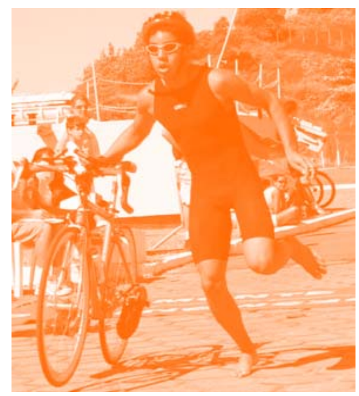
triathlon



energy and training module

ITU Competitive Coach

ITU

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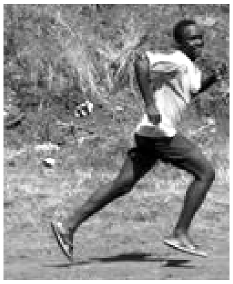
energy & training

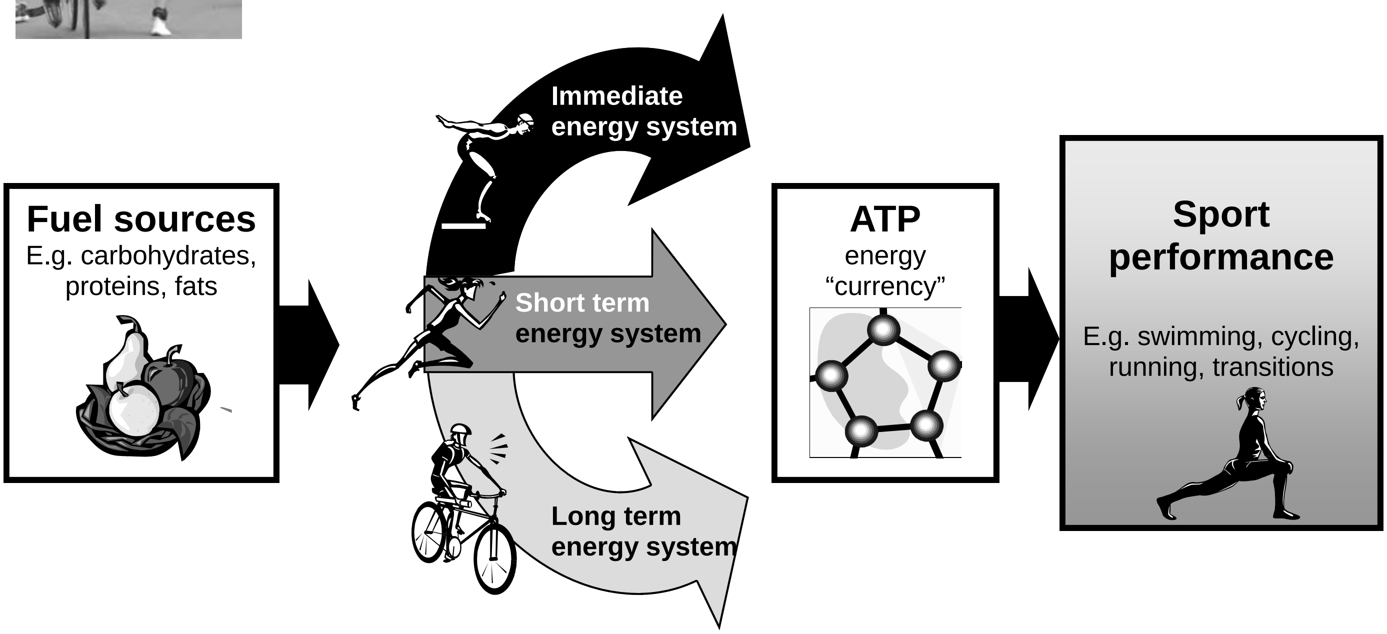


- Have you ever wondered why some athletes shoot off the start line while others take a moment to react?
- Have you every experienced a “burning” sensation in your muscles on the bike?
- Have athletes ever claimed they could ‘keep going forever!’?

All of these situations involve the use of energy in the body. Any activity the body performs requires work and work requires energy. A molecule called ATP (adenosine triphosphate) is the “energy currency” of the body. ATP powers most cellular processes that require energy including muscle contraction required for sport performance.

Where does ATP come from and how is it used?

ATP is produced by the breakdown of fuel molecules—carbohydrates, fats, and proteins. During physical activity, three different processes work to split ATP molecules, which release energy for muscles to use in contraction, force production, and ultimately sport performance. These processes, or “energy systems”, act as pathways for the production of energy in sport. The intensity and duration of physical activity determines which pathway acts as the dominant fuel source.



1	During what parts of a triathlon might athletes use powerful, short, bursts of speed?
2	What duration, intensity, and type of activities in a triathlon cause muscles to “burn”?
3	When in a triathlon do athletes have to perform an action repeatedly for longer than 10 or 15 minutes at a moderate pace?

energy systems

Long Term (Aerobic) System

The long term system produces energy through aerobic (with oxygen) pathways. This system is dominant at lower intensities and efforts lasting longer than 2 to 3 minutes. Production of energy, or ATP, occurs in the mitochondria of the muscle fibers. Mitochondria contain special enzymes that permit the breakdown of fuels (e.g. glycogen, fatty acids) through interaction with oxygen to produce large amounts of energy. Training the aerobic system increases the number and size of the mitochondria, making the muscles more efficient at using oxygen for fuel.

