
SMARTER ATHLETES
ENERGY SYSTEMS 101
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WARNING:

It's hard to talk about energy systems without getting into sub-topics of biology and chemistry such as metabolism and cellular respiration.

There are a few biology and chemistry terms that may make their way into this presentation, but we will do our very best to keep things, for the most part, about methods and reasons for energy system training for athletes.

What are we talking about?

The bodies **energy systems** refer to the various processes that enable us to do work.

They rely on different sources of fuel (**substrates**) in order to perform properly.

The primary energy "system" at work is dependent primarily on **intensity**, and secondarily on **duration**.

What are we talking about?

The **food** we eat plays a big role in fuelling our energy systems and influences how effectively and efficiently they perform.

Of course, specific energy systems can also be **trained** in a conditioning environment.

Why are we talking about it?

Athletes who understand how their bodies obtain and use energy have a competitive advantage when it comes to:

fuelling for performance, sustained energy, and recovery;

budgeting their own energy based on volume and intensity expectations;

planning their training sessions, training weeks, and long-term training programs.


Part One.
Our Energy Systems
Part Two.
Aerobic vs. Anaerobic
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Part One.
Our Energy Systems
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Our energy systems

The body relies on three energy systems in order to perform work:

The phosphagen system: responsible for very-short maximal and sub-maximal bouts of high-intensity work...

Glycolysis: used in "all-out" bouts of exercise lasting from 30 to 120 seconds in duration...

The oxidative system: relied upon for stamina and aerobic endurance during extended bouts of exercise.

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Part Two.
Aerobic vs. Anaerobic
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Changes in contribution...

Phosphagen

Glycolysis

Oxidative

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Aerobic Systems

Our aerobic systems rely on a steady supply of oxygen in order to maintain efficient and effective function.

When a supply of oxygen remains constant for the most part, an athletes maximum volume of oxygen uptake (VO_2 MAX) is trainable.

The **oxidative system** is entirely aerobic. It provides energy during lower-intensity exercise and rest.

Anaerobic Systems

Anaerobic is derived from a greek term with a literal translation to *living without air.*

In the exercise science world, anaerobic refers to processes that occur without oxygen.

Even for the most efficiently-trained anaerobic athletes, the maximum duration of time spent relying on an energy system that is **primarily** anaerobic is approximately 2 minutes.

The **phosphagen system** is entirely anaerobic. Tasks that engage this system do not rely on Oxygen.

What about Glycolysis?

The bodies glycolytic pathways can be used in both aerobic and anaerobic capacities. Therefore, glycolysis is sub-categorized into two types.

1) **Fast** (sometimes called anaerobic) glycolysis
2) **Slow** (sometimes called aerobic) glycolysis

During fast glycolytic processes- our bodies also produce lactic acid which provides energy at a faster rate- hence the term.

The alternative, slow glycolysis requires a sufficient supply of oxygen at the cellular level.

