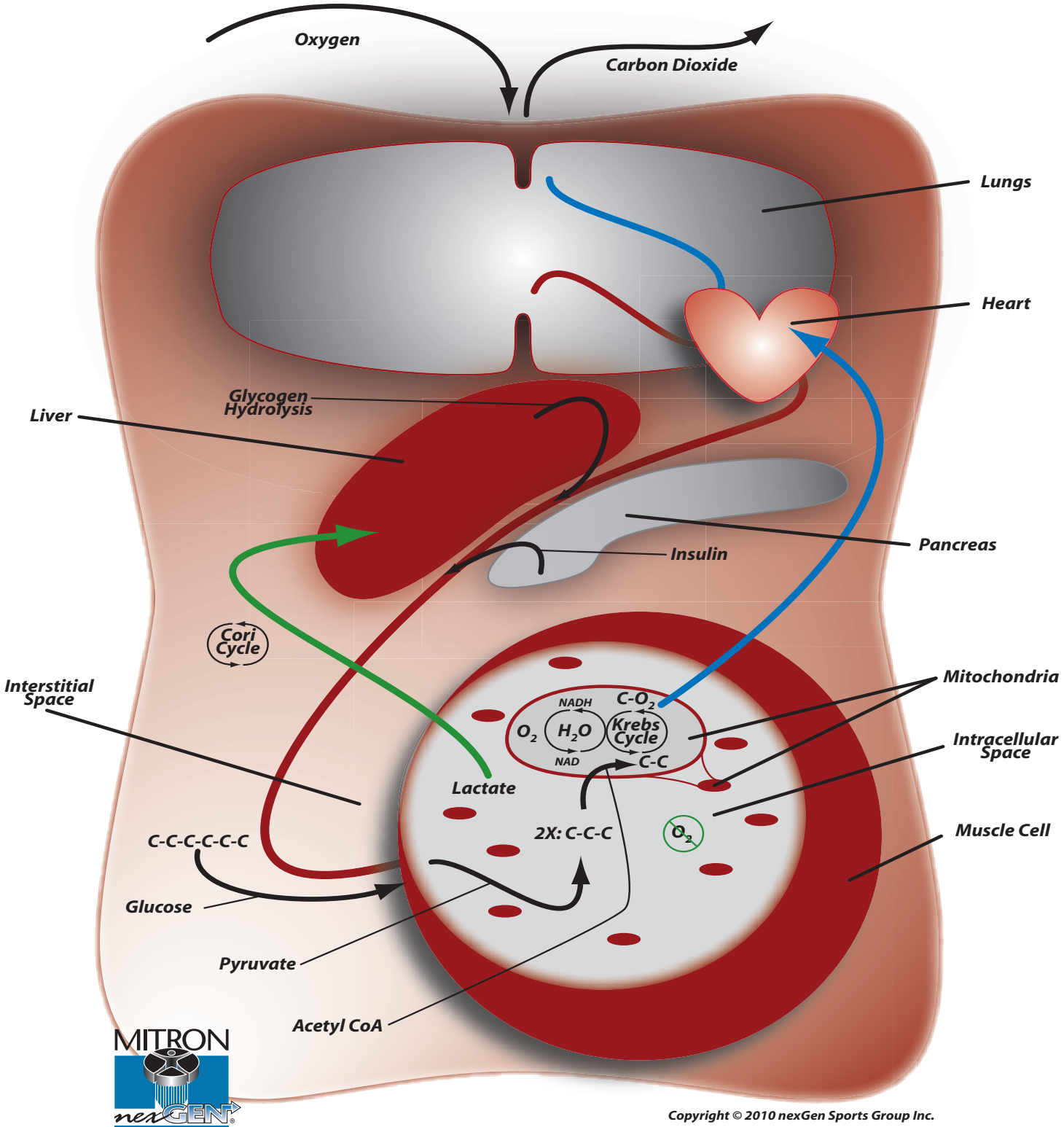
The better trained or enhanced the systems are the more effective they are to respond to the demands of competition.

Adenosine Triphosphate

Adenosine triphosphate (ATP) is considered to be the energy currency of life. ATP is a high-energy molecule (Adenine Dinucleotide) that stores the energy we need to do just about everything we do through a process where, in its simplest explanation, ATP ("tri" = 3) is broken down into Adenosine Diphosphate (ADP) ("di" = 2) in a reaction with water.

ATP + H_20 = ADP + Pi (Hydrolysis of ATP)

Mitron nexGen Coach/Player Development System
Coach Clinic Module 10 - Physical Preparation: Energy Systems



Energy Systems & Training

Each of the three energy systems can generate power to different capacities and varies within individuals. The capacity to generate power of each the three energy systems can vary with training. The ATP-PCr and glycolytic pathways may change by only 10-20% with training. The oxidative system seems to be far more trainable although genetics play a limiting role here too. VO_2max, or aerobic power can be increased by as much as 50% but this is usually in untrained, sedentary individuals.

Energy Systems Used in Sports

From very short, very intense exercise, to very light, prolonged activity, all three energy systems make a contribution however, one or two will usually predominate.