Short Term (Anaerobic Lactic) System

As intensity increases, it becomes increasingly difficult for the body to provide enough oxygen to fuel aerobic pathways. The short term, or anaerobic lactic (without oxygen, with lactic acid) system begins to contribute more energy to fuel the muscle. Fuel for this system comes from glucose in the blood and stored glycogen in the muscle. Along with energy (ATP), lactic acid is produced as a byproduct of this system. As exercise intensity increases, so does the accumulation of lactic acid in the blood and muscles. If this accumulation becomes too high, then the short term system cannot continue. At maximum intensity, this system is exhausted within 60 to 120 seconds. Athletes experience shortness of breath, pain (burning sensation), and weakness in the muscles.

In triathlon, the aerobic and anaerobic lactic systems often operate in tandem, with energy being supplied through both pathways as intensities fluctuate. A well-trained aerobic system allows athletes to perform at higher intensities before lactic acid builds up and recover faster after hard efforts.

The Immediate (Anaerobic Alactic) System

When sudden, explosive or immediate movements are required, a third system produces ATP at a very high rate. The anaerobic alactic (without oxygen, without lactic acid) or ATP-CP system is fueled by stored ATP and another high energy substance, creatine phosphate (CP). Because these fuel stores are relatively small, the immediate system only supplies energy for up to about 10 seconds of high intensity activity. ATP-CP stores can be replenished in a few minutes of rest. During a triathlon this system is dominant during races starts, very explosive movements like flying bike mounts, and accelerations or surges that are less than 10 seconds in duration.

Energy System Integration

The energy systems do not work independently. During exercise, all the systems operate simultaneously in different degrees, depending on the energy demands placed on the body. During a triathlon, the long term system is dominant, but the immediate and short term systems are accessed when an athlete increases their intensity. While a majority of the triathlete's training will rely on the long-term system for energy, some training (starts, surges, and fast repeats) should make use of the immediate and short-term systems. This type of balanced training will lead to improvements in maximum oxygen uptake and work efficiency; more work done at less cost.

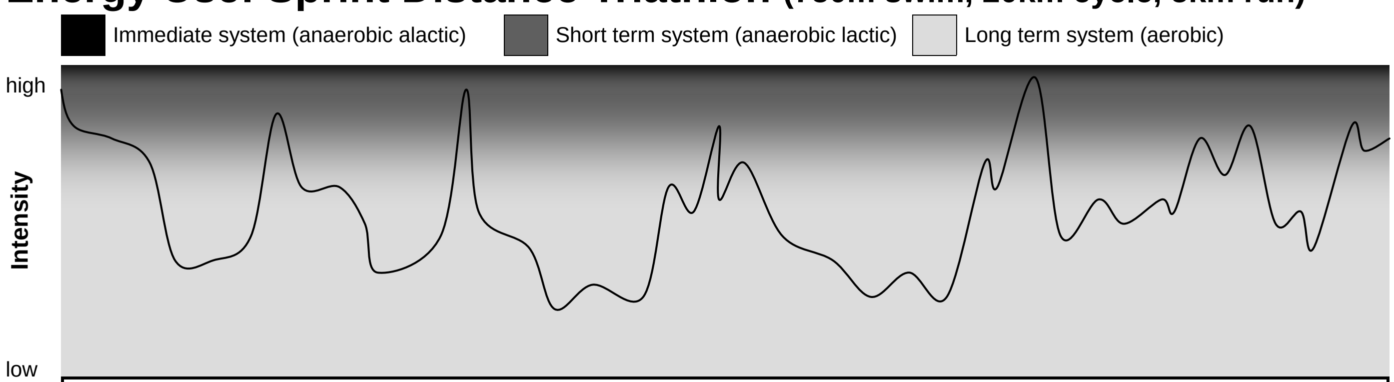
Energy System	**Aerobic (long term)**	**Anaerobic Lactic (short term)**	**Anaerobic Alactic (immediate)**
Fuel Source	Circulated nutrients (oxygen as a catalyst)	Glycogen (stored carbohydrates) in the muscle and liver	Stored ATP and CP (creatine phosphate)
Limit of fuel source	The body's ability to process oxygen.	At 100% intensity; 10 seconds to 2 minutes ***the limiting factor at maximum intensity is the build up of lactic acid, not the depletion of glycogen stores***	Up to 10 seconds
Byproducts	ATP, CO_2, H_2O	ATP, Lactic acid	ATP, Creatine
Intensity of exercise when system is dominant	Low to moderate; higher intensities for efforts lasting longer than 2 minutes ***significant overlap with anaerobic system at higher intensities for events longer than 2 minutes***	High to very high for longer than 10 seconds (up to 2 or 2.5 minutes at maximum intensity)	Very high intensity; explosive movements (up to 10 seconds, unless stores have time to replenish)
Recovery of fuel stores after use 	Highly dependent on intensity. Lower intensity, 6 to 24 hours. Higher intensity, 24 to 36 hours.	Rate of lactic acid removal 25% in 10 minutes 50% in 25 min. 100% in 75 min. ***low intensity exercise can help "flush" lactic acid out of the muscles and facilitate faster recovery*** Replenishment of glycogen* following continuous, high intensity endurance activities 60% in 10 hours 100% in 48 hours Replenishment of glycogen* following intermittent activity 40% in 2 hours 55% in two hours 100% in 24 hours   ***in order to replenish glycogen stores, athletes must consume carbohydrate-rich foods***	50% replenished in 30 seconds 2 minutes for complete restoration (if resting)
Athletic abilities developed by training this system	**Aerobic power** (highest intensity that still involves the aerobic (oxygen) system) **Aerobic endurance** (ability of the body to supply muscles with oxygen for long periods) **Muscular endurance**	**Muscular endurance** (repeated muscle contractions) **Speed** (moving as fast as possible; 10 seconds to 2 minutes)	**Power** (moving against resistance or a force as fast as possible) **Maximum speed** (up to 10 seconds)
Use in triathlon	Dominant system in triathlon; all components.	Supplement to aerobic activity at high intensities (e.g. surges, accelerations, longer than 2min) First two minutes of higher intensity activity within the race (e.g. first 100-200m of the swim).	Race starts, surges, rapid accelerations and/or power increases up to 10 seconds