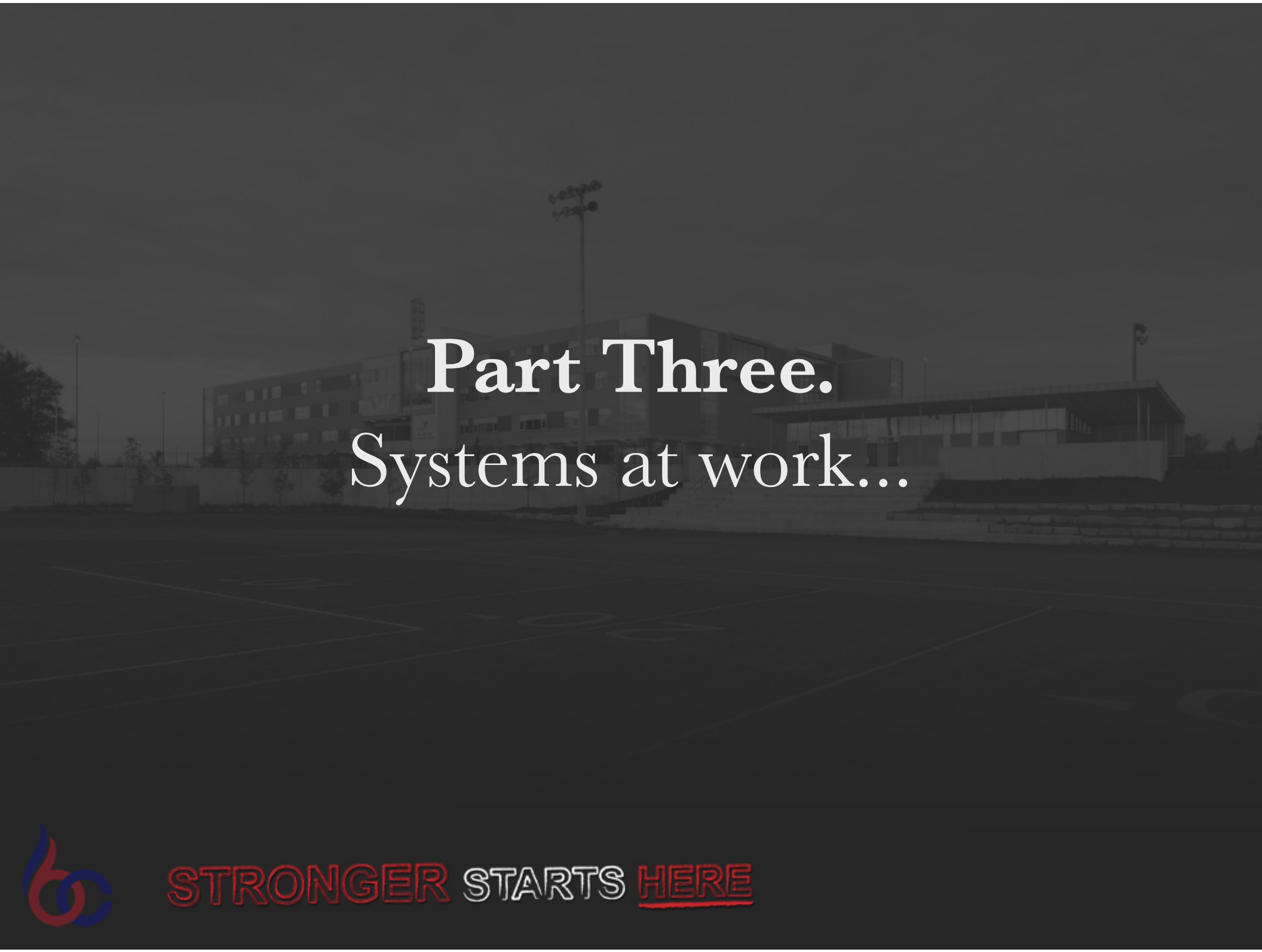
What an athlete should know:

Glycolysis is always an anaerobic process... the terms aerobic/anaerobic are not really suitable to differentiate the two categories.

Lactic acid is not the cause of sore, tired, "dead" muscle (more on this later).

The glycolytic pathway promotes muscular function at higher intensity for longer periods of time (30-120s).

Efficiently trained athletes can utilize slow glycolytic pathways while their less-efficient counter-parts are relying on fast glycolytic pathways.