Factors affecting which energy system is predominant

- Intensity
- Duration

A New Model for Energy Systems?

In the year 2000, a scientific questioned why the current model failed to explain fatigue caused by anaerobic metabolism in 5 key areas:

i) The heart and not skeletal muscle would be affected first
ii) No evidence of anaerobic metabolism and hypoxia (lack of oxygen) in skeletal muscle during maximal exercise.
iii) why fatigue ensues during prolonged exercise, at altitude and in hot conditions.
iv) Cardiorespiratory and metabolic measures such as VO_2max and lactate threshold are only modest predictors of performance.

The new models suggests that a more holistic and synergistic approach be adopted, where mulitple factors affect fatigue, including in general cardiovascular efficiency; energy supply and depletion rate; muscle recruitment and power; biomechanical efficiency and psychological/motivation factors. Undoubtedly, fatigue is a complex subject that can result from a range of physical and psychological factors.

IS LACTIC ACID - FRIEND OR FOE?

Lactic acid (lactate) is not:
- responsible for the burn in the leg muscles when exercising very fast
- responsible for the soreness you experience in the 48 hours following a hard session
- a waste product

Lactate, which is produced by the body all day long, is:
- resynthesized by the liver (Cori Cycle) to form glucose that provides you with more energy.

SOUNDS LIKE A FRIEND!

ENHANCING HOCKEY PERFORMANCE

Now that you have a reasonable understanding of the three energy systems that affect the body, we will examine how they affect the hockey player and some discussion about improving these systems to create a high performance hockey athlete.

Power

Power is rate of performing work. It is a measure of how much energy is created in each second that passes, the size of the force applied and the velocity at which it is applied.

Power = Force x Distance ÷ Time

Aerobic Power

Aerobic power is dependent on the chemical ability of the muscular tissues to use oxygen in breaking down fuels and the combined ability of the cardiovascular and pulmonary system to transport oxygen to the muscular tissues.

Aerobic Capacity

Given that high levels of lactate/hydrogen ions will be detrimental to performance, one of the key reasons for endurance training is to enable the body to perform at a greater pace with a minimal amount of lactate. This can be done by long steady runs, which will develop the aerobic capacity by means of capillarisation (formation of more small blood vessels, thus enhancing oxygen transport to the muscles) and by creating greater efficiency in the heart and lungs. If the aerobic capacity is greater, it means there will be more oxygen available to the working muscles and this should delay the onset of lactic acid at a given work intensity.

Anaerobic Power

Anaerobic power is the ability to produce energy by the ATP-PC energy system and can be assessed with the Running-based Anaerobic Sprint Test (RAST).

Anaerobic Threshold

Lactic acid starts to accumulate in the muscles once you start operating above your anaerobic threshold. This is normally somewhere between 80% and 90% of your maximum heart rate (MHR) in trained athletes.

What a low Lactate Threshold means

If your lactate threshold (LT) is reached at low exercise intensity, it often means that the "oxidative energy systems" in your muscles are not working very well. If they were performing at a high level, they would use oxygen to break lactate down to carbon dioxide and water, preventing lactate from pouring into the blood. If your LT is low, it may mean that:

- you are not getting enough oxygen inside your muscle cells
- you do not have adequate concentrations of the enzymes needed to oxidize pyruvate at high rates
- you do not have enough mitochondria in your muscle cells
- your muscles, heart, and other tissues are not very good at extracting lactate from the blood

The process of lactic acid removal takes approximately one hour, but this can be accelerated by undertaking an appropriate cool down that ensures a rapid and continuous supply of oxygen to the muscles.

Improving your Lactate Threshold

The accumulation of lactate in working skeletal muscles is associated with fatigue of this system after 50 to 60 seconds of maximal effort. Training continuously at about 85 to 90% of your maximum heart rate for 20 to 25 minutes will improve your Lactate Threshold (LT).

Training sessions should comprise of one to five repetitions (depends on the athlete's ability) with near to full recovery.

A session should be conducted once or twice a week and commence eight weeks before a major competition. This will help the muscle cells retain their alkaline buffering ability. Improving your LT will also improve your time VO_2max.

The aim is to saturate the muscles in lactic acid in order to educate the body's buffering mechanism (alkaline) to deal with it more effectively.

How do Mitron Hi Tempo/Flow Practices improving your Lactate Threshold

The secret is in ***Lapping process***. Since the best method to train the internal organs to deal with Lactic Acid and Hydrogen Ion saturation or otherwise improve the LT is to saturate the blood with these elements so that the organs know how to handle and perform in the presence of the substances.

By having the drills properly timed in terms of work to rest ratio and having the player memorize a pattern, first, the body can then concentrate on training the organs to deal with the substances. The process of Lapping Sequence drills first teaches the player the pattern, then the Lapping causes the muscles to demand fuel and insulin from the organs, thereby exceeding the VO_2max and overloading the blood with the substances then immediately placing the player back into the hockey drill to execute the pattern while under fatigue. Over time the body is trained to perform effectively even under these conditions.