The diagram below is a hypothetical “energy chart” of an athlete completing a sprint distance triathlon.

- **The lighter region** at the bottom represents the aerobic, or long term system. This system is dominant throughout the race.
- **The darker grey** represents the anaerobic lactic system. As athletes increase intensity, for example, cycling or running uphill, they will start to use more anaerobic energy pathways.
- **The black region** at the top of the graph represents the anaerobic alactic system. Athletes activate this system for only very short periods at extremely high intensities—for example starting a race.

The span of systems an athlete utilizes during a triathlon event illustrates why it is important to balance training using a variety of intensities. After developing an aerobic base of fitness and strength, training should be designed to condition athletes for the specific demands of their event.

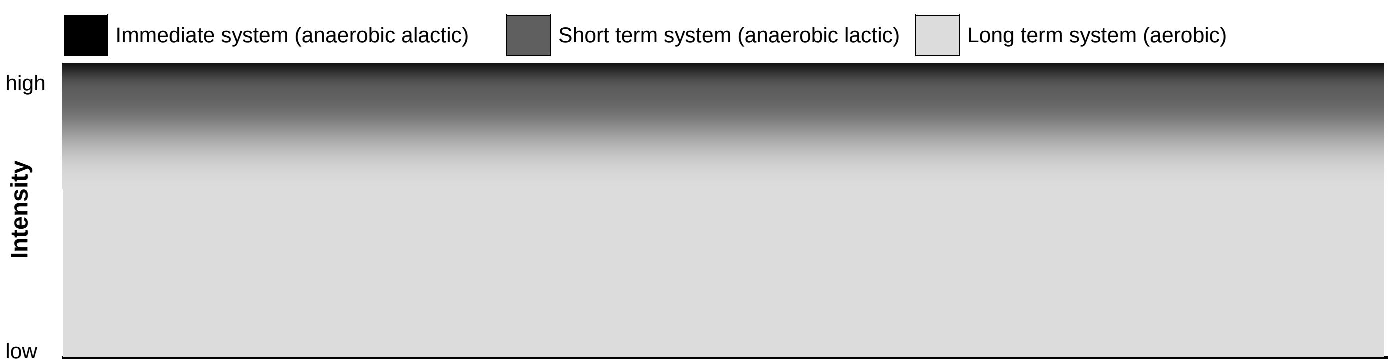
Energy Use: Sprint Distance Triathlon (750m swim, 20km cycle, 5km run)



start	2-10min	Swim exit	300m to T-1 (run)	T-1 & bike mount	Bike (flats)	Bike (rolling hills)	Flats	T-2	Run (flats)	Run (hills)	Sprint finish (300m)
Race Components and Terrain											
0-2	2-10	11	12-14	15	16-20	20-30	30-50	51-52	53-58	59-70	71-72
Total Race Time (in minutes)											

Energy Use: Olympic Distance Triathlon (1.5km swim, 40km cycle, 10km run)

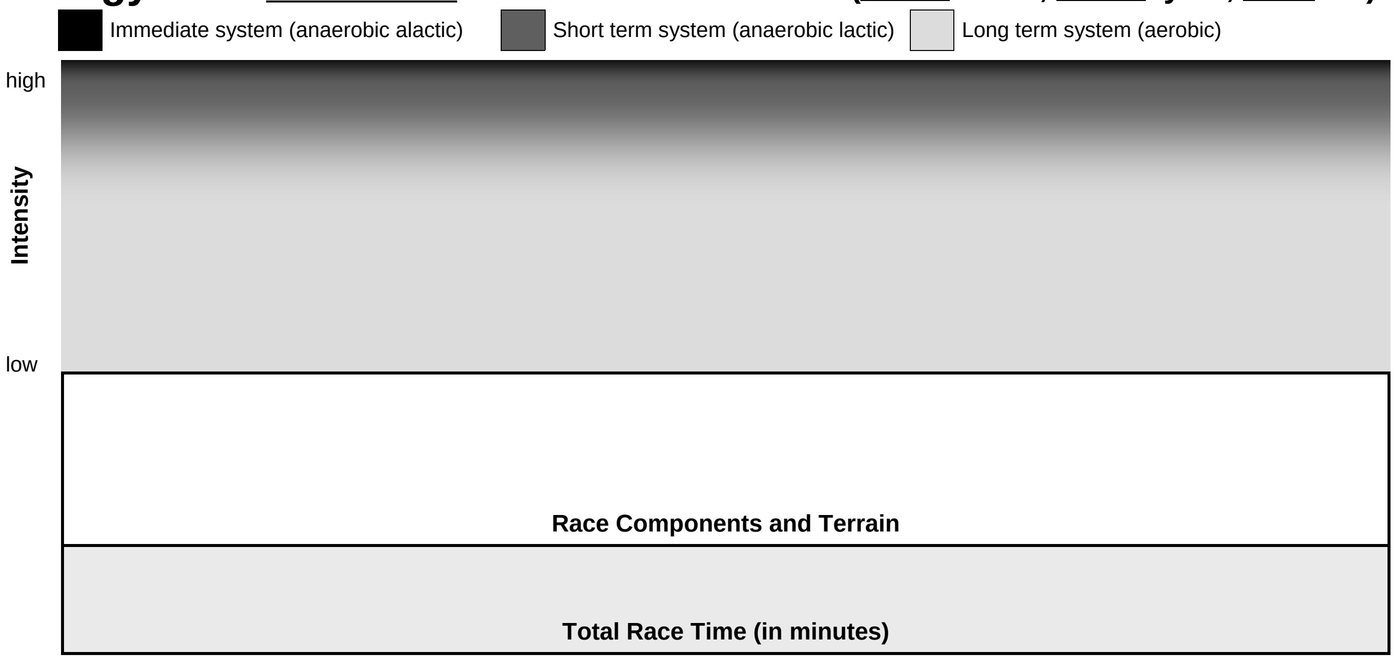
Based on the information you now know about energy systems, draw your own interpretation of an athlete’s energy use (during an Olympic Distance triathlon) on the chart below.