Part Three.
Systems at work...
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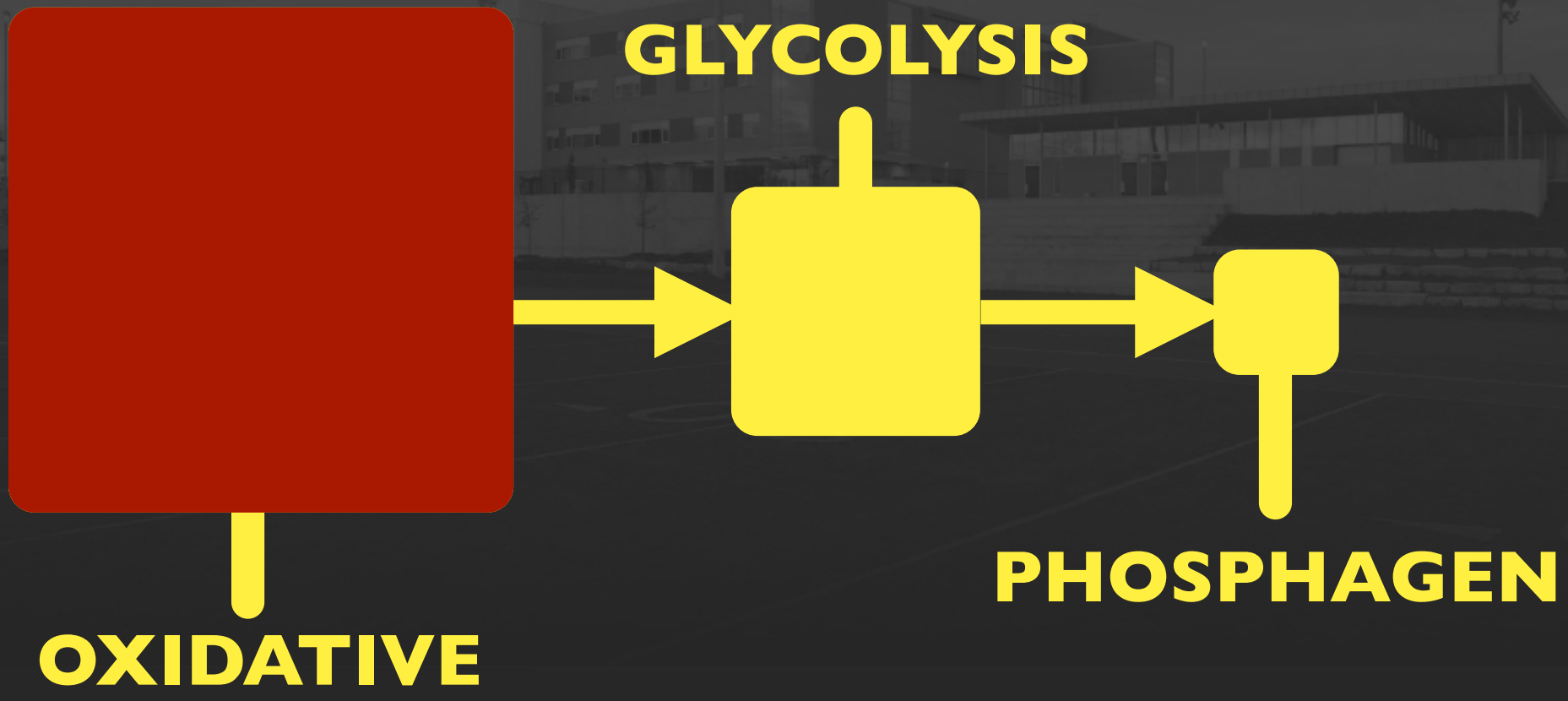
When we do work…

At any level of intensity- when our bodies are performing physical work, we are demanding output from muscle at the cellular level.

The intensity and duration of a task collectively determine which energy systems contribute to it, and in what proportion.

For a minute, let's think of our energy systems as three gas tanks- all of which, are readily available to do work- **but not necessarily in the same way.**

Three fuel tanks...



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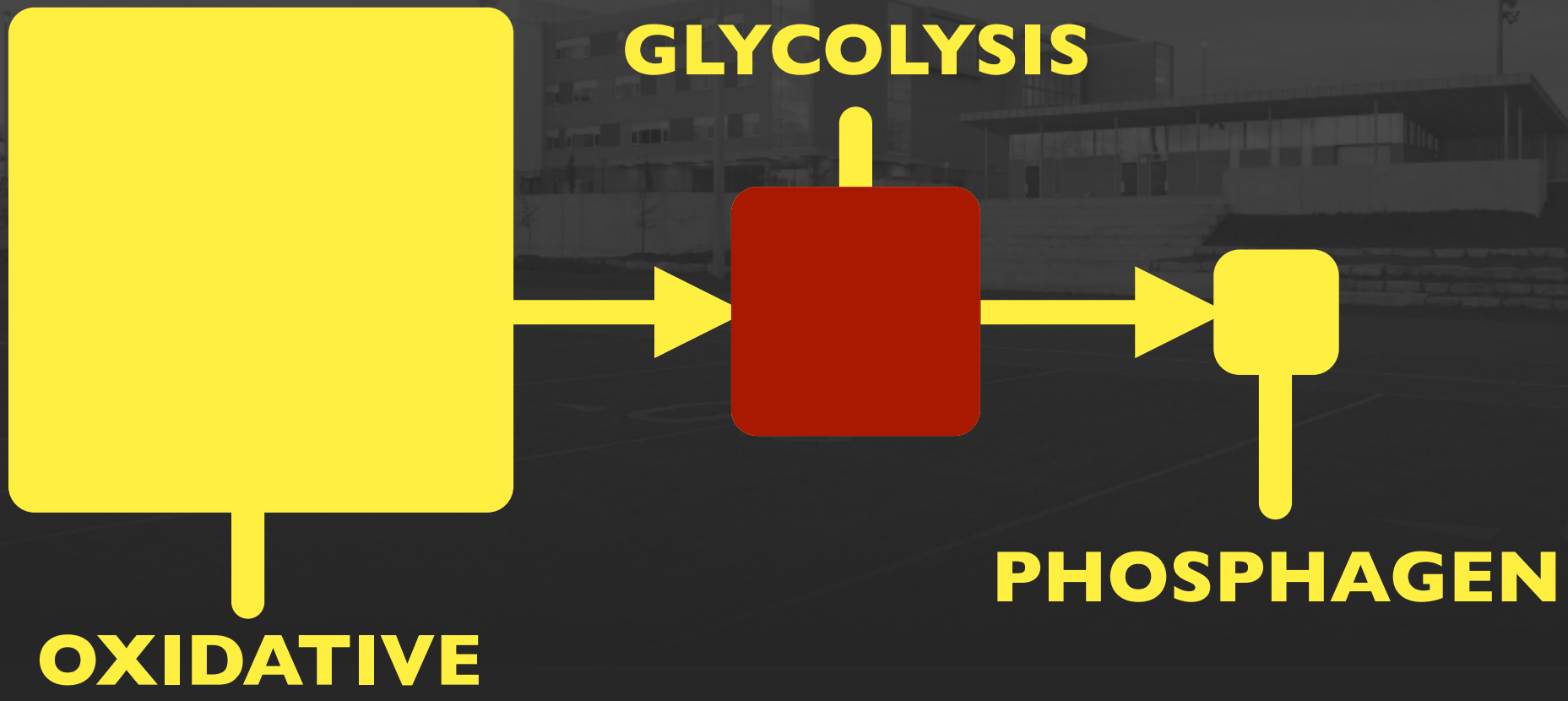
The Oxidative System