Start (at water edge)	swim	Swim exit (beach)	100m to T-1 and T-1	Bike mount and start of cycle	Bike (racing to keep up with another athlete)	Bike (5 steep hills; accents and descents)	Bike (flat, slightly rolling, 4 surges of 10-15 sec. each)	T-2	Run 1km uphill Flat for 3km; 2km on trails; 2km slight downhill; 1km with 3x100m steep hills	Finish (1km flat)
Race Components and Terrain										
0-2	2-22	22-23	24-26	27-35	36-46	47-70	71-95	96-97	98-138	139-143
Total Time (in minutes)										

Create your own energy use diagram for a race distance of your choice. Label the terrain, components of the course, and time for each. When you have completed the diagram, swap with another coach and analyze each of your races. Would you change anything based on your discussion?

Energy Use: _________ Distance Triathlon (_____ swim, _____cycle, ____run)



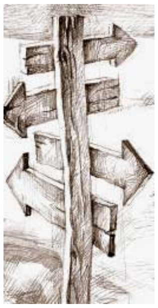
training the energy systems

There are more and less formal methods of training the energy systems. However, it is important to realize that MANY variables affect how well these methods work. There is no “one right way” to train each energy system. Every athlete will respond differently to training depending on age, ability, past training, morphology (body type), physiology (e.g. muscle fiber type), character, mental state, motivation, skill level, and other variables.

Before moving on to more formal methods of training, use the chart below to brainstorm some creative methods of training each energy system, based on the information you already know. Just as the body uses a blend of energy systems within a race, training also involves a combination of energy systems within practices.

Immediate system (Anaerobic Alactic)	Short term system (Anaerobic Lactic)	Long Term system (Aerobic)
E.g. practice multiple swim starts with several minutes rest between	E.g. After a 15 min. warm-up, cycle spurts of 2-3 minutes very fast with easy riding to recover in between	E.g. run for 60 minutes at ‘talking pace’ (easy intensity)
E.g. flying bike mount + 200m power cycling (standing up)	E.g. ride repetitions of hills (1-2 minutes each with several minutes rest between)	E.g. after a warm-up, do a 15 min. hard cycle at “race pace”

general training guidelines



Formal training of the energy systems is part science and part art. Coaches must take into consideration the science of "what system to train, when, and how often" with the individual needs and capacities of each athlete. Novice athletes require different variations of training, with a focus on the aerobic system for the first two to three years they are in triathlon. Below are some GENERAL guidelines for training each system.

There are derivatives of the energy systems that you might be familiar with such as speed, power, endurance, and strength. These terms refer to athletic abilities or components of fitness that different train aspects of the energy systems and other systems in the body concurrently. More information on these holistic concepts will be introduced later in this module.

	Aerobic system (lower intensities)	**Aerobic-anaerobic mixed systems** (high intensities for longer than 2 min.)	**Anaerobic system**	**Anaerobic Alactic system**
Number of sessions per week	3 to 5 times a week	1 to 2 times a week	2 to 3 times a week	1-2 times a week
Recovery time between sessions	6 to 36 hours	24 to 48 hours	24 to 36 hours	24 to 48 hours
Duration or time	Longer than 15 minutes per interval or segment	10 to 30 minute efforts (moderate to high intensity) 2 to 10 minutes (shorter, higher intensity efforts)	20 seconds to 2 minute intervals	5 to 10 second intervals
Number of intervals or repetitions	Usually just one repetition per practice (e.g. a long run)	1 for 10-30 min. efforts 2 to 10 repetitions for 2-10min. efforts	4 to 12 repetitions	8 to 18 repetitions
Rest between intervals	N/A	2 to 10 minutes Work: Rest ratio 1 : 0.5 or 1:1 or 1:1.5 (e.g. for a 5 min. interval, athletes rest for 2.5 minutes, 5 minutes or 7.5 minutes)	60 seconds to 8 minutes. Work : Rest ratio 1 : 3 or 4 (e.g. for a 1 min. interval, athletes rest for 3 or 4 min.)	20 seconds to 5 minutes (usually training is done in sets—groups of 4 to 6 efforts—with 30-60 sec. between efforts followed by 3-5 min. between sets to allow ATP stores to replenish)
Intensity	Easy pace to moderate pace (able to talk—slightly out of breath but not labouring)	Race pace to near maximum effort	Near maximum effort	Explosive, maximum effort

How do you think these training recommendations will differ for novice athletes (1-2 years in the sport) and intermediate level athletes (2-5 years in the sport)?

In the chart below, design a workout or activity to train each system in each of the sports. As you apply the general guidelines, consider how you might be more creative and innovative in applying these guidelines to designing activities. Throughout your coaching career, you will continue to expand your knowledge of these systems, their application and how each athlete adapts to training.

	Aerobic system (lower intensities)	**Aerobic-anaerobic mixed systems** (high intensities for longer than 2 minutes)	**Anaerobic system**	**Anaerobic Alactic system**
Swim				
Bike				
Run				
Transition				

triathlon energy

Now that you have some knowledge of the energy systems and how to train them, it is time to apply this information to triathlon. Training involves both general and specific components. More information on general components will be covered later in this module. For now, we will deal with the specific energy requirements an athlete might encounter when doing a triathlon. Based on these sport-specific requirements AND an analysis of athletes' strengths and weaknesses, a coach can develop specific programmes that best train the athlete to meet their goals in the sport.

1. Read each activity under "Triathlon Component" in the chart.
2. Decide what energy system or systems would dominate in each activity and record it in the second column.
3. Discuss methods of training this activity and record ideas in the third column. Use the information you have learned on energy systems related to frequency of training, length of efforts, and rest periods.

Triathlon Component	Dominant Energy System(s)	Training Methods
E.g. Race start	Anaerobic alactic	• Repetitions of simulated starts (pool starts; dive starts; beach starts) • Reaction time drills • Short swim sprints up to 10 sec. with 3 min. active rest
Swim (first 100-200m)		
Swim (main component)		
Swim exit		
Travel to transition • Short (100m) • Long (200m+)		
Swim to bike transition (T-1) • Taking off and putting on equipment or clothing • Unracking bike • Traveling with bike through transition to mount line		
Mounting bike		
First 1-2 km on the bike 1. Slow pace while hydrating 2. Fast pace while sprinting up to speed		
Biking hills (longer than 10 sec. each)		
Biking flats		
Surging to catch someone or trying to keep pace with another athlete (10-15 sec)		

Triathlon Component	Dominant Energy System(s)	Training Methods
Dismount bike		
Bike to Run Transition (T-2) • Traveling with bike through transition to bike racks • Taking off helmet; changing shoes (if applicable) • Walking or running out of transition		
First 1km of the run 1. sprinting to the cheers of the crowds 2. Jogging slowly to “warm up the running legs”		
Running up a steep, short hill (about 12 sec.)		
Running through 2km of trails (off-road; soft surface)		
Running flats (slightly higher intensity to keep up with someone for 2-3 km)		
Running at talking pace for 10 to 15 minutes.		
Sprinting the last 200m of the run (about 45 seconds)		
Walking after finishing the race for 5 to 10 minutes		
Add additional activities, skills, or components of a triathlon below that you think should be in the list.		
Other:		
Other:		
Other:		
Other:		
Other:		

holistic energy systems

The energy systems require a number of systems in the body to work in synchrony.

The Cardiovascular and Respiratory Systems

The cardiovascular system (heart, blood vessels, arteries) and cardiorespiratory (heart and lungs) systems help deliver oxygen to the muscles for aerobic metabolism. The circulatory system also removes waste products from the body, such as lactic acid, and delivers nutrients to the muscles from food for glycogen storage and other functions.

What effect will a stronger, more efficient heart muscle have on an athlete's anaerobic and aerobic performance?

The Nervous System

The neural system includes the CNS (central nervous system—the brain and spinal cord) and the PNS (peripheral nervous system—all nerves extending to all parts of the body). No movement would occur without the functioning of this system which is responsible for both conscious and subconscious activation of muscles. As the nervous system fatigues, efficiency of muscle contraction decreases.

If muscle contraction decreases with fatigue how will this affect athletes' skills and technique? How might changes in skill, or technique, affect anaerobic and aerobic performance?

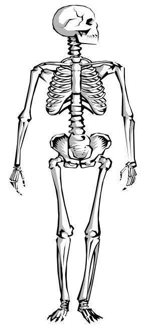
The nervous system is also responsible for psychological influences on performance such as confidence, anxiety, motivation, emotion, and related areas. All thought processes related to learning, memory, perception, and attention are also controlled by the nervous system.

How might a strong mindset and positive psychological outlook affect the rate and degree of fatigue?

The Musculo-Skeletal System

The muscular and skeletal systems create a structure for energy systems to train. Bones provide the frame on which muscles pull to create movement. Although often thought of as solid and inflexible, bones are actually factories that produce much of the body's red blood cell store. Red blood cells contain hemoglobin which transports over 95% of the oxygen in the body to working muscles.