The oxidative system is the main contributor to extended bouts of mild-to-moderately intense physical activity. It is an aerobic system.

The oxidative system works as our primary energy system during any continuous, steady-state of exercise at mild-to-moderate intensity lasting more than 90-seconds.

Athletes with well-trained oxidative systems show better endurance, and can perform better by lasting longer in low-to-moderate intensity tasks.

Three fuel tanks...



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The Glycolysis System(s)

As we discussed, glycolysis occurs in two forms (fast and slow). Both processes are anaerobic (occur without oxygen), however- slow glycolysis does use an oxidative process known as the krebs cycle to produce energy, whereas fast glycolysis provides energy via lactic acid.

Although lactic acid is a bi-product of fast glycolysis- it is not the **cause** of muscular fatigue, and is actually a stimulus for improved mitochondrial density- a key factor to improved strength and capacity for hard work!

Read: Lactic acid is a good thing!

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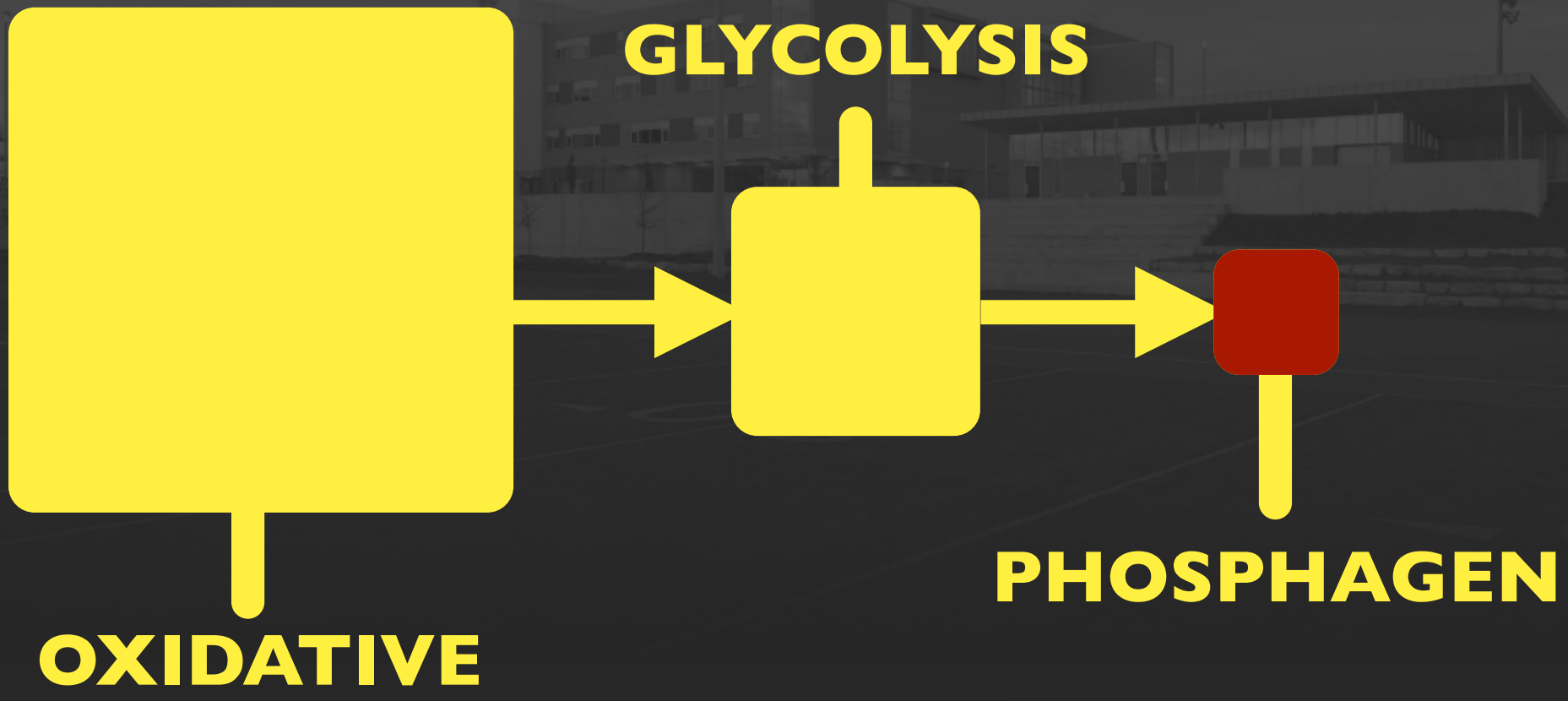
Three fuel tanks...