In children, bones are pliable and flexible. Physical activity, or force of the muscles pulling on bones, results in a stronger skeletal structure. Over the long term bones supercompensate for the "trauma" and grow stronger. Overuse or extremely high loads (forces) impact bone formation and in extreme cases, deformation. As people age, bones tend to grow more brittle as mineral density declines.



What effects might each energy system have on the skeletal system?

- **Are there risks or benefits to anaerobic alactic (explosive, powerful) training on the bones of children and older adults?**
- **What effects might excessive distance training have on the skeletal system?**

Muscles contract as a result of stimulation from nerve fibers or electrical signals transmitted via the nervous system. Muscles only pull, they do not "push" so they work in groups. During a movement, one muscle or group of muscles act as the agonist (primary movers of a bone in a certain direction). Another group assists or supports the movement. Antagonist muscles resist or oppose the movement, in some cases "guarding" against injury by restricting the range of motion of a joint.

If an athlete has inefficient technique and uses "too many muscles" to perform movements, what effect will this have on energy system efficiency and use?

Skeletal muscles are composed of different fiber types: slow twitch, fast twitch, and intermediate types. (Note, there are sub-groups of each type, but they will not be detailed in this module).

- Slow twitch muscles are slow to fatigue, produce comparatively low forces, and are small in diameter.
- Fast twitch fibers fatigue quickly, are more explosive, produce large forces, and are large in diameter.
- Intermediate fibers have moderate resistance to fatigue, intermediate force capacity and diameter.

People have a genetically determined ratio of each fiber type, however, these can be modified through training. Intermediate fibers are the easiest to train and can act MORE like slow twitch or MORE like fast twitch depending on the type of training. Slow and fast twitch muscle fibers can be modified as well, but not to the same extent as intermediate fibers. Someone with a majority of slow twitch fibers will be predisposed to longer distance events. Likewise, an athlete with a majority of fast twitch fibers will excel at shorter, more powerful speed-based events.

Are there parallels between the energy systems and muscle fiber types?

Do you think an athlete with a majority of fast twitch muscle fibers would respond more quickly to aerobic or anaerobic training? Why?

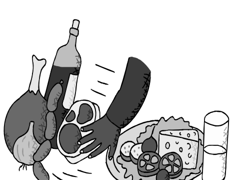
All systems of the body are affected by the fuel athletes consume. Energy systems are directly and indirectly affected by innumerable connections between nutrition and performance. A few examples that are particularly relevant to triathlon are:

- ***Carbohydrate is the energy nutrient.*** Without sufficient CHO intake, glycogen stores will be affected and athlete performance will suffer. Consuming small amounts of carbohydrate during training and racing can maintain glucose levels in the blood and slow down the glycogen-depletion process.
- ***Glucose is vital to brain function***. If glucose levels are too low the brain starts to “slow down”, neurons misfire, and performance is inhibited.
- ***Water*** is a conductor of electricity and because nervous system and muscles communicate through electrical signals, dehydration can disrupt nervous system function. Water also facilitates the diffusion of oxygen from the lungs to the blood, helps lubricate tissues in the body, aids in digestion, and regulates body temperature, among other jobs.
- ***Fats*** (particularly unsaturated) are also critical to performance. Besides providing energy reserves and essential components of cell membranes and nerve fibers, fatty acids transport the vitamins A, D, E, and K. These vitamins are critical to recovery, calcium absorption (i.e. muscle function, bone integrity—see below), red blood cell production. What effect will insufficient fat intake have on triathlon performance?
- ***Protein*** is the ‘healing’ nutrient and performs functions such as tissue growth, regeneration, maintenance of the immune system, regulation of fluid balance in the body, and production of hormones, enzymes, and hemoglobin.

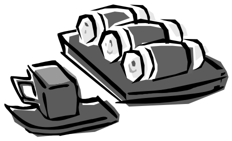
How might <u>insufficient</u> intake of a) carbohydrates, b) fats, c) protein, and d) water, affect the performance of the anaerobic and aerobic systems?

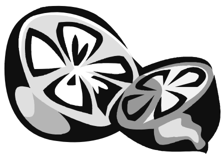
Vitamins and minerals are vital to performance. They do not provide energy, but improve the efficiency of all processes related to energy production.

- ***Calcium*** is essential for bone health and plays a vital role in muscle contraction. Best sources include dairy products, green leafy vegetables, and legumes.
- ***Iron*** is a component of hemoglobin contained in red blood cells and responsible for over 95% of oxygen delivery in the body. Iron is also involved in ATP production in the aerobic system. Iron is found primarily in meats, poultry, and dried fruits (red meats providing the highest levels of iron to the body). Iron deficiency can lead to anemia which decreases oxygen transport, increases fatigue, and limits both training and racing ability.



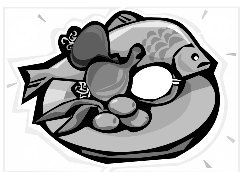
**Iron deficiency has long been an issue with female endurance athletes, as iron is lost through menstruation, sweat, and long distance running. Athletes who restrict their diets—e.g. eat insufficient quantities of protein, red meats, and other key nutrients—are at particular risk for iron deficient anemia.*



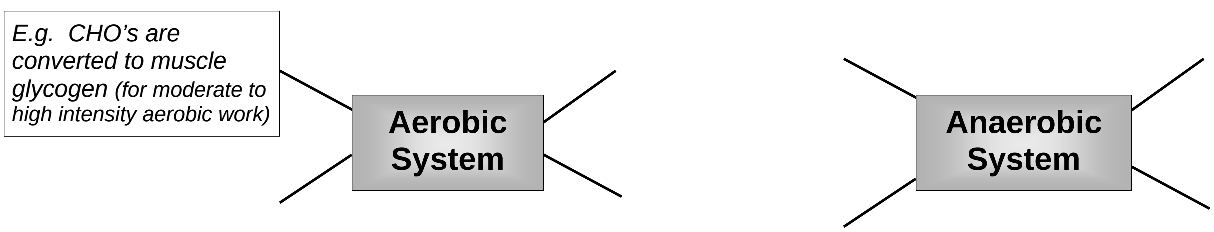


- **Potassium and magnesium** play roles in muscle and nerve function. Key sources of these minerals are nuts, legumes, dark green leafy vegetables, seafood, poultry, and dairy products.
- **The B vitamins** help the body convert carbohydrates into energy; assist in red blood cell production; help the body use proteins; support the nervous system; among other jobs. Sources differ depending on the vitamin. Some general sources include fortified breads, cereals, whole grains; lean meats, eggs, legumes, dairy products, nuts; poultry; seafood; and a variety of dark green leafy vegetables.
- **Vitamin C** helps the body absorb iron, promotes wound healing, and assists the body's immune system. Best sources include citrus fruits, strawberries, tomatoes, broccoli, green peppers and other fruits and vegetables.

Based on the connections between nutrition and performance, discuss the benefits of consuming a wide VARIETY of foods in the diet.



Based on the information you have just reviewed, identify all the possible connections between the energy systems and various nutrients, minerals, and vitamins below. *Keep in mind that this information represents only a small snapshot of nutrition-performance relationships*.



As a coach, what recommendations would you give your athletes based on these relationships? Justify your response.

derivatives of the energy systems

Fitness abilities

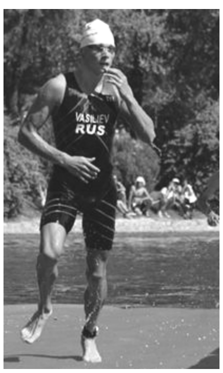
As mentioned earlier, there are derivatives of the energy systems that define more familiar "training methods" in sport. These terms refer to athletic abilities or components of fitness that different train aspects of the energy systems ***and*** other systems in the body concurrently. Think back to the list of triathlon components on pages 8 and 9. As you read the following list, consider what fitness abilities are required in each triathlon component. Athletic or fitness abilities are trained according to sport-specific needs. The specific distance of the event will also help determine the specific fitness requirements. While triathlon is primarily a contest of endurance, all the fitness abilities play a role in an athlete's performance.

Under each definition, write an example from triathlon.

Cardiovascular or Aerobic Endurance

The ability of the heart, lungs, and blood vessels to deliver adequate amounts of oxygen and nutrients to exercising muscles over long periods.
Low to moderate efforts for longer than 15 minutes.

Dominant systems involved:
Aerobic energy system, circulatory system, and respiratory system
Triathlon example:



Aerobic Power *or* Aerobic Capacity (VO_2 max)

The point (intensity) at which the maximum amount of oxygen that can be delivered to muscles and used by the body before having to rely 100% on anaerobic processes.
Very intense efforts between 2 and 10 minutes (15 minutes for highly trained athletes).

Dominant systems involved:
Aerobic energy system, circulatory system, and respiratory system
Triathlon example:

Speed and Speed Endurance

The ability to perform a movement as quickly as possible or to move as quickly as possible especially over short distances. Maximum intensity for up to 20 seconds.
Speed endurance is the ability to maintain a very high speed for longer periods.
Maximum intensity for up to 2 minutes.

Dominant systems involved:
Anaerobic lactic and alactic energy systems, muscular, and nervous systems
Triathlon example:

Muscular Endurance

The ability of muscles to resist fatigue and contract repeatedly over time.

Dominant systems involved: aerobic and anaerobic lactic energy systems, muscular, and nervous systems
Triathlon example:

Muscular Strength

The ability of a muscle to exert force; the ability to overcome great resistance. Maximum strength involves one maximum force exerted by the muscle. Submaximal strength involves moving a sub-maximal resistance for less than 30 seconds or less than 15 repetitions.

Systems involved: all energy systems (anaerobic lactic and alactic dominant), muscular, and nervous systems
Triathlon example:

Power

The ability of muscles to overcome a resistance at maximal speed (force X time); a combination of strength and speed. Involves quick, explosive movements.

Systems involved: anaerobic alactic and lactic energy systems, muscular, and nervous systems
Triathlon example:

Flexibility

The range of motion through which joints can move. Flexibility is influenced by length, strength, activation, and relaxation of the muscles around a joint (e.g. shoulder, hip, knee, ankle, etc.).

Dominant systems involved: aerobic energy system, muscular, skeletal, and nervous systems
Triathlon example:

Balance **(skill-related fitness component)**

The ability to maintain equilibrium while stationary (static balance) or moving (dynamic balance).

Dominant systems involved: all energy systems (the postural muscles responsible for more static balances are highly aerobic; the movements required to maintain balance in sudden, quick movements (e.g. avoiding an obstacle on the bike) require anaerobic alactic system integration); muscular, nervous, and vestibular systems
Triathlon example:

Coordination **(skill-related fitness component)**

The ability to use the senses in concert with the body to perform movements smoothly and accurately. Involves synchronization (timing, rhythm) of multiple actions.