The Phosphagen System

We rely on the phosphagen system for ultra-short, sudden bursts of power and high-speed movement. As a primary system, it cannot last much longer than 6s- even in well-trained anaerobic/power-based athletes.

In order to fully replenish, this system requires 3-4 minutes of recovery once it is depleted.

Your phosphagen system is by-far your smallest fuel tank with respect to the volume of work that it can handle before becoming depleted, but is also by-far the most powerful and explosive contributor.

Diminishing Returns...

An athlete training at their highest capacity in any of the three systems should exhibit diminishing returns with respect to training results.

What are diminishing returns?

Diminishing returns are caused by muscular fatigue, oxygen debt, and mental fatigue.

Diminishing returns in a training session or practice can also create a training stimulus- which is most-often required in order to benefit from a training adaptation.


Part Four.
Training adaptations
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Aerobic Adaptations

When we train our aerobic (oxidative) system, we improve the capacity to do work with respect to total volume and time to fatigue.

Muscular and aerobic endurance are the foundation to many long term strength and conditioning programs and are improved through use of the oxidative system.

Because high speed movements are generally not involved in oxidative/aerobic training, the risk of injury to untrained and beginner-level athletes can be reduced.

Training the oxidative system is a gateway to improved efficiency all-around.

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Anaerobic Adaptations

When we incorporate things like high-intensity interval training into our workouts, our bodies respond positively at the cellular level by increasing the number of mitochondria that exist in our muscle fibers.

Although this also happens through aerobic processes, studies have revealed that the best response occurs when athletes train across **all energy systems!**

Read: Even the marathon runner or cross-country skier has a reason to be in the weight room. Just as the 100m sprinter should go for a nice long run every-so-often!

Speed/Power Adaptations

When we train in a high-speed, power-focused capacity we are predominantly targeting two things:

1) Muscular recruitment/activation - we want as much of the muscle we have available to actually work for us!

2) Rapid force development - we want to improve the **rate** at which we recruit that muscle.

Properly training the phosphagen system means paying attention to set, repetition, load, and rest protocol.

Read: '*too many*', '*too heavy*' and '*too often*' are real concerns training the phosphagen system.

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Efficient Systems

Athletes (especially younger ones) that are under the impression that they do not need to spend any time training one particular energy system are selling themselves short.

For the sprinter or power-based athlete, efficiency in glycolysis and the oxidative system become increasingly important in order to increase mitochondrial density and potential for increased muscular activity!

For the football player- stamina and muscular endurance are desirable traits in order to keep up with the tempo of a game while making smart decisions as the end draws closer.

Efficient Systems (cont...)

Well-rounded athletes train regularly across all energy systems in order to maintain fitness and build/improve in areas they consider to be their *weak links.*

Powerful athletes who tire too early or need frequent breaks become useless in fourth-quarter situations.

Likewise, athletes with great endurance and stamina but never leave their comfort zone in a training environment will always lack speed, power, and strength to out-do their opponents in truly meaningful competition.

Appropriate energy system training is a big part of **deliberate practice.**

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