Dominant systems involved: all energy systems (dependent on requirements of the task), muscular, sensory, and nervous systems
Triathlon example:

fitness abilities: application

Now that you have an understanding of what each fitness component requires and where it fits with triathlon, you can apply these to planning and training in each sport. Fill out the chart below with your own ideas, and then compare with others and record your ideas on page 17. The Planning module will further apply energy systems and fitness abilities to annual, seasonal, and weekly schedules.

	Swim	Bike	Run	Combined sports (transitions, bricks)
Aerobic endurance				
Aerobic power				
Speed				
Speed endurance				
Muscular endurance				
Muscular strength				
Power				
Flexibility				
Balance				
Coordination				

fitness abilities: other applications

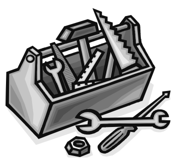
	Swim	Bike	Run	Combined sports (transitions, bricks)
Aerobic endurance				
Aerobic power				
Speed				
Speed endurance				
Muscular endurance				
Muscular strength				
Power				
Flexibility				
Balance				
Coordination				

Notes

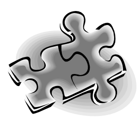
coaching: best practices

As you move on to learn more formal methods of training, it is important to remember that coaching is both science AND art. As you apply these concepts to planning, training, and finally to your own programmes, keep the following advice in mind.

Learn about your athletes—how they respond to training; what they enjoy or dislike; their history, morphology (body type); goals; psychology, emotions, character, and so on.



Learn the tools—training methods, how the energy systems work; evaluation methods for measuring fitness, teaching methods…. Keep up with recent trends in research and science, but always take a critical eye when learning. There are key principles, but there are MORE variations within those principles than constants. Never stop learning.



Apply tools to meet your athletes' needs. Avoid using tools "just because you have them". Apply tools with a purpose. Do not use tools just because someone else uses them. Track and measure how well the tools work so changes can be made if a tool is not working (assessment and evaluation).

concluding questions

It is now time to take this information on training and apply it to weekly, monthly, seasonal, and annual plans. How do you schedule energy systems over a year? How do you alternate sports, training intensities, and rest periods within a week? What differences will there be in programmes for athletes doing sprint distance triathlons and athletes aiming for Olympic distance events?

The following questions will start you thinking about how to approach long and short term planning.

1	Do you think all athletes use the same combination of energy systems in each sport in a triathlon (swim, cycle, transitions, and run)? Explain your answer.
2	What differences do you think exist between the energy systems of adults, youth and children?
3	How would you schedule training for different energy systems and fitness abilities for a novice athlete over a year-long period?
4	What individual differences might you expect to see in: a) athletes' energy systems, b) their requirements for training, and c) their adaptation to training? How will these variables affect how you schedule training over a month, a season, or a year?

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appendix A

Reference Scale for Rating of Perceived Exertion and Training Zones

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Zone	Swim Pace	Percent of Lactate Threshold Heart Rate (Bike)	Percent of Lactate Threshold Heart Rate (Run)	Rating of Perceived Exertion or RPE (Borg Scale)	Breathing and Perception Using Running as the Example	Purpose and Cross-reference of Terms Commonly Used To Describe Each Zone
1	Work on form, no clock watching.	80 and less	84 and less	6-9	Gentle rhythmic breathing. Pace is easy and relaxed. For running, intensity is a jog or trot.	Easy, Aerobic, Recovery
2	T-pace + 10 sec per 100	81-88	85-91	10-12	Breathing rate and pace increase slightly. Many notice a change with slightly deeper breathing, although still comfortable. Running pace remains comfortable and conversations possible.	Aerobic, Extensive Endurance, Aerobic Threshold Endurance *(Note: Some coaches call this region Lactate Threshold. See text for details.)*
3	T-Pace + 5 sec per 100	89-93	92-95	13-14	Aware of breathing a little harder, pace is moderate. It is more difficult to hold conversation.	Tempo, Intensive Endurance *Longer distance (2-3 x Olympic Distance) race pace for experienced athletes is typically within Zones 1 to 3*
4	T-Pace	94-99	96-99	15-16	Starting to breathe hard, pace is fast and beginning to get uncomfortable, approaching all-out one-hour run pace.	Subthreshold, Muscular Endurance, Threshold-Endurance, Anaerobic Threshold Endurance
5a	T-Pace	100-102	100-102	17	Breathing deep and forceful, many notice a second significant change in breathing pattern. Pace is all-out sustainable for one- to one-and-a-half hours. Mental focus required, moderately uncomfortable and conversation undesireable.	Lactate Threshold Endurance, Anaerobic Threshold Endurance, Superthreshold, Muscular Endurance *Olympic-distance race pace is typically Zones 4 to 5a for experienced athletes*
5b	T-Pace – 5 sec per 100	103-105	103-106	18-19	Heavy, labored breathing. Pace is noticeably challenging but sustainable for 15 to 30 minutes. Discomfort is high but manageable.	Aerobic Capacity, Speed Endurance, Anaerobic Endurance *Sprint-distance race pace is typically Zones 4-5b, with limited 5c for experienced athletes*.
5c	As Fast as Possible	106+	107+	20	Maximal exertion in breathing, pace is sprinting effort, high discomfort that is unsustainable for over one minute.	Anaerobic Capacity, Power